

Marcus: Continuing the legacy



Marcus at the WIPP site last year with B. D. Liaw

DESPITE THE SCIENCE of radioactivity having been ushered in by a woman, the field of nuclear engineering remains decidedly male more than 100 years later. So, perhaps it's not unexpected that the 47th president of the American Nuclear Society is only the second woman elected to the position.

That said, upon reviewing the achievements of new president Gail Marcus, who is principal deputy director of the Department of Energy's Office of Nuclear Energy, Science and Technology, her gender endures as an afterthought. In her 30-year career, Marcus has published more than 50 papers on nuclear power and regulation, energy problems and

In an industry where males traditionally have outnumbered females, Gail Marcus has made significant contributions to nuclear R&D legislation, risk assessment, and radiation effects on materials, as well as to ANS.

policies, radiation effects on materials, and risk assessment. Through innovative technical and policy analyses, she has made significant contributions to nuclear R&D legislation and is recognized for her work on risk assessment methodologies. Marcus played a principal role in developing the Nuclear Regulatory Commission's Principles of Good Regulation. As a resolute ANS member since her student days, Marcus has chaired five national committees, a professional division, and a local section. Based on questionnaire responses from ANS members, Marcus conducted enlightening research on the status of women in the nuclear industry. And, Marcus is believed to be the first woman in the United States to receive a doctorate in nuclear engineering.

Although she takes seriously her role as a prominent woman in the nuclear industry, Marcus remains insouciant about any of the tribulations that her gender has presented throughout her career. "It is probably a quirk of my personality that I'd rather laugh about something than cry about it, so I have mostly been amused by instances where it is clear that the experience is being affected by the fact that I am female," Marcus remarked. "For the most part, these experiences seem to revolve around such earth-shattering issues as the availability of ladies rooms."

Beach girl

Gail Marcus grew up on the New Jersey shore, in Long Branch, one of the earliest and, at one time, most glamorous seashore resorts in the United States. The town was a summertime destination of several presidents in the late 19th century including James Garfield, who convalesced there unsuccessfully following the attempt on his life, hoping the sea air would help him recover.

The sea air also attracted Marcus (then Gail Halpern), who lived a mile away from the ocean and recalled with a chuckle her good fortune at being able to while away summers on the seashore.

Her interests, however, didn't end there. Besides reading whatever books she could get her hands on, Marcus was interested in school—especially science—and counts academic activities as the hobbies of her childhood. Science and speech and other clubs, various science projects, as well as the Girl Scouts, took up most of her time during the school year.

"I was always interested in science," Marcus remembered recently in her office at DOE headquarters in Washington, D.C., "so I took all the science courses I could in high school. Somewhere along the line, I'm not quite sure when, I decided I liked physics. I think maybe



Marcus with her mother in Washington, D.C.



Childhood portrait

it was because it was the hardest course I took in high school. It was the only one that really, really challenged me.”

Marcus's academic inclinations were fostered by her like-minded parents: Her mother was an elementary school teacher and her father an electrical engineer. In fact, her parents didn't ask Marcus to decide whether she wanted to go to college—they asked her to choose which college she was going to attend.

Bent on studying physics, Marcus applied to a number of colleges. She finally settled on the Massachusetts Institute of Technology, and entered in the mid-1960s.

College years

When Marcus was a freshman at MIT, male students outnumbered female students by about 20 to one, and she estimates that there were, maybe, a couple of hundred women on campus. Although a boon for dating (and its mere mention drew envy in her women friends who were attending other schools with more balanced student populations), the male-to-female ratio at MIT would have intimidated many women—and many men—who were not serious about their academic pursuits. The effect on Marcus was minimal. She managed to earn both her bachelor's and master's degrees with four years of coursework, an accomplishment she described as “almost unintentional.”

Not that being among a pronounced minority didn't have its effects, some more innocuous than others. “I stood out,” Marcus succinctly explained. Besides upsetting her chances of escaping a professor's attention during the occasional classroom rumination on after-class activities, her difference in gender from her classmates spurred some troubling comments from professors. “You guys let a girl beat you,” one professor told her classmates.

