Oral History of Human Computers: Marcelline (Marcie) Smith and Ruth Van Marter Wick

Interviewed by:
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David Alan Greer: It is June the 6th, 2005. I'm David Greer the interviewer, and with me today are Ruth Van Marter Wick and Marcie Smith. We don't need to check. We're ready to start. Ruth and Marcie worked at Ames Research Lab as human computers and our interview today is going to be about their experiences there. Marcie, would you like to start and say when you worked there and what you did?

Marcelline (Marcie) Smith: Well, I started on the 3rd of January of 1950.

Greer: Okay.

Smith: And I worked there until the 3rd of July of 1993, so it was 43 and a half years.

Greer: And what division did you work in?

Smith: Well, I always worked-- the first division was theoretical aerodynamics and it had in it an analog computer, the first analog computer that Ames had gotten. And then, there were lots of reorganizations in those years and I worked always in the major computation organization at the center.

Greer: Okay.

Smith: Until the very end.

Greer: Until you retired?

Smith: Until I retired.

Greer: Okay, and Ruth, you?

Ruth Van Marter Wick: I came to work in June of 1942 and I left in January or February of '45. At the time that I left there were still only calculating machines and slide rules to work with, so all the other equipment came after I left. So, my experience is purely with hands-on computing.

Greer: Okay. Before we started this interview, we talked a little bit about your background, so I wonder if you could just recap that here so that we have that on tape, Ruth, why don't you start?

Van Marter Wick: Well, I went to-- I grew up in Richmond, California, a very redneck community at the time, if you want to eliminate that but at any rate. And I went to UC Berkeley, graduated there in physiology.

Greer: Okay and you said you learned some mathematics because of physics.

Van Marter Wick: Yeah, in order to major in physiology you have to have a lot of physics or to do physics you have to have a lot of math, so I guess they felt that I had a strong enough math background that when I took the Civil Service examination they asked me to go to Ames and I did.

Greer: Okay. And, Marcie, you were a math major.

Smith: Yes, I was a math major and did a year of graduate work at Stanford and--

Greer: In mathematics?

Smith: In mathematics.

Greer: Okay and your undergraduate?

Smith: Was in mathematics-- oh, it's the San Francisco College for Women, an obsolete college, another obsolete college.

Greer: But it served its purpose.

Smith: It served its purpose, yes.

Greer: Okay.

Smith: And when I was at Stanford I took a statistics course and it was a fascinating course and the gentleman who taught it told about Ames Research Center at that time Goetting this analog computer and that it was a breakthrough in technology for that area because this was in 1949.

Greer: Okay.

Smith: And, so I thought that sounded like fun, so I applied to Ames and was very lucky and was hired.

Greer: Now, can you tell us a little bit about the analog computer? Did it have a name? Can you tell us who built it?

Smith: Yes, it was called the REAC, R-E-A-C, and it was because it was made by Reeves and it was the Reeves electronic analog computer.

Greer: Okay. And with it you were solving what sort of problems?

Smith: Differential equations that was all it could do. It had differentiators and integrators and components for storage, holding stuff.

Greer: Storage additionally, yes.

Smith: Yes, it wasn't called storage then. It was amplifiers.

Greer: Amplifiers.

Smith: Really to do that. And it was a huge, huge machine and you did all the settings for all like you programmed every equation and then put all the settings in and it was so big that I had a little stool I carried around so I could step up on the stool and reach the top row of the potentiometers to set them.

Greer: To set them. And--

Smith: That was hardly desk computing but that was--

Greer: It was hardly desk computer. How long did they keep that machine?

Smith: Oh, they kept that machine for about, oh I would think maybe three, maybe five years.

Greer: Okay. Through the mid-50s.

Smith: Yeah, they got their first digital computer about 18 months after so it was like middle of '51.

Greer: Okay.

Smith: And I left the analog group and went to the digital group, so I didn't stay with that but the digital, the analog part of computing at Ames was a very, very strong activity and lasted, I don't know where it is now but it was there when I left.

Greer: Okay. And you talked a little bit about the kind of problems that you solved with it. It was differential equations but it was ballistics as well.

Smith: It was mostly solving missile flight paths.

Greer: Okay.

Smith: There was a lot of activity at that point of the missile intercept.

Greer: Right.

Smith: In the aeronautical field there was-- that was one of the dominant areas at Ames Research Center.

Greer: Okay. And your initial job in working with this computer was not only to set the dials and get the differential equations set.

Smith: Well, first what they hired me for by definition was to do the desk checks.

Greer: Right.

Smith: For the engineers who were doing the programming, the equations and running of the machines and all the rest of it.

Greer: And you could explain to us what the desk checks were so we can get that.

Smith: Well they were just solutions of differential equations by numerical techniques with a desk calculator or Friden. We only had Fridens. I never got exposed to the other ones, ten digit Fridens, and that was the--

Greer: And you had worked through the differential equations.

Smith: And you didn't have to go very far because most of the output were in plots so you only had to do maybe one cycle.

Greer: Right.

Smith: And that would tell you if it was right or not, close enough to right at that point.

Greer: Close enough to right.

Smith: Yeah.

Greer: What happened when you went from analog to digital? Did your work change?

Smith: Well, yes and no. The computational problems at Ames were not only these missile type problems and not only the wind tunnel problems but there were a wide range of solutions to mathematical equations that they were using in aeronautical research.

Greer: Right.

Smith: Determining the flow around airplanes and things of this type. So, when they formed the digital group they had one group which did all the wind tunnel data processing which was done on Electrodata 200, 201 and 205 [console terminals].

Greer: Something like that, yes.

Smith: Something like that. And then they had IBM card program calculator to do everything else. Now they did do some wind tunnel reduction on the CPC [IBM Card programmed Computer/calculator] too.

Greer: Right.

Smith: But mostly I was involved in the theoretical solutions of problems, problems for theoretical applications, the calculation of flow.

Greer: Okay.

Smith: Like when they were doing the design for the swept wing aircraft.

Greer: Okay.

Smith: The mathematics for that and the numerical approach to it was to slice it.

Greer: Right.

Smith: And so we would run for weeks going slowly across.

Greer: Slice and its slicing parallel to the fuselage?

Smith: Yes.

Greer: Yes, and so you're getting a little slice and doing it across that.

Smith: Yes.

Greer: There was a gesture there we needed to record I think. Ruth, you were then involved in the wind tunnels and Marcie mentioned data reduction. Was that part of your work?

