Interviews of the Margaret MacVicar Memorial AMITA Oral History Project, MC 356

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GAIL H. MARCUS – class of 1968

Interviewed by Madeleine Kline, Class of 2020

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Margaret MacVicar Memorial AMITA Oral History Project

Gail H. Marcus [SB Physics 1968, SM Physics 1968, ScD Nuclear Engineering 1971] was interviewed by Madeleine Kline [Chemistry and Biology, class of 2020] at her home in Cabin John, Maryland on January 27, 2018. At the time of the interview, Dr. Marcus – a trailblazer for women in nuclear engineering – was a consultant in nuclear technology and policy. She was also helping her classmates prepare for their 50th reunion in June 2018.

After receiving her ScD from MIT, Dr. Marcus moved to Washington, D.C., where she worked as a systems analyst and nuclear specialist for a not-for-profit organization called Analytic Services (ANSER). She conducted analyses on proposed Air Force systems at ANSER for eight years before moving to the Congressional Research Service (CRS), where she worked as the Assistant Chief of the Science Policy Research Division. At CRS, she was responsible for work for Congresss on a broad range of science and technology issues, and was involved in the analysis of proposed congressional legislation concerning nuclear policy and risk assessment. In 1985, Dr. Marcus began working for the U.S. Nuclear Regulatory Commission (NRC), where she held numerous positions, including as technical assistant to one of the agency's commissioners. She spent half a year in Japan while at the NRC, working with Japan's Ministry of International Trade and Industry on the Advanced Boiling Water Reactor, and another year as a Visiting Professor at the Tokyo Institute of Technology (1998-1999).

When she returned to the United States, Dr. Marcus worked at the Department of Energy (DOE) as Principal Deputy Director of the Office of Nuclear Energy, Science and Technology. She served as President of the American Nuclear Society (2001-2002) and worked as Deputy Director-General of the OECD Nuclear Energy Agency in Paris (2004-2007). Dr. Marcus is the author of the book *Nuclear Firsts: Milestones on the Road to a Nuclear Power Development,* and of the NRC's Principles of Good Regulation.

KLINE: First, I'm wondering how you grew up. What mentors or influences you did you have in your family? Also, what was your childhood like and how did it steer you toward your future?

MARCUS: I grew up in a relatively small resort town in New Jersey – Long Branch, which is right on the ocean. Long Branch was a somewhat quiet town when I was growing up, but in the 19th and early 20th century it was a major resort destination. It was visited by seven U.S. presidents between Ulysses S. Grant and Woodrow Wilson, wealthy people had summer estates in the area, and Winslow Homer painted there. So I had a pretty idyllic childhood. I spent all day

every day on the beach in the summers growing up, and I found it hard to understand how people could live without an ocean nearby.

My parents were New Yorkers, Jewish, and heavily focused on education. They wanted to give us – the "us" is that I have two younger brothers – a good background and a good foundation.

So we had all the wonderful, good life experiences that middle-class American children had in those days. We had music lessons. We had scouting. There was never a "You should go into science," directive from my parents, but I do remember a number of times both my mother and my father demonstrating scientific phenomena for us – for example, my mother dipping stalks of celery in water with dye in it to show how they sucked up the water, and my father taking us out on the back porch in the middle of a thunderstorm to count the time between the thunder and the lightning, and calculate how far away the storm was.

My father was an electronics engineer and worked for the government at Fort Monmouth [New Jersey]. My mother was a teacher, so education was number one, and it was a factor in everything we did. As we grew up, there were science projects, books, microscopes, etc. In terms of professional guidance, if anything, my mother always talked about a good profession being either a medical doctor or a lawyer. One of my brothers is a doctor, the other, a lawyer. Since I'm the oldest, in a way it's a bit surprising that I was the iconoclast who didn't follow one of those paths. But I was drawn to science, and they certainly didn't discourage me.

KLINE: Were your parents born in the United States?

MARCUS: Yes, my parents were born in the United States, but all my grandparents were born abroad, so my parents were the first generation to be born in the U.S. In fact, my mother may have spoken Yiddish in the home until she went to school, because her parents didn't speak English in the house. I believe that my father's family spoke English in the house, but he spent time with his grandparents and spoke Yiddish to them.

My funny story is I grew up in a neighborhood with a lot of older Italian people. There had been that huge wave of immigration late in the 1800s and early in the 1900s – Jews and Italians and Irish. All the Italian grandparent-age people I knew spoke with a heavy accent, and my grandparents spoke with a heavy accent – so I was sure that when you got to be the age of a grandparent, you suddenly developed an accent! I just didn't understand how. But when I saw a

television program with a grandparent not speaking with an accent, in my mind, I knew it wasn't depicting reality.

KLINE: Did you go to a public high school or a private high school?

MARCUS: I went to public school throughout.

KLINE: Since you didn't have an older sibling to look up to, who were your role models?

MARCUS: That's a good question. I don't really remember too many people that I viewed as role models at the time, although surely there were some people I admired. I was not only the oldest in my family, I was the oldest among my cousins, too. I do have one second cousin who's slightly older than I am, but we didn't see that branch of the family very often when I was growing up. I'm the oldest of the first cousins, so there was nobody before me in my generation in my family as a role model. I did admire my mother and, as a child, wanted to be just like her, so she was probably the closest thing I had to a role model (although I assume most little girls want to be just like their mothers.)

Maybe, in a way, the fact I had no one in my own generation as a model made me a little bit more of a leader, or at least made me feel like a leader. I remember shanghaiing my brothers once or twice to sit there while I played teacher to them. They didn't like that much, and they didn't sit very long for that! But I didn't have, in particular, an older brother to make me think, "Well, the boy does this, and the girl does that." So I'm sure my being the oldest was important in some way, although I've never really tried to psychoanalyze that.

KLINE: And in your high school, was it common for people to go into engineering or for women to want to go to MIT?

MARCUS: My high school was a pretty ordinary high school. That is, there were a wide range of capabilities and interests. A handful of people went to top-notch schools like Harvard and Yale. Most, however, stayed closer to home. There were one or two people a couple of years older than me, male, who had gone to MIT, although no one else went there from my class. And as far as I know, no women from Long Branch High School had gone to MIT.

As a result of the fact that my school was probably about average, I always felt that I didn't have as much preparation as others when I got to MIT. In other words, I didn't have much AP, or advanced or honors math or science classes, which might have been helpful. But I had a decent education. And I had a group of classmates in high school that were on par with me academically. I graduated

as valedictorian, but that was superficial; I had a group of intellectual peers, which made school fun and challenging.

I also probably benefited from the fact that I grew up in what I guess I'd call the "post-Sputnik" era. The year I started junior high school, the city public school system started what they called a pilot program. So in a sense, I had a little bit of extra background that other students didn't have. This class of about 25 or 30 students had some accelerated studies, but it basically petered out by high school.

Although it turned out that this program did not provide as much additional education as had perhaps been intended, it did group the highest-achieving students together. So the most challenging students at my grade level were in the same classes for at least two or three years, until our interests diverged. I think the intent had been to keep everybody together for six years, but not everybody was interested in science, and not everyone wanted to take advanced second-year physics and subjects like that, and I didn't want to continue studying Latin, which was another emphasis of the original program, so the group eventually diverged.

KLINE: But you knew pretty early that you were into science and math?

MARCUS: I try to trace that back. I think so. Yes, I think that probably by junior high school or early high school I was interested in science. I remember being drawn into science in one junior high school class. What field of science it was going to be, I didn't know. But I got into doing science projects, and I enjoyed them, and I enjoyed finding out about how things worked.

I would probably say I never remember being focused on anything else. Maybe when I was a little, little girl and wanted to be just like my mother, who was a third-grade teacher – maybe then I had a different thought. But by the time I really was thinking career-wise, I might not have been thinking MIT, but I was thinking sciences of some sort.

