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## Ceremonies and Celebrations

Recognizing inspirational women in engineering



# IEEE women in engineering MAGAZINE

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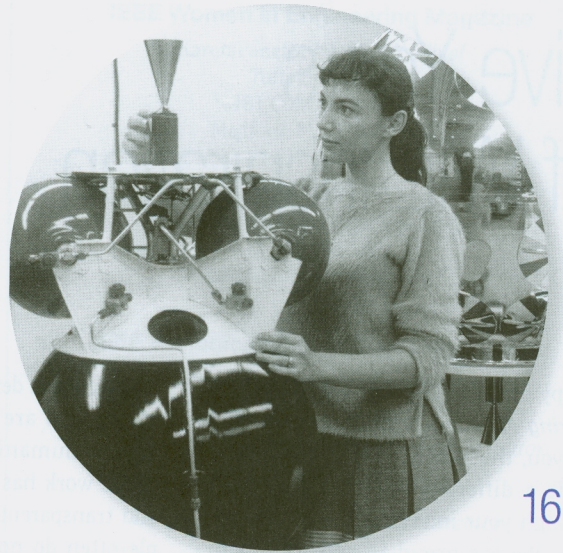
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BY KATIANNE  
WILLIAMS

# Blazing Their Own Trails

THE ENGINEERING  
PASSION  
OF JUDITH COHEN  
AND NEIL SIEGEL



In the summer of 1969, Judith Cohen, eight months pregnant with her fourth child, watched the moon landing from her living room in Pacific Palisades, California. For Cohen, watching the lunar excursion module lower itself softly onto the gray surface was an especially gratifying experience. An electrical engineer for TRW, Cohen's work—a small, vital computer called the abort guidance system—was on board. Until this point, she had worked largely on defense projects—weapons systems that were never seen, seldom talked about, and hopefully never used.

Over at a Jack in the Box on Wilshire Boulevard, her son Neil Siegel took a break from flipping burgers to watch the landing on a grainy television someone had brought in for the occasion. The lunar module contained not just his mother's work, but his father's, too. His father, a chemical engineer, had participated in the design of the variable-thrust descent engine that allowed the module to land on the moon. Growing up in his household, Siegel may have "just assumed that every mother worked, everybody in the world was brilliant in math and science, well-read, and all that," but, by the time he was a teenager, Siegel was beginning to understand that his family was probably not the norm.

Siegel himself became an engineer, following his parents to TRW, and rising quickly through the ranks to become vice president and chief engineer of Northrop Grumman's Information Systems Sector. He has been elected to the U.S. National Academy of Engineering, is a Fellow of the IEEE, and was awarded IEEE's Simon Ramo Medal in 2011 for what IEEE hails as "groundbreaking systems engineering work in creating the 'digital battlefield.'" This defense project, also known as the Blue-Force Tracker, has revolutionized the U.S. armed forces

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and is credited with saving countless lives in the Balkans, Iraq, and Afghanistan.

Siegel was, of course, influenced by his parents, but he cautions that just how they influenced him is not a story of two engineers “targeting” their son to become one as well. On the contrary, Siegel was encouraged to—as his mother herself did—find his passions in life and make the most of them.

### Ashtrays and Box Scores

As a young girl, Cohen would sit in the living room pushing ashtrays around the coffee table with her father. She was eight or nine, with wide brown eyes, delicate features, shoulder-length brown hair that she wore sometimes in two braids. She didn’t understand what was happening yet, but her father, an intellectual who had given up his ambitions of becoming an architect or an engineer to take on the family soda business, was teaching her mathematical algorithms.

Looking back, Cohen jokes that she was lucky to have had a sister but no brothers because her father taught her and her sister “all the important things you need to know if you’re a little boy,” like keeping score in football and baseball. Still, she didn’t consider engineering right away. She enrolled in Brooklyn College with the idea of majoring in math and planned to become a math teacher simply because, as she says, “I had a woman math teacher and so I knew that was possible.” It was 1950—there were only so many professions a young woman was encouraged to enter.