Van Marter Wick: If that was the term used, I don't know.

Greer: Okay.

Van Marter Wick: It could have been but what we did was to take all the material that came from the wind tunnels themselves and they had machines that ran figures as the tests were being performed and that was the material that we worked with.

Greer: And you described it. The data came in tapes. They would be recorded by a pen on a rotating drum.

Van Marter Wick: Yeah. It was-- the tapes came in big rolls and with just a strip of figures down the tape and that's the way it came off of the equipment in the lab, in the wind tunnels themselves. So, they would-- and it would be things, much as she was talking about where they-- there would be a model and it would be at this level and then it would be tipped and then it would be tipped and then it would be tipped and so each one of those things you had to compute the information for them, had to do with what was the drag on it at that stage? What was the lift and that sort of thing? So, that was the material that we had to work with.

Greer: Right. Tell us the story about holding the pencil.

Van Marter Wick: About what?

Greer: Holding the pencil.

Van Marter Wick: Oh, well you never-- may I?

Greer: Yes.

Van Marter Wick: You always worked with a pencil in your hand like this, never put it down because you could do this, you could write the figure, you could do this, you could write the figure like that and so you never-- if you didn't do that it was difficult for some of the young women who came to work and you were trying to train them. They would have their pencil down. They would do the thing. They would pick the pencil up. They would write it down. They would put that down. They would move the thing you see. It was very time consuming and well for one thing it lessened the burden of mind deadening activity to work with yourself to try to speed up the calculations and that sort of thing. Plus, the fact it was wartime and these were planes-- actually one of the planes that was being worked on in the tunnel, one of the tunnels at that time was the very plane that my cousin lost his life in during the war and they were working to improve this airplane and--

Greer: Do you remember which plane it was?

Van Marter Wick: It was a fighter plane. I don't remember which one it was now. So, that was the type of things. There were a couple of things that we worked on and we were told that this was-- we weren't cleared to go in and this was top, top secret. And, my husband would say to me well we're working on the mix master today so.

Greer: Whatever the mix master was.

Van Marter Wick: Was, yeah, so that was it. But from the standpoint of the type of sophisticated mathematical work that she was doing this was nothing like that. It was sort of like being at an adding machine at a bank or something, you know.

Greer: Right but you mentioned again earlier how you would sometimes in fact be scaling with numbers from the tape. You'd read it off. You'd add 50, multiply.

Van Marter Wick: Yeah, there was always a factor that you had to work with whether you-- depending on what it was you were measuring. Were you measuring lift? Were you measuring drag on the plane, that sort of thing? There was other equipment. There was a table they called a light table and some information came under there and it was so fine and tiny that you had to have this sort of a magnifying sort of table that we would have to go and read and then again you kept your pencil in your hand and read figures off of that at times. And then there was at times, not very often but at times there was actually plotting of figures to do. [Some of the engineers would trust us to do some of the plotting work they usually did themselves – Ruth Van Marter Wick.]

Greer: Right. Then you mentioned earlier again that you had a wider range of tools that you had a Burroughs calculator.

Van Marter Wick: We had a Burroughs. We had a Friden and a Marchant and the slide rule.

Greer: Were they used for the same sort of-- and a slide rule. Were they used for the same sort of problems? Did you--

Van Marter Wick: It was just-- it was the rapidity with which you could work that made the difference.

Greer: Okay.

Van Marter Wick: So, when you were-- if you were skilled enough the Burroughs of course was the old adding machine type of thing.

Greer: The one that stood on its own stand?

Van Marter Wick: Yeah-- well, no, they were all table machines.

Greer: All table machines.

Van Marter Wick: All table machines and those were the first ones they had and I think-- do you remember was it the Marchant or the Friden that was the more sophisticated? I can't remember which. I think the Friden was the--

Smith: I think so.

Van Marter Wick: Yeah.

Smith: I never would have any exposure to the other two.

Van Marter Wick: Right. I think it was the Friden and there again some of the women never really mastered working on the Friden. And so there were just a few of us using that. But when I first came it was the Burroughs. Then they got, they did get some Marchants in and then that was an improvement then.

Greer: What kind of training would you get in the computing equipment? I get a laugh here that says none.

Smith: Would you agree?

Van Marter Wick: I came and I sat down and was shown the machine and this is the way it worked and that was it.

Greer: Okay. That was the same with you?

Van Marter Wick: Yeah.

Smith: Yeah.

Van Marter Wick: Yeah.

Greer: Okay, just curious, I don't know if there was or not. You also mentioned the slide rule. Was there extra training in slide rules?

Van Marter Wick: Oh, yes.

Greer: Or was it just a more common tool that you would have <inaudible>.

Van Marter Wick: Well all the engineers of course used slide rules but we used them, a couple of us who-- I was one of the early computers there so naturally I was-- given more sophisticated work earlier on than the others and we had a certain amount of work to do sometimes and we would have to-- we'd be, you know, involved enough to use the slide rule. But, not as often as the machines.

Greer: I have two other tools I just would like to ask about, nomograms which are these graph things that you draw lines across multiple scales to get a calculation done. Neither of you are registering that one at all?

Van Marter Wick: Huh uh.

Greer: And books of mathematical functions, trig functions, log functions.

Van Marter Wick: No.

Greer: None for Ruth, yes for Marcie.

Van Marter Wick: They were all-- I'm sure the engineers had things like that.

Greer: And it would make more sense in the theoretical group too.

Van Marter Wick: Yeah.

Smith: Yeah. I'm surprised. I was just trying to think because some of those equations did involve trigonometric functions and I was thinking how you got them.

Van Marter Wick: Well--

Smith: You know table look up type things.

Van Marter Wick: Yeah. Well most of that, you see that was engineering.

Smith: That was all done ahead for that.

Greer: Okay, so that was not in your--

Smith: But in my area there was a lot of it and I think that's why they got the Fridens because one of the things you could do easily on a Friden was interpolation.

Greer: Yes.

Smith: And so we had the books.

Greer: So you'd enter the two key numbers, then you'd get your point…

Smith: I remember Fourier transforms. That was the challenge.

Greer: By hand, oh my! Do you have any sense of how big a problem you were working on with the Fourier transform?

Smith: What do you mean by big?

Greer: Big.

Smith: We had sheets, computer manual sheets with columns.

Greer: Right.

Smith: It was nothing to have them two-thirds of the length of this table.

