SWE STORYCORPS INTERVIEWS

Phyllis Gaylard and Pamela Strong Interview

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This oral history interview was recorded October 26, 2007 at the Society of Women Engineers National Conference in Nashville, Tennessee as part of StoryCorps, a nationwide initiative of Sound Portraits Productions to record and collect oral history interviews. A copy of the audio recording of the interview has been deposited at the Walter P. Reuther Library and Archives of Labor and Urban Affairs, Wayne State University. The interview may be used for research and educational purposes only.

Phyllis Gaylard and Pamela Strong

Phyllis Gaylard began her career in 1959 as a structures engineer with North American Aviation. She then moved to TRW Systems Group, where she worked on space vehicles, rocket engine structures, and contributed to the development of the lunar module descent engine for the Apollo program. Later, she joined PDA Engineering and was promoted to a program manager with responsibility for the air launched cruise missile recovery system program. She retired as an engineering manager of applied technologies at Rockwell International's
Satellite Systems Division. Gaylard received a bachelor's degree in engineering from the University of California Los Angeles in 1959. She went on to complete a master's degree in engineering from UCLA and an MBA from Pepperdine University in 1982. A Fellow of the Society of Women Engineers, Gaylard joined the Society in 1958 while a student at UCLA and received the Society's first scholarship, served on its national executive committee in the 1960s and 1970s, founded the SWE Orange County Section, and received the Society's Distinguished Service Award in 2001.

Pamela Kay Strong began her career as an analytical chemist at Henkel Corp., developing new analytical methods and technical

services for cosmetics, surfactants and detergents, and oil field and water treatment products, as well as new pharmaceutical products. In 1980 she moved to the Hughes Aircraft Company, and later to General Electric as a senior advanced
composite quality engineer, developing the first composite jet engine vanes and other engine parts good to 700 degrees Fahrenheit. In 1985 she became a senior quality assurance process engineer specialist for Northrop Corp., where she made significant contributions to the Stealth B-2 bomber. She joined The Boeing Company in 1987, where she served as an associate technical fellow, providing technical and design support for nonmetallic manufacturing processes and material parameters used in a number of aerospace and defense projects. She became a senior engineering specialist at The Aerospace Corporation in 2007. Strong received her B.S. degree in organic chemistry from Philadelphia College of Pharmacy and Science (now the University for the Sciences in Philadelphia), and completed Ph.D. research in organic chemistry at Bryn Mawr College. She received numerous professional awards from Boeing and General Electric. A Fellow of the Society of Women Engineers, in 2007 received the Society's Achievement Award for leadership in the field of non-metallic technology and pioneering the use of non-metallic composites, which revolutionized the aerospace industry.

In their 2007 SWE StoryCorps interview, Gaylard and Strong discussed their backgrounds; how they entered engineering; their work histories; the mentors and obstacles they faced; and shared stories from their lives and careers, including their work in the aerospace industry and meeting Albert Einstein.

- July 2016

Phyllis Gaylard: This is Phyllis Gaylard. I'm sixty-nine years old. And today is October 26, 2007. We're in Nashville, Tennessee, and I'm going to interview my friend Pamela Strong. But first, a little bit about myself because I've got some stories, too. I'm a retired aerospace engineer. (To recording technician) Okay.

Pamela Strong: This is Pamela Kay Strong. Today's date is October 26, 2007. The location is Nashville, Tennessee. And Phyllis Gaylard is going to interview me. What was I supposed to say? Okay, that's it.

PG: Okay. I'm a retired aerospace engineer with some management as well. And I've worked on a number of different kinds of projects. Some aircraft, spacecraft, lunar descent engine of the Apollo program, some ground stuff, some black hole stuff can't tell you about. But it's been an interesting career. But I've been happily retired for eleven years, been enjoying that very much. My friend Pamela has a different background than I, so we thought that we would first have her tell you what she's done, and then we'll get into a little discussion here.

