An Interview with

ALEXANDRA FORSYTHE

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Conducted by Pamela McCorduck

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Alexandra Forsythe Interview
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Abstract

Forsythe discusses the career of her husband, George Forsythe, from the time of his Ph.D. in 1941. He studied meteorology at UCLA in preparation for a military commission. After the war he taught meteorology at UCLA, where he became involved with the National Bureau of Standards Western Automatic Computer (SWAC). In 1957, when the National Bureau of Standards closed its operation at UCLA, George accepted a position at Stanford University to establish its program in computer science. Forsythe recalls some of her husband's difficulties in securing funding for computer projects, the resistance he encountered in his attempts to sell computer time to the private sector, and his eventual success in establishing a well-funded program in 1965.

At the end of the interview, Forsythe briefly discusses her textbooks, which grew out of her efforts in the late 1950s to introduce computers into mathematics instruction in Palo Alto's public high schools. She also mentions her teaching positions at Stanford and the University of Utah.

ALEXANDRA FORSYTHE INTERVIEW

DATE: 9 May 1979 INTERVIEWER: Pamela McCorduck

LOCATION: Stanford, CA

McCORDUCK: This is a conversation with Alexandra Forsythe at Stanford on 16 May 1979. In the article that Professor Knuth and Herriot and a few others wrote that appeared in the *Communications of the ACM*, I understand that you and your husband were married right after he got his Ph.D.?

FORSYTHE: Same day.

McCORDUCK: Were you also a student then?

FORSYTHE: Yes.

McCORDUCK: Were you also getting a Ph.D.?

FORSYTHE: No, I never finished. But Jack and George got theirs on the 14th of June in 1941, and George's father was a doctor; he ran a health service at the University of Michigan, and so he could come to Providence for either the Ph.D. or a wedding, but probably not twice, so we just arranged to do it the same day.

FORSYTHE: Were you a student of mathematics?

McCORDUCK: Yes, I was a student at Brown.

FORSYTHE: And where did you go after you got married?

McCORDUCK: Well first, the year after we got married, George had the rating -- I forget what -- so he was liable to be called for military duty and he had an appointment here at Stanford and I had an appointment to teach at Vassar so much to everybody's amazement, I went to teach at Vassar and he came here to Stanford.

McCORDUCK: Oh, you were a pioneer!

FORSYTHE: He thought that he would probably only be one quarter here, but actually it was between the Winter and Spring quarter when he was actually called up and they sent him to UCLA to become a meteorologist. I taught that year at Vassar and toward the end of the year, the woman who was the head of the mathematics department told me to go out to UCLA and look it over and see if I could get a job and if it looked as though it would be a good idea for me to be out there. She offered me my job back at Vassar with a big raise if I stayed there, but I decided to go out to Los Angeles and went to work for Douglas Aircraft in the aerodynamics division and actually I was put in charge of computing airfoils and pressures on airfoils, and it was a computation that took a week.

McCORDUCK: Let me interrupt you. What kind of machinery were you using for this?

FORSYTHE: Desk calculators -- Marchants. And that was really the first real computation -- I'd come home every night and ask George how to get out of the problems I got into because we were supposed to compute the pressure all along this airfoil. They had always done it in windtunnels, I guess, and they wanted to get to the state of doing it with a formula and with splines. And they had one that went quite a ways and then at the very front there was a different one and there you were vertical. I'd get out these books and try to substitute their formulas and everything would blow up near the nose and nobody gave me any direction. They said "Well, this is what you're supposed to be able to do" and they didn't have many mathematicians around. What Douglas did was to put two groups, one in one part of the company and one in another part of the company and set us both off and then compare our results. We were on the same problem. They didn't tell us. We just discovered it.

McCORDUCK: How did you discover that?

FORSYTHE: Well, I don't really know how I discovered it, but I finally learned that there was another group, and I tried to contact them and that was taboo because we were supposed to be checking each other. Anyway, I used to ask George things every night about when I got into trouble -- you know, disappearing denominators, and all sorts of things that, there was just nothing around that helped, so we were really all primed for being interested in computation. He went through that meteorology course and they kept him as an instructor. He had a whole little class of people he was tutoring at the same time he was taking the course and he would tutor them because he already had a Ph.D. and a lot of these people didn't really have very much background, so George was working with them every day and he got a lot of his friends through who never would have gotten through. I remember they gave him a very nice engraved cigarette case that expressed their sentiments.

McCORDUCK: So this must have been around 1942-1943?

FORSYTHE: Yes, and then he stayed through a number of further classes and was an instructor and he wrote a book with [Jorgan] Holmboe and [William Sharp] Gustin on meteorology. And then he eventually got sent to Washington.

McCORDUCK: He was working for the Air Force all this time?

FORSYTHE: Yes.

McCORDUCK: And you were continuing at Douglas Aircraft?

FORSYTHE: No. I only worked there for a year or maybe a bit more because it was difficult to get down there. There wasn't a bus or anything and I didn't have a car.

McCORDUCK: Where were you living at that time?

FORSYTHE: Westwood. But I was offered a job to work for one of the projects in the mathematics department and I was teaching some classes. I forget what they were called, but they were people in industry who were learning simple mathematics and I taught those classes for I guess a couple of years, and then we went to Washington. By that time I was pregnant.

McCORDUCK: This would be about 1944?

FORSYTHE: Yes, summer of 1944.

McCORDUCK: And what were you doing in Washington?

FORSYTHE: George was working at the Pentagon and I was just surviving.

McCORDUCK: I understand that housing was just terrible there.