“At the time, I thought, that's a little embarrassing, but it's also a little funny. But I didn't realize that it's also damaging. I've since learned what that attitude represents and what that makes my male colleagues think and what that makes me think. At the time, I just



Marcus as a teenager with her immediate family, at her brother's Bar Mitzvah

wondered why the teacher was singling me out like that, just because I did well.

“But that was the exception,” Marcus continued. “Most of the professors treated me very well. Most of the other students were so wrapped up in their own work that they either ignored me or treated me fine.

“I had a social life, so I didn't feel lonely. I was in a dormitory with other women, so I had other female friends. And I had dates. For me, it was a very positive environment. I didn't realize until afterwards that there were some special challenges. At the time, they were just minor inconveniences.”

Able to talk shop with her dormitory-mates, Marcus said she may not have had as much rapport with other women had she attended another, less technically inclined university. Once, a friend of hers, who was studying math at another school, said to her, “Gail, you're so lucky. If I come back to the dormitory and say, ‘Boy, that was a really stimulating math lecture,’ everyone looks at me like I'm crazy. But you can do that and people will say, ‘Yes, it was.’”

Having developed an interest in low-energy physics while an undergraduate, and hav-

ing enjoyed the fission and nuclear reactor courses she had taken, Marcus decided to pursue a doctorate at MIT in nuclear engineering—and, unwittingly, become the first woman in the United States to receive the degree in that field.

Career beginnings

Reaching for a styrofoam-ball-and-toothpick model she keeps on a bookshelf near her desk at the DOE—the same model she used as a graduate student to visualize crystal formations—Marcus explained the gist of her doctoral thesis: She researched proton channeling as a technique to study radiation damage in crystals.

The thesis was related to one of her first jobs in the nuclear field. While still a graduate student, Marcus was hired as a physicist at the U.S. Army Command in Fort Monmouth, N.J., who were interested in the survivability of equipment in the radiation-intensive environment resulting from an atomic bomb. In the summers of 1968 and 1969, she studied permanent and transient radiation effects in semiconductor devices.

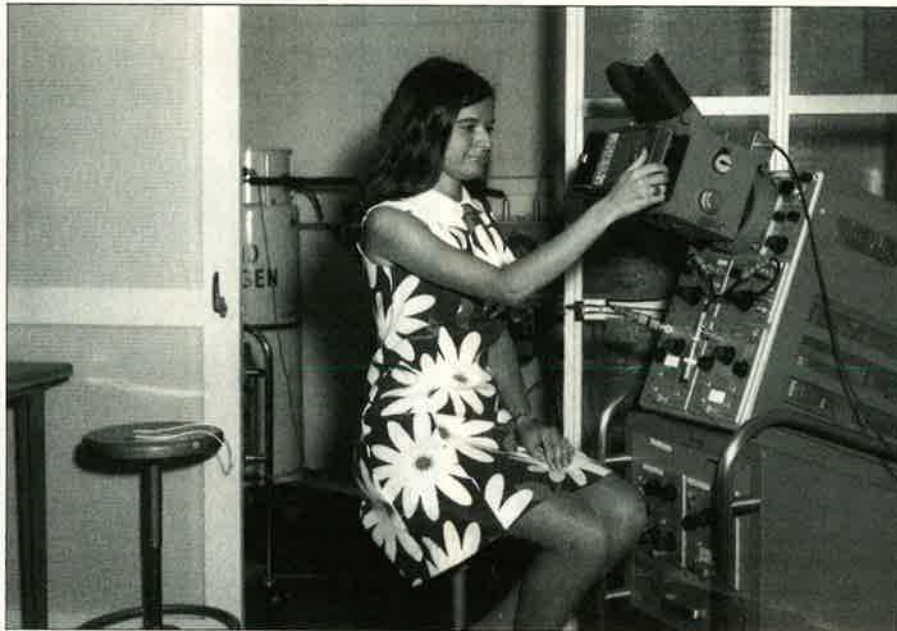
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Shortly after receiving her Sc.D. in 1971, Marcus and her husband (Mike, a former classmate, whom she wed two days after graduation in 1968) decided to take an extended trip through Europe before professional obligations would make such trips impossible. Eight weeks later—"right around the time it was getting cold in Europe, and we were getting tired of wearing clothes that had been handwashed in the sink for two months," Marcus explained—they returned to their apartment just as the phone was ringing.