PS: I was first a chemist, and now I am an *Ingenieur* [German word for "engineer"]. Never took any engineering classes but I have three fellowships in engineering and two in

chemistry, numerous awards in both, and a lot of on-the-job training in chemistry and in engineering. I am a rocket scientist predominantly, now, and dealt with all the Deltas and the Titans [two lines of U.S. rockets]. I have worked on aircraft, both commercial and military. Just about every one that you can name.

PG: All right. My start in engineering was basically the influence of my father, who brought a lot of stuff home. He had *Aviation Week* in the house all the time and I got interested in aircraft engineering, if you will—— aircraft field of study. But in the days in the early fifties it was men's careers and women's careers and ne'er the twain shall cross. But after rejecting secretarial (clears throat), thinking about teaching and deciding that I didn't want to deal with those kids, I was going to be a mathematician until I thought, "No, I'd rather solve my own problems." My dad took me to an engineering——not a career fair so much as an engineering career night program where engineers explained what they did and passed out information. And I found out I needed to——this is my junior year in high school——that I was going to need drafting, so I went off and got started. I bet——I understand your background was quite different in that direction.

PS: Oh, yeah. We lived in Alamogordo, New Mexico, just outside of White Sands, and we had 450 to 500 scientists and engineers trench through the house, some of which were Donovan Brown (???), Albert Einstein, Glenn Seaborg, Linus Pauling, Robert Oppenheimer——and his sister, whom I later actually studied under at Vermont——and lots and lots of others. And they were a big influence on my life.

PG: And they got you going in the experimenting in rockets.

PS: Oh, yes. They did. Experiment in rockets. At four I crawled up on Einstein's lap and he gave me the theory of relativity. At five I made my own rocket——oh, a composite rocket, that is. Wood and nails (laughs)——and watched. It didn't' go to the moon. But he encouraged me.

PG: Did it get up into a tree? (laughs)

PS: Oh, yes. It went all the way up to the top of the tree and then back down again on the——and it didn't go to the moon.

PG: Well.

PS: But our propulsion was a piece of rope over the limb of the tree.

PG: Your rocket was too heavy. (laughs)

PS: And the rocket was too heavy, yes.

PG: Well, that's a great background. I didn't get those kinds of influences in my career. But I did choose engineering in high school and I recall after that career night I went in to do my senior schedule and the guy that was doing schedules for us was the basketball coach. He said, "Girls don't take drafting." (laughs) So he signed me up for Home Ec. [Economics], and when he went out to coach the basketball team I went back and switched it and took drafting. (laughs) Fixed him. (laughs) So I went off to UCLA [University of California, Los Angeles] engineering school and got my degree in engineering, which made it much easier than your history, which was quite different in that direction.

PS: Well, yes. I had several different teachers that really influenced me. A Dr. Taylor, who was in Ancient History in seventh grade. And I wanted to be an archeologist until I found out how much (clears throat) they get paid, which was insignificant. And then I hit my professor, Dr. Murray Zanger, with a cork and he thought that was the sign of a good chemist. And so he encouraged me in chemistry and at the time I was taking a triple major——chemistry, biology, pharmacy——and I was mainly going towards the pharmacy

direction. And changed it to chemistry and my parents wouldn't talk to me for six months. But that was all right, I was supporting myself anyway. They later decided that maybe chemistry was okay. And let's see, I made an AIDS cocktail, thirteen marketed drugs. I had eighty-two in the pipeline, and that was during my undergraduate / graduate work. And now I am a rocket scientist.

PG: Well, it's kind of neat to have commercial things like that out there besides stuff we can't talk about, or even with military stuff. When I had entered engineering, of course I got some job offers through the college, and started right out as an engineer without too much trouble. Subtle little things, like the men I worked around in this un-air conditioned office used to blow their cigar smoke up my little desk fan so I could choke and wheeze on it, but that was supposedly all in fun. Didn't have any real problems when I started.

