SWE60 1950-2010
Success on Your Own Terms: 60 Years of Inspiring Perspectives

# Achievement Is

Since 1952, the Achievement Award, SWE's highest honor, has been given to an exceptional woman in recognition of career accomplishments in engineering. The criteria of the Achievement Award are the same in 2010 as they were in 1952. This constant offers a rare, inside look at the nexus of two of the 20th century's most dramatic areas of change: technology and the status of women.

BY MEREDITH HOLMES, SWE CONTRIBUTOR

The 57-year history of the Achievement Award is a proud one. It traces astonishing scientific and engineering breakthroughs from the middle of one century to the beginning of the next. Achievement Award recipients have always been innovators, working at the leading edge of their disciplines, and often in emerging fields, such as aeronautical, biomedical, and computer engineering. Their accomplishments are both individually and collectively remarkable. They include innovations in a range of technologies — solar energy, ceramics, rocket booster design, solid-state physics, and sol-gel science, to name just a few.

For an overview of the technical contributions of all 58 Achievement Award recipients, read the table beginning on page 37.

The first Achievement Award recipient, Maria Telkes, Ph.D., was recognized in 1952 for her visionary applications for solar energy, such as seawater distillation systems, home heating, and generators for use in homes and outer space. After a brief reemergence in the 1970s, solar technology in the United States has only recently begun to have wider public acceptance and significant commercial development.


Telkes

Edith Clarke, 1954 Achievement Award recipient, and first woman to graduate from M.I.T. (in 1919) with a degree in electrical engineering, applied her understanding of higher mathematics to the emerging field of electrical power systems. In the early 1920s she filed a patent for a "graphical calculator" to solve electrical power transmission problems.

Roberta Nichols, Ph.D., 1988 Achievement Award recipient and an automotive and environmental engineer at Ford, was about 30 years ahead of her time. In the 1970s, she researched, designed, and advocated for alternative fuel cars, causing aerospace engineer and writer Robert Zubrin to say that if there were a Nobel Prize for engineering, Roberta Nichols should have won it.


**Dr. Roberta Nichols and her husband at the 1988 SWE convention (conference) in Puerto Rico, where she received the Achievement Award.**

The Achievement Award is also testament to the determination of SWE's leadership that women be full participants in the engineering advances that shaped the 20th century. The history of the award and the women upon whom it was conferred is a cautionary tale as well as an inspirational one. Without a supportive national organization that provided advocacy, mentoring, career development, and leadership opportunities, and without federal laws like Title IX and Title VII, the engineering profession might look very different today.

It's important for young women engineers to know their history, says Mary Rouse, associate director for Women in Science and Engineering at Case Western Reserve University (CWRU) in Cleveland. At CWRU's School of Engineering, 21 percent of the undergraduate students are women, higher than the national average of 17.9 percent. The price of this success, however, is a belief that gender discrimination no longer exists. Many students say to Rouse, "That was your battle, and you won it, but we live in a different world."

Peggy Layne, P.E., counselor for the SWE section at Virginia Tech and director of the ADVANCE program there, has observed the same phenomenon. "I think it's natural for young women to believe that they will always be judged on their capabilities, rather than their gender — I certainly felt that way when I was an engineering student in the late 1970s." However, Layne said she never would have believed that 30 years later, women would make up almost 50 percent of all

# the Constant

medical students, but still less than 20 percent of all engineering students and only around 10 percent of practicing engineers.

Rouse worries that without a realistic understanding of the role of women in the profession, many young women engineers will enter the work force unprepared. "They still need to do all the things that professionals do to advance their careers, like peer and professional network building and cultivating mentors to find out about opportunities." Rouse pointed out that, "In a field where women are still outnumbered by men 10 to one, it's important to understand your situation and to be proactive."

Layne agrees, saying, "While we have made much progress, SWE and our allies still have a lot of work to do to ensure that the current generation of engineering students has the opportunity to achieve success on their own terms."