Analytic Services, a northern Virginia not-for-profit company engaged in systems analysis for government agencies, was calling to offer Marcus a job. ANSER needed experts in all fields, and Marcus was to be the resident nuclear specialist and provide R&D support to the Air Force.

She analyzed an array of subjects—from everyday, real-world concepts such as training-simulator technologies and the effects of solar radiation on orbiting satellites, to more abstract and speculative notions, such as the once-discarded possibilities for nuclear propulsion of aircraft.

Since ANSER's main product was reports and presentations, Marcus had plenty of opportunity to hone her technical writing skills. And, several years later, in 1980, Marcus took a position with the Congressional Research Service in Washington, D.C., a government agency that provided briefings and reports to members of Congress. She was assistant chief of a research division that conducted technical and policy studies in all fields of science.



Marcus at her first job, with the U.S. Army Command

"It covered everything, from AIDS to zoology," Marcus said. "And it was much more timely and topical than ANSER. At ANSER, I was doing projects that were years away from happening, and, in fact, a lot of them never happened. At CRS, I was looking at legislation that Congress was debating, or items that were going to be near-term legislation or that were of interest to legislators at that moment. So, I'd study a subject one day and the same issue would turn up in the newspaper the next morning.

"Mount St. Helens erupted while I was working there, and suddenly we had to put out an issue brief on volcanos. And then that subsided and we went on to something else. AIDS was beginning to become of public concern, and we were putting out briefs on that. Nuclear power was in the mix the whole time."

In 1983, Marcus authored a congressional committee report on risk assessment methodologies. The paper was circulated widely because there was little comparable material at the time that offered such an overview. "That work seemed to fill a void that existed at the time in pulling together all the aspects of risk assessment, and it

was widely cited for a long time," Marcus said. The piece eventually formed the underpinnings of legislation on the use of risk assessment techniques in government agencies, Marcus noted.

While working at CRS, Marcus said she became convinced of "how important it is to have some good technical input into science policy, because a lot of the people making science policy aren't technical people. They are smart people, but they don't have quite the same insight that scientists or engineers can bring."

ANS roots

Throughout her five years at CRS, Marcus remained active in ANS, serving on the Honors and Awards Committee, on an ad hoc committee on society programs, and as an invited speaker at the ANS Congressional Colloquies on Nuclear Energy.

She had joined ANS in 1969, while a student at MIT. But she did not become actively involved in the society until a few years later, a development that she credits to her husband. At the 1972 ANS Winter Meeting in Washington, D.C., Marcus presented her doctoral thesis on radiation damage studies using proton channeling. When her husband, who had registered for the meeting to come hear her speak, received his ANS badge he noticed something peculiar. "In the early 70s, spouses were called wives," Marcus explained. "The nontechnical portion of the meeting was the 'Wives' Program.' They had to pay the registration fee for 'wives.' And the badge was pink. My husband said to me, 'You ought to do something about this. We shouldn't be "wives" and the badge shouldn't be pink!' And my career with ANS developed out of that."

The "Wives' Program" was renamed "Guest Program" shortly thereafter.

Women in the industry

In the mid-1970s, Marcus began to wonder how women in the nuclear industry were far-



Wedding portrait, 1968

ing compared to men. She received approval from ANS to conduct a survey on comparing the career experience of female ANS members with that of males.

The survey was administered through questionnaires mailed to the approximately 100 women listed in the ANS directory and to 150 randomly selected men. At the 1975 ANS Winter Meeting, Marcus presented the results of the survey at a panel discussion devoted to the problems and prospects of women in the nuclear field. (*NW* described the assembly as "something of a first for ANS technical sessions.")