Later on there were some subtle issues where people were trying to insolate me from things, which was really a holdback. Like the guy who said, "Oh you don't want to go to these ugly meetings. I'll go for you." (laughs) He took credit for my work. (laughs) And a boss whose wife couldn't balance a checkbook so he didn't want to bother me with the

vagaries of pricing a proposal. And then he was out sick the day we had to price it, and I had to jump in and do it without any help. (laughs) So little subtle things like that, but I gather your experience at getting into engineering was a little different than that.

PS: Ah, slightly. I was a chemist. In fact I was the first American employee of Henkel and they sent me nine volumes of instructions, all in German. So I had to translate them from English into—I mean from German into English. And then five years later they were going to get rid of that company and they wanted me to start the research group, General Mills chemical division. But it was in Milwaukee, Wisconsin, where snow is truly a four-letter word.

So I wanted to stay in California and I walked down the street, got a job at Hughes [Aircraft Company], and they said, Now you are an engineer. I'm going, "No, I'm a chemist." And they said, No, you're a process engineer. Sink or swim. Well, I almost sunk, but I did a good backstroke. And after that I went to Irvine Sensors, and from Irvine Sensors I went to General Electric, and from General Electric then I went to Northrop, and Northrop to McDonnell Douglas. McDonnell Douglas was in merge with Boeing, and I even worked at what was the former Rockwell

[International Corporation unit), and now I retired from Boeing, and worked at Aerospace Corporation.

PG: Uh-hm. I worked at Rockwell three times and retired from Rockwell before Boeing bought them out by about six months. Although Boeing sends me a pension, it's Rockwell I retired from. (laughs) I heard it went downhill. Sorry about that. Major accomplishments. I did some interesting things on the lunar descent engine. We had some strange government requirements. One of which was the Mars—the moon lander had to withstand landing on a flat-topped, twenty-four inch high rock without tipping over. So we had to have the nozzle extension that comes down off the bottom of the spacecraft collapse if it happened to hit something like that. Which is not—you know, you normally don't design things to fail. (laughs) To withstand all the loads you need to up to a certain point and then crumble. Well, no loose parts, just squish. And we succeeded in that.

We had an interesting test that they calibrated using corrugated tin trash cans with heat lamps on them, and a squash test to make sure that they would collapse under that load. And a vibration test. They took a Goodyear racing tire, shaved the tread off it, and inflated it to provide a thrust force against it. And I said, "Oh, I'm

racing a car and they've taken the tread off that tire. I could have used it!" (laughs) But I didn't get to use it. So I've got interesting things like that.

Later I got into working on a former Greyhound bus that we installed a wheelchair lift into for handicapped people, which was kind of a whole different ballgame but it was fun, too. So I've had some interesting things. You know, a few SWE recognitions, but you've got lots and lots of recognitions. I know, because I wrote you up for some of them, your fellowships and the like. (laughs)

PS: Yeah, well, we don't know that you'll get that one yet. (both laugh) But I think that's about the last one. Let's see.

PG: Well, you've got some highlights that you might——

PS: I might. I have five different fellowships. I'm a Boeing Associate Technical Fellow, a Fellow of the Society for the Advancement of Material and Process Engineering, a Fellow of the Society of Women Engineers, Fellow of the Royal Australian Chemical Institute, and a Fellow of the American Institute of Chemists. I remembered them all.

PG: Some of the things that you've done that gendered those awards, though, included developing the stealth materials to make the stealth bombers stealthy.

PS: Oh yes.

PG: And a plastic engine, which everybody says, A plastic jet engine will melt. No, it didn't.

PS: No, it didn't. It got up to seven hundred degrees.

PG: And saving all that weight on the rocket motors so that you could launch bigger spacecraft. (laughs)

PS: Well, I actually developed the material that allowed the stuff not to get burned up. It's good up to seven, and in some cases eight hundred degrees. It's called PMR-15 [polyimide]. And because of the PMR-15 I was able to start an entire field of chemistry and subsequent engineering. They used PMR-15 on the inside of the General Electric aircraft engines, saving 464 pounds and $1.2 million dollars in fuel per aircraft per year. Then that same material was used on the outside of the B-2 stealth bomber for structural aircraft. It was also used on the F-15 engine housings, later then on the F-18 engine housings, and the Mars Rover heat shield. And that was just one of the many things that I've done.