In presenting her top five choices for the 1953 award, selection committee member Margaret Ingels, P.E., further refines the criteria in a letter dated Dec. 25, 1952, to Marie Reith, 1953 awards committee chairman. Stressing the collaborative aspect of engineering as well as diligence and reliability in the workplace, her letter is prescient in the post-WWII era when women were generally not encouraged to work outside the home or pursue a profession. Among the criteria she suggested were: "Planned to be an engineer when starting to college and studying engineering when they got there — to earn an engineering degree"; and "Worked in the profession and proved they could do a job, do it well, and hold the job over many years."


Busch-Vishniac

In her Dec. 31, 1952, letter to Reith, recommending Elsie MacGill, 1953 Award Committee member Pearl Clark stressed commitment to the profession, saying she had eliminated those no longer active in engineering. She also weeded out candidates who had already been recognized, saying that the Achievement Award should recognize someone new. Finally, Clark asserted that she favored candi-

## The Engineering Approach to Life

SWE Achievement Award recipients also applied their considerable problem-solving skills to non-technical obstacles, such as gender discrimination and work/life balance. Here are just a few examples.

**Collect the data.** Irene Peden, Ph.D., 1973 Achievement Award recipient, is currently professor emerita of electrical engineering at the University of Washington in Seattle. In 1970, at age 45, Dr. Peden was the first American female to conduct research in Antarctica as a principal investigator. She and her team did their field work 12 miles from Byrd Research Station. Conditions were harsh, and time was short, but she returned to the U.S. with the data.

She was just as dogged about getting and publishing her data a few years later, in the mid-1970s, when she served as associate dean of engineering at the University of Washington. She was one of very few women in any American university to have reached that level. As chair of the committee on faculty women and known to have feminist views, Dr. Peden heard widespread complaints about the status of women at the university.

"So many faculty women came to us pleading for help," Dr. Peden recalls. "What were we going to do first? And — I think it was the engineer in me — I said, 'We're going to do something first that … will be numerical, that they can't contradict and can be done in a finite amount of time, and that nobody can argue with when it's done.' I mean, isn't that what engineers do?"

**Quantify, quantify, quantify.** A highly regarded expert on the conservation of engine oils, and the 1999 Achievement Award recipient, Shirley Schwartz, Ph.D., relishes a challenge. She says, "Beginning with my graduate school days, when I had a baby in one hand and a book in the other … I have faced many problems and derived a great deal of satisfaction from challenging each one of them." Among these she counts developing environmentally friendly industrial lubricants, creating systems that tell drivers when to change engine oil, and pursuing a graduate degree in chemistry while taking care of a baby.

Dr. Schwartz was pregnant when she decided to be a chemist. "However, I assessed my life and decided that the good news was that there were 168 hours in one week," she recalls. "From this 168, I used 68 in household chores and 56 hours sleeping, which totaled 124 hours. That meant I had 44 hours left for grad school. The bad news was that those 44 hours were available only three minutes at a time!"

**Clear your vision.** F. Suzanne Jenniches, Achievement Award recipient in 2000, counsels women entering engineering to develop a thick skin, a "rhino hide," as she calls it. An expert in manufacturing innovation and productivity, Jenniches acknowledges it can be "incredibly hard" to discipline yourself not to react visibly to unfair treatment.

However, the payoff is the ability to see your situation more clearly. Not reacting annoys people "who are trying to get under your skin," she says. "But it is [also] interesting, once you have rhino hide, you will be able to see that generally these people are obnoxious to everyone. …It is their problem, not yours — so don't waste time worrying about it — use your time on something productive. Agonizing … is counter-productive…"

dates whose careers involved hands-on engineering over those with largely administrative or teaching experience.