Marcus reported that the average salary level for men in nonsupervisory positions was 17 percent higher than the average corresponding salary for women—with no accountable differences between the two groups. Also, women were also underrepresented in employment at utilities and universities. And a number of women listed sex discrimination as a causative factor in unemployment, underemployment, nontechnical employment, or job dissatisfaction at some point in their careers. "These findings indicate there is, in fact, discrimination against women in nuclear-related professions. This discrimination is particularly apparent in level of educational attainment, salary, management responsibilities, and type of employer, and cannot be attributed to differences in age or work experience," her abstract concluded.

The results of the survey, of course, were not unique to the nuclear profession. There was, however, one particular aspect of the industry contributing to the problem. Marcus said that at the time, some organizations held overly conservative views on regulations prohibiting pregnant women from being exposed to radiation. All women of childbearing age—not just pregnant women—were often prohibited from radiation-exposing activities, Marcus explained. Reactor physicists who can't go near the reactor have a hard time becoming chief reactor physicists.

"I'm not sure people were deliberately preventing women from advancing. They were just trying to be what they thought was conservative and safe, and it had that consequence," Marcus said. "One woman I knew was not able to have children, and told that to



With her husband Mike at the Great Wall of China, during the 1983 ANS trip

her company. But they still said, 'You're under the age of 50 and we don't want you working there [near radiation].'"

On to the NRC

In 1985, Marcus took a position with the Nuclear Regulatory Commission. She began work in the policy and planning office, and worked directly with the office director and the division directors to develop the plan for the office and the budget. "As someone said to me, 'At CRS, you were doing policy with a capital P. This is policy with a small P.' And it really wasn't what you'd think of as policy. It was planning and program development," she explained.

In other positions at the NRC, Marcus was responsible for technical reviews of advanced reactor designs, headed a project directorate which provided regulatory oversight of seven nuclear power plants in the Midwest, and temporarily served as deputy executive director of the Advisory Committee on Reactor Safeguards/Advisory Committee on Nuclear Waste.

She also served as technical assistant to a commissioner for almost five years. Marcus advised then-commissioner Ken Rogers on

proposals before the NRC, and recommended positions and negotiated consensus with other commission offices on license renewal, implementation of safety goal policy, and incorporation of risk-based approaches to regulation, radiation standards, and operator licensing.

She is most proud of her role in developing the NRC's Principles of Good Regulation. The five principles amount to descriptors of what the NRC aims to be: independent, open, efficient, clear, and reliable. The words can be found posted on the wall of almost every NRC office.

Rogers explained: "Sometime around 1990 I decided that the commission really had no general guiding principles for regulation. We had a lot of regulations, and largely they were developed piecemeal in response to a problem that somebody saw or that arose. But there was very little in the way of some kind of an over-arching, basic set of principles that should guide regulatory decisions."

Rogers and Marcus, along with the rest of his staff, went through the archives and looked at every speech that an NRC chairman had given that in some way could be construed as a guiding principle of regulation. "[Marcus] worked very hard on this and came up with a lot of good ideas on how to structure it," Rogers said. "Other people participated as well, but I'd say she was the principal staff person on finally getting us to a set of five principles of good regulation. . . . [S]he played a very important role in . . . digging out the basic foundations that we thought would be useful." The NRC agreed to adopt the principles as a policy statement in 1991.

Later that year, Marcus was detailed to Japan as the NRC's first long-term assignee to Japan's Ministry of International Trade and Industry. Japan was licensing advanced boiling water reactors, which the United States would also soon be doing, and Marcus spent five months analyzing Japanese regulation and licensing policies.

The experience led to a long-term interest in Japanese nuclear policy, and, in 1998–99,



Marcus, second from left, with an ANS delegation to China in 1983, and Chinese hosts



Marcus receiving an award from then-NRC commissioner Ken Rogers



Marcus is shown with students and staff of Ninokata Laboratory, during her 1998–99 trip to Japan. Marcus estimates that she has visited more than two dozen commercial reactor sites worldwide, and a number of research facilities.



Marcus, representing the DOE, at last year's NRC ceremony for the certification of the Westinghouse AP-600 pressurized water reactor design

Marcus spent a year in Japan serving as visiting professor in the Research Laboratory for Nuclear Reactors at the Tokyo Institute of Technology. She conducted research there on comparative nuclear regulatory policies in Japan and the United States.