PG: But it's kind of setting new boundaries in the world of advanced composite materials.

PS: Oh, absolutely, and pushing composites. For instance, we now have a Delta rocket that was less than one percent composites and now it is over seventy percent composites of its structural weight, saving enough weight so that between thirty and a hundred pounds of payload—— depending on which of the Deltas, of course. There's five different Deltas——but thirty to a hundred pounds of extra payload in orbit.

PG: And that's a real——

PS: And that's significant.

PG: Absolutely. Absolutely. So people who are not familiar with the aerospace industry might night realize that advance composites now find their way into car bodies and interiors and all kinds of housewares and things.

PS: And that was from the aerospace industry, and not from the auto industry.

PG: Sure. And things like the Corvette. I went to the assembly plant yesterday. The Corvette used to be a big, blown fiberglass in a mold, big, thick thing, and I'm sure

they're doing a much neater, fancier, carbon fiber job these days than they used to because it's——

PS: Well, they should if they've got——

PG: ——it's a lot lighter and stronger. Yeah, it doesn't crack so fast. So it's an interesting field to have gotten involved in. I was peripherally using some of that stuff, but not very strongly. I got more involved in the metal stuff.

PS: Well, composites are, or can be, five times stronger than that of steel.

PG: Yeah. Right. So when I was developing my career I didn't have any mentors. So I was pretty much on my own. My dad encouraged me to get a master's in engineering, but that didn't pan out due to various strange reasons, so I got an MBA instead, since I got into management. But I gather you've had some mentors along the way that have helped.

PS: Oh, I've had some wonderful mentors and really that's why I am now the *Ingenieur* that I really am now. And I keep mispronouncing it on purpose, because I don't want to belittle people who have actually gone and taken engineering classes. But there were five gentlemen, and I became the sixth composite person, that did just about

everything at General Electric. And these gentlemen were all in their very late sixties, mid-seventies, and they took me underneath their arms. In fact one of them would walk into the room singing "Me and My Shadow." But I was only a shadow for about two weeks, and then they gave me my own project, which I successfully completed. Nine months after I started at General Electric I won a prestigious General Electric Manufacturing Technology Award, and as far as I know I was the only woman that had ever won that award. And it's only given to one person in all of General Electric.

PG: Yeah.

PS: And General Electric is, at that time, I think was one and a half million people.

PG: That's a lot of people. And they did a lot of different things, too.

PS: So I was very proud.

PG: Yeah, absolutely. I kept running into odd situations where men wouldn't take my word for something. When I first started at TRW my boss took me out to the shop to show me around and see if I knew anything about hardware and, surprise, I was working on a racecar in my spare time. I

knew all about hardware and I was telling the designers that they weren't torquing the bolts tight enough to make them not loosen up under vibration in space. And, Oh no, they'll break. So finally we had a standoff and I went and did a test and showed them the bolts would break under torque at about five times what they recommended, so we got all the bolt torques bumped up so they wouldn't back out under vibration. And it was another special project that I got involved in. A guy dreamed up this, what they call the double door (???), which a door (???) is basically a thermos bottle, and it was a thermos bottle inside a thermos bottle, to keep liquid nitrogen——no, liquid——

PS: Ah, helium?

PG: ——helium, probably, very cold so he could do an infrared telescope out in space.

PS: Helium.

PG: And I looked at his design, and what he had done was build a conical thing with a flat bottom and to reinforce the flat bottom he had put a series of ridges, but he made the circumferential, you know, circles instead of ribs, and what does that do? It looks like an accordion. And I said, "This isn't going to work. They're going to expand and

touch each other across this vacuum gap." Next thing I know he's gone to my boss and said, "She won't do. Give me somebody else." So somebody else went and told him the same story and he had to give up. (laughs)

PS: (laughs)

PG: They don't like to take our word for anything. Like we don't know what we're talking about, but surprise. That was problems I had, but I don't think you had quite as much trouble as that.