FORSYTHE: Well, we got an apartment at Park Fairfax which was the Metropolitan Life Project and it was I am sure better than most. It had some funny rules. It had the rule that you couldn't hang any piece of laundry outdoors. They had ordered dryers but the dryers never materialized. They enforced the rule and here all of us had young children.

McCORDUCK: Before the day of the Pampers.

FORSYTHE: Well, we had diaper services but all the rest of the laundry, you just had to -- some people had racks and they would put the racks out and then when -- we always had inspectors running through the grounds -- and they would run in with their racks.

McCORDUCK: I am picturing this -- we are in the middle of a war and still they had time to run around and check

whether some laundry was hanging out.

FORSYTHE: It was really very hard living because you didn't have libraries close by or anything to sort of have for recreation and there were no kind of community facilities of any kind and -- George was away a lot. That was a hard time.

McCORDUCK: I am curious whether you can remember now, did it seem that the war would ever end? We look at it in history books and it very neatly ends in 1945. Did you have the sense that this thing would come to an end one day or very soon?

FORSYTHE: Well, it seemed to go on an awfully long time and I think we made a lot of decisions differently because of the war.

McCORDUCK: Yes, that's the kind of thing I was wondering about, like what?

FORSYTHE: Well, I can remember I was very enthusiastic graduate student and I am sure I would have finished a Ph.D. if it hadn't been that I kept thinking that well suppose that George goes overseas and never comes back and I'm sitting somewhere studying and you know and I would have spent years that I could have spent with him. And I think if it hadn't been wartime I think I would have finished and I don't know how much difference it would have made in my life in general, probably not too much. Hard to say.

McCORDUCK: Most of the people I know were affected by the war and affected very deeply by it -- they immigrated or they lost someone they loved.

FORSYTHE: Well, I remember those years as being in many ways very lonely and I really don't mind spending a lot of time by myself, but it was excessive. When you are alone for weeks -- he was only a few months old -- [too young] to really be company.

McCORDUCK: But certainly small enough to keep you from going anywhere else.

FORSYTHE: And we didn't have any transportation, the buses were not very good. I think people who could live in a community where they were already integrated, you know and had friends and things like that, but I lived those years in, well in Alexandria at the Park Fairfax place where I made friends with my neighbors right around but I really didn't have any roots there and I think that's one of the big difficulties of the war, when you are moved to a new place and you don't have any roots and you don't have any friends -- it's an awfully hard situation. When you live like I do here, even though I am living alone, I have lots and lots of friends so I don't ever feel alone.

McCORDUCK: When you finally left Washington, was it to go to Boeing?

FORSYTHE: No, we went from Washington to Asheville. Sometime during that time the weather service changed from the Army to the Air Force, and they moved the headquarters from the Pentagon down to Asheville, North Carolina and we often laughed about the fact that that was sort of toward the end of the war and Kenneth Arrow and -- oh, the man in statistics here at Stanford, Stein -- the three of them were in that office and they really had nothing to do and there were times when they used to get the world almanac and play a game. Somebody would look up something and the others would try to guess what it was. The real work at the place had sort for stopped. We weren't there terribly long, like not over six months and then we moved to Langley Field. I guess they must have moved the headquarters to Langley Field. We didn't move to the base at Langley, we moved to another -- Newport News and all the time George was getting a certain amount of pressure to sign up and to stay in a little bit longer and he was wanting very much to get out, and about then he had enough points to get out. Then he had to decide what to do and his alternatives, the final two things that he was deciding between were going back to Brown to teach mathematics or going to Boeing to work on their research, and that was a very hard decision for him.

McCORDUCK: Given the fact that he ended up the academician's academician, how is it that he decided to go to Boeing?

FORSYTHE: Well, I think there were a couple of issues involved. One of them was that the dean of Brown had been really very difficult to me. He took away my fellowship because he didn't think I properly stayed on the sidelines like a woman should do. I'd gone to Swarthmore where people are treated as equal and the dean at Brown was a very conservative man and I wasn't even aware of his attitudes. But although my grades were straight A's and I was doing very well, my fellowship wasn't renewed and I was told by the other people in the department that it was just prejudice. I wasn't very anxious to go back to Brown. But I would have gone if George had really wanted to, but actually his parents had both come from Oregon and he was interested in being on the West Coast, so we went to Seattle.

McCORDUCK: How about you? Where were you brought up?

FORSYTHE: I was brought up in New York, upstate. I was born in Boston and then my family lived in Philadelphia and then finally my parents decided to move to a small town to bring up their kids. My father had gone to Cornell and we moved to a town called Cortland which is about 15 miles from Ithaca. And George had grown up in Ann Arbor.

McCORDUCK: So anyway, he decided to go to Boeing. Where there other considerations?

FORSYTHE: No, Boeing offered him a lot more money. We had a good time in Seattle; we liked it, but I think George -- you knew he introduced -- got them to get IBM machines to do scientific computing. We liked Seattle, but I think he did sort of miss the academic life and when UCLA's Jorgan Holmboe was head of the meteorology department, who had been anxious to get George back ever since George had been teaching the meteorologists, made him a nice offer to go to UCLA, George was sort of hung up on that, too. He found his decisions sort of hard to make, but he finally decided to go to UCLA. Once he got there, that was in 1947, I guess Holmboe was on sabbatical in Norway and that made a lot of difference in the department. If he had been there I think George might have been happier, but he didn't find it as interesting as he would have liked and I think he began looking around pretty soon after he got

there. I think the meteorology department really wasn't what he wanted to do. And it was just then that they were starting and they were going to build [SWAC] The Bureau of Standards built this group and they had a building on the UCLA campus and it was all set up for Harry Huskey to build his machine. George heard that this was going to happen and John Curtis was in charge of the institute at the point and he and George talked a lot back and forth -- George wanted a certain grade of appointment -- and I think John felt a little bit that he would have given it to him if he had been somewhere else to bring him there, but he was already there so he wanted to get him a little bit lower. But Boeing was also interested in getting George back at Boeing because he had done a pretty good job there. Well in the end, John Curtis came through with the offer and George worked for the Bureau of Standards then for quite a long time. He was absolutely thrilled at the idea of that computer. He was just like a little boy. He was so excited about the fact that they were actually going to build one there and he was going to do all sorts of things.