She was thin and muscular, a ballet dancer with the Met, her features drawing comparisons to Audrey Hepburn’s. She dated an engineer, a boy named Al she had been seeing since high school. He was a smart boy with glasses who looked a bit like Woody Allen. They worked in Cohen’s living room, their problem sets spread before them on the floor. Soon they realized they liked each other’s homework better than their own. They swapped assignments. For Cohen, math was “all abstraction and dots and letters” but in the

engineering department she discovered it was about real things—like “a boat going down a river at a certain rate of speed,” and she couldn’t get enough.

It was an acceptable arrangement, but then the boyfriend changed his major. A panicked Cohen asked him what she was going to do, and he, the answer so obvious, told her to change *her* major. “So,” she says, “I went to the guidance counselor, and he said, why don’t you take mechanical drawing and see if you like it, and so I did, and I loved it.”

### Rosie the Riveter’s California

It was because of another boyfriend—Bernard Siegel, the man who would become her first husband—that after two years of college, Cohen left Brooklyn for the west coast. North American Aviation (NAA) wanted Bernard, and so they offered Cohen a position, too, even though she hadn’t completed her undergraduate degree.

She had the hope that California would be more supportive of a female engineer than New York City. A summer job at a local engineering firm had proven that gender presented a barrier in New York: despite being an engineering major, she was assigned to be secretary to the chief engineer. Cohen, her voice still incredulous all these years later, remembers how she told her superiors, “But I don’t take shorthand and I don’t know how to type.” It didn’t matter.

Post-World War II California, though, was the home of Rosie the Riveter, and there were still plenty of women working in aircraft plants. Many of these women now had years of seniority and strong mechanical drawing skills and weren’t being asked to be secretaries. Cohen accepted the job at NAA as a junior engineer. With NAA’s tuition reimbursement program, she was able to continue working nights toward both a bachelor’s and a master’s

degree at the University of Southern California (USC). In addition, in 1954, she and Bernard started their family.

As an undergraduate, Cohen was one of eight women engineers in an engineering class of 800. She never ran into the seven other women, but the men who were her classmates liked to tease her. She was unflappable. “I’d be in a surveying class, out there working with instruments,” she says, “and they’d say to me, ‘You should be getting married,’ and I’d say, ‘I am married.’ They’d say, ‘You should have a baby,’ and I’d say, ‘I have two of them. Now can we get on with this?’”

In 1957, Cohen graduated from USC and took a job at Space Technology Laboratories, which would become TRW before, finally, becoming Northrup Grumman. Her first large project was a communica-

tion satellite to soft-land on the moon. Although this innovative satellite did not succeed—it blew up at launch—she continued to work on such projects. A decade later, she worked on the proposal for NASA’s abort guidance system (AGS), designed to perform a critical job—if the primary computer should fail, the AGS had to return the lunar module and its two-

person crew to the command module.

Over the years, Cohen worked on a number of different projects in a variety of technical and management roles, encountering both resistance and encouragement along the way. In an early position reviewing missile systems, a coworker told her repeatedly that she was “a Girl Scout trying to earn a merit badge at their expense.” In 1969, while working on antiballistic missiles to be test launched in the Pacific, her excellent systems engineering work earned her a promotion to manager even after she disclosed that she was pregnant. Then, in the late 1970s, Cohen went to work as a system engineer on the Hubble Space



Cohen as a young girl.

Telescope Science Operations Ground System, and this became one of her favorite projects. Here, Cohen says, “while system engineering was considered men’s work before this, I wound up having a group of talented women managers as well as workers, and we did a wonderful job that I am very proud of.” By the end of the project, Cohen was deputy project manager. The Hubble, still in use today, “lasted longer and did more science than anyone would have predicted.”