Greer: Okay and two-thirds of the length of the table would be about five, six feet.

Smith: Yeah and you rolled them up underneath each other.

Greer: Wow.

Smith: And of course they all had headings which said you take column-- somebody had put in all the headings times column eight and the next one was-- that was column ten and then you divided it by column two and that's the way you did it. So, you didn't have to-- you didn't have to figure each line out so to speak.

Greer: Right. This was the common way of recording processes of computations at the time.

Smith: Yeah, right.

Greer: Greer: And so yours were big sheets and rolls.

Smith: Well, they were, you know, they were never much wider than this because you couldn't--

Greer: This being about eleven inches.

Smith: Twelve inches, yeah, because you couldn't handle them on the desk with the machine and the books and--

Greer: Exactly.

Smith: But they were long.

Greer: When they did these were these printed? Were these a standard printed form that people wrote in instructions by hand?

Smith: Yes, they were. I don't remember them being printed. I remember them being like mimeographed.

Greer: Yeah that was another...

Smith: Pasted. It was very primitive sir.

Greer: I understand that. I've seen depression error computing sheets. I'm trying to understand what they were like.

Smith: Yeah. And, as I remember they were-- they sort of had a standard form I think that we used.

Van Marter Wick: The things that we had did I know.

Smith: Yeah.

Van Marter Wick: That we had to work with.

Smith: That was sort of the way it was laid out.

Greer: Okay.

Smith: So, any problem you sort of knew what it was going to look like.

Greer: And they were done probably with the mimeograph stencil.

Smith: Right.

Greer: The A.B. Dick stencils.

Smith: Yes and put together.

Greer: Okay.

Smith: But those Fourier transforms were God awful and the best part, you know, you could always mix up the-- I hadn't thought about this for thousands of years, you could always mix up the F transform and the E transform and T transform. I don't remember what they were.

Greer: I know what you're saying yes.

Smith: But I knew what they were then and you'd get the wrong column because you had this book. It was horrible. That's why electronic computing even if it was slow as Christmas was a big boom because you didn't have to do all this manual stuff.

Greer: Right. You've both hinted at this. I'd like to sort of talk about the two things boredom and Marcie just a minute ago we were talking about the fear of making a mistake of, you know, flipping a number and having all this work go to pieces. What sort of feelings did you have during the work of it? Was it that boring? When you got down to a problem was it? Your face is just saying a million words right now. You should never play poker.

Smith: I don't.

Greer: Good.

Smith: I worked 43 years, David, and I really never had a boring day.

Greer: Good.

Smith: It was never boring.

Greer: Okay.

Smith: Now, there were days when you wished that you could erase the previous three days.

Greer: That's good and why was that?

Smith: Well, if you made a mistake and you spent three days Goetting this answer and it wasn't right then that was pretty much a waste of time and you also had an engineer sitting at the end of the room who was not radiant.

Greer: Not radiant, not necessarily radiating warmth, not pleased.

Smith: No, no, not pleased.

Greer: Not pleased.

Smith: One of my favorite sort of stories if we can interrupt a bit.

Greer: Sure, please.

Smith: I worked for this gentleman, Harv Lomax.

Van Marter Wick: Oh, yes.

Greer: Who is who?

Smith: His name is Harvard Lomax, was Harvard Lomax and I was also in a ride group with him and he was a perfectionist and able to do anything and he did often his own computing sheets. And this day-- and I was in digital computing by then and I would say, "Harvard, Harvard, Harvard, Harvard" and he wouldn't have anything to do with it. And so he got in the car one night and he was in a grouchy mood and I said "What happened?" He said, "I've spent two days on this formula and got it all calculated and I made a mistake setting it up." And, I said well if you're using the computer that would be nothing. You just throw that answer in the thing and we'll redo it.

Greer: Yeah.

Smith: So, we talked a little bit and the next morning when I drove to let him off, he said "I want to go to your office," so he came to my office and he had-- he always took home a briefcase and he pulled out his equation and he gave it to me and since I was running the facility by then I said "Here give it to me" so I programmed it. It was just one equation and in Fortran you bang it out and then I pulled rank and got it, so it was the next job on the machine and ran it. And gave it to him like almost less time than we're talking about it because it was very simple. But it did have things like Fourier transforms and stuff in it. And he took it from me and he said "That's not the right answer" and I said, "Well, let's look at it" and I had plus sign or minus or vice versa. So, I said "Well look here. Give it back to me and I changed it and put it back in and gave him his answer. This all happened in like a half hour.

Greer: Okay.

Smith: And he said "Give me the manual so I can learn that" and from then on he became a star in the mathematics for computation, just a genius. He was a genius to start with and he just enhanced it.

Greer: In a sense pulled the frustration out of him.

Smith: Yeah and it also gave him a level of confidence that he never had before because mistakes could be made.

Greer: Okay.

Van Marter Wick: And not have to worry about it.

Greer: Not worry about it. Ruth, you talked a little bit about one of the reasons you quit is that you sort of had enough of the work.

Van Marter Wick: Well, yeah, I didn't have any intention of going on with it.

Greer: Okay.

Van Marter Wick: It wasn't anything that-- you know we had nothing that was as interesting as she's talking about and none of us actually saw that in the future either. I might have stayed on if it had been that but by that time I had a family so I didn't.

Greer: How many people worked in your office? How many computers?

Van Marter Wick: When I first came there I don't think there were more than eight or nine of us. By the time I left they were desperate for help and I think they maybe had about 20 computers all told. Well, it would have been more than that throughout the field because by that time there were three operating tunnels and they each had their computing sections, so there may have been as many as 40 all told, yeah.

Greer: Okay.

Smith: I was going to say those computer departments for the tunnels were all between ten and 15 women.

Van Marter Wick: Yeah, yeah.

Smith: For height.

Van Marter Wick: Yeah.

Greer: Right and having researched the people at Langley, which I assume is a similar of facility.

Van Marter Wick: Yes.

Greer: They were typically 12.

Van Marter Wick: Yeah. There were-- some of the people that-- most of the people out here came from Langley originally that opened up this laboratory came from Langley. [This was not true of those who came after World War II. – Van Marter Wick note].

Greer: Okay, I didn't realize that.

Van Marter Wick: Yeah, uh-huh. No, it was-- it made it more interesting as I told you because some of the engineers were willing to or even suggested that we go down and see the experiments and see what was going on so we could understand what it was we were working on and that made it much more interesting.