As the number of women engineers has steadily increased, and as equal opportunity for women was made law, and then generally accepted, the prestige of the Achievement Award has increased. Irene Peden, Ph.D., observed that the largely male engineering profession of the 1970s was not very impressed with her Achievement Award. But what a difference two decades makes! The 1993 Achievement Award recipient, Elsa Reichmanis, Ph.D., was certain that the award increased her prestige among her peers — both men and women — and paved the way for other opportunities. The SWE Achievement Award almost always receives prominent mention, along with membership in the National Academy of Engineering and other prestigious awards, in the biographies of this extraordinary group of women.


Karle

The resumes of Achievement Award recipients are peppered with "firsts." Many of the pioneers — women who entered engineering in the 1940s, '50s, and '60s — took advantage of opportunities created by world events. During WWII, university engineering departments languished because so many young men were in the military, and an unprecedented number of women were accepted. Then in the 1950s, when the U.S. government allocated huge resources to the space program and aerospace research, there were opportunities for women engineers in this new field.

Sometimes being barred from an established field directed women to a new field. For example, Barbara Liskov, Ph.D., 1996 Achievement Award recipient, had always excelled at math. After earning her B.A. in math from the University of California, Berkeley, she was rejected from graduate math programs at Princeton and Berkeley. But she was accepted into computer programs at Harvard and Stanford and chose to do graduate work in artificial intelligence at Stanford in the early 1960s. The computer science field was in its infancy then, and Dr. Liskov was the first woman in the U.S. to receive a Ph.D. from a computer science department.

Many Achievement Award recipients were the first woman to earn an engineering degree from their university, the first to be elected to professional societies, the first to chair their university engineering department, and the first woman to head up divisions of major corporations or branches of the U.S. military. Those who came after in the 1970s, '80s, '90s, and 2000s continued to break new ground, not only technically and scientifically, but also socially, advocating for women in engineering and encouraging young women to enter the profession.

### Extraordinary women, common traits

The 58 women selected for the Achievement Award from 1952 to 2009 represent a variety of backgrounds, scientific and engineering disciplines, and ages. Some received the award in mid-career, and some were very well established — even renowned — in their field. Achievement Award recipients come from every part of the United States, and some came to the United States from abroad, adding a new language and culture to their list of conquests. Some worked in the same discipline for their entire career, while others applied the problem-solving tools of engineering to a variety of disciplines. Achievement Award recipients have distinguished themselves in every arena: government, business, the armed forces, and academe.


Clarke

Nevertheless, this remarkable group of women has some common characteristics: They are hard working, purposeful, and persistent. Most had interests and abilities in science and math that showed up early and set them apart. (Several of the pioneers, including Yvonne Brill and Edith Clarke, worked as "computers" — that is, people who did mathematical computations — before they discovered engineering.)

Almost all cite someone — a parent, teacher, a mentor — who encouraged them. Finally, Achievement Award recipients are willing to take risks, to try new things, and entertain new ways of looking at the world. This original, even visionary, thinking is essential to the problem solving that all engineers do.

### It shows up early

Most Achievement Award recipients showed an early interest in science, technology, and exceptional ability in math. Maria Telkes, Ph.D., born in Budapest, Hungary, in 1900, became interested in the possibilities of solar energy when she was in high school. Joan Berkowitz, Ph.D., 1983 Achievement Award recipient, did such an impressive school science project on weather systems that her teacher announced she was destined to be a scientist. Isabella Karle, Ph.D., a physical chemist and 1968 Achievement Award recipient, was so mathematically and scientifically precocious that she'd earned her Ph.D. by the time she was 23.

Bonnie Dunbar, Ph.D., currently President and CEO of the Museum of Flight in Seattle and a veteran of five space flights, including the first space shuttle docking with Mir, was the 2005 Achievement Award recipient. She remembers watching Sputnik pass over her home in eastern Washington State when she was a child. "I had this intense desire to find out about the world around me — especially space — and to participate in the exploration of space and to really solve the unknowns." Watching mission control for the U.S. space program launches was also a formative experience for Lisa Klein, 1998 Achievement Award recipient. "I was in first grade when news of Sputnik reached us, she said. "I may have taken it more personally than most, but I wanted to be part of it all."