"I feel I made some important contributions to the understanding of Japanese regulatory policy through my research there. This is useful for Americans doing business with the Japanese," Marcus noted. "I think, but cannot confirm, that my research findings may be finding their way into some of the changes in Japanese policy. Certainly, it is true that I have written on some of the Japanese practices and commented on the desirability of changes, only to find, a year or two or three later, that those kinds of changes are being made."

Today

In her current role in the DOE's Office of Nuclear Energy, Science and Technology—which is responsible for virtually all of the government's activities associated with the development of civilian nuclear energy—Marcus provides technical leadership for related programs and facilities. She has senior management responsibilities for development of next-generation nuclear power plants, advanced nuclear energy technologies, and isotope production and distribution. In addition, she assists with overseeing the operation of the DOE's test and research reactors and various research, environmental, and facility management activities.

"In a given week, there will probably be at least a couple meetings with embassy people in Washington from various countries, or perhaps with visitors that they bring in from France or Japan or Korea, for example, or from other places," Marcus said. "There will also be several meetings with industry people or NEI [Nuclear Energy Institute] or with some of the laboratories that work for us or with NRC. Of course there are internal meetings, meetings with my own staff or meetings with other offices of the DOE. This is a spot with which the whole nuclear community worldwide interfaces. Over a period of a few weeks, we'll see every segment of that community."

Marcus has been involved with the International Nuclear Energy Research Initiative, a DOE program designed to focus on advanced technologies for improving the cost, safety, waste management, and proliferation-resistance of fission energy systems by leveraging federal investment with investments made by the international research community. And she has also worked with the DOE's Generation IV efforts to develop the next generation of sustainable nuclear energy technologies. As part of the latter, she traveled to South Africa in February to discuss the pebble bed modular reactor-based power plant design to be built by the South African utility Eskom. "We talked to them about what their schedule was, what testing they have planned, what testing we think NRC might want [for a PBMR plant in the U.S.], and how we might come together on this. [One American utility] is now a partner on this project, so we have a

real need to work with the South Africans on areas of common interest," Marcus said. Her trip was the second the DOE has made to South Africa. "If this project goes, it won't be the last."

Free time

One summer day in the early '70s, shortly after Marcus and her husband had moved to the Washington, D.C., area, they found themselves feeling uncomfortable. "We tried to sit and read the paper outside one Sunday morning and we were dying from the heat and humidity. We said, 'We have to get out of this town on the weekends.'"

They soon enrolled in an "instant sailor" course, and the former beach girl and her husband had themselves a new hobby. Before actually purchasing a boat, they decided to rent one a half a dozen times to make sure they really liked sailing. The plan fell apart, though, as they were so taken they bought a boat after one rental.

On weekends, the two can still often be found out on the Chesapeake Bay aboard *Silvergirl*, named from a line in a well-known Simon and Garfunkel song. (On her Web page, Marcus describes herself as "an unrepentant baby boomer caught in a 1960s time warp.")

"We mostly day-sail. So, we take the boat out and sail up or down or across the bay, and just get some fresh air and relax. We also like to take long weekends, or even a week, to cruise on the bay. Chesapeake Bay has a lot of little rivers that feed the bay, with little bays and secluded anchorages that we like to explore."

When Marcus was in high school, she thought hard about whether to pursue science



Marcus at a demonstration of the Tadotsu shake table in Japan, in 1992

or creative writing. She eventually decided that there were better opportunities in science, but she still enjoys writing. For instance, on the occasion of her 25th college reunion in 1993, Marcus penned "MIT Homecoming," a tribute to a locally renowned bridge, that is linked to the Web site of her alumni class.

In her spare time, Marcus has remained close to MIT, through activities with the MIT Club of Washington and the MIT Educational Council. She recently ended a 20-plus-year stint as an educational counselor, for which she interviewed students for admission and helped encourage women and minorities to apply to MIT.

Marcus has also been active with the Washington Internships for Students of Engineering (which ANS cosponsors) almost since its incep-

tion in 1980. During the summer internship program, which is designed for engineering students entering their senior year in a university program, students travel to Washington, D.C., to learn how government officials make decisions on complex technological issues and how engineers can contribute to legislative and regulatory public policy decisions. Marcus has worked closely with nearly 40 students in the program throughout the years.