KLINE: And what made you think of MIT?

MARCUS: Well, it wasn't on my list initially. I probably thought it was a step too far. But we were going around looking at colleges, so we were in the Boston area. My father says, "Oh, come on. While we're here, let's look at MIT." And I looked at it, and I still wasn't really convinced. But my father kind of challenged me. He says, "Well, come on. I'll pay for you to submit an application. We'll just see." And then when I got in, and I'm waffling back and forth, because I knew this was

a big decision, he almost dared me. Really. I will say that. He'd go, "Come on, don't you think you're smart enough? Come on, you can do it." So I attribute it to my father needling me.

KLINE: Did he go there?

MARCUS: No. My father got caught up in the war [World War II]. He had started college, and frankly, I think he had started in a field that he wasn't interested in. He was pushed by his mother in a certain direction. I think the war was a good excuse for him to drop it. And then by the time the war ended, he was married. And shortly after he came home, I was on the way, and he never completed college.

My mother actually completed college while my father was away. And then later on, while I was in junior high school, she went back and got a master's degree. Her undergraduate degree was in business, but she had started teaching elementary school, so she went back for a master's degree in education. I remember being very proud of her, because I knew at that time that not too many women had advanced degrees. I also remember that she sometimes had me "help" her. I say help with quotes because she put in a lot of work herself. But I was a studious kid, so she sometimes asked me to review her work. I actually offered her advice that she took, so I was very proud when she got a good grade! Once I even read a book and worked with her on the book report. This was a heady feeling, because I was in 8th grade, and I thought I was doing graduate level work! Only a little, of course, but at the time, it seemed like a big deal.

But, returning to my father, he was very smart. He was an electronics engineer. And actually, he was the one I usually turned to for math help or science help, or for help on my science projects. He had the background, but not the degree.

KLINE: Do you think some of his pushing you toward MIT was sort of a vicarious wish?

MARCUS: Ooh, that's interesting. It could be, but I never thought of that. I'll have to ask him. I would have assumed he might have thought one of my brothers would take that path, so I wouldn't have assumed he would have pushed me, but it could be.

KLINE: Did your brothers go to MIT?

MARCUS: No. One brother went to U of P [University of Pennsylvania]. He became an ophthalmologist. And the other brother went to Cornell, and then later became a lawyer. So we all went to good schools, but we all went in different directions.

What is interesting is that I think the brother who became the ophthalmologist always had an interest in science. And now, when I really don't pursue science very much, he takes classes and pursues science as a hobby. I don't know if he feels that he missed his calling or what.

KLINE: When you got to MIT, did you live in McCormick Hall?

MARCUS: Yes, McCormick had opened just the year before I came to MIT. In fact, it was the only place a co-ed could live at the time if you weren't from the immediate area. And, as I think about it, I'm not sure my parents would have let me go to MIT if there was not a girl's dormitory – so my timing was probably fortunate. It was the first year the dorm filled up. And because it was just filling up, I ended up with a single room as a freshman that I kept all four years.

KLINE: Wow!

MARCUS: That was amazing. People don't have that luxury now. There were certain benefits from that time.

KLINE: When we spoke earlier, you mentioned your freshman year chemistry class, and how you and your husband's mutual distaste for it brought you together. Are there any other classes you want to talk about?

MARCUS: I was always interested in physics. But the interest was probably solidified by the fact that the main lecturer for 8.01 was Tony French [Anthony French, MIT Professor of Physics 1962-2018; dedicated to undergraduate physics education; American Physical Society fellow]. He was fantastic. He was very engaging. I think there are a number of people in my class who had not planned to major in physics, but who turned to physics because of him.

As I say, I already thought I was interested in physics. But he would do things like jump on the table at the front of the lecture hall and run across it with strobe lights flashing to show us the motion. That's the most vivid thing I remember, but he was an excellent teacher.

I mentioned to you that my high school didn't have much in the way of honors or AP courses. I think I was feeling that freshman year. Freshman year was very hard for me, as it was for a lot of people. I'm actually finding out now that I think each of us was in our own little vacuum and thought, "Oh, I must be having the world's worst experience!"

KLINE: That's so common! Everyone thinks that they're struggling so much, and everyone else is just—

MARCUS: I know. I'm finding that out, because I'm working on the reunion book for our 50-year [class of 1968] reunion. And some of the bios we're getting, all these people are saying, "I was so overwhelmed." Wait a minute – you didn't tell me that then! I thought you were very confident and I was the one that was overwhelmed!

But it is true, actually, that my first term, I worried I was going to flunk out, and I spent all my time either studying or worrying about my courses. Well, to be honest, I tended to goof off until everyone went to bed, and then I did my work. I did enjoy talking to others about how we were going to save the world, and all that. So I pulled all of these all-nighters that I probably wouldn't have had to pull if I'd started my homework at a reasonable hour. But I felt I was working very hard and was almost always working.

About the only thing that gave me hope was that, at some point, I learned that the standards for admission for women at the time were tougher than those for men. The powers-that-be rationalized that this was because of limited housing for women, but this policy had apparently been in effect before McCormick opened. It was really that there was entrenched institutional discrimination in society in those days against accepting women equally into traditional male fields. Unfortunately, I didn't learn this my freshman year, when it really would have helped me most, but once I learned it, whenever I was feeling overwhelmed by the work, I would think to myself that there must be at least one male student in the class who was dumber than I was!

Some people were even more traumatized than I was by the challenges – but that also added to my stress. A couple of people who I knew became suicidal during the first year, and would talk openly about committing suicide. I'd never encountered that, so I initially took it as a joke – after all, who hasn't said, "Oh, I did so badly on that test that I think I'll kill myself"? But when we realized it wasn't a joke, we had to learn how to deal with these people. They eventually got help, and I guess I learned something in the process, but that made the first year even tougher.

In any event, my grades weren't spectacular. I mean, I passed everything, and I think I even made Dean's List my second term freshman year, probably by the skin of my teeth, but I was not breaking any records. [The Dean's List was abolished after my freshman year.] And I did end up getting two degrees in four

years, so in retrospect, I guess things weren't quite as bad as they sometimes seemed at the time.

KLINE: Did they have Pass/No Record back then?

MARCUS: No. Pass/Fail started around when we were graduating.

KLINE: OK.

MARCUS: So we had grades. That probably added to the pressure to work really hard. And then the second term, I said to myself, "If I have to work this hard, I shouldn't stay at this school." So I worked less hard, and my grades went up. And then the third term, I slacked off some more, and my grades went up again. I thought, "Wow, I'm on a roll!" Of course, it didn't last. My grades flattened out. But they flattened out at a respectable level, and I was still studying hard, but I was having more fun, too, so I stayed.

In retrospect, I think what happened is that a lot of people came in with academic benefits that I didn't have. That made their first term and their first year easier, and then we all equalized. So I didn't exactly rise to the very top of the top after that, but I was in a better place. Still, it was a hard transition. And I place a lot of blame on my high school math teacher, who would not teach calculus.

KLINE: Wow!

MARCUS: He said, "Calculus is for college," and refused to teach it.

KLINE: So did you take 18.01?

MARCUS: I had to take all the regular courses. When I took 18.01, most of the students taking it had had at least some calculus. So it was a bigger challenge for me than for them, but I got through it. I guess what doesn't kill you makes you stronger.

KLINE: Yeah, absolutely. Do you want to talk a little about Millie Dresselhaus or any other professors, advisors or mentors?