Greer: So, they took you down to the tunnels.

Van Marter Wick: We went down actually into the tunnel to see the stuff going on and all if it was something that wasn't too classified.

Greer: Well we hit classified again. You both dealt with work that touched on classified issues I would assume. Ruth, you said so. Marcie is it true for you?

Smith: Yes, yes.

Greer: And neither of you had security clearances or Marcie did you have a clearance?

Smith: I had a security clearance.

Greer: You did have a security clearance. So that you could see in effect what the problems were and what was going on?

Smith: Yeah.

Greer: Were there others that worked with you who did not?

Smith: Well I'm sure like the keypunch operators, the lower level people didn't but if you were responsible for the answers you produced you generally had a secret clearance.

Greer: I'm asking questions of some of the other wartime groups. They basically gave the equations without units without trying to explain what the physics, whatever they represented.

Van Marter Wick: Right, yeah.

Greer: To get around the classified problem.

Van Marter Wick: Yeah, well I think that was the point. My husband had, well you know, classification that he could go to Russia during the times when they had to travel with somebody, another American always with them, you know, that sort of thing, so he had that kind of. The only kind of classification we had were the kind that you had to have to get on and off the base.

Greer: Okay, I just was curious to see if they did. Could we also get back to sort of the calculations and checking for errors. Marcie, you talked about the engineer or the person who did calculation could recognize the results were bad. How did people look at results to check and see if they were good or check for errors? Was there anything special they did?

Smith: Well, I guess they had-- that's a tough question to answer because you were always on the receiving end of the wrong answer and not part of the solution, the solution of Goetting there. A lot of the material we worked on there had been simpler solutions, simpler problems solved.

Greer: Right.

Smith: So--

Greer: Differential equations with fewer terms basically.

Smith: Yes or when you got into the more advanced mathematics you knew what the responses, what the answers should be.

Greer: Right, looked like.

Smith: Looked like, so there was lots of times you'd run a test case which was a case that you knew the answer for to ensure that the answers were right but that didn't prevent you from making a massive mistake or something that was really dumb.

Greer: Right, I just, I know there were techniques for differential equations known as differencing that was often used.

Smith: Yeah.

Greer: Also Fourier transforms which is in effect a matrix operation. You had certain checks that could tell you if you had gone astray.

Smith: Yeah. Well, and of course--

Greer: And then you'd have to back up and figure out where you had gone astray.

Smith: Well, I think as you moved into machine computation which, you know, was what a lot of the staff of computers that were at Ames, the human computer, moved into that these, I think all of you women had a tremendous sense of what the answer ought to look like and they had done enough and they knew the dimensions and the magnitudes of many of these variables, so they could look at it almost and tell you what's wrong.

Greer: Okay.

Smith: And same way with some of the engineers that they would be able to-- they'd say well I'd ran this case the other day and it didn't look like that.

Greer: What level of accuracy are we talking about, were we just needing two decimal digits? Were we needing seven, 15?

Smith: Well everything I ever did was in ten decimal digits.

Van Marter Wick: Something like that.

Smith: Yeah.

Greer: Okay. Yeah, we want to make that clear because many people looking at this will know, ah yes, Fortran's loading point.

Smith: Yeah, well no this was not what I mean.

Greer: That's not what you mean.

Smith: But most of that calculation I think they did in the department I was in was ten digits plus.

Greer: About ten digits plus, which is quite substantial. Now you made the transition into electronic computers and you became a programmer? Or, was your job sort of--

Smith: I was still a computer.

Greer: I know that you need to explain this for the tape too. Really the only title they could give you was that of computer even though you were perhaps entitled to a professional title.

Smith: Right.

Greer: Yes.

Smith: That was true for all the-- I mean it wasn't just I. That was true for all the women and all the people who came into that group. The first thing that they did was teach us to program. They did a little bit of teaching there, teaching us to program these computers and--

Greer: And this would be like the Electrodata 200.

Smith: And the card program calculator. We had people who wired boards and one of the things that we taught each other was how to wire a board.

Greer: Right.

Smith: Because you had all the-- I mean it wasn't like you just had the calculator. You had all these punch card units.

Greer: Yeah, the Card Program Calculator [CPC] was a very complicated thing to program.

Smith: Yeah.

Greer: Did you learn how to do that from other people? In particular there was a man at UCLA who is well known as a board wirer. Did he come up here? His name was Everett Yowell, Y-O-W-E-L-L.

Smith: No, I don't think so.

Greer: Okay, just was wondering.

Smith: Yeah, I don't remember. We had a lot of IBM staff, you know, the old IBM system engineers that came and they provided. We always had at least one or sometimes two and same way with Electrodata people who were located with us full time.

Greer: Okay.

Smith: And, of course, they had had a lot of training and they had a lot of resources that they could go back to if you got stuck. But that's where it started.

Greer: That was about it for training.

Smith: Yeah and then the other thing that people like Ruth has talked to like Carol Mead for example, I can remember Carol coming over and they had-- we still had all these tapes off the machine and the tongues weren't instrumented except to produce the tapes.

Greer: The tapes, which was basically the measuring device was connected directly to a pen and the tape, yeah.

Smith: Right. And so all that data had to be keypunched in.

Greer: Onto cards.

Smith: Onto cards as the input data to these sheets. Now you got to remember that all these ladies who had been working all this they thought well at least this is one step forward but they sure weren't very happy, so that's one of the reasons we were so-- it was so easy to pick up these computer-- these human computers and train them because they-- it just opened a whole batch of excitement.

Greer: Now you've mentioned Langley and there were some connections with Langley and the work done there. Did you have connections with or knowledge of any other computing organization or get ideas from them or know of people who were computers at other offices whether in the NACA and you got the acronym right and I forgot it, National Advisory Committee on Aeronautics.

Smith: Aeronautics.

Greer: Or in some other organization?

Smith: I don't know. You'd have to answer that question.

Van Marter Wick: We had no contact with Langley. I think the setup for the situation was certain laboratories worked on certain problems or certain aircraft or whatever. In my day it was all aircraft.

Greer: Right.

Van Marter Wick: After that it was missiles and it was space and everything else but nothing but aircraft when I was there. And they would sometimes have conferences at the different centers that the engineers would go to but we had no contact with people from other laboratories.

Greer: Okay. Now during your time, June '42 to '45, it would have been the Office of Scientific Research and Development or their division called the Applied Math Panel that had computing organizations that you might have seen.