PS: Ah——

PG: You had a few, though. I remember——

PS: Well, I had a few. I was the first signature on all the six thousand drawings for the Delta, the Delta II, the Delta III, and Delta——all of the family of Delta IVs. There's five Delta IVs. And so they had to come to me and get my approval first. And this one young man was relatively new. He said, "No. I'm the designer. I know." And I said, "Well, if you design it that way it won't fly." And so he went back to his boss and he said, "This Pam Strong, you know she's just an M&P [Material and Process] engineer. What does she know?"

PG: (laughs)

PS: And he proceeded to tell him what I knew and to go do it my way. He came back, did it my way, saw how the part really worked, and goes, "You know, the way I had it designed, it wouldn't have worked." And I go, "Uh-huh." He said, "How did you know?" I said, "Well, I've been out in the shop, and I've actually seen parts." "Oh." And from then on, no one in his entire department ever gave me a problem.

PG: Yes, that's what it takes. You have to show them they're wrong.

PS: But, I ended up having to redesign, and actually almost to design, the entire rocket.

PG: Yeah. I worked with a lazy design engineer one time who said, "Minimum weight. I'm going to make it as skinny as I think—you know, as thin as possible." And he said, "You prove me that it won't work, and if it's not strong enough you fix it." So I had to redesign everything he did because he made them all too light and too frail and they failed. So I had to all this work to make him fix it. But he was too lazy to do anything himself. So it's unfortunate.

PS: Well, every once in a while I'd come up with these young kids——

PG: Hard heads. (laughs)

PS: ——wanted to make it, Well a computer can make it to five decimal places. And I said, "At what temperature are you going to actually ascertain the seventy foot beam is going to be, you know, X long. And he goes, "At what temperature?" (laughs) Forgetting thermal expansion, of course.

PG: (laughs) Yes. Yes. There's been so many fun things that go on in a shop. So I recall some other tests that were kind of fun. We had an orbiting geophysical observatory satellite. It was a big rectangular——looked like a file cabinet in space, with solar panels sticking out of it and some antennas. And they were having trouble with the thing. It was using up all of its gas that kept it lined up in row. And it had an antenna that stuck out that was a bimetallic thing that was coiled over. It was an open, flat piece that kind of rolled over on itself and stuck out sixty feet. And we did a little quick lab test and discovered that when that thing swings it doesn't swing like a straight stick would. It torques. And when you put

the sun on it, it gets hot on one side. That makes it expand and kind of move and stretch and it swings in a kind of a figure eight instead of an arc, and that's what was wagging the dog. It was a tail. So they had to cut it off and that solved the problem. But we got to play with it in the lab and do a lot of funny things like that, just to see what was going on.

But the space program was fun, except that there were times when you couldn't find out what happened. I worked for a year and a half on a satellite program, developing an antenna that under thermal distortion from the sun—because it didn't rotate with the satellite—that it would still meet the criteria of flatness and shape and all this so it would send a proper signal. It failed on launch. It never worked. And I lost a year and half of work and don't know whether it was right or wrong and it really frustrated me. And I learned from all of these things that what really made me like a job was to see that the end result worked. And so I found out that whenever I went job hunting my goal was a job where I could follow a project through from start to finish and make sure how it worked, and get involved in the hardware, because hardware is fun.

PS: It really is fun.

PG: Yeah, I know you've done a lot of work on the launch pads and with things like that, too.

PS: Oh, yeah. Well, when they first brought me the plans for the Delta II—the Delta II is sort of pregnant and comes down to an eight foot—goes out to a thirteen foot diameter and comes down to an eight foot diameter.

PG: Looks like an upside down turkey baster.

PS: Well, no.

PG: A little bulb on top?

PS: It's sort of like the fairing [nose cone] itself, the housing of the satellite.

PG: Yeah.

PS: It looks extra fat.

PG: Well, like the turkey baster bulb on top.

PS: Yeah, okay. Or top, upside down.

PG: Yeah.