MARCUS: I didn't have Millie Dresselhaus as a professor, but she took an interest in the coeds. [Professor Mildred Dresselhaus, a pioneer for women in science and engineering who was known for her work on carbon science and carbon nanostructures, was associated with MIT for 57 years and held professorships in two departments, Electrical Engineering and Physics. Among numerous other

distinctions, in 2014, she was awarded the Presidential Medal of Freedom.] And she came and spoke to us once – I guess my freshman year – about her career and how she'd done things. I must say what struck a lot of us in a somewhat negative way is that she really didn't take any time off when she had her children. She went right back to the Magnet Lab with an infant, and we weren't sure that was a good thing. And at that time, I'm not sure if that had the positive effect that she and the administration wanted it to have. But in retrospect, she was one of the few people around who could conceivably be any sort of a model of a woman succeeding. I don't think I had any female professors as an undergraduate. I can't remember any. So in terms of role models, there were very few.

But you know, for my mother's generation, things were even harder. My mother once said she once had been interested in science, but she knew she wouldn't be able to get a job, so she didn't end up majoring in science. She went to Hunter College [in Manhattan].

This is on my mind because I always knew that [medical physicist] Rosalyn Yalow, the [1977] Nobel Prize winner [in Physiology or Medicine, for the development of radioimmunoassay], had gone to Hunter College, but I recently discovered another Nobelist who had gone there. Rosalyn Yalow went there around the same time as my mother. They didn't know each other, but it was around the same time. The other woman was a few years earlier. [Rosalyn Yalow graduated in 1941 and Gertrude Elion, who received the Nobel Prize in Physiology or Medicine in 1988 for the development of immunosuppressive agents to treat AIDS, graduated in 1937.] And both of them, when they graduated, couldn't get jobs at all. They either worked unpaid jobs or worked as secretaries, and worked their way back into science. So at least my generation was way, way ahead of that.

KLINE: Did you experience any sort of discrimination for being a woman?

MARCUS: You know, it's hard to tell; I always ended up with a job. And I always ended up getting pretty much where I wanted and doing what I wanted. So if there was discrimination, it may have cost me a particular job, but it didn't really hold me back in the end. But I could probably write a book about comments – some of them a little bizarre, some pro, some anti – from job interviews and things like that.

For example, one interviewer who asked, "You probably played with dolls when you were growing up, didn't you?" I said, "Yes, but why is that relevant?" [And he said,] "Well, boys take clocks apart and put them together again." So I didn't

get that job, but that was just a summer job, and I got some other job anyway. And then there was somebody actually who tried to make a positive out of it [my being a woman] in a weird, weird way, saying, "You could probably go down to the machine shop and get them to give the jobs from our office priority!" I wondered what he expected me to do, flirt with the machinists?

So there were some strange comments. But I think at that time there were beginning to be some people who either realized what was fair or even who wanted to give a helping hand – so I feel pretty lucky about my career. I feel it's been, in many respects, better than I ever would have imagined.

KLINE: How do you think MIT prepared you for the important positions you held throughout your career?

MARCUS: That's a good question. Considering how much time I spent on problem sets and on equations that described physical phenomena, I find I really haven't used them directly during most of my career. Maybe people in other fields do use their technical education longer and more directly, but I moved very quickly out of the areas I had studied and into a much broader and more general area.

What has been useful is how MIT taught me to attack problems – how I think about them, and how I put them in perspective with the bigger picture. And, I'm sure the tenacity I developed in persisting until I solved a problem is no small part of what MIT taught me. MIT people aren't quitters. When the going gets tough, they don't quit. They are in their element. They got used to getting an education from a firehose, and tough challenges, and they got used to being deluged with a lot of information.

I sometimes like to joke that the most important thing I learned at MIT was the art of estimation. This was a part of 8.01 when I took that course, and we got problems like how many blades of grass are there in the Great Court, or how many cars can be on Massachusetts Avenue between Harvard and MIT. They are not physics problems, *per se*, but they teach you how to get an understanding of the big picture. I probably use that lesson, in some way or another, many times a year, certainly more times than I have to solve an integral equation! And I use it both in my professional work and in my personal life. It helps me get a scope on a problem—size it up quantitatively, determine how big or small or important it is.

But to get serious again, in every job I've had, and every issue I've tackled, in most cases, I haven't been the person who did the original technical work. However, I did have to understand the technical work, understand the strengths

and weaknesses of the results, and figure out how they fit into the bigger picture. The general analytical skills that I developed at MIT have allowed me to address a broad range of issues in the course of my career, to analyze them, and to figure out how they fit into the bigger picture.

KLINE: Before we move on, is there anything else about undergrad at MIT that you'd want to mention?

MARCUS: Well, of course, meeting Mike. [Michael Marcus, Electrical Engineering SB ’68 and ScD ’72; worked for the Federal Communications Commission for 25 years developing important policies concerning the availability of certain types of radio waves, Wi-Fi and Bluetooth.] That was big. It was freshman chemistry class, which we both hated, and he asked me on a study date. I guess he thought coeds had to be smart – right? – and that I would help him. And I assumed he was going to help me, so that didn't work out, initially. We really didn't click right away. But then later, he was in a co-op program coming to [AT&T] Bell Labs, which is near where I grew up, and we clicked at that point. So that was even bigger than my degree. We graduated and got married two days later.

KLINE: Where did you get married?

MARCUS: In Asbury Park, New Jersey. Does Bruce Springsteen ring a bell?

KLINE: Yes!

MARCUS: Asbury Park is just a few miles down the coast from Long Branch. Bruce Springsteen didn't actually come from Asbury Park – in fact, he was born in my hometown, about a mile from my house – but he got his start in Asbury Park. And his first album is *Greetings from Asbury Park, New Jersey*.

KLINE: Then did you intend to go straight through to Ph.D. work?

MARCUS: I don't know when I came to that conclusion, but by the time I reached my senior year, I had come to that conclusion, and since Mike wanted to continue in grad school, it made sense. And a lot of people talk about the value of taking a break, but I always thought if I took a break, I'd never—

KLINE: Never go back.

MARCUS: --go back.

KLINE: That's how I feel.

MARCUS: So I wanted to go straight through. And Mike had gone into ROTC, so he owed the Air Force some time. There was a benefit to him of continuing in school: he could be deferred [from his service obligation] as long as he was in school. We both wanted to finish our educations, because we didn't know where the Air Force would take him and where we'd end up – it was, conceptually, four years – and what we'd want to do after that. So we both stayed, but there was some pressure to finish fairly quickly, because it wasn't guaranteed that they would let him stay forever.

KLINE: I forgot to ask you about how you graduated in '68 with both a bachelor's and a master's.

MARCUS: You know, that was not intentional. I'd gotten to the point where I was taking advanced courses, and I suddenly realized that I had enough courses for an extra year, and the right courses. All I needed was to do a bigger thesis. So when started my thesis, I started with the intention of doing a bigger thesis and got the two degrees.

It wasn't that uncommon to get two degrees. Mike really earned a second degree as well, but because of the Air Force, he didn't want to pick it up right away, because they might have considered that the terminal [highest level] degree. And then, later, when he asked his thesis advisor, "OK, now can I get the degree?," his professor said, "Nope, now you're at the doctorate level, so you don't go back and get a master's degree, too." So he never picked up that extra degree.

My joint bachelor's and master's thesis was on the scattering of gamma rays. I worked in the basement of Building 2, which was a pretty grungy environment. The main thing I remember – aside from the fact that moving lead bricks around was hard work for a girl who was 5'1" and weighed about 100 pounds – is that the lab was used to study the radiation levels in the bones of the watch-dial painters. These were women who used to paint watch dials with radioactive paint. No one realized the danger, so the women used to lick the tips of the brushes to make a fine point, ultimately giving them a high dose of radiation. So when they died, their bones would be sent to this lab in copper boxes. The copper boxes were welded closed, and I didn't work on that, so I never saw the actual bones, but it was still pretty creepy.

KLINE: Getting back to after you were married, did you live in an apartment while you were in graduate school?