McCORDUCK: Did that machine actually get built?

FORSYTHE: Oh yes, sure.

McCORDUCK: What was it like?

FORSYTHE: Well, it took up a whole room. And it had a storage capacity of 256 words and you ran everything twice and if the results agreed you figured it was ok and if it didn't then you ran it a third time. It was really a lot of fun and it had those Williams tubes memories that weren't really very reliable and caused problems all the time, but it was a very exciting time. I worked there part time or I guess about quarter time.

McCORDUCK: Was this the SWAC? I have the acronym and don't know what it stands for.

FORSYTHE: Standards Western Automatic Computer. And there was a SEAC, Standards Eastem Automatic Computer, in Washington.

McCORDUCK: What did you do?

FORSYTHE: I learned to program this machine before it was built and they had classes for programming and of course machine language, because there wasn't anything else and the first program that anybody had to run was to -- you had to program division because the machine added, and subtracted and multiplied but it didn't divide, so division was the first.

McCORDUCK: So, this was Harry Huskey's design?

FORSYTHE: It was his design, yes, and they were trying to get a pool of people who could program it and it was all very exciting. And then they had another sequence you went through to become an accredited operator of the SWAC. And to this you had to come in at 6 o'clock in the morning to turn the machines on, there were certain switches that had to be thrown in a certain order so you didn't get a surge of power, and having turned it on, you then had to do various other things during the day and at the end of the day you had to turn it off. And if you went through this whole sequence you became a qualified operator and then you could come in and run it yourself.

McCORDUCK: What kind of problems was it being used for?

FORSYTHE: Well, in the beginning they were pretty simple, because the machine had such a small capacity. But it wasn't very long before they put on -- it's a big round thing about this high that stores and tracks all the way around it, and it was one of the first ones -- a disc -- and it didn't work very well, it kept losing things but it allowed people to write a lot longer programs. George wrote some programs on semi groups because they didn't... The tests were very short. Lots of people came and did problems. Most of the problems I remember doing were fairly routine and while the SWAC was getting ready, it took it several years after it started before it really was operating, George and I did some experiments with the CPC, the card-programmed calculator. I wrote the program and ran them and he did the theory for methods of steepest ascent, we were testing a lot of methods and we wrote a paper together that was in the Bureau of Standards Journal. We used to go over in the evening because I had two children by then and it was

easier to get babysitters in the evening so we would go over in the evening after supper and do the work. And there weren't other people around so that the machines were freer.

McCORDUCK: Was the notion that the machine would be extended somehow or was it just a one of a kind machine. The SWAC?

FORSYTHE: Oh, I think it was a one of a kind machine and actually the storage was fairly unreliable. I don't know if the face of these tubes were, the spot things seemed to be not reliable enough to warrant building any more like that. I think everyone learned a lot, it was great fun and it was very exciting. There were lots of visitors, international visitors, and it was an exciting time.

McCORDUCK: Just when was that? What year?

FORSYTHE: It must have been 1948 until -- I'm not exactly sure when it was that the Bureau of Standards closed their Western Division there. It had to do with that battery additive problem, do you remember that? Well, there was a battery additive that was much touted and the Bureau of Standards declared that it was useless and it didn't do anything and as I understand it, the industry, the interests that were behind that additive really went after the Bureau of Standards and they succeeded in getting the Head of the Bureau of Standards dismissed. I'm trying to think of what his name was. He was very well known, and I don't think he was responsible. At that time they closed the western division.

McCORDUCK: That's very interesting. I don't think of the Bureau of Standards as being kind of the consumers' watchdog, but it almost sounds like it.

FORSYTHE: I'm not sure they knew they were going to cause such an uproar or whether they would have done it had they known, but the funds for the Bureau were so curtailed that they weren't able to keep the western branch open. So I think the idea was that UCLA would sort of absorb most of it and at the UCLA math department they

weren't really very happy to absorb it although they did absorb most of the people I guess who wanted to stay. George was transferred to the UCLA math department at some point in there, but I think he never felt that the math department was really sympathetic with applied mathematicians. Magnus Hessness was at UCLA. Arnold was his brother in the mathematics department -- an applied mathematician and he had very close ties with the Institute for Numerical Analysis and he was anxious for George to be in their department. It wasn't only George, there were two or three others too, but I think George didn't really think that the department was very happy with the absorbing of this group. About that time Stanford began exploring the possibility of George coming to Stanford with the idea that eventually they would develop computing here and that of course interested him very much.

McCORDUCK: Was the idea then of a Department a reality or were they still talking in the division of the Math Department?

FORSYTHE: Well, I don't think that the question of whether there would be a division or a department was really cause for much concern at that point because there was nothing or practically nothing and it was just that they wanted to develop computing and that they thought was very interesting to George. And he came up and looked around and then the whole family came up and look around. It was sort of hard to decide to move, whether to move or not because our son was entering junior high school and that isn't a really good time to move. Our daughter was still young enough that it didn't matter so much for her, but eventually we decided to move and I am certainly glad we did. We had a nice house in Santa Monica and a lot of good friends, so we sort of teetered a bit and could have gone either way.