PS: And the wind, I kept telling them, "Have you put this in the wind tunnel?" "Oh, no, no, no. We don't need to. We know what we're doing."

PG: Famous last words.

PS: Well, when it launched the first time, you could—I have never seen a launch since then—it was just as if it was in the wind tunnel. You could actually see the wind come down off the nose cone and impinge upon the smaller area. And that smaller area, exactly where it impinged, was where the gyros were. So the gyros were doing somersaults and back flips and whatever. And it kept sending a signal down to earth saying, "Blow me up. I'm going the wrong way. Blow me up, I'm going the wrong way." And the poor range safety guy almost lost the rest of his finger, he was pushing the button so often and so hard. And finally it said, "Well, you have ignored me. I am going to blow myself up." So he had to send the, "Abort. Abort. Abort," signal, and so (laughs)—because it was going up straight, but the rocket didn't know it as going up straight, though.

And so finally after MECO, which is main engine cutoff, and the solids were gone and so forth, and the range safety went over and grabbed—and I do mean literally grabbed—our vice president, the Boeing or McDonnell Douglas vice president at that time. Reamed, streamed and dry cleaned

him and told him next bird was not going to move. And the next bird was ready for launch in three weeks.

So I got on a plane with some vibration dampening foil, and me and whole group of people went up to the pad and put this twenty-two inch by whatever we cut it. Ten mil aluminum with five mil viscoelastic sticky stuff on to dampen the vibration, and we put it on in layers. Well, I was supposed to have assistance, but my assistant got sick (clears throat—I think he went to Disneyland (laughs)—and I never saw him again. So I had three shifts, twenty-four hours a day, that I was responsible for.

Well, after the fourth day of no sleep—because all I had time to do was to go to the hotel and change—I got the first shift started and this guy comes in about two, three minutes after the first shift starts. And I said, "It's okay, I don't care why you're late. Just go on over there." "But, but—." "Go on over there," and I shook my little cane at him and he went over there. And he put the first layer on, and then he came over, "I put the first layer on, but I have to leave." And I said, "What do you mean you have to leave?" "Oh, the general's waiting." And I go, "Oh. Are you a member of the military?" Well, he was wearing civilian

clothes and then all of a sudden I noticed that his badge was slightly different than my badge. And I go, "Well, um." And he says, "Yes, I'm a first looey [lieutenant]." And I said, "Well would you like to leave now?" And I said, "But what were you doing here?" And he says, "Well, I wanted to find out what you were doing." And I said, "Well, now you know."

PG: (laughs)

PS: And so I gave him permission to leave and he started leave and laughter just followed him all the way down all seven floors. And I said, "Well, did you guys know that he was a member of the military?" "Uh-huh." "Well, why didn't you say, 'Oh, Pam'?" "You weren't letting us get a word in edgewise."

PG: (laughs)

PS: So later that afternoon I had a meeting and the head of the base came down and he says, "Pam, I understand that you had some assistance." And here I'd only been with this company for maybe six or nine weeks. And of that six or nine weeks, I'd been traveling six weeks. So I go, "Oh my God. I'm here all the way in Florida and I'm not going to be able to get back to California because he's going to fire me and I'm

not going to have the money to go back home." And he goes, "Oh no, Pam, don't worry about it." He says, "Anyone"—because I had started to apologize—he says, "Anyone who can get the customer to do our work for us can come to work for him anytime." But that was his way of saying, "Don't ever do that ever again." (laughs)

PG: Yeah, right. (laughs) So you started watching badges more carefully after that, huh?

PS: But that's one of the few stories that I'm not going to be able to say tonight at the [SWE] meeting.

PG: Yeah. But that's all right. That's a good one. I like to see that, one-upmanship on the customer. (laughs)

PS: (laughs)

PG: Yes, I never got a chance to do that, but that's, that was fun.

PS: It was, but you don't want to do that. Believe me. You don't want to do that.