Elaine Oran, Ph.D., physicist, originator of computational methods for solving complex reactive flow problems, and 2006 Achievement Award recipient, says

## Achievement Award Recipients, 1952-2009

### Maria Telkes
**1952 Award for:**
Applications for solar energy
**Education:**
Ph.D., Physical Chemistry
**Contributions & innovations:**
20 patents for solar devices; portable solar still for converting salt water to fresh water; chemical process for storing solar energy; solar oven

### Elsie Gregory MacGill
**1953 Award for:**
Pioneering work in aeronautical engineering
**Education:**
B.S., Electrical Engineering; M.S., Aeronautical Engineering
**Contributions & innovations:**
Designed Maple Leaf Trainer II pilot training plane; adapted WWII Hawker Hurricane fighter plane for cold weather flight; transformed a railway boxcar plant into an aircraft factory in WWII

### Edith Clarke
**1954 Award for:**
Advances in stability theory; circuit analysis, research, and design
**Education:**
B.S., Mathematics and Astronomy; M.S., Electrical Engineering
**Contributions & innovations:**
In early 1920s invented "graphical calculator" for solving electric power transmission problems; introduced use of hyperbolic functions to calculate power line's transmission capacity

### Margaret H. Hutchinson
**1955 Award for:**
Significant contributions to petrochemical engineering
**Education:**
Sc.D., Chemical Engineering
**Contributions & innovations:**
Designed processes for first large-scale production of penicillin; improved refinement of crude oil

### Elise F. Harmon
**1956 Award for:**
Important innovations in field of component and circuit miniaturization
**Education:**
B.S., Chemistry
**Contributions & innovations:**
Micro-miniaturizations of printed circuitry components; devised engine generator refinement that enabled WWII U.S. fighter planes to fly above 15,000 feet; developed new methodology for producing printed circuitry

### Rebecca H. Sparling
**1957 Award for:**
Expanding knowledge of metallurgy and space materials engineering and nondestructive testing of metals
**Education:**
M.S., Physical Chemistry
**Contributions & innovations:**
Prepared first book on malleable iron structures to be written in U.S. in 20 years

### Mabel M. Rockwell
**1958 Award for:**
Electrical control systems
**Education:**
B.S., Science, Teaching, and Mathematics; M.S., Electrical Engineering
**Contributions & innovations:**
Invented Serjdetour telephone protector; designed electrical control system for Polaris missile launcher

### Desiree le Beau
**1959 Award for:**
Chemistry, rubber reclamation
**Education:**
Ph.D., Chemistry
**Contributions & innovations:**
Patented method of producing reclaimed rubber in particulate form and for reclamation using amines and acids; developed rubber tie pad for railroads

### Esther M. Conwell
**1960 Award for:**
Physics; solid state research
**Education:**
Ph.D., Physics
**Contributions & innovations:**
Research in electrical properties of semiconductors contributed to improved transistors; founding member, Committee of Women in Physics

### Laurel van der Wal
**1961 Award for:**
Contributions to bioengineering and bioastronautics
**Education:**
B.S., Mechanical Engineering
**Contributions & innovations:**
Originated Project MIA study of physiological effects of space flight on mice in U.S. rockets; worked on escape and recovery systems and the design of manned spacecraft

### Laurence Delisle Pellier
**1962 Award for:**
Significant contributions to the field of metallurgy
**Education:**
B.S. & M.S., Metallurgy
**Contributions & innovations**
Researched construction metals for chemical manufacturing plants; developed technique for applying electron microscopy to metallurgical problems; holds patent for gold plating surgical needles

### Beatrice Hicks
**1963 Award for:**
Significant contributions to the theoretical study and analysis of sensing devices under extreme conditions and for achievements in international technical understanding, professional guidance, and engineering education
**Education:**
B.S. and M.S., Chemical Engineering; M.S., Physics
**Contributions & innovations:**
Invented gas density switch; pioneered design, development, and manufacture of aircraft gas and pressure density controls