MARCUS: We lived in Eastgate, and I thought that was great. I guess I've been lucky. I think most of the places I've lived are great. The first year, we had an apartment on a low floor, but then we moved back to New Jersey, because we had summer jobs there, and they didn't hold our apartment. When we moved back again for the fall, we were on the 16th floor, overlooking the river and overlooking Boston – and overlooking that expensive apartment building on the other side that was paying a lot more money to look at us than we were paying to look at them! So it was nice. It was a new building at the time, and everybody else in the building was in the same boat – that is, we were "poor, starving graduate students." At least we thought of ourselves that way. But we were close to campus, so it was very convenient. And there were a few little restaurants nearby, so we really had everything we wanted, despite living on a grad student income. It was a great life. I really didn't want to graduate.

KLINE: But you graduated in three years?

MARCUS: Yes. Well, as I say, we felt some pressure that we weren't going to be given forever, so we both pushed ourselves. Also, the professor I was working for ended up leaving MIT, so that put additional pressure on me. So in the end, we both completed our work incredibly fast.

KLINE: OK. Actually, I'm not really familiar with the difference between a PhD and a ScD.

MARCUS: I think at one point there had been a different requirement, maybe an additional language requirement for the PhD. But by the time I graduated, there was no different requirement. It was really a matter of choice. We decided on the ScD because it was more unusual (very few schools in the U.S. offer it). And also because I liked the color of the hood better! So it was not a profound decision! A lot of people introduce me as a PhD, and I don't even bother to correct them.

KLINE: What was your doctoral thesis on?

My doctoral thesis was on the study of radiation damage in crystals by means of proton channeling. So it was really a physics experiment, but one with indirect implications for nuclear reactors. The idea was that, by shooting protons through crystals at the right angle, they could travel a long distance through "channels" in the crystal structure. But they would be stopped by any damage to the perfect crystal structure, and thus were a tool to study the damage. I did the experimental work at Lincoln Labs. I remember it being very time consuming

to keep adjusting the crystal a little at a time to get the protons to channel properly, but the elation I felt when I finally succeeded.

I was using a device called a multi-channel analyzer, which looked at the whole spectrum of radiation at the same time. One funny memory is that, one day, I realized that, before multi-channel analyzers, this same experiment could only be done looking at particles of one energy at a time. I commented to my advisor that it must have taken someone forever to finish a doctoral thesis with a single-channel analyzer. However, he answered me that, when that was the only equipment available, probably one curve of the whole energy spectrum, generated one point at a time, would constitute an acceptable thesis. But with a multi-channel analyzer, I had to generate multiple curves. So I could get more done, but a thesis probably took about the same amount of time.

KLINE: And so then, after you graduated, what were you thinking?

MARCUS: After we graduated, my husband owed his soul to the Air Force for a while. Fortunately, with the doctorate, they were going to keep him in technical work and not send him to Vietnam. There were only a couple of places where they were doing the kind of technical work he could contribute to. The best choice seemed to be Washington, because we thought it was the best chance for me to find a job. We truly thought it would be temporary. Three, four years – we would move on to someplace else, I don't know where.

I ended up getting a job at a very small, very unknown think-tank-type organization (Analytic Services, or ANSER) – a nonprofit company that worked primarily, at the time, for the Air Force. I did systems analysis. And it was such a small company, the president did a lot of the interviews. He had come to MIT around the time I was finishing my thesis and looking for a job, and had interviewed me. The announcement had said they were looking for nuclear engineers, but he got all through explaining the whole company and I hadn't heard anything about a nuclear-related project. So I asked him, "What do you need a nuclear engineer for?" And he said they tried to have people in all different disciplines so that they could pick up and do anything they needed to do.

As a result, I did a lot of things that were seemingly not nuclear-related. One of them was simulators for aircrew training. Now, they're not quite like simulators for nuclear power plants, but after I got through working there and went on to other jobs, I realized that the nuclear industry used simulators. And there were a lot of commonalities between simulators for pilots and simulators for control room operators that I had never even thought about. I always thought it was

interesting how something I thought was totally removed from the nuclear field turned out to be very relevant to my later work in the nuclear field. And then there were a couple of projects that were nuclear-related, and they were always given to me. So the job worked out better than I thought it would.

KLINE: I forgot to ask why you chose to go from physics to nuclear engineering.

MARCUS: Good question. For some reason, I was more interested in low energy physics. And it was my husband (well, not yet my husband at the time) who realized that. He says, "You know, if you're interested in low energy physics, I think that's what the nuclear engineering people are doing." And I hadn't thought about that. I just assumed I'd stay in the physics department, but the physics department at that time really didn't focus on that, so I don't know if I would have found a home there.

But when Mike mentioned that, I looked into the nuclear engineering department, and sure enough, it seemed to be a good fit. Of course, there was some engineering background that I didn't have. So again, the first year in graduate school, which was also the first year I was married, proved to be very challenging. I had to take some fundamental engineering courses that most of my graduate school classmates already had. But it worked out in the end, and I did do a thesis that I would consider more physics than engineering. It wasn't designing a reactor, it was really looking at the interactions between particles in crystals.

KLINE: Did you know that you were the first woman to have earned a PhD in nuclear engineering at MIT?

MARCUS: I didn't know it when I entered. And, in the 'small world' department, there had been a woman from the same floor of McCormick, Margaret (“Muffet”) Chatterton, who was a couple years ahead of me and who had gone into the nuclear engineering department for grad school, so I didn’t think of myself as a pioneer in that department. But Muffet stopped with an engineer's degree. By the way, she later ended up at the Nuclear Regulatory Commission with me, so our paths kept crossing.

But it's a small field. And the head of the department, Manson Benedict [PhD ’35 Chemical Engineering; worked on the Manhattan Project and became the first head of the Nuclear Engineering Department at MIT], interacted with all the other department heads in the field. One day, he told me that he had asked the other department heads, and there were no other women getting a doctorate at the time at any university in the country. I learned this while I was

in the middle of doing my thesis. Muffet had already graduated by the time I entered, so I was the only woman in the whole department in the time I was there, with about 115 students.

KLINE: Wow – what was that experience like?

MARCUS: It was a little strange at times. Again, mostly I lived in my own little bubble, and I went and did what I needed to do. But there were occasional times that I was the recipient of strange comments, or strange actions. For example, there was one guy who said to me, "You should be home taking care of your house for your hubby," or something like that. And I said, "It's a one-bedroom apartment. How much effort does that take?"

And there was one professor who I really liked. He was a good professor. But I come in one day, and I'm sort of rushing in late, which was a bad habit of mine. He's handing back the tests we had taken the week before, and he suddenly says to the class, "You guys let a girl beat you." The really funny thing is that it was probably the only time I did the best in the class.

So there were few moments like that, but mostly, if I was not accepted, I just didn't notice that I wasn't accepted. I just persisted and did what I felt I had to do. And I had enough people who were making that possible. I won't say I did it all by myself. For example, I had an excellent thesis advisor, Professor N. Thomas Olson. In fact, we still keep in touch with each other. And you know, regarding the professor who made that comment, I think that was his idea of a joke. He was basically very nice to me the rest of the time. So despite such comments, my time in the department was overall a good experience.

Some of the guys may have gotten together to study and do problem sets, but since I was a newlywed, I always wanted to go home anyway. They didn't invite me, but I don't think I would've wanted to join them even if they had invited me. So I'd go home and do my studying.

One funny story that I only discovered years later: Since I was the only woman in the department at the time, apparently, some of the students, particularly the foreign students, would later use my name to explain when they were there—as in, "I was in the MIT nuclear engineering department at the same time as Gail Marcus." So my time there became kind of the "Gail Marcus era" to some of the other students.