McCORDUCK: Now according to the papers in the archives, George was the unanimous choice of the Math Department. If they were going to start computing up then George would certainly be the one.

FORSYTHE: I think there were several reasons for that. One, he had been here. A long time before. Jack knew him well. And, Jack was here so it seemed like a good fit and I don't think George ever regretted that he came. He always was very happy here.

McCORDUCK: For most of us it is inconceivable to think of the Stanford computing without him.

FORSYTHE: George had so much enthusiasm for computing. It is really incredible how excited he could get about all of it. And then Albert Bowker here was very anxious to get computing started and he certainly gave George all kinds of support.

McCORDUCK: When exactly did you come here?

FORSYTHE: We came in 1957, in September.

McCORDUCK: I see that the actual division wasn't formally instituted until 1961 and I was curious about that gap.

FORSYTHE: Yes. Well, when George came there he would have been essentially the only one. Jack had had a machine over in Encino -- one of those clunky IBM things -- the student's card machine, the one that followed the CPC, the 650. They had that here and that was essentially it, so they began planning for that. I don't think George was anxious to strike out alone, when there really was no need for it. I think it was John McCarthy's appointment that precipitated whatever division there was because John McCarthy wasn't their first choice for somebody to join the Mathematics Department, but George felt he was the best person to bring in for the computing area because he represented an area of computing that was not mathematical, and George thought that was important that they make such an appointment. Wasn't his appointment about synonymous with division? And then it was another five or six years before they were separate departments.

McCORDUCK: Yes, I guess it was January of 1965, so about four years.

FORSYTHE: As the department began to grow a bit and get stronger, their interests and activities just separated from mathematics sort of naturally. I don't think there were any sort of battles or anything between the mathematics

and computer science. It was just that their sphere of activities separated and it became more evident as the computing grew that computing science wasn't synonymous with mathematics or subset of it.

McCORDUCK: You were starting to talk a minute ago about the kind of support that Al Bowker gave, could you elaborate on that a little?

FORSYTHE: I think he was very interested in having computing built up here and he and George had lots of talks together and Bowker seemed to be very supportive of all the things George wanted to do, so they got on just fine.

McCORDUCK: That seems to me very visionary to see that this would not be simply a service that would be useful to various members of the university but would in fact become a discipline in its own right. That it would have its service function but in addition it would become a discipline.

FORSYTHE: Yes, that's probably why Bowker is now what he is, Chancellor of Berkeley.

McCORDUCK: Yes, I am going to see him on Monday and I am going to put that to him -- "Why did you have that vision? How did that enter your mind?" What, I guess I'd like to ask you, the same question, if you can possibly remember how George had this vision, that this should be a discipline in its own right. It is not an obvious thing except in retrospect.

FORSYTHE: Well, he seems to have had it almost from the very beginning. That it would grow and be important. I think lots of mathematicians didn't work with machines and he did, so I think he had more feeling for what a machine could do.

McCORDUCK: But you've just described this kind of clunky creature that you had to program in machine code and it had a tiny memory by modern standards, and I am trying to get at how one could make that leap and say "This is the wave of the future" and not say "Well, this is very nice and it will be a very handy gadget."

FORSYTHE: But you see when you compare that very clunky thing with the hand calculators that we were using before the war, there is a big jump there to the fact that you could actually store numbers in the machine. You see the trouble with desk calculator was that every time you wanted to make a calculation, you had to write down the intermediate results, and that's where you get tremendous errors in a whole column of figures which were all intermediate figures, and you had to write them all down and put them back later with something else. That's where all the error came. With this new machine, even though it didn't have very much storage, you didn't have that intermediate step, and that was a tremendous step forward. But I must say George, once he started on the computing, I don't think he ever faltered in his feeling that that was the wave of the future, and of course he was helped along as things developed fairly rapidly, but there were so many funny things like when the students had the 220 and they programmed the card stunts for the football games. We went down to the stadium, he was really excited that day and thought that would be great fun and he had kind of helped them and overseen them. We went down to the stadium early to help the kids put out the directions and it was windy, and we put those printouts that told you what card to put up. We would put them down on the seats and the wind would blow a bit and they would fall off and of course if you got the wrong one it would mess up the lines so it was a very tense hour or so until the students arrived and took these things in their own hands. Actually, it was very successful because when the students did it, as they used to do it, you know, over beer or coffee or something the actual lines of the design were not straight. They would tend to sort of waver and with the computer printouts and if the directions got on the seats correctly, the lines were very clear and you could read the letter so much more clearly. That was really great fun and it was even more successful than anybody had hoped because of this fact that the designs were so clear.

McCORDUCK: Well, the letter was just delightful because it is actually to the head of the student body or the head of the pep squad and George was saying, "Look, we want to get started earlier next year so we can have a better one," and the enthusiasm that we were talking about earlier just comes through the lines. Despite the fact that he is doing all these arcane things in mathematics he is just as delighted to do the card stunts.

FORSYTHE: Oh yes, he got a lot of fun out of that. There was something else that was just on the tip of my tongue

and then we started talking about the card stunts. When the 220 first came to Stanford, it had, I think it was the Bank of San Jose that had the night shift and they had, they were just starting to run their checking accounts overnight and I don't think any other bank around here had done that. That was the first bank to use the computer.