### Grace Murray Hopper
**1964 Award for:**
Visionary leadership in early computer programming and software development
**Education:**
Ph.D., Mathematics
**Contributions & innovations:**
Designed the first English-language compiler system, later part of COBOL; pushed for development of user-friendly computers and English-language compilers, opening the way for modern data processing

### Martha J.B. Thomas
**1965 Award for:**
Contributions to chemistry
**Education:**
Ph.D., Physical Chemistry
**Contributions & innovations:**
Developed natural white phosphor for improved fluorescent lights

### Dorothy Martin Simon
**1966 Award for:**
Achievements in space engineering
**Education:**
Ph.D., Chemistry
**Contributions & innovations:**
Isolated an isotope of calcium using kinetic theory; developed a process to manufacture predecessor of Orlon

### Marguerite M. Rogers
**1967 Award for:**
Advances in field of tactical weapons
**Education:**
Ph.D., Physics
**Contributions & innovations:**
Instrumental in changing U.S. Navy emphasis on nuclear weapons to improved conventional weapons

### Isabella L. Karle
**1968 Award for:**
Pioneering methods of crystal structure analysis
**Education:**
Ph.D., Physical Chemistry
**Contributions & innovations:**
Used electron and X-ray diffraction to study the structure of molecules

### Alice Stoll
**1969 Award for:**
Development of fire-resistant fibers and fabrics
**Education:**
M.S., Physiology and Biophysics
**Contributions & innovations:**
Did pioneering studies of heat transfer by flame contact; invented apparatus to analyze heat transfer by flame contact

*Continued on page 39*

of her childhood, " … I have always loved science and numbers, and anything in a book. At about age 8, I found a paperback book about science called *One, Two, Three, Infinity*, and read it from cover to cover. I didn't understand much of what it said, but I just *knew* that if I ever did, life would be wonderful."

The exceptions to this rule suggest that some people just take a more roundabout route to the profession that matches their talents. F. Suzanne Jenniches, 2000 Achievement Award recipient, said, "When I was growing up, I aspired to be a beautician, which is pretty hot stuff in Davidsville, Pa." Fortunately, Jenniches's guidance counselor convinced her she was college material. She got a scholarship, majored in biology, got an M.S. in environmental engineering, and became a manufacturing engineer.

In her 1997Achievement Award acceptance speech, Ilene J. Busch-Vishniac, Ph.D., revealed that she never thought she would be an engineer. "The family plan was that … one of us would be a doctor, the other would take over my father's business, and I would be a lawyer." Dr. Busch-Vishniac's interest in music drew her to a course in the physics of music. Then her love of physics and math led her to a Ph.D. in mechanical engineering.

## Hard work, focus, and persistence

Among Achievement Award recipients, these three qualities are inseparable. Barbara Crawford Johnson, in addition to being the 1974 Achievement Award recipient, was the first girl ever to deliver the *St. Louis Post Dispatch*. She worked all through secondary school and finished her undergraduate degree in two years, holding down part-time jobs the whole time. She had never given much thought to the "glass ceiling," despite being one of very few women at her level in the space program. She just wanted to do the work that interested her. "I'm sure I would have been at a higher level in management … but I didn't really worry about it ... I just got so gung ho working on this stuff."

Mildred Dresselhaus, Ph.D., 1977 Achievement Award recipient, echoed this view in a 2001 interview. "The women engineers who entered the work force in the 1940s and 1950s had rather low expectations. We weren't concerned with big salaries or even good working conditions. We were looking for jobs that would enable us to do the work we wanted to do." Dr. Dresselhaus's neighborhood school in Brooklyn, N.Y., was substandard, so she applied to Hunter High School, a selective public high school for gifted students. "I had to study hard for that entrance exam, and I had to do it by myself. There was nobody to help me. I just worked the math problems until I understood them, and I passed the exam."