PG: Fortunately I didn't have to do much traveling on my job for my company. I think it was one trip we took that was memorable. We had a meeting in St. Louis followed by a meeting in Dayton, Ohio, on a proposal. And we wanted to

meet with McDonnell Douglas in St. Louis about working with us on this proposal. And it was a classified proposal so we went to Dayton to Wright Patterson [Air Force Base] to get all the poop about this proposal. Three of us went. And it was another nice, hot, Santa Ana week in southern California. We're dying of the heat. We get on the airplane at four in the morning, we get to St. Louis, and it's snowing. And it was four degrees that night. The next morning it's still snowing in Dayton. Brrr. We didn't sleep well. I had a diesel truck outside my room with an engine on all night. So we get to Dayton. We go to this classified meeting. And they said, "No note-taking. We'll send you something." They turned the lights out and start with the slide presentation, and we all go (snores). (laughs)

PS: (laughs)

PG: And between the three of us I think we pieced it together but they never sent us anything in the mail, either. (laughs) We got on the airplane and went back to the heat. So that was enough traveling for me. It was hateful. (laughs)

PS: Well, I have been traveling since I have been working for Aerospace Corporation, which is the technical arm of the Air Force. I have been approving the parts that they're

actually going to use to fly or whatever. And so I've been on a plane, must be about nine months out of the ten months that I've been working for them.

PG: And with the current flying restrictions that must be really fun.

PS: Ah, yeah. You can spend all day getting to point A.

PG: I'm so happy to be retired. (laughs)

PS: Well, I retired for one day.

PG: (laughs) Whoop-de-do.

PS: Then started to work. (laughs)

PG: (laughs) I did want to talk to you more about inspiring our future engineers and how would you encourage women to become successful engineers. We having had such fun with our careers. How would you get the young ones interested or able to do the kinds of work we do?

PS: Well I have mentored engineers all the time and I have, oh, a whole gamble, gaggle? Gaggle, I think it's called. And I actually have five engineers over at Boeing even though I'm no longer at Boeing. And every other Friday we meet because

that's when I have off, every other Friday. But getting young engineers—they need mentors—

PG: And they need—

PS: —and they need to have someone take them underneath their arm and say, "Okay, this is how it's done."

PG: And they need to go to engineering school to get the skills that employers look for to get the jobs with.

PS: Well, true.

PG: Which is why I know that you have been working with the Girl Scouts on aerospace badges and things.

PS: Oh yeah.

PG: And when I do, I tell them how a rocket works. I gave out samples of the rocket—they give me the samples back. And so forth so that they actually can touch parts. When I was at McDonnell Douglas Boeing I took them out to what was called the Boneyard and would show them parts that had been scrapped but were still, you know, seeable.

PG: Yeah. I know when I was in high school we had—I lived in Westchester, which was the hub of the aerospace industry in southern California.

PS: At the time it was.

PG: Yeah. Well, when I was a kid. We had a class project to do and I talked to my dad and he said, "Here, I'll explain to you how a jet engine works and you can make that your project." (laughs) Well, spaghetti-style, you know. He told me all about it. It went in one ear and when it came time to talk about it, it came out the other ear and that was the end of it. But he helped me put together a report and pictures and all this stuff and it made sense at the time. And it took a few more years before I fully grasped what he was telling me, but that was such a help. And it really got me interested in doing that kind of work. And I think giving kids—— showing them what the stuff is and explaining how it works has got to get them excited about getting involved in it. And I know the younger you start on them the better.

PS: Absolutely.

PG: And you have been mentoring people at all ages.

PS: I was really lucky. Every time I had a physics problem or a practical mechanical problem I could call up Wernher von Braun until he died. (laughs) And like high school and college physics, you know.

PG: That's great.

PS: And say "Onkel [Uncle] Wernher, help me!" (laughs) He wasn't really my uncle, but you know.

PG: Yeah, that's close enough. The only help I really got was about the time I got—I was in my sophomore year and living at home and guy moved in across the street with some buddies and he was two years ahead of me at UCLA engineering. And he had all these old exams and papers and stuff and so he said, "Here, look through these." (laughs)

PS: (laughs) Oh boy, that was a real help.