McCORDUCK: That was probably true because the first big scale one was ERMA for the Bank of America and that was later in 1963-64.

FORSYTHE: But I am not sure when the 220 became -- do you have those notes? Well, what I remember is that the first weeks after the bank started they simply couldn't get off in the morning because they had bugs in their program and they hadn't got the accounts updated and it was very embarrassing to everybody because of course the University wanted the Bank of San Jose to be happy because they wanted them to buy that night shift and the bank wanted their accounts to be in order so I think they used to let the bank run on a while. George was the Director of the Computer Center and the head of whatever this affair was in computer science. He was sitting with two or three different hats on all at once but none of the operations were very large.

McCORDUCK: Well you could do that then -- well not everybody could -- it took an enormous amount of energy.

FORSYTHE: Well, as things grew, things separated, but there were some problems
in separating. When one person has held several jobs and then you try to pull them apart it sometimes has difficulty in pulling the roots apart.

McCORDUCK: Yes, in fact I was around Stanford and I can remember that there was a certain amount of animosity between the computer center people and the computer science people. I should say all the animosity being on the computer center side because there was a certain feeling that "here are these blue sky people and what do they know about the real grubby work of making a computer get up and run" and things had been smaller and more compact and it was in a sense George talking to George. And that ended and a certain community ended at the same time. Gene Golub and I were talking about that very thing this morning.

FORSYTHE: I suppose the same sort of thing goes on right now with so many people, that one doesn't have any idea of what the computer center -- that whole activity is just so far away now.

McCORDUCK: In fact, I remember just after Ed Feigenbaum became the computer center director, I think he may have been acting director then, it was decided that there would be a picnic and it would be for the computer center, but not for the computer science or visa-versa, I don't remember. And I remember George coming in to see me, because I was Feigenbaum's secretary then, and saying that his was very embarrassing. "How can we invite one side and not the other." And, wherever this was going to be held could only accommodate the one group and I said, "Well, I don't know, but that's the way it has been arranged" and he said, "Well, which one are you coming as?"

TAPE 1/SIDE 2

McCORDUCK: You were saying about George.

FORSYTHE: He was very much against discrimination or shutting anybody out of anything. He always wanted to include anybody and that was a very good trait. When were you here?

McCORDUCK: You know it's funny, I had to stop and actually count on my fingers this morning and I decided that I must have come in about 1965, so it must have been right after the department was officially formed, and I was here until about 1967. So as I was going through the archives it was really often very mixed feelings about seeing some of the issues that I had forgotten completely about and how exercised people were about them.

FORSYTHE: Were you there when they had that big luncheon out there under the oak trees between Polya Hall and Pine Hall? Was that the dedication of the department?

McCORDUCK: I guess, I wasn't there for that [the dedication]. There was such a function as that when I was there,

but it was much later.

FORSYTHE: They had various speakers from different places and...

McCORDUCK: Yes, in fact a written record was made of that.

FORSYTHE: That was a very nice occasion.

McCORDUCK: I would like to get back to this business of selling time on the computer because one of the things you forget is how terribly expensive computing was relative to the kind of budgets that one had in those days and what a terrific problem it was to raise the money to buy the machine in the first place and second to make it a useful thing. And, apparently at one point just after the Burroughs 5500, it hadn't been upgraded to 5500 yet, it was still 5000. Time was being bought by Stanford Research Institute and they were running it again on the third shift much the way the bank had been running and apparently George was still just scrounging around for money like mad because there wasn't enough and it occurred to him that you might sell some more time to more commercial ventures and Bowker came back to him and said "No, I don't think that the University should be in the business of selling computer time, we will find the money somehow. I don't know how, but we will." He was very strong about that...

FORSYTHE: I don't remember that, but I do remember that they were always terribly short of money.

McCORDUCK: George wrote a note to himself that is somewhere -- he was always writing notes to himself -- on the 30th of November 1964 and he said he is actually tempted to resign as Computer Center Director because Stanford won't put enough money into it and he said, "I think Stanford wants too much for too little." Do you remember some of the discouragement about that sort of thing?

FORSYTHE: Well, now that you remind me, I do. He really didn't get as much support as I think he deserved, but it seems as though now there is so much -- maybe it is easier to get now. He worked very hard over a lot of things and

was really discouraged over the fact that money was so hard to come by. I think if he hadn't had so much basic enthusiasm, he probably would have gotten discouraged. Whether he would have quit or not -- I don't think he probably could have. He was too much involved.

McCORDUCK: Was it hard for him to give up the Computer Center when ;he took over solely as department chairman?

FORSYTHE: Oh, I don't think so. Well, he wasn't really an empire builder. I think he was a good administrator.

McCORDUCK: That seems to be a unanimous opinion, by the way.

FORSYTHE: You see, his father was a good administrator and I think George got his talents directly, but I don't think he was really trying to build an empire -- I never had that feeling. So I didn't have any feeling that losing the computer center was any...I think it was probably something that had been necessary to do -- but the department was where his love was.

McCORDUCK: Yes, that seems to be very clear. What was Terman's role in all of this?

FORSYTHE: I don't know. I don't think George had a lot of contact with him, whereas he did with Bowker. Terman was more tied to the engineering I guess, I really don't know.

McCORDUCK: His name comes up from time to time in the correspondence and it is sort of ambiguous exactly what role he did play.

FORSYTHE: I can't shed any light on that.

McCORDUCK: One of the other very constant themes in the correspondence is "What is the proper relationship

between the computer center and the computer science department?" Do you remember some of the debates about that?