Irene Peden, Ph.D., confronted danger and difficult conditions at the Longwire research station in Antarctica where she studied the electromagnetic properties of the 7,000-foot-thick ice sheet. Some equipment crucial to her research went missing, and she and a graduate student had to adapt another piece of equipment before she could proceed. She worked 12-hour days under intense pressure from her superiors to finish the field-work on time.

**1974 Achievement Award recipient Barbara Crawford Johnson at her desk, circa 1970.**

Asked how she felt when the crew of the space shuttle Atlantis successfully docked with the Russian Mir space station for the first time, Bonnie Dunbar, Ph.D., said she was thinking only of the task at hand. "Up until then it was very busy; everybody had a job to do. When we finally got the latches around and closed, there was a sense of 'we're finally there,' but we were all very focused and intent on what we needed to do."

Reflecting on the most fulfilling aspect of flying 200 nautical miles above the earth, Dr. Dunbar said for her it's being a part of a project that involves the contributions of so many people. "I enjoy the missions because ... you're the eyes, ears, and hands of all the people on the ground. You get to share in the success of their science and engineering experiments, their discoveries."

Persistence requires confidence, but it also builds confidence. Elsa Garmire, Ph.D., 1994 recipient, discovered the truth of this möbius strip early in her career. In 1974 she was the first woman and the first American to do research at Standard

**Maria Telkes (3rd from left) receives the first Society of Women Engineers Achievement Award during the 1952 American Society of Civil Engineers Centennial of Engineering in Chicago. From left, Rodney D. Chipp, Beatrice Hicks, Maria Telkes, unknown, Dot Merrill, unknown.**

## Achievement Award Recipients *continued from page 37*

### Irmgard Flugge-Lotz
**1970 Award for:**
Central role in development of modern aircraft industry and advances in fluid mechanics, especially wing theory and boundary layer theory
**Education:**
Ph.D., Engineering
**Contributions & innovations:**
Computation of wing-lift distributions

### Alva T. Matthews
**1971 Award for:**
Significant work in engineering mechanics and applied mathematics in shock analysis, elasticity, and structural design
**Education:**
Ph.D., Engineering Mechanics
**Contributions & innovations:**
Influenced development of models for wave propagation in soil and rocks; advanced solutions of acoustic fluid-structure interaction problems

### Nancy D. Fitzroy
**1972 Award for:**
Advances in materials and thermal engineering
**Education:**
B.S., Chemical Engineering
**Contributions & innovations:**
Invented thermal chip to measure temperature in integrated circuits; invented thermal protection system for use in U.S. early warning system

### Irene Carswell Peden
**1973 Award for:**
Radio wave propagation research and electrical engineering education
**Education:**
Ph.D., Electrical Engineering
**Contributions & innovations:**
Significant research about radio propagation and the polar ionosphere, buried antennae, electromagnetic properties of the ice sheets, and radio propagation over long paths in polar regions

### Barbara Crawford Johnson
**1974 Award for:**
Major contributions to aerospace engineering, especially support of manned spaceflight programs
**Education:**
B.S., Engineering
**Contributions & innovations:**
Worked with NASA on lunar landing, Skylab, and Apollo-Soyuz programs

### Sheila E. Widnall
**1975 Award for:**
Important advances in fluid mechanics of low-speed aircraft and hydrofoils
**Education:**
Ph.D., Aeronautics and Astronautics
**Contributions & innovations:**
Advanced understanding of helicopter rotor blade aerodynamics, unsteady loads on high-speed trains, and breakup and decay of aircraft wave vortices; holds three patents in airflow technology; designed MIT's advanced wind tunnel facility

### Ada I. Pressman
**1976 Award for:**
Significant contributions in power control systems engineering
**Education:**
B.S., Mechanical Engineering; M.B.A.
**Contributions & innovations:**
Developed emergency safety systems for fossil-fuel and nuclear power plants