KLINE: Do you think that having two brothers growing up helped you feel more comfortable being around so many men all the time?

MARCUS: It could be. I never thought too much about that. Actually, I sometimes use that fact as a little joke. When I'm giving a talk, I say, "No, I don't need a microphone. I can talk loud, because I'm used to talking over my brothers." Of course, I had my mother, and I was pretty close to her, so it's not like I grew up only among men. I really identified with my mother. Sometimes I would take her side when I didn't really care about an issue, but I didn't want her to feel like she had no one on her side. But on the other hand, yes, having brothers meant I had to deal with boys of my age, so I was used to that.

KLINE: So then, jumping back to after that think-tank job, you—

MARCUS: OK, Mike was in the Air Force, it turns out, for three and a half years. They terminated his service early because the war was ending, and they didn't need so many people anymore. All of a sudden, he calls me one day at work, and he says, "I'm going to be out of here in a month, and I've already got my resume updated." Imagine that. By the time he called me, he had already written his resume and was getting started! By that time, we had a house, and we had bought a boat. Of course, none of these things are things that couldn't have been sold if we'd moved, or moved with us (in the case of the boat), but we were pretty comfortable in that area.

KLINE: In the Washington, D.C., area?

MARCUS: Yes. We were living in Northern Virginia, and the boat was on the Chesapeake Bay. Actually, we didn't even really discuss very much what we should do. He just started by looking for jobs in the area. And he ended up at a think tank called the Institute for Defense Analyses (IDA), so we stayed in the D.C. area. A couple of years later, by happy coincidence, my think tank moved into the same building his think tank was in. So we commuted together for a couple of years.

I was at ANSER for a total of about eight years, and I was beginning to think that I wasn't going to go any further in that job. In the meantime, I had gotten active in the MIT Club of Washington. This is where I'd say the networking comes in, sometimes in unexpected ways. There was an older guy named Dave Gushee – from a totally different field (he earned an SB in chemical engineering in 1950). He sounded like he was doing some interesting work at a government organization called the Congressional Research Service (CRS). I didn't know much about the organization, so I asked him about it, and he says, "You know, there is a vacancy in another division right now." I applied, and I ended up working there.

CRS is actually part of the Library of Congress, so it's a job in the legislative branch. They advise, write reports for Congress and brief congressmen and staff on various subjects. I like to say that this is when I got Potomac fever. Do you know what Potomac fever is? Well, people come here with the intention of not staying long, and then they kind of get sucked in by the process, and the excitement of being part of the process.

Now, when I was at Analytic Services, which was the company I was working for, everything was very long range, and most of it was classified. So it was very hard to discuss anything with anybody outside the Air Force or the company. If you asked me what I was doing, I could say something – it wasn't that I couldn't say anything – but I'd have to be a little careful. And you'd never have heard of it anyway, because it was all things that might happen years down the line. Or might not ever be funded.

When I worked at CRS, Congressional Research Service, what I was working on was the current legislation the Congress was working on. It was the stuff that was in the evening news, so suddenly, my work seemed very timely and very exciting. I'd go into a meeting, and there'd be congressmen, there'd be senators. So I suddenly was seeing the inside of Washington, which was very exciting for me.

KLINE: Was this legislation about nuclear policy?

MARCUS: One of the biggest things I worked on was risk assessment. This wasn't only for nuclear, but risk assessment is a big part of nuclear studies. But it also applies to chemical processes, for aircraft, and for many other systems and activities. The work I did related to when probabilistic risk assessment should be done and that kind of thing, and there was some legislation on it. In addition, I worked on energy-related legislation, some of it focused on nuclear, but more of it covered both nuclear and other energy sources.

KLINE: And how long were you there?

MARCUS: I was there five years.

KLINE: Until when?

MARCUS: Until 1985. And then I went to the Nuclear Regulatory Commission. In a way, going to NRC pulled me out of the center of what was happening. It certainly took me away from the work on the Hill. But it got me back into the nuclear field. And NRC moved people around, so I had a variety of jobs while was there.

Working at NRC was my longest gig. But in the years I was there, I first worked in the Office of Research. I later worked in the Office Nuclear Reactor Regulation. This office dealt with both operating and advanced reactors, and during my tenure in that office, I worked on both sides.

The most exciting period of my time there is when I worked for one of the commissioners, Kenneth Rogers, as one of the members of his staff – which again, put me at the top of that organization, where all the decisions were being made. That was a lot of fun, very interesting, and used both my technical background and the ability to work with other people and to synthesize different viewpoints. So in other words, it wasn't strictly technical. Other people were running the computer programs and crunching the equations, but I had to understand it and bring it to the point of some logical rule. How do you turn esoteric technical findings into a sensible rule that people can follow?

KLINE: And I don't know, was it 1986 when the Chernobyl disaster--

MARCUS: Yes.

KLINE: And did that affect the field at all?

MARCUS: Somewhat. Three Mile Island (TMI) [the partial meltdown of a reactor in Pennsylvania that was the most serious nuclear power plant accident in U.S. history] which had been in '79, occurred before I went to NRC, but NRC was still dealing with the aftermath of that accident. TMI affected NRC and the U.S. industry a lot more than Chernobyl because, of course, it occurred in our own country, and it involved the kind of reactors we had. The Chernobyl reactor was a different kind of reactor, and to a large degree, we were able to prove that it wasn't an accident that could have happened to our reactors. So Chernobyl had some effect on us, but the impact on our work was not as great as TMI had been.

KLINE: So how long were you and your husband here in the D.C. area?

MARCUS: We moved here in 1972 and are still here today! So, a long time.

I was at NRC from 1985 to late 1999, but in a variety of jobs. But during that time, I had two stints in Japan.

KLINE: What brought you to Japan?

MARCUS: Well, this was a result of us following each other, and of a long-standing interest in Japan. I like to joke and say that my interest in Japan is the result of karma, because my father had been stationed in Japan at the end of WWII and had brought back many Japanese souvenirs that decorated the house as I was growing up. But Mike and I had been finding that Japan was doing important work in both our fields, and we had taken a couple of language courses in Japanese. We had even hosted a Japanese high school exchange student for a year (in 1989-90, before either of our stints in Japan), and we still keep in close touch with her.

This interest slowly morphed into something concrete, and Mike twice got assignments in Japan, and I arranged something so I could join him. His first assignment was through the National Science Foundation Japan Program. It allowed him to work for six months in Japan. I was able to arrange to work in the office of NRC's counterpart in Japan (that is, their nuclear regulator) during the same period.

This was a fascinating experience, in many respects. In the first place, the offices are very different than in the U.S. They had a very open office plan, so I had a desk next to me and a desk across from me, with no separation at all. In the second place, the government employees in Japan are mostly generalists. They are very smart and very hard-working, but they are moved from position to position, and most of my colleagues didn't have technical backgrounds. Instead, they relied very heavily on advisory committees. Superficially, it may look the same as our system, because we have advisory committees, too, but in reality, the role of the advisory committees in the two countries is quite different.

And the second time, it was for a whole year. There is a government program called the Mansfield Fellowships that trained several government employees from different agencies in Japanese for a year and then sent them to Japan. That time, I was able arrange to work at a university there [the Tokyo Institue of Technology] in the nuclear department. That turned out to be great, too. So both were wonderful experiences.

I was able to use this experience to conduct a more in-depth comparison of the regulatory processes in Japan and the U.S., and in fact, after we returned home, Mike and I co-authored a couple of papers on the topic. I also was able to teach on the subject. The student body there included both Japanese students and students from several other countries. The good part of that was that I wasn't expected to speak fluent Japanese. I had studied Japanese, so had some rudimentary capabilities, but all the professors and students spoke some English, so I was able to work in English.

KLINE: And did you ever think about working in a university, or did you always think you wanted to go the industry/policy route?