### Family Life

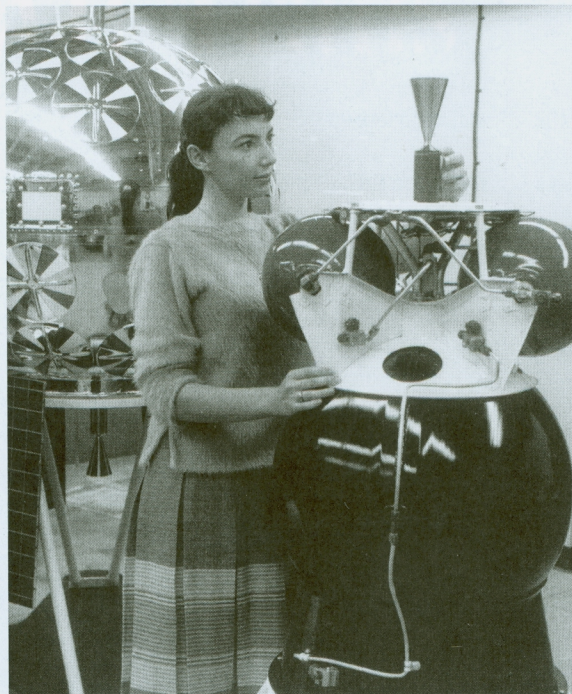
When Siegel was four, the family was living in Bellflower, California, near Long Beach, and both his parents were working at Space Technology Laboratories. Siegel wanted to learn to swim, and so he says, his parents, “took me on the city bus, showed me the route—once—and then would leave each morning giving me two quarters, one for the fare there, one for the fare back, and would send this four and a half year old off on the bus for swimming lessons.”

This memory makes Siegel chuckle. “I always laugh when I hear my colleagues talk about driving their kids,” he says, “because if I wanted to do flag football or Little League, I had to get on my bike and go. But it was empowering, and somehow we didn’t get into too much trouble.”

Cohen was doing something that not many women did in the 1950s and 1960s—juggling work, school, and children, returning home on her lunch break to nurse babies. By the time her fourth child, Jack, was born (when Siegel was 15), Cohen was a major multitasker. “There was a problem we were trying to solve,” she remembers. “I called my boss—I was looking at the readout—and he said, ‘Where are you calling from?’ and I said, ‘Oh, I’m at the hospital, I just gave birth to a baby boy. Now about these readouts...’” Cohen pauses

and laughs. “We told that story for many, many years after.”

In their house they had nannies, sometimes live-in nannies, and parents who came home from work long after the children were home from school, but it worked: “To the first approximation, we could do what we wanted,” Siegel says,



Cohen with the Atlas-Able Satellite that was developed to soft-land on the moon.

“but, you know, we had a good relationship with our parents and we could always talk to them.”

### Musical Youth

In their household, which Siegel affectionately calls “unstructured in the extreme,” it is music that seems to connect everyone. Sort of. Cohen “tinkered” with the piano, and they had one in the house, but none of the children took to that particular instrument. They all found their own sound—folk, pop, and classical—and, when the kids were home, from behind bedroom doors drifted different types of music.

When he was six or seven, Siegel started learning the flute and discovered he

had a real passion for it. “Again,” he says, “Mom said if you want music lessons you can do that, but you’re going to have to get on your own bicycle and go there and back, and I did that, and a few years later I wanted to learn to play guitar, and so, same thing—I’d get on my bicycle and ride myself to music lessons.”

Siegel became what he calls “kind of a child prodigy as a musician” and by the time he was 12 or 13 he was performing. Down the road, he put himself through USC as a musician, playing Bar Mitzvahs, giving lessons, and recording. He is still a member of the Musician’s Union—probably the only aerospace executive in the country who belongs to a union.

When Siegel was ten, Cohen, who had been doing Balkan folk dancing for years, began taking him with her. “She started taking me,” Siegel says, “and dancing became another big passion in my life.” He joined a major performing group when he was 15.

Around this time, Siegel befriended a musician from Turkey who introduced him to the ney, a traditional Turkish flute-like instrument made of cane. A few years later, he met an Iranian musician and began playing an Iranian long-neck lute called the târ.

He was dancing at the Renaissance Faire near Los Angeles in 1974 when a woman came backstage to be introduced.

Her name was Robyn Friend, and she was a dancer whose family hailed from Bulgaria. This began a partnership of dance and music that continues to this day (they were married in 1979). Although Siegel says they are now performing less, for over 30 years Siegel and Robyn performed around 50 concerts a year all over the world, dancing and playing at major theaters all over the United States, Europe (including at the Edinburgh Festival), and in many places in Asia (including the prestigious Sharq Taronalari festival in Uzbekistan).