FORSYTHE: Yes, but I am not sure that the solution has been reached even yet.

McCORDUCK: What were the issues then?

FORSYTHE: I don't really think that they were theoretical issues, I think that it was purely practical; that when nobody was much interested in computing, there wasn't much to do and it was fairly natural that the computer center should be sort of nestled in the same place as the computer science department, but when lots of other groups began computing...I mean there was the issue of whether they should try to keep all of the computing all under one direction or let it grow up in a lot of different departments. That one has I guess settled itself -- we have computing everywhere. But in the beginning there was really so little done that everybody who wanted to do a little bit couldn't have had his own machine so it was fairly natural that it be in the same place as the computer science department.

McCORDUCK: George apparently had very strong feelings about why the centrality of computering should be maintained, and he actually wrote a little memo on it. I just noticed the date -- it's the same date he threatened to resign. And some of the issues -- well the first one is there is so much money involved, and he suggested then that there would be more computing spent than for buildings in the next five years. Heffner half way disputed that later, he said that Stanford had just put 25 million into buildings in the last five years and they didn't think they were going to put 25 million into computing. But if the numbers aren't precisely right, certainly the principle is correct -- there weren't enormous amounts of money to be allocated. Then the memo goes on and says "Without planning we will end up just like UCLA -- lots of computer centers"...apparently this is something he wanted to avoid.

FORSYTHE: But I think a lot of things have actually changed in the sense that during most of the time George was worrying about these things, one large computer seemed to be the best thing to work for, so that you could get enough storage, and now that all of the storage was so cheap, that issue really doesn't seem to be a decisive one,

although it did at that time.

McCORDUCK: He said something else that I thought was very interesting. "Prospective buyers really don't know what the future potentiality is of computers...they must be exhorted or compelled to keep their plan open" and it seemed to me that is another good example of again his vision -- he couldn't just buy for today -- you had to be flexible as possible because things were changing so much.

FORSYTHE: Of course he devoted an awful lot of time thinking about these issues at a time when most people didn't think about them at all.

McCORDUCK: A theme that comes up again and again -- that computing is not an auxiliary service, it's central to what the university is going to do and what it is going to be about.

FORSYTHE: Yes, I think George would be happy if he came back and looked around and saw that the department had moved into its own building now.

McCORDUCK: And not only a building but right on Palm Drive, you couldn't get more central than that.

FORSYTHE: Because he was really very discouraged about ever being able to..you know, he was always making comparisons of how much teaching the department did and how much money was allocated -- did you ever see those memos? They must be in there -- the number of students and the number of hours everybody taught and the rate at which the computer science department was allotted money was very low and he was always trying to get them to raise it. And another issue he used to worry about was the fact that whereas the law school and the business school and the medical school and engineering -- they all had graduates who made a lot of money and were ready to give it back to the university, and of course the computer science department didn't have those -- it takes a long time to build up such a body. Actually he would have given a lot to have had such a body of people to contribute things for the department -- I guess it hasn't happened yet, but it probably will. When you see all the nice things that get given

to the law school and the business school and the medical school, you think it would sure be nice to have some of those in computer science but they just have to build a body of alumni who make a number of millions of dollars.

McCORDUCK: And that's happening and then you have to get these alumni into the frame of mind that says...that's an appropriate place to put money...because when you are a student in law school you see that this golden urn was donated by so and so in the class of so and so, and so it already is in the minds that - aha - an appropriate thing is to give money to one's alma mater.

FORSYTHE: Well, I think graduates are -- well, you see, one problem is that Stanford doesn't have a computer science undergraduate degree and I guess it's undergraduates who give money -- not Ph.D.s so much although I guess Hewlett and Packard have been a lucrative source.

McCORDUCK: I'd like to branch back down the tree a little bit and talk about what you were doing at this time. You came up to Stanford here and did you begin teaching right away or...

FORSYTHE: While I was still in Santa Monica I had gotten a junior college teaching credential because my next door neighbor taught at the Santa Monica City College and he had talked to a few people and they had said if I got a credential they could use me there. So, as it turned out, I had to take a summer before I got here. So I had a junior college credential, but I did not have a secondary [school credential]. Sally Herriot was teaching in the Palo Alto schools and she wanted me to teach at Cubberly High, which was where she taught. She talked to the principal who was an outstanding principal, and he offered me a job but I really wanted to spend one year getting my kids sort of integrated into the school system and the community and things like that, but I guess I taught about half time. It couldn't have been that much. I did some that year and the next year I signed a contract and began teaching calculus in high school and I did that for three years and during that time, they must have had the 220 at Stanford some of that time because Burroughs offered me time on it. I was doing a little bit of computing with the calculus stuff, adding things up and doing a little integration stuff with programs and I took the cards up to Stanford and ran them through the computer. And Burroughs and IBM were both very generous with their time for high school students. I never

had to pay anything and I worked with the kids on computers for at least 10 years and they always... Well Ed [Feigenbaum] was very helpful too. He got my kids on the network and that was a great boon. I can't think of the name of that program that we got the kids doing. I had calculus in high school and what I would do was to check whoever was teaching at Stanford and use the same book and did the same lessons. I mean we didn't do the problems one-for-one, but I kept essentially the same schedule and in one semester we did what they did. We did a full year's calculus in a year. Well the students are excellent, high school students have more time than college students, we had reasonably small classes, and the principal was so helpful. You always felt that he was right behind you, ready to help. The kids worked hard and I worked hard. They did very well.

McCORDUCK: You actually got this underway in about 1957, 1958?