The year ahead

By the time Marcus finished with the industry survey of women in the mid-'70s, she said she knew something about the society, and they knew something about her. "I had the feeling that ANS said, 'Here's this person with all this energy and all these ideas—and she follows through.' So, a year or two later someone asked, 'How would you like to be on a committee?' One thing led to another, and



At the helm of *Silvergirl*



Marcus presents a certificate to Gil Brown, with Steven Stamm looking on

suddenly, over time, I found I had been on half a dozen different committees and a chair of a local section and a professional division," Marcus said.

A tireless ANS supporter throughout her nearly 30 years as a member, Marcus has been involved in most major activities of the society. Since the mid-'80s, she has chaired the committees on Finance, Scholarship Policy and Coordination, Honors and Awards, Planning, and International activities (acting), as well as the Nuclear Installations Safety Division and the Washington, D.C., Local Section. Marcus recalled the mentoring she received through ANS, as well as the opportunities to network and learn new skills in her early ANS committee assignments.

Of her ANS accomplishments, she said she is proudest of her role in fostering greater communication with members. One result has been a change in the election process to allow candidates to offer longer statements on the ANS Web site than has been possible in print. "I am looking forward to opening this process still further, so members have a better sense of the priorities and goals of each candidate," she remarked. Since being elected, she became the first vice president to have a bi-monthly column, and she established a Web site for posting input from members in response to her columns.

In her ANS national election candidate's statement, Marcus pledged to involve society members and work to enhance the credibility of ANS. The society "must play a lead role in helping the industry transition to a deregulated environment and in preserving our academic infrastructure," she wrote. Also, with her extensive international background, Marcus hopes to expand ANS's international collaborations.

Marcus has been soliciting input from members, and she is committed to enhancing communication throughout the society. "I know



Aboard *Silvergirl*, in the late 80s, with her husband Mike

very well what the active members think. Of course, they're very important because they're the ones who keep the society going. But, other members who decide each year whether to rejoin and continue their membership: What's bugging them? What do they need or what do they want? Do we know what they think is right or wrong about our meetings? So, we're trying to ask more questions and get more input and use that in our thinking."

Along those lines, Marcus would like to tighten the focus on the society services that members perceive as being valuable. "We do a lot of good things, but I think, for a lot of members, some of these are abstract," she said. "Either they don't care because they don't participate in them, or they don't know what's going on. I think we can bring more services directly to them. So that when they join or decide whether to renew, they say,

"These are the services that the society does for me and that are useful to me."

"For example, only a fraction of members get to the meetings every year. . . . I think for these members, we have to give them other services. With the Internet, there are services we could provide that previously we couldn't. These are services that don't have all the costs of a print publication, or all the difficulty of a print publication. For instance, areas of a Web site where members can talk to each other about an issue or an area that's of interest to them and exchange technical information."

Postscript

Looking back over the changes in the industry over the course of three decades, Marcus said she has seen improvement. "I think things are better than they were. We've now had women head most of the major agencies, if not all, in government. . . . At the time [of the ANS survey], the number of women who had reached such top government posts was very small. Certainly, in the '70s, I don't think I expected to reach the kind of position I have now."

But not all is perfect. Marcus said she still sees some of the same problems she saw 25 years ago. "I think there are still some hurdles. Government has had more success getting women into high positions than a lot of the industry. . . . And to tell you the honest truth, I still occasionally find myself in a meeting with 20 men. And that's about the same ratio as I experienced at MIT. I still sometimes walk into a room and think, How much has really changed?"

Yet Marcus remains hopeful about the future. According to last fall's enrollment figures, 41 percent of undergraduate MIT students are female, compared to approximately 5 percent when Marcus attended. "There's been tremendous change in the undergraduate level, and that's going to trickle through. It's going to change more over time," Marcus said. "And in 10 years it will be harder to find another meeting with 20 men and one woman."—Patrick Sinco



Marcus with family at her parents' 50th wedding anniversary