"If you want to ask how did my mom influence my life," Siegel says, "getting me interested in dancing was probably the most important thing that she did, because that's how I met my wife."

### Rising Through the Ranks

Siegel, a math major, had no plans to become an engineer. This changed in graduate school: "Robyn and I were living together," he says, "and I read an article in the newspaper and realized that between my music income and teaching assistant salary, and Robyn's earnings at the engineering library at the University of California, Los Angeles, where she had a part-time job, we were living at half the poverty level. I decided it was time to stop being a starving student. I left school after a master's degree and got a job at TRW as a programmer." He did eventually return to finish his Ph.D. in systems engineering.

In 1976, he was assigned to his first project. The 300-person org chart was printed on large paper and tacked to the wall. Siegel's name, he says, was "literally the last name in the lower right corner." His mother was on the same project, but, Siegel says, "in a completely different chain of command, and near the top of the chart."

This is where their professional lives intersect. Throughout Cohen's successful career, she still had to fight a number of battles to prove she was "management material." She understands this as a result of the military mind-set of the times: "Customers were army people and air force people ... and when you're dealing with a project with a customer who is not used to dealing with women, it was perfectly reasonable," she says.

She knocked against a glass ceiling and can say now with both candor and levity, "My bosses decided that even though I was wonderful and was helping them get promoted and was doing all of this marvelous work, they couldn't really promote me to upper management."



Judith and Bernard with children Rachel, Howard, and Neil.

On the other hand, Siegel's rise was swift. He made a good impression on this first project, and when his boss left unexpectedly, something unheard of happened—Siegel, a year and a half out of school, was made interim head of the 20-person crew. After this, he was assigned to a new project named BETA.

The BETA project, though, hit hard times. It was at risk of being canceled when Siegel came up with a potential solution: "Within 24 hours, I was in the four-levels-up boss's office in the corner explaining my idea," he says. "The next day I was put in charge of a small team to implement it, and we actually succeeded." This success made people sit up and take notice: "I was 25 years old, so not really very capable, but I had accomplished this one thing."

Around this time, Siegel developed a career ambition—"the only career ambi-

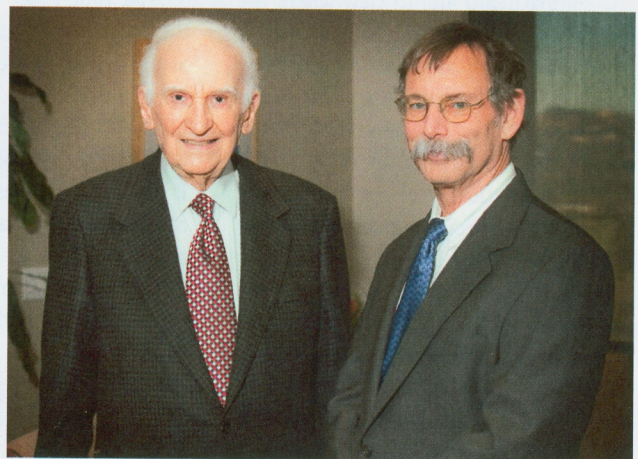
tion I've ever had," he jokes—to be chief engineer on a big project. At 34, he achieved this goal, but this project (the Forward-Area Air Defense system) was also in trouble—this was to become a hallmark of Siegel's career, becoming the fix-it-guy. As he says, it was "literally under a partial stop-work order from the government, on the verge of being canceled, it couldn't have gotten worse."

With "nowhere to go but up," he spent two and a half years on this project and helped turn it into a "roaring success." This system, 20 years later, still saves lives every day in Iraq and Afghanistan.

At this point, Siegel had fulfilled his only career aspiration and wasn't sure where to turn next. A company vice president and division general manager named Jack Distaso asked to take control of Siegel's career for a few years. Siegel says, "He put me in a whole series of positions that turned out to be very interesting and very worthwhile, but were things I never would have asked for myself. He put me in charge of business development, proposals, made me a program manager, a business-unit director, and, lo and behold, a few years later when he retired, I was named to his job as vice-president and general manager of the division."