FORSYTHE: It certainly wasn't 1957. I really thought I started about 1959 on the calculus. And from then on they had expanded and it is still in progress.

McCORDUCK: To the best of your knowledge, had anybody been doing this at the high school level any place else?

FORSYTHE: Oh, I'd be surprised if nobody was, but nobody else was in Palo Alto when I started and the idea was ripe. I didn't happen to be in contact with anybody else who was but I'd be really surprised if we were the only people who were doing it. But it was a lot of fun to be able to sort of carry a little computing along and then after the calculus got going a little bit, they let me have one semester out of the year to just do what I wanted to with computing. I tried mixing the computing with different courses. We didn't really have other material to teach. I did quite a bit with analytic geometry and that was a lot of fun. That's when I first began to learn about round-off error. We were doing three dimensional solids, like ellipsoids and parabaloids and thing like that. You take the equation and put it into standard form -- you automatically move the origin so that it's at the center of the solid and then it is supposed to come out in standard form to be one of these second degree solids and there is B square minus AC, there is a sort of formula which tells you what that thing should be, and what happened with our computer is that we

would compute with this little formula and it would say that it should be an ellipsoid and then it would come out as a paraboloid or it would come out as something which moved one way or another. The eccentricity has to be -- if it is less than or equal to one you get these different things and there was enough round-off in our formulas as we changed the formulas from one place to another so they didn't come out like they were supposed to come out, and it took us quite a while to understand those, and I learned a lot. Up to that time I thought if you substituted in the formula, it ought to work. I shouldn't have thought that. I had worked quite a long time before with experimental stuff before so I knew a little bit about round-off but it hadn't occurred to me that it would come up in these transformations of axes. And I tried other things to mix computing with and it was a lot of fun. I had a good time. And then along about 1963, 1962 or 1963, that principal left the Palo Alto district and his replacement was a man who really didn't give support and I still had some classes but it was like the light was turned off and then I'm not sure when it was that we started working SMSG course and that brought it all back again. The SMSG started close to 1960...

McCORDUCK: Tell me how you got involved with that.

FORSYTHE: Well, I read a letter somewhere that that was going to -- that Ed Begle at Yale was starting that and I wrote a letter to him and said I was interested and then it turned out that he moved to Stanford after a year or two and that brought it all here and after it came here, I was involved in the winter time testing the materials that were written the previous summer. But I worked on the geometry and second year algebra, elementary functions and the matrix algebra over a period of three or four years. And then when they started the computing that's when I really got involved. I was involved in that one form the very first planning meeting. George was on the advisory committee and I was one of the few high school teachers who had done very much computing and also had experience teaching high school. There were very few and most of the -- well the SMSG -- so much of it was written by professors who were overly interested in theory -- in the abstraction, and they sort of lost sight of the applications. I think that that is really a very valid criticism of the genera SMSG program. George Ploya was a good friend of mine; I see him a lot, every two or three weeks we get together, and he used to worry so much about that program because people would ask him to criticize and he hates to hurt anybody's feelings. He gets caught between the truth and his dislike for

hurting other people's feelings. So what he would often do -- he was more spry then -- he would come up here and we would walk around this park, round and round and round and he would tell me what he would plan to say when he was going to give a certain talk and my job was to listen and make sure that nobody's feelings would be hurt. But I think he has been born out in his criticism. We were working to correct the rote learning but they went too far toward the abstraction, and he wanted us to put more applications in. But when the computing came -- see in a way computing is an application -- and so that never had any of the difficulties that the mathematics classes had. The biggest problem that the computing had was that the high schools just weren't prepared to teach it. But nevertheless we did prepare this big body of stuff and eventually we rewrote it and I think it was mostly used for the first year college courses for sort of schools at the state college level and there it did very well...but I doubt many high schools used it.

McCORDUCK: Because of this abstract problem?

FORSYTHE: No, no, no! That was the problem of the SMSG mathematics courses -- that's not the problem of the computing, the only thing the schools even conceived of doing was to teach something light -- a little bit of Fortran or a little bit of Basic or maybe a little bit of Algol but that's about all -- not may. But they didn't have any -- most of their teachers were math teachers who had learned a little bit in some summer institute and they weren't prepared to ever get down to any principles. What we were trying to do was to try to teach the kids a few things -- a few principles so that whichever language they happened to learn, these things would be in common and it seemed to us that because high schools are only preparatory, you ought to try to teach some general things -- things that would be ok no matter what came next, but most schools really didn't have anybody -- well, they didn't have any place to put computing.

McCORDUCK: Well, if it's one thing that's hard to learn in the abstract -- it's computing -- you really have to play around with it.

FORSYTHE: Well, you see in high school the only place they can go is the mathematics department in general.

Once in a while it would be in a business department but our sort of stuff with a much more kind of -- the underpinnings for a computer science department which was never would materialize in high school. I think it was an effort that was worthwhile doing but it really didn't get very far in high school. but it was very successful in the first edition of the computer science book. It sold a lot of copies and got translated into 9 or 10 different languages. Some of our stuff is still used at Open University in London. I can't understand it because it was published in 1969 -- 10 years old! I would have thought that they would have prepared their own stuff by now, but they are still using it -- not in large quantities but it is still used. We had it in Japanese, Chinese, Portugese, Spanish, French, German, Dutch -- not all of them were exact translations of the main book. some of them were translations of maybe one of the language manuals, about half for them were translations of the whole book but I think the Dutch, for instance, they took our material and sort of adapted it to what they wanted and then translated that. It was the firs of its kind and that's a good place to be. And then there were lots of others. Bill Gear told me that SRI approached him with a proposition that he should write a competing book that would be better. But they gave him or book as a starting point so he used the pattern and I think he did write a better book, so nothing lasts forever. Then I worked on another on programming languages project with Elliott [Organick] and that book came out last September. It's again a new way of teaching something.