Van Marter Wick: No.

Greer: That doesn't ring a bell?

Van Marter Wick: No.

Smith: The Department of Energy or AEC also.

Greer: Yes, right.

Smith: Because I was talking to a friend telling her I was going to do this and she was one of those computers at White Sands.

Greer: Okay.

Smith: So we were highly private.

Greer: Now there was a magazine that started, a journal that started in June, July, January '43 called Math Tables and Other Aids to Computation does that sound familiar to either of you? I'm Goetting shaking heads.

Van Marter Wick: No.

Greer: Okay, I'm just looking. And then in the early '60s, Marcie, you might have seen this, a book that was entitled the Handbook of Mathematical Functions.

Smith: Yeah.

Greer: You're familiar with that?

Smith: Yeah that I'm familiar with.

Greer: Okay. You may not be familiar but the lead editor was a woman named Irene Stegun who got her start--

Smith: Irene what?

Greer: Irene Stegun, S-T-E-G-U-N. There were two editors.

Smith: Yes, I remember.

Greer: Abramovitz and Stegun.

Smith: Yeah.

Greer: Abramovitz died very early and Irene Stegun finished it. She got her start as a human computer in the 1930s.

Smith: A lot of people.

Greer: A lot of people did but that would have been familiar to you?

Smith: Yeah, that was familiar because, you know, it wasn't too long. I remember. You see I have a passion about Fourier transforms.

Greer: You have a passion. I'm trying to get to it.

Smith: Fourier transforms but I remember that my boss who was a brilliant mathematician--

Greer: And who was this boss?

Smith: William Mersman, M-E-R-S-M-A-N.

Greer: Okay.

Smith: He was very, very good and since all the theoretical stuff involved in these Fourier transforms. He got the equations so we could run them on this CPC and we ran around the clock, especially second and third shifts producing these tables of Fourier transforms.

Greer: Right.

Smith: And we had so many of them that we had file cabinets, lining the length of the hall in our office building.

Greer: Of different Fourier transforms.

Smith: Of the Fourier transforms for all these different values and stuff.

Greer: Different functions that you were looking at.

Smith: And then when you needed one you would go get, you know, we started to have, I don't know how we knew all this. We were smart. But you'd go get the stack that was going to have the Fourier transform that you more or less needed and you'd put that into the computer and it would be the same, the 407 would feed it and then do the interpolation it needed and that's how you got them in.

Greer: Okay, I'm all of a sudden focusing on this in a way I didn't. The stack is a deck of cards.

Smith: Right.

Greer: Right and it's a Fourier transform of a certain size and scale.

Smith: Yeah.

Greer: To be applied against a function of that same-- of the scale that you need.

Smith: Yeah.

Greer: So, okay, that makes sense.

Smith: No, you think that's funny to think you'd sit and grind out billions, not billions but thousands of cards holding nothing but Fourier transforms.

Greer: But if you-- it sort of would simplify calculations later if you could do it ahead.

Smith: And made them all faster.

Greer: I think we need to stop now don't we? Well, we're going to stop now. <Audio gap> of Ruth Wick and Marcie Smith and we were just talking about how computers in particular electronic computers made things simpler and during the interim, Marcie, if you could give us a quick summary of what you had said.

Smith: Well, everybody who was involved in desk computing, engineers who got the results and people who were doing it, whether it was theoretical or for the wind tunnels, the amazing thing was the reduction in time to accomplish what your target was, so we read a lot about technology being not so well accepted because it impinges on what people were doing and how it takes away that security. But I never saw any of that at Ames because all the stuff that was bottlenecking the research efforts and, of course, this was a research lab so you have to keep that in mind.

Greer: Right.

Smith: All the stuff that was bottlenecking the research lab just got squished with the improvements in technology and that went on from the day it started when I was first exposed to it.

Greer: Right because you went analog and then CPC I assume and Electrodata.

Smith: And the 650 we had.

Greer: And the 650. What comes after the 650?

Smith: The 7040.

Greer: Okay.

Smith: 7090.

Greer: Okay.

Smith: Then we had one of those famous direct coupled systems that IBM put where they saw the bottleneck of printing so they put the 7040 in front of the 7090 and the 90 did the computation and the 40 did the bookkeeping.

Greer: The 360?

Smith: Then after the 90 did we have a 360? I don't think we-- I think we went to the Cray. We must have had--

Greer: Control Data 6400?

Smith: No. We did have one of those somewhere in there, yeah. But then we went to the Cray-1.

Greer: That would have been '75, '76.

Smith: Yeah, '75, yeah. I made a time history of those and I think that's about when I figured. I didn't go back and look it all up. But then Cray and then we had multiple Crays.

Greer: Multiple Crays of various flavors and varieties.

Smith: Right and hooked together in different ways and so forth but, you know, it was just a constant, constant challenge to get what you were-- and then by, you know, somewhere along the line then everybody said well it's not only that we can do what we're doing faster and make better progress in the research. It was well now we can refine what we're doing and now you went from so many mesh points to so many more points.

Greer: With a Cray and you need to help me on this one, I remember that that was, that people were thinking of using that as a numerical wind tunnel that you would actually do the flow calculations on that.

Smith: Yes, they did.

Greer: Were you doing it before that?

Smith: Oh, yeah. They were doing it in this theoretical aerodynamics activity that I was...

Greer: So basically everything was--

Smith: So we did a lot of those on some of those primitive machines.

Greer: You're making a face now. It would suggest it didn't work so well.

Smith: Well, no, I was thinking about, I was thinking about whether you'd know there was something in the design of the swept wing. There was something called area rule where you had to compute the area.

Greer: And the swept wing is the design of the swept wing particularly fighter initially.

Smith: Yeah.

Greer: But it has impacted every other aircraft. And this was done I believe like '52 to '54 or early part of the '50s.

Smith: Yeah, the early part of the '50s, right.

Greer: Okay.

Smith: And that was done, the concept of that was R.T. Jones.

Van Marter Wick: Right, right.

Smith: Who was a man, he was an engineer at Ames. What we did area rule and you talk about being bored we did area rule calculations on the CPC and the only thing you had to do was pick up this deck of cards. It was bigger than my hand but if we had male operators it was okay. Pick that batch of cards up and put them back into the hopper and put them through again and that stepped it along the points this was until it got a point and then it would take a new step down and that was all you'd do and you'd do that for 12 hours.