MARCUS: Well, I guess I assumed when I was working on my doctorate that I'd probably end up in academia, because I always thought that's what PhDs do. But I never gave it that much thought. Maybe if we hadn't gone to Washington, I would have pursued that path. I don't know.

But I must say, when I was doing my doctoral thesis, I was working on part of it at Lincoln Labs. I had an office on campus in the reactor building, but some of the experiments were done at Lincoln Labs. I was in a room in the basement with no windows. You couldn't tell what was happening in the outside world. There was a pipe that ran from the ground level down to our lab. I could sometimes hear if it was raining, and that was all I'd know about the outside world. I used to joke that I wouldn't know if the world had ended outside. Something about that psychologically turned me off, and I didn't want to spend my life in the basement of a laboratory. So maybe that was a signal, too, that I was not going to go into academia.

When I went to Japan, my experience was as what they called a visiting researcher. I didn't teach full-time; I taught only one or two hours a week, and I was mainly doing research. My research was on a comparative study of the Japanese and U.S. regulatory systems. And it wasn't in the basement!

KLINE: So after 1999—

MARCUS: That was 1998 to 1999. I came back, and well, NRC, which usually did a very good job in the personnel area, was somewhat slow in placing me. Admittedly, I was in a management position, so there were fewer options of where to place me. So it was harder for them, but I couldn't really see where things were heading, and while they were scratching their heads about where I was going to be, I started looking around, and I saw an opening that looked interesting at the Department of Energy. I ended up moving from regulatory work on reactors to helping develop advanced reactors – and other things. That's not all the office did, but that's my way of characterizing the change in a few words.

I ended up going to Department of Energy in the Nuclear Energy Office [as Principal Deputy Director of the Office of Nuclear Energy, Science and Technology], and that was very exciting, too. That brought me back closer to working with the Hill again and working with policymakers at a very high level. So it was a total change and very exciting.

In the first place, we were at the forefront of the efforts to develop the next generation of reactors. Everyone was interested in that – industry, Congress, and the international community. I had a chance to testify before Congress several times, I met with congressional staffers to discuss the work we were doing. I traveled – a lot – to the national labs, and to conferences in the U.S. and abroad. What was particularly rewarding was the opportunity to work on the start of an international collaboration on the development of advanced reactors.

KLINE: And you were there for how long?

MARCUS: I was there the end of December 1999 to April 2004. And then I went to France.

KLINE: Really? For work?

MARCUS: Yes. One advantage of sitting in that office was that I became aware that there was a position at the OECD, the Organization of Economic Cooperation and Development. One of its pieces is called the Nuclear Energy Agency, and they had an opening for the Deputy Director-General of that organization. And Mike and I were both thinking that it was time to do something new. So this time, I got the gig abroad, and he followed me. And that was three years in Paris.

KLINE: Do you speak French?

MARCUS: No, but my husband does. He took French in high school. Actually, the OECD wanted people to speak French, but they made an exception for higher management people. And really, almost everybody there spoke English. There was one IT person in the office who didn't speak English, and my secretary, who was French, interceded when I had to deal with him. It very seldom became an absolute necessity to speak in French. I did take French lessons, and I learned what I call “survival French,” but I never learned enough to carry on a technical conversation.

De facto, almost everything took place in English, and there was simultaneous translation for meetings with outsiders. There was one internal management meeting that was led by the Secretary General of the OECD, who at the time was from Canada, so he was definitely bilingual. If somebody asked him a question in French (he was from the English-speaking part), he would answer in French. But I only attended that meeting if my boss couldn't. So, maybe I went to three of those meetings in three years. And I knew enough French to get a general sense of what was being discussed.

KLINE: Having that experience in all three of those countries, what do you think were the main differences in the workplace and the field in different countries?

MARCUS: Oh, many, many, many differences. It's hard to say. I loved both experiences, by the way. In Japan, things were supposed to be done a certain way. Sometimes I would try to conform, and sometimes I just couldn't. And I would finally throw up my hands and say, "I'm an American. I'm going to do things my way." But people worked very hard and very long hours. And fortunately, I discovered – especially since I didn't speak Japanese – that they didn't quite expect that of me. I kept pretty normal hours, but they would really work extremely long hours. Sometimes I wasn't sure how effective all the work was. But they would show their dedication by being there until 10:00 at night, every night, which I didn't like.

The university was a little less like that. I basically just kept my own hours there. The university was very flexible. First of all, this was a position for a foreign visiting professor because they wanted their students exposed to foreigners. So it was a very casual and comfortable atmosphere.

In the government office, they always seemed to be running around. Sometimes I said to myself, "Gee, if they did it this way, wouldn't this be better?" But I couldn't say that to them; they wouldn't do it that way. The French office was not really so French. I mean, there were more French there than anybody else because most of the secretarial staff, et cetera, was French but the technical staff was multinational. So that was a very interesting atmosphere and a lot of fun.

But again, there were cultural differences. For example, I was accustomed, especially in the Department of Energy, that people stayed in the office when things were happening. So if you had to work through lunchtime, you would. Even the secretarial staff would sometimes move their lunchtime around at DOE. However, I could not get my secretary in France to stay for lunch. Don't get me wrong, she was a very hard worker. But she had her lunchtime, and she took her lunchtime. And officially, she was entitled to it! Sometimes, I would try to tell her it would really help if she could stay a half an hour and then take lunch…"Nope. I can't do that."

One thing I definitely did not like about either country was that smoking is much more acceptable and much more prevalent in both countries. This was particularly troublesome in the open office in Japan. The other people around me wouldn't give up smoking, so if I had to go to the xerox machine or the

bathroom, I would wait to run my errands when a neighbor lit up. In France, I had a private office, but I still was bothered by the smoke from the person in the next office. I managed to get him to close his door most of the time, which helped.

There were different kinds of rigidities that you have to deal with in each country. I'm sure we have ours in the U.S., too. You just had to figure out what you had to accommodate, what you could work around, what you could ignore. But I loved the experience of living in both countries. It's much different than visiting and much more eye-opening to the different ways of doing things.

KLINE: That's really neat. So when you came back from France--

MARCUS: Well, we had both had to take early retirement to take those jobs, so we had no jobs when we came back. My husband, while he was in France, mostly did consulting work. And when we came back, I picked up some consulting work, too, although he's done a lot more. So I haven't gone to an office for more than 10 years.

I had a couple of very big projects. I worked mostly for other governments and for international organizations. My biggest project was working on a feasibility study for one country considering starting a nuclear power program. They ultimately decided not to start one right now, but they are doing a lot of preliminary work, such as research and education, so that they can move in that direction in the future if they decide to later on. It was fun, but very intense.

For a while, I was busy because President Obama had nominated me for a Presidential appointment in a small agency called the Defense Nuclear Facilities Safety Board [DNFSB]. The vetting for that position took a lot of time. This was toward the end of President Obama's second term of office, and most of his nominations stalled. I was actually voted on, and approved, by the Senate Armed Services Committee, which had jurisdiction over the DNFSB, but the full Senate never voted on my nomination, so it died at the end of the 2016 Congressional session.

I also wrote a book during the period after we returned from France [*Nuclear Firsts: Milestones on the Road to a Nuclear Power Development*, 2010]. That kept me busy for over a year.

KLINE: What prompted you to write the book?

MARCUS: I kept reading news articles saying that it's the 50th anniversary of this, or so many years since the first of something. For some reason, these stories interested me, and I started collecting them. I suddenly realized that I had accumulated quite a file. I said to myself, “You know, I ought to look into this because I think it would make a nice story."

Initially, I was just was going to put together what I had, which would have been a little thin. But then I started trying to look up missing pieces, or look more into the pieces I had saved, and I kept finding more and more. Then, because an anniversary comes and goes, my thinking segued into looking at what was the first. So the book ended up focusing on the firsts of various events, hardware, and even organizations.