McCORDUCK: What kind of pedagogical principles does it use?

FORSYTHE: It uses a diagram to -- I guess we call them snapshots -- if you have a program that's running that is in a programming language, and you stop the thing at some particular point and you draw a diagram of all the relationships of different variables, what their values are and how all the different environments are related to one another -- and it can be done with this method that was originally designed by a man -- Johnnie Johnston -- at New Mexico. We adapted it so it is a little easier. His is much more abstract and I think Elliott took the thing and saw that it would be a very nice device for teaching students a lot of the different kinds of parameters and different kinds of calls, functions, or procedures -- how you could see different handling of things. So he began developing a course and I went to teach at the University of Utah and I audited his course and took the notes and rewrote them and then he asked me if I wanted to work on a book with him so over a period of years it evolved. They used it at Stanford, fall

quarter and winter quarter, which is only two times they have taught their first programming course. Whether they use it next year will be the acid test. In a way Stanford students are better than the kind of students we were aiming at. We were aiming again at the state college -- the University of Utah students are not as sharp as the Stanford students and they need a lot more help. Gio Wiederhold taught it in the fall and he said what he liked about it was that he didn't have to worry -- he didn't have to lecture any of it or even think about it -- he could just give it to the students and then he could pursue what he wanted to talk about in class. So I guess it served a purpose in a way that we hadn't really planned for, but it really came out too late last fall for many people to use it because it wasn't really out -- they got the books here about a week late, so a lot of people who might have used it didn't but apparently. I've had a number of calls from people who said they are going to try it in the fall. Most of the programming language courses are taught at a higher level and our book is projected at that. Some people will try teaching at a little lower level and then come back with a higher course later. But I like book writing -- it's sort of fun, but I don't have any other plans.

McCORDUCK: I find I need to take a nice long rest after books.

FORSYTHE: How long did you work on yours?

McCORDUCK: Off hand about three years, but it has been in production for an inordinately long time for the usual sorts of reasons...it seems like a very long time for a book that only has to be typeset. There are no diagrams.

FORSYTHE: The diagrams were what the book was built around and they were very interesting so they took a long time on it too, but they did a nice job. We've been lucky. Both our book had...and they did a very nice job. After starting off quite badly, they recovered themselves and did a nice job. Well, book writing is fun, don't you think?

McCORDUCK: Oh, yes, I intend to keep doing it. I just need a rest right now.

FORSYTHE: I hear you are going to go to New York in a while. You're anxious?

McCORDUCK: Yes, I am really looking forward...

FORSYTHE: I don't think I have ever been to Pittsburgh. It has excellent music.

McCORDUCK: Yes, it has excellent music and that got me from Sunday to Sunday...Simon would come by my front door almost daily and my study faced out onto the street, usually finishing work as...would go by and I would say "Would you like to come in for a cup?" There were lots and lots of interesting people there, but the city itself is really depressing -- a way that only a 19th century city can be depressing. I had grown up in this area, so it wasn't like I was coming from Detroit to Pittsburgh; coming from the Bay Area, it was really hard on me. When we first went there I said to Joe, "Well, I think I can stand five years in Pittsburgh." And he said "OK, five years is what it will be." Of course, he settled into the department there and just loved it and couldn't dream of moving finally around year six I said "I can't stand it anymore" and at year seven I finally said "I'm going back to California and either you are coming with me or you are not coming with me, but you just have to make that choice because I just can't take it any longer." I know to do it cost me a great deal emotionally, but it was costing me more emotionally to stay there. He started looking around for another job, came up to Columbia and I was willing to go back across the Rockies again to New York.

FORSYTHE: Where will you live?

McCORDUCK: In New York City, in Manhattan. Columbia has some subsidized housing so we will be right on Riverside Drive looking over the river in a huge old place, the kind of thing that it is impossible to afford if we had to pay for ourselves with real money.

FORSYTHE: Well, quite a few people have been going to New York and seem to thrive on it. There are those that claim that...in Manhattan but even so it seems a lot livelier since years ago when I wan an undergraduate student there. I haven't been there in a long time. I think the last few times were -- John Kennedy...

McCORDUCK: Oh sure, the same for me...

FORSYTHE: When I was young we used to often spend Christmas in New York City in the McAlpin Hotel and they used to have a beautiful Christmas tree. I think it was a nicer hotel. But my father had two brothers and they would bring their families and we would all have rooms together at the hotel and then go out and had a good time.

McCORDUCK: It's really a good city for that, and I think after a period of not being...I think it has become so again. Well, I'm not sure a family can have a good time because it is so expensive but certainly by the time you are an adult and have some disposable income it is a great place to be. I couldn't live there year around -- I'm glad we are keeping our place in Berkeley so we can come back in summertime.

FORSYTHE: What was the year Joe was here?

McCORDUCK: He was here the first time somewhere in the '60s around '66.

FORSYTHE: There were a lot of people here.

McCORDUCK: That's the lovely thing about Stanford, the visitors just flow through. I'm sure they still do, although I speak in the past tense because I'm not there anymore. But anybody who was anybody came to Stanford.

FORSYTHE: Would you like a cup of tea?

McCORDUCK: We will conclude this. We have been talking for two straight hours non-stop. This has been a conversation with Alexandra Forsythe on 16 May 1979 at Stanford.

END OF INTERVIEW