He never would have known to ask for it himself, but this series of classic

Siegel with Simon Ramo, cofounder of TRW and the namesake of the IEEE Simon Ramo medal, which Siegel won in 2011.



management experiences was something Siegel needed: "I am a much more effective CTO for having been a division general manager, business unit director, project manager.... I have much more credibility with the people who are now in those division GM positions, because everyone knows I was a very successful division general manager and therefore, I understand their job."

Cohen was pleased to watch her son receive recognition and rise to such high ranks within Northrup Grumman: "My son traveled and did a lot of wonderful things. At that point, I had another child and wasn't as anxious to run around to strange places. My son ended up a much higher-level manager than I ever was. He moved on up the ladder very quickly." She laughs as she says this, acknowledging, "He does have a higher IQ than me."

### Digitizing the Battlefield

The program that "made" Siegel's career is the Force-XXI Battle Command Brigade-and-Below system, also known as FBCB2, or the Blue-Force Tracker. This system has "digitized the battlefield" for the U.S. Army, bringing interconnected computers and real-time situational awareness to almost every vehicle on the battlefield—tanks, artillery, helicopters, and so forth. This allows U.S. personnel to see where all other members of the combat team are, to view where the enemy is, and to evaluate other relevant information, such as the location of mine fields and contaminated areas. "It seems so ordinary today," Siegel says about the system that was started in 1995, "but it was so revolutionary... putting a computer into the decision process for every step on the battlefield."

Siegel continues, "Think of how this was before.... You're in a tank—an armored vehicle, all sealed up, no windows, just little prisms two inches tall and eight inches wide that they call a vision block. Tanks throw up tons of dust, there's



Siegel and his wife Robyn performing.

smoke from gun fire. So you look out this tiny vision block and you see almost nothing. Then you have a radio that can talk to the other vehicles that are in your vicinity. The fact that anybody can accomplish anything under these circumstances is kind of a bloody miracle. ... So, digitizing the battlefield—bringing all of this relevant information right to the tank commander—was a big idea, but technically and socially very, very difficult."

It required a communications network that could, according to IEEE, achieve "reliable infrastructureless wireless communications for tens of thousands of mobile platforms, without depending on cellular towers or fixed-site relays." This proved so difficult, in fact, that the U.S. Army is still the only army in the world to have such a system.

The Blue-Force Tracker was taken to the Balkans in the spring of 1999. In 2002, as the Army prepared for possible combat operations in Iraq, Siegel and U.S. Army partner Colonel Nick Justice led the effort to deploy the Blue-Force Tracker to Iraq. It was a huge success. Today, 90,000 units of Blue-Force Tracker are in use in combat and peace-keeping missions around the world, and the Army plans eventually to acquire 250,000 of them.

### You Can Be...

Siegel believes that one of the ways his mother most influenced him is that

he has "always seemed to make a specialty of hiring and promoting women." In fact, his first two hires were women. He says he "grew up thinking that women as engineers was normal, at a time when most other people didn't."

Thanks to that, he says, "as I became a manager and was looking for people—I pretty quickly realized I would be more successful if I had better people working for me. Since everybody else was competing for the best men, I kind of fell into a strategy that I would hire the best women—because no one else was

trying to hire them."

In the late 1990s, a TRW survey on women and minorities showed that 38% of Siegel's top-tier management team was women and minorities. For most of the other divisions at TRW the percentage was zero. Siegel jokes, "I had apparently attracted all of the women managers in the company to my division."

This, he believes, he owes to his mother, saying, "Rather than targeting me to be an engineer—I didn't become one until farther along in my career, having started as a mathematician—the biggest professional influence Mom had was causing me to believe that women as engineers and managers was normal."

Today Cohen is retired from engineering. She and her husband, illustrator David Katz, publish a series of *You Can Be...* children's books encouraging young girls to pursue careers in engineering, architecture, and many other fields. For Cohen, attracting girls to the sciences comes down to early exposure, to keeping their interest alive as opposed to trying to rekindle it in high school or college. As she says, "The important thing is—like my father did with me—talk to kids about possibilities, and then show them things and play with them in ways that they can respond."

—Katie Williams is a freelance writer living in Massachusetts.

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