### Mildred Spiewak Dresselhaus
**1977 Award for:**
Significant contributions in teaching and research in solid state electronics and materials engineering
**Education:**
Ph.D., Physics
**Contributions & innovations:**
Pioneering studies in superconductivity, carbon science, thermoelectricity, and physics at the nanometer scale

### Guiliana Cavaglieri Tesoro
**1978 Award for:**
Significant contributions to the science and technology of polymers, fibers, and fabrics in textile and chemical engineering
**Education:**
Ph.D., Organic Chemistry
**Contributions & innovations:**
Developed flame-resistant fibers and anti-static chemical for synthetic fibers; holds over 100 patents for organic compounds and textile processing

### Jessie G. Cambra
**1979 Award for:**
Outstanding contributions to the planning, design, and construction of major public works
**Education:**
B.S., Civil Engineering
**Contributions & innovations:**
Managed Alameda County, California road department; designed and supervised first successful highway construction project in California; designed first computerized traffic signal at a major arterial intersection in California

### Carolyn M. Preece
**1980 Award for:**
Significant contributions to research and education in materials science and metallurgy
**Education:**
Ph.D., Metallurgy
**Contributions & innovations:**
Started research programs on cavitation erosion of metals and alloys for NSF and Office of Naval Research; studied surface modification of materials by ion implantation and laser processing for Bell Labs

### Thelma Estrin
**1981 Award for:**
Outstanding contributions to biomedical engineering, especially neurophysiologic research through application of computer science
**Education:**
Ph.D., Electrical Engineering
**Contributions & innovations:**
Pioneered application of engineering to medicine; designed first system for analog-digital conversion of electrical activity from the nervous system; directed data processing laboratory at UCLA's Brain Research Institute; helped design Israel's first computer, the WEIZAC

### Harriet B. Rigas
**1982 Award for:**
Significant contributions in the field of electrical engineering and computer technology
**Education:**
Ph.D., Electrical Engineering
**Contributions & innovations:**
Enabled automatic patching system for an analog/hybrid computer; founded computer engineering program at Washington State University

### Joan B. Berkowitz
**1983 Award for:**
Significant contributions in the field of hazardous waste management
**Education:**
Ph.D., Physical Chemistry
**Contributions & innovations:**
Pioneered alternatives to landfilling hazardous waste; wrote definitive U.S. EPA handbook on hazardous waste management; founded her own environmental consulting firm

### Geraldine V. Cox
**1984 Award for:**
Significant contributions to environmental management, in particular, water pollution
**Education:**
Ph.D., Environmental Science
**Contributions & innovations:**
Developed policy for chemical industry in energy, toxic substances, health and safety, and transport of hazardous materials

### Y.C.L. Susan Wu
**1985 Award for:**
Fundamental research in electrofluid dynamics of MHD and for outstanding service as an educator and administrator
**Education:**
Ph.D., Aeronautical Engineering
**Contributions & innovations:**
Administered Energy Conversion R&D programs at Univ. of Tennessee Space Institute; founded ERC, a scientific and engineering services company with 900 employees

*Continued on page 41*

Telecommunications Laboratory in England. She was in the middle of a laser experiment when the equipment stopped working. A resentful technician had intentionally misaligned the laser. None of the other engineers were able to fix the problem and suggested Dr. Garmire replace the sabotaged equipment. She did not follow their advice, but took the time and trouble to realign all the lenses. "I turned it on, and it worked," she recalled. "The technician was so impressed he confessed to his boss."


**Doris Kuhlmann-Wilsdorf, Ph.D., receives a pin from President Suzanne Jenniches at the 1989 Society of Women Engineers national convention (conference) in Oakland. A decade later, Jenniches received the Achievement Award at the 2000 SWE convention.**

"Work hard, conscientiously, faithfully, and joyfully!" advised Doris Kuhlmann-Wilsdorf, Ph.D., 1989 Achievement Award recipient. She holds many patents resulting from