Greer: So, you'd have an operator who would read through the cards. You take them out of the hopper at the end. You stack them up and put them in the start and push the button again and that's what you did.

Smith: Well, we were smarter than that. They never let us stop. Of course it was sometimes hard to get to lunch and it wasn't a very big deck. I can remember.

Greer: Okay. It would seem that you would want to print a couple multiple copies so that you could just--

Smith: Well maybe I-- you may be absolutely right. Maybe the deck was only that big and we ran six at a time but I'm sorry. I don't remember those details.

Greer: No, but it's an interesting issue about how a machine is used to get a problem done.

Smith: Yeah.

Greer: I wonder if we could go back to and if you could talk, if you could just conjure up what a typical day was like. How did you start? What problems did you work on? How many tapes did you do? Did you get a break?

Van Marter Wick: Did we get a break? Yeah, we had lunch.

Greer: You had lunch.

Van Marter Wick: Half hour I think, yeah.

Greer: You'd come in in the morning.

Van Marter Wick: In the morning, well sometimes in the morning, sometimes I worked all three shifts.

Greer: Not at once.

Van Marter Wick: Huh?

Greer: Not at once.

Van Marter Wick: Not at once.

Greer: No, but there were three shifts running there?

Van Marter Wick: There were three shifts running and then once I was married my husband and I always worked different shifts. That was very well planned but anyhow it depended. At that time, it really didn't make much difference. The shifts were just about as busy whatever shift it was. It was just the routine of going through the tapes and doing the calculations. She was talking about the improvement in time it took, if you take the improvement that we felt when I first came to work, we had a Burroughs machine. That was it. We went to a Marchant, which was again an improvement. You'd get out maybe in a half an hour what we did in an hour and then when we got to the Marchant, this was just heaven because we were zipping through the tape.

Greer: I think the Friden.

Van Marter Wick: The Friden I mean.

Greer: Yes.

Van Marter Wick: Because you could just zip through the tapes and that did help a great deal. I think later on for many of the women who came and got stuck doing just the same thing day in and day out, I had the responsibility of training people and that sort of thing, so that did break up the monotony of just working with the machines but it was pretty much that. There was the difference out there I think that might have been different. I'm sure maybe you felt this even by the time you got there. There was a strong sense of camaraderie between the engineers and the computers. There weren't very many of the engineers who are typical of what a lot of men were. Excuse my saying this but I think it was very true. Women were secretaries and women were helpers and the men were, you know, the stars.

Greer: Right.

Van Marter Wick: Well, there was not so much of that at Ames. Everybody kind of worked together and that made working there comfortable for one thing. But it didn't really-- I think for the girls who came, young women who came later on they had a really very boring job because they were really piling on the work as the war went on and they sat all day just doing these tapes with no break. They'd explain to us what the job was and what we were actually doing, what the airplane was, if it was possible to go that far. That made it more interesting. It really did and we knew when a project came and when it ended. For some of the girls they just got tapes and frankly many of them didn't care. They just wanted to get through the day and that was it, you know. So, it depended on the individual I think how interesting, as it does in any field in any work how much you put into it what you got out of it. But it was not the interest that the engineers had I assure you.

Greer: Understand. Were there any discipline problems? Did people sometimes balk at the work or stop or want to go slower or faster?

Van Marter Wick: Oh, there was of course the problem of some people being inadequate and, you know, you would have to try to hurry them up and things like that. Some of the engineers would be unpleasant if there was an error made but, as she said, you learned after a time. You could tell these answers are not what they should be and you were able to figure that out for yourself and go back and check. But all the computers' work as it went on it was checked by a head computer before it went to the engineer.

Greer: Who was the head computer?

Van Marter Wick: Huh?

Greer: Who was the head computer?

Van Marter Wick: When I first went out there the head computer was Barbara Goett [ph?], Harry Goett's wife. He was head of the 7x10 foot wind tunnel and then when she left a girl called Mary Hartman who is

still alive but unfortunately has Alzheimer's. [“After Mary Hartman left Ames, I was head computer until I left”. Ruth Van Marter Wick].

Greer: Oh, bless her heart.

Van Marter Wick: And Barbara I don't think--

Smith: Oh, she died not very long ago.

Van Marter Wick: Huh?

Smith: Barbara died just oh a couple weeks, a month ago.

Van Marter Wick: A month ago and Harry died a couple of years ago.

Smith: Yeah.

Greer: Okay.

Van Marter Wick: Yeah, so--

Greer: And what was the difference between the head computers and the rest of you?

Van Marter Wick: Just that they were the ones that assigned the work. When the work came in from an engineer the head computer would say give it to so and so or give it to so and so.

Greer: Give it to you and then there you go.

Van Marter Wick: Yeah.

Greer: Did they have special expertise or was it just more of a management?

Van Marter Wick: It was, I think it was, if it was just-- some of the things were a little more involved than others and I think that there were computers who were considered very good and they were given the more difficult jobs to do and it's just the very routine lift, drudge tapes went to some of the others you know. It was a bit varied and the interest was in what you were working on if possible.

Greer: Just to probe this just a little bit further you had a staff of computers, a head computer who sort of handed out the work and had perhaps more experience than the others.

Van Marter Wick: Uh huh.

Greer: Working there and that person reported to the engineer who was in charge of the wind tunnel?

Van Marter Wick: Yeah.

Greer: Or the individual who was in charge of the wind tunnel?

Van Marter Wick: The wind tunnel, yeah.

Greer: So it was considered a computing force associated with the wind tunnel?

Van Marter Wick: Right, yeah. Each wind tunnel had its own at that time. Later on they had a central computing staff I think.

Smith: But they never did--

Van Marter Wick: Did they always have that?

Smith: They always had them attached to some unit, I mean to a branch, yeah.

Van Marter Wick: Because I know that they did have a central, yeah. But each branch had its own computing staff.

Greer: Okay. And that was part of it, whereas Marcie you were not exactly part of a computing staff. You were sort of almost on a, as you said—

Smith: Yeah, I was almost a jack of all trades for a while.

Greer: Yes.

Smith: And then when we went into digital computing and it took off then they formed the digital computing organization. Well they split the two so there was an analog department and a digital department. And then we worked, one of my functions in life was to help build that organization and then

we worked to pick, bring in these women who were out there as computers and that's how Ames built its programming staff.

Greer: Okay. That's interesting because I've not seen large groups of computers that became programmers but that was true at Ames.