Then I discovered that there were some complications, because it's not as simple as saying, "OK, the first reactor, there's one, that's it,” because there's a first of each kind of reactor. I didn't do the first of each size, because that keeps changing, but I did come to the realization that some of the firsts were really so small that they weren’t practical, so I had to make a distinction as to what was the first one big enough to count. And then, the reactors have different kinds of coolants and different kinds of fuels. Furthermore, there are other parts of the fuel cycle, like enrichment and reprocessing, so I dealt with the firsts of all the different parts of the fuel cycle. And I even noted the firsts of the different kinds of organizations that sprung up around the industry – first industry association, first professional society, first international organization, etc.

It also turned out there were a lot of claims to "firsts." For a few of them, when I looked into them, I discovered that people got careless about their wording. For example, you find things like the first city powered completely by nuclear power. Well, yeah, maybe at midnight. But after years of hearing that those were firsts, I had to wonder what gave me the right to be the one who says, "No, that's not a true first?" Or "That doesn't count, but this other one counts?"

So, instead, I just tried to explain just how each was a first, and what the qualifications were. OK, this was a first, but it was at midnight when the demand was low. Or, this was a first, but it was a military facility that was diverted for some civilian use, so it was not the first intended for civilian use. And that meant that something else down the line was the first that provided practical levels of power, or the first built for civilian operation, et cetera. This made it much more complicated than I thought, but a lot of fun because of that.

KLINE: Good!

MARCUS: The really rewarding part is that people seem to have recognized the significance of the story I put together. In 2013, the ASME gave it an award, which really pleased me, for Best Book by an Engineer-Historian. I didn't even think of myself as a historian.

KLINE: That's so interesting. So you've maintained an involvement with the MIT Club of D.C., right? And do you think there are other ways in which MIT background has influenced your career?

MARCUS: Well, yes, many. Early in my career, I remember one job interview where somebody said, "Well, I see you have a degree from MIT, so I know you're smart." I thought to myself, "You're dumb to take that as the only measure!" But it has been a great credential to have.

One thing is that I've had made many connections because of MIT. I told you the one related to the Congressional Research Service. By the way, the job I ended up with in Japan at the university – the Tokyo Institute of Technology – was also due to an MIT connection. In this case, it was Alan Levin [SB Mechanical Engineering ’75 and SCD Nuclear Engineering ’80, a senior technical advisor at the Office of Nuclear Safety at the Department of Energy and manager of DOE’s Nuclear Safety Research and Development Program], who was an MIT graduate, but not even at the same time as me. I actually know him through both the American Nuclear Society and NRC. So there are really three connections. It could have been any one of them or could have been the combination of the fact that we had so many things that linked us that made him interested in helping me. And the person he directed me to, and who I worked with at TITech, Hisashi Ninokata [Professor, Politechnico di Milano and Tokyo Institute of Technology; Chair of the International Nuclear Societies Council], was also an MIT grad.

In terms of jobs, there may be other less direct links that I can't think of right now. I know, for probably one or two places, the fact that my degree was from MIT was certainly a plus, whether they said it in so many words or not.

Also, when we were in both France and in Japan, we hooked up with the MIT groups there. So it's always given us some sort of social outlet, and an outlet to people to connect with. In Japan, we ended up going to a university and doing some lectures there through one person we met through the Japan MIT Club. So there have been multiple connections.

I've also been engaged with MIT periodically in other ways. For example, I was on the visiting committee for my department at one point. Both Mike and I have

stayed engaged with MIT in a lot of ways. And we're class secretaries, so we're engaged with the class as well.

KLINE: That's really cool. One other thing I wanted to ask is, what you would say your biggest accomplishments were?

MARCUS: Well, I wouldn't have thought it at the time, but one of the things that now seems to be one of my most enduring contributions arose from when I worked for Commissioner Rogers at NRC. One day, he said, "We need some regulatory principles to follow." He put me in charge of it, which didn't mean I wrote the whole thing, but I gathered everybody's opinions, and synthesized them, and developed something that we called the Principles of Good Regulation [a celebrated one-page statement of the NRC's values that has served as a model for other U.S. and foreign organizations and agencies]. That was 25 years ago.

Last year at NRC, they brought me back, and they brought him back, and they had an event to celebrate the 25th anniversary of those Principles. In addition, the concept has expanded to some of the utilities and other organizations, and there are a number of companies and other organizations that have put in place a similar set of principles. You'd think the Principles are obvious, but it helps to state them, and it helps to be able to be able to say, "Because of this Principle, we should do X." The Principles include being open, being efficient with using resources, and being clear. These sound so obvious. But sometimes the obvious needs to be stated. So the Principles of Good Regulation are one accomplishment I'd point to.

I think it's been superseded now, but the work I did on risk assessment in the Congressional Research Service was important at that time. There was a committee print [a publication issued by a congressional committee on topics having to do with their research or legislative work] that I think was pretty widely circulated and used. But that was a long, long time ago, so I don't think it is directly used anymore.

At Department of Energy, I don't know if there's anything really that's just my product, but I came to that position when the office was starting to work on what they called Generation IV reactors, so I was heavily engaged in the development of that initiative. We were looking at what design concepts we should pursue, and I recall wanting to make sure that we included all the major types of technologies, so made some recommendations that ended up being incorporated into the final list of options to explore.

At the Nuclear Energy Agency, probably the things I'm most proud of were negotiating a cooperative agreement with Russia, which was not a member of OECD, and of implementing a project on knowledge management. Knowledge management refers to the retention of institutional knowledge over time as people retire, and has become a real issue in the nuclear industry as research projects end and as people retire.

KLINE: And I understand that you were President of the American Nuclear Society.

MARCUS: Yes. That was quite an honor for me because that was the top position with professionals in my field. It turned out to be an important year in a very sad way, because 9/11 happened early in my term. So what I thought would be an ordinary term really became focused on what this event might mean for the nuclear field, both in my government work and at ANS [American Nuclear Society]. And then I also pursued other initiatives that I thought were important for the society. So I feel very good about the work I did there.

KLINE: I was wondering if you could talk a little bit about the MIT summer internship program in D.C. There is a fund that you support?

MARCUS: Yes. When Mike and I started to think about giving more money to MIT, we wanted to give it to something we thought was important. There are a lot of important things, but one problem is that we're in different fields. So we either have to give to just one of our two departments, or we have to water down our contribution and give half to each department. Or, we thought we should find something special that we both can really relate to.

Because we are technical people who went into the policy area – my husband likes to say that we are "policy wonks" – we thought that supporting the MIT summer internship program would be something that's special for us, and that, by supporting that, we could pool the money and have a bigger impact. We've been doing that for a couple of years now, and hopefully we'll grow the money. I think it's especially meaningful for us.

KLINE: So would you encourage younger engineering people to look into policy?

MARCUS: Well, I always say I'd rather see people with an engineering background work on technical policy issues than see others do that. Now, that is not to say that non-technical people aren't smart and capable, or that they can't do good work, but I think technical people bring a more in-depth understanding. And policy decisions affect all of us, so we should not leave them to people who don't fully understand the technology or the issues. That's particularly true in the nuclear

field, where there are strong feelings on both sides that should be tempered with scientific facts.

Policy decisions affect the funding, affect technology development, and affect regulation. So it's important not to just sit back and say, "Well, somebody else will take care of that. I really want to tinker with my experiments." Not that everybody has to do it, but some subset of people in the engineering field need to get out of the lab and into the halls of Congress. People in the engineering field need to think more about what role they can play in affecting policy.