PG: I was a better student than he was, but at least I got a clue what kind of questions they were asking and it helped a bit.

PS: Oh, I'm sure.

PG: But not, you know, a great deal. But it was enough to get confidence that, "Oh, I can do that. I can do this. I can do the other." And of course I think was going into electrical [engineering], which was not something I cared to even tried to do. I stayed in mechanical-type engineering because it made sense to me. I could see what was going on. Electrical? Electrons? Come on. I don't

believe it. (laughs) It's like turning on a tap and watching the water come out. That I can see. I don't see the electrons. (laughs) So, that's about all the questions that I can think of. Have you got some further comments that you want to add to our little discussion here?

PS: Oh, if you get me started on the stories, you know, it will be way too late. So how many more minutes? We only have five more minutes.

PG: You can talk for five minutes.

PS: Yeah. Well, do you want the Einstein story?

PG: Sure. Absolutely.

PS: Okay.

PG: You mentioned his name, you've got to tell us about him.

PS: Okay. (laughs)

PG: Uncle Albert.

PS: Onkel Albert, *ja*. Well, as I said we lived in Alamogordo and I was about four years old at the time. And the doorbell rang and I had been anticipating Onkel Wernher, Wernher von Braun. And he brought a friend along. And so I yell out to my mom, "Hey, who's the guy with the teddy bear

hair?" And it turns out it was Onkel Albert. My dad immediately introduced him as Uncle Albert, Albert Einstein. And then I had been real good that day so I got to sit with the adults. And I sat right next to Onkel Albert. And about three quarters of the way through dinner he must have gotten an idea. And he went down to his watch pocket and pulled out a thin steno pad, and still attached to his watch fob, because I guess he was always losing his notes. And he started to write. Well, writing at the table was *verboten* so——forbidden——so I put my little hand down and said, "That's not nice. Mommy doesn't like that." And the silence was sort of deafening. And immediately an exception was made for Albert Einstein. (laughs)

PG: (laughs)

PS: And me. That was the one and only night that I got to write at the table. (laughs)

PG: (laughs)

PS: And so later that night I was watching television. And all the science fiction shows way back then——this was in the early 1950s——had $E=MC^2$ prominently shown. And when I had had questions on math or science I'd always ask my mother, who was a full professor on nursing arts. But she would usually

say, "Well, why don't you ask your Uncle Wernher the next time you see him." Hoping that I would forget because, you know, precocious children never forget, of course. And so just as this was occurring, who would walk in but Onkel Albert. So I went running over to the TV. "Look! Look! Look! Do you know what that is? You're an uncle."

PG: (laughs) Do you know what that is. (laughs)

PS: And he sat down and said, "Well, perhaps." And invited me to sit on his lap, which I took as an extra invitation to investigate his hair, because my mom wasn't around to tell me not to do it. I mean I knew not to do it, but (laughs) it was too tempting. And so he takes out his steno pad again and starts to write. And at the end of each page he asked, "Well, did you understand?" And I go, "*Ja*," so that I could continue playing with his hair. Now, I don't quite understand why at the age of four he was telling me the theory of relativity, since all I knew at that time was my ABCs in both English and German, and my numbers in both languages, and little short addition and subtraction, but no higher math. However his trip was extremely brief and very, very secret and because of that no pictures were allowed. So maybe he wanted to give me something to

remember him by. Unfortunately it didn't last my many, many moves because I could have used them in graduate school.

PG: I would think so. (laughs)

PS: But at twenty-seven pages later he finally said, "Did I really understand?" And I said, "Oh, *ja*, I thought it was a great bedtime story. Do you have any more?" (laughs) I wanted to keep on playing with his hair. (laughs)

PG: Other people would have thought it was a sign of (snores). (laughs)

PS: Well, I still think it's a great bedtime story. (laughs)

PG: Oh yes, absolutely.

PS: Thank you very, very much, Phyllis. I really enjoyed this.

PG: Sure. It was fun. We talk a lot. We know each other pretty well, and it was fun to do this.

PS: Yes, it was.

END OF INTERVIEW