Smith: Yes, I would say--

Van Marter Wick: That was, Ruth was.

Smith: Ruth, Jessie, Yvonne.

Van Marter Wick: Enid.

Greer: Could you give us the full names so in case the people come across other information on them, Nat?

Smith: Let's see, Nat James, Natalie James, you'll have to help me, Jessie Gaspar, Julie Stephenson, Ruth Mosman, oh there were more than that, Yvonne Shaefer [ph?]. Oh, I'm sure there were--

Greer: More but every name we get is good.

Smith: Yeah.

Greer: Every name is important.

Smith: Because those departments essentially once they put in these systems they almost phased out because the need wasn't there.

Greer: Of course.

Smith: The other place these people went in some cases was into operations functions, not programming but into operations.

Greer: Operations meaning the management of the….

Smith: No, of the operating of the machines.

Greer: Oh, okay.

Smith: And became computer operators.

Greer: Okay.

Smith: And I mean people like Janet Conrath [ph?] and, oh, I can't think of some of those people. That's one of the heads up I needed.

Greer: Yes. If others come to mind but this would be things like taking card decks, scheduling jobs.

Smith: Yeah and of course mounting tapes was a full time operation.

Greer: Yes.

Van Marter Wick: Ruth Mosman is an interesting one because she left Ames after I did. I don't remember when she left. Her husband went to one of the other aircraft factories. She became quite a computer specialist. I've forgotten whether it was IBM she went to work for or what. She was out setting up people's computer labs and everything.

Smith: Yeah.

Greer: We have a listing of her as Ruth Kistler Mosman?

Van Marter Wick: Right.

Greer: And she's now living in Denver.

Van Marter Wick: Yeah, she is, yeah.

Smith: She was with Martin at first. Didn't he go back to Denver to go to Martin? I thought she was there too.

Van Marter Wick: Well they went first down to Convair down in San Diego and then he went to Martin Denver, Martin Marietta, Denver, yeah.

Smith: Yeah, but she was another one that was-- there were a lot of them. That's the way we built the staff. And we had a problem because some of the people didn't want to work in the computational organization. They wanted to stay with where they were. So, then it became a question. They became the familiar word open shop programmers and it was the question of how, I mean there was no shortage of work because the engineers have all these ideas and they kept them more than busy but it was setting standards so you could run a centralized facility because not everybody had run something before.

Greer: Right, okay, not at that point. As you talk about these facilities and the things you've done do any incidents or events come to mind, special projects that were done, problems that were solved through great effort and energy, skill on the part of the people? You're laughing.

Smith: I'm laughing.

Greer: There would have to be a half dozen good stories behind that.

Smith: Oh, well there are lots of good stories. I mean one of the things that we did, which we never were able to perfect well enough was when we had the 709 we connected it to the analog system which was halfway across the field.

Greer: Okay.

Smith: And then we used, they transmitted through hard wire the data at some point in the analog operation across to our system and they could take control of it at the time they needed it and they would stop everything, dump everything, get the tapes lined up for them and then they would run for maybe three or four minutes or more.

Greer: Right.

Smith: And we'd ship it all back and we'd go back to where we were and we tried to do that and were pretty successful invisibly to the users.

Greer: They just didn't know and in some sense that's the goal.

Smith: That's right. That was the target. It didn't work very well as well as it might have because it took an awful lot of trust and the timing would always, it was always a little critical because we asked a little bit to know in advance not what minute they were going to do that but what time because we had to have, we had 27 tapes or some ungodly number on our 709. And we had a-- another thing we did that was sort of interesting we had a satellite 1401. This was for this Harvard Lomax that I told you.

Greer: Right. Right.

Smith: And he got his own 1401. He's the only person I knew at Ames who got his own machine. And he had priority when he wanted to run he could interrupt what was ever on, run his job and we'd send it back to him and nobody ever knew it. And we did that seamlessly and that was back in the '61, '64, somewhere in there. And then we put on satellite.

Greer: With nothing of an operating system really to mention to do that with.

Smith: No, nothing really and we did it with 1440s when we had the direct coupled system. We had four satellite ones located remotely from the facility and we were-- we got to be really good at that.

Greer: You're smiling. You clearly are quite proud that you got to be very good at that.

Smith: Well, I guess the thing I think that was really most interesting was you were breaking ground for everything, being able to interrupt things and restore it was-- now is trivial.

Greer: But then it was not.

Smith: It wasn't and you didn't know how to do it and so we talked about sharing. Once we got into digital computing then we did a lot of sharing and we worked with IBM and their activities and we were the first people in the country to do that.

Greer: And I'd like to just sort of switch just there's an enthusiasm and a love for seeing this whole thing advance through your career. Ruth, you had started before this happened and you saw the stuff that Marcie worked on unfold before you. Did you think about it? Did you follow it with interest? Did you have other things in your life that took away from it?

Van Marter Wick: Well, I had a lot of other things in my life.

Greer: You had a family. You certainly did, yes.

Van Marter Wick: Family, volunteer work and all that sort of stuff but well because my husband finished his career at Ames.

Smith: See he was one of our customers.

Van Marter Wick: Huh?

Greer: Oh.

Smith: Her husband was one of our customers.

Greer: I didn't make that connection, ah, now I know, okay.

Van Marter Wick: He was head of the aeronautics division at Ames and--

Greer: Oh, of course and then you would be doing the theoretical studies that his group needed.

Van Marter Wick: And probably before that during the space age he was a space engineer then for a while.

Smith: Right, right.

Van Marter Wick: But he wanted to get back into aeronautics and the other thing.

Smith: A lot of the people. Ames I think and I think Ruth touched on it in a different way. Ames was a wonderful place to work, first of all because there was a lot of freedom. It wasn't terribly constrained. We talked about breaks. Yeah, we had breaks and we had lunches and it was disciplined but it wasn't. And there were so many bright people. It was like being in this environment in which you couldn't possibly absorb what was going on.

Van Marter Wick: Yeah.

Smith: You just had to pick and choose.

Van Marter Wick: It was very much that way.

Greer: Go ahead.

Van Marter Wick: Well, I think too you talk about the very bright people, I think that they were very bright people but it was different. I've been in other situations. I worked for a while at Stanford with the Physicians for Social Responsibility as a volunteer for years and got into the-- exposed a lot to the medical profession and I don't mean to put the medical profession down but I didn't have any sense that the people working in Stanford Medical Center had that same sense of being treated as equals as it was out at Ames. It seems like everybody was considered important. Everybody had a role to play and except for very few incidences, there were a couple of engineers that I could have done without but--

Smith: Oh, yeah.

<overlapping conversation>

Greer: We won't name those on the tape. When I now think of Ames as some middle of this area, their houses, their shopping centers around it, I assume when Ruth when you came out here it was fairly--

Van Marter Wick: It was Santa Clara Valley. It was not Silicon Valley and there were cherry trees and there were apricot trees.

Smith: And [Highway] 101 had two lanes, maybe four, four lanes with no freeway.

Greer: No freeway.

Van Marter Wick: Where was that?

Smith: 101 had two lanes or maybe four.

Van Marter Wick: Oh, no 101 was-- no, 101 had two lanes each direction.

Smith: Okay, all right.

Van Marter Wick: Bloody Bayshore it was called.

Smith: Okay but no freeway, no freeway.

Greer: But were in effect a small community with that focus of the air base and the research and that.

Van Marter Wick: Yeah, really. Mountain View was a very small town. Los Altos was a train stop. Actually there was a train that went through there then when we moved out there. It's gone now and it's now got-- that's where the expressway in Los Altos is. It was a very small community.

Smith: I want to reinforce your point about the people being so, all the same, treating everybody the same because I stayed long enough to have to fight and I didn't fight but I had to go through the ladder. And, people talked about, have talked to me about discrimination and how bad it was and how difficult it was. And, I always felt like I was really lucky because as I said a couple times today I went to work as a computer to do desk checking and there were four guys and the office we had was no bigger than this except for the machine.

Greer: Right.

Smith: It was a small office with four people sitting at one table, no desks.

Greer: Right.

Smith: A table like this. So we were really on top of each other but the thing, those men didn't have me in that job more than a month before they were saying, well here Marcie you can program that. And, it wasn't six months until they were treating me equal.

Greer: And it was a question of could you do the work?

Smith: Could I do the work?

Greer: If you could do the work and then you were one of them.

Smith: Uh huh. Yeah and the thing I always said was part of it was because they all knew that they were in control so you never threatened them. They could promote you. They could reward you. They could do all these things because you were never going to get that one job that they were competing for because you weren't going to make that and that was very interesting. But I never felt discrimination.

Greer: It's interesting. It's both restricting and very freeing at the same time.

Smith: Well, yeah.

Greer: Because they didn't have to worry about you.

Smith: Yeah, and I didn't have to worry. I didn't think about it even and I went to a woman's college and I wasn't exposed to this putting down. I thought a woman could do anything, these women like teachers or presidents they were great so I could--

Van Marter Wick: I didn't have that experience. I went to Berkeley.

Smith: So, I really felt like they're not-- they're just my best friends but they were very, very good, a lot of them.

Van Marter Wick: Yeah, most of them really were.

Smith: Yeah.

Van Marter Wick: Really.

Smith: It was a great place.

Van Marter Wick: Dr. DeFrance who was head of Ames Laboratory at the time we went out there was such a charming fellow. He was a wonderful old guy and they were all very nice. Harry Goetts.

Smith: Oh, Harry was a love. They were great.

Van Marter Wick: Charley Frick.

Greer: I'm sorry, is there any other stories that you'd like to sort of get down as part of this that I may have missed?

Van Marter Wick: I could tell you one very-- My “almost quit” incident. I won't tell you the name of the engineer because you probably know him.

Greer: Okay.

Van Marter Wick: The one engineer that did not follow the pattern we're talking about. But anyway it was some kind of material that I was not familiar with so I had no knowledge at all of whether what I was turning out was good, bad or indifferent. And it was boxes and boxes and boxes of stuff. And this went on for I guess two or three weeks and he came in one day just laughing his head off and he says, "You know, Ruth" he says "way back there" he said "I made a mistake and all this is wrong." If I had made a mistake way back there and all that was wrong, he wouldn't have been laughing, so that was my one bad experience.

Greer: That was your one bad experience.

Van Marter Wick: Yeah. Okay, no that's-- generally it was a good place to work. [“Well, the other-- it was interesting because not having to do with computing particularly but when the war was over some of the men went back. Dean Chapman went back to get a Ph.D. and the fellows who just had Bachelor's degrees and I said to my husband "Don't you want to go back and get your doctorate? We're okay." And he said, "No" he said "I can learn more at Ames Research Center in one year than I could learn in four years working for a Ph.D." And I think that was the sort of thing it was. It was a challenge to people to do whatever they could do. They could do as much as they wanted, so it was a-- and I think that's the way it was with the women.” – Ruth Van Marter Wick]

Smith: Yeah.

Van Marter Wick: If one of the computers showed an interest and wanted to work that was great. They would go ahead and let them do it.

Greer: Good, good. Is there one story left for you, Marcie?

Smith: I don't know. I've covered most of it haven't I?

Greer: We've had a wonderful afternoon here and I think we should bring it to a stop.

Smith: I better not tell that one do you think? I better not tell our favorite story do you think?

Greer: You can do it without names.

Smith: I don't think I should.

Greer: Please, you've got a story.

Van Marter Wick: Tell it and I'll see if I guess who it was.

Smith: You can guess. I'll tell you who he is <inaudible>. Now this was a good experience but I mean it always reminds me of how good intentions are very much on the margin. But we had all these tapes, hundreds, not hundreds and my husband, as he told you, was in the computing business too and he had a sort job. He was in the business side and he had a sort job which was bigger than his machine could handle because it didn't have enough tapes. So, I said "Well, gee, that's too bad. We've never used a sort program on the 7090 but it would be fun to do that."

Greer: Right.

Smith: Now you know that is verboten with all kinds of capital letters.

Greer: Right, using government equipment for private business.

Smith: Private business. So, we talked to the manufacturer and they made a deal that they'd take the machine.

Greer: Okay.

Smith: So they took the machine and got the 7090 sort working and we sorted this job. While he was thinking about it we had it done but the funny part of it was we had an audience of about 25 or 30 people in the machine room because they had never seen tape spin like that.

Greer: Because there was a sort and scientists don't do sort.

Smith: It was a sort and we never sorted and so it was just going like mad and he was the hero and we had a lot of fun and nobody ever knew it.

Greer: No one ever knew it, good. Well I think on that note we will call it. Thank you so very much. This has just been absolutely wonderful.

Smith: You've been very nice, thank you.

END OF INTERVIEW