Of course, you don't only have to come to Washington. People can work at the state-level, or with their local congressional offices, or in other ways. Not everyone has to come and plant themselves in Washington, but some people certainly should. There are other programs that recognize this need. The AAAS [American Association for the Advancement of Science] runs a program where people in mid-career come for a year. The American Nuclear Society and other societies participate in that program.

People who come usually work on the Hill. They can work other places, but they usually work on the Hill for a year. Some of them stay, and some don't. If you've talked to Aviva [Aviva Brecher, SB and SM Physics ’68; worked in MIT’s Departments of Physics and Earth and Planetary Sciences as a technical consultant, and as a research scientist at the U.S. Department of Transportation], she did that.

Some end up staying here. I know several who were AAAS Fellows who stayed and worked on the Hill after their Fellowship, or worked at DOE, or worked at other government agencies. Others have gone back to academia or other places, and hopefully brought back their knowledge and used it to influence policy from their respective jobs. And hopefully, what they learned in that program also helps them in their work and in bringing a perspective to their work that they wouldn't have had otherwise.

I should add that other universities have summer internship programs along the line of MIT’s program, and there are also other opportunities for students. One that I’ve been involved with in the past is called Washington Internships for Students of Engineering (WISE). It is supported by a number of professional engineering societies, such as IEEE and ASME, and brings undergraduates to Washington for a summer to conduct research on a technology policy issue. I served for a number of years as the advisor to the American Nuclear Society students who participated in the program, and also as the faculty member in

residence for one summer. My husband also served as the faculty member another year, so this is another area where we have had shared interests.

KLINE: Yes. And then sort of a different question: I'm curious about mentorship, and support systems. It sounds like you had a pretty demanding career. Who were those people for you?

MARCUS: You know, I never thought about it at the time, and so I have a hard time now. I had a couple of bosses, and my thesis advisor as well, who I think mentored me in ways – although we never used that word. I didn't go to anyone and say, "I want you to mentor me," which I guess people now do. Or I never went to anybody and said, "I'm going to mentor you."

So it was more piecemeal. I have helped people, but I wouldn't call myself an ongoing mentor. If somebody came to me and asked me for career advice, or to help them make connection, I did that. And people have done that for me. I consider that mentoring. In fact, one of the very gratifying experiences of my career has been that, on a couple of occasions, someone I don't even know very well has seen me at a meeting and thanked me for directing them to someone or someplace that ended up turning into a job for them. I never even knew that at the time, and in my own mind, I had really only made a suggestion to them in answer to a question of theirs, such as who was doing some kind of work. I wasn't trying to get them a job, but it worked that way just because I was able to answer their question and share my network.

A couple of my bosses – either to help me personally or because they wanted to help women in general – were very good about making sure I had opportunities. They were my direct bosses, though, so they were also responsible for getting the work done. So at the time, I always felt that the mentoring was mutually beneficial – it was going to help them get their job done, too. Only now, I realize they could have proceeded another way if that was their only objective, and that they may have been consciously helping me.

I was really lucky in that most of my bosses were very good. However, lest you think I was 100% lucky, I should add that I had a couple of bosses who I thought were lousy, whether it was in part a gender-related thing, or whether they were just not nice people. Sometimes I thought, "What is this? I can't get along with this person." Over the course of my career, I've discovered that it's not really me. I've found that if I can't get along well with a person, it's more than likely that other people have problems with that person, too. And if I think somebody is wonderful, and it's because we have such rapport, it's not just me, either; I find they have good rapport with other people, too.

So yes, I've had one or two people that were hell to work for, and afterwards I said, "What I learned from this is what not to do as a boss"! But I had some wonderful bosses that I still keep in touch with and have very good feelings about – and I hope I helped them, too.

KLINE: I'm sure. And then, I'm always sort of curious. I hope you don't mind my asking. It seems like you and your husband have chased each other around the world and that you have a really, really strong relationship. I know that that isn't always the case when you both have really intense careers, and I was wondering if you could speak about that a little bit.

MARCUS: I guess we've been lucky, because it is a good relationship. We have different fields, but we've always found interesting connections. It probably helps that we have the MIT connection in common and were even the same class. Because of that, we have a lot of the same friends and a lot of the same experiences.

And over the years, we've found that sometimes things that we think are totally unrelated end up having some connection. The most recent example was just this past week or two. He has always been interested in the fact that the Nuclear Regulatory Commission has an advisory committee called the Advisory Committee on Reactor Safeguards, the ACRS, and in the way it functions.

One of my jobs, by the way, for a while, was working in that group, not as one of the advisory committee members, but rather as one of the managers supporting that group. Mike had worked for the Federal Communications Commission, and he always felt they needed such a group. And even now, although he's not working for FCC anymore, he's trying to work to help them connect with ACRS people to find out how they work, to try to bring in some of that understanding to FCC and develop something like that for FCC.

So we basically look to each other's fields and find things that help both of us.

KLINE: Is there anything else that you want to add?

MARCUS: The harder thing has been, as you say, chasing each other around the world. But every time something's come up, he says, "Well, I'd love to do that. Let's figure out a way." Believe me, we have become experts on figuring out some very creative things about how to work the system to find legal ways to do things that we want to do.

Maybe it's good fortune, but maybe it’s commitment that we've been able to try say, "Oh, OK. You really want to do that? I'll look around and see what I can do." We've made it work. We’ve had some luck, but we’ve also worked at it.

Of course, the easy thing to do was always to say, 'We're staying here." In fact, that was always one of the things we used to say we liked about Washington. For many years, we didn't move, and therefore, we didn't have to coordinate job changes. So for most of our career, we would say, "OK, we're staying in Washington, so I won’t look for a job outside of Washington." Washington's an interesting place because there were a lot of job opportunities for both of us. And so that made things easy. I changed jobs when he stayed in one place, and he changed jobs while I stayed in one place. The harder part was going to Japan and to France. But I those were exciting enough opportunities that we just were determined to make it work.

KLINE: I guess my last question is if you think your field has changed, in terms of women in science and engineering – if you think that since you've been involved, you've seen changes in it.

MARCUS: The nuclear field, or more broadly?

KLINE: I mean the nuclear field.

MARCUS: Well, certainly, in the nuclear field and everywhere, there are more women now. I almost always used to be the only woman at the meeting, or in the room, or in the office. As an undergraduate, I used to try to keep a low profile, especially if I had had an all-nighter and was falling asleep. I sat at the back of the room, where I hoped nobody would see me. But I learned later that wasn’t the case! When I stood at the front of the room as a teaching assistant in grad school, I suddenly realized that I could see everyone. I could see someone doodling, I could see someone dozing, could see someone day-dreaming.

And in many of my early meetings, given the science of small numbers, I was the only woman, so I was certainly visible. Sometimes I still am in a meeting and see that there are very few women or almost no women. But more and more, there are more women, and that's a good thing.

My professional society certainly has more women now. When I started there, one of the things that got me involved was that I had decided that the nuclear field must be better than other fields for women, because Marie Curie was a pioneer in the field and I was going to prove we were better. I decided to do a survey to prove it, but when I did the survey, I discovered it wasn't so! There

were a lot of problems in the nuclear field, just as in all other fields. In fact, one of the women who had already been active in the society befriended me because of that survey, and got me involved in the Society's activities. We were both named Gail [Dr. Gail de Planque, ANS President 1988-1989], so we were both mixed up sometimes. I don't think that would happen as much now, because there are more women. So they no longer think, "Oh, it's a woman, it must be Gail." By the way, she ended up being the first woman to be president of ANS, and I ended up the second, which, for a while, only added to the confusion!

I haven't had the experience of being back in the classroom, but certainly, in terms of the American Nuclear Society meetings, and when I did worked in an office, there were more and more women during the course of my career. So I think there's been a noticeable change for the better.

KLINE: I think that's all. Thank you so much.

MARCUS: It was my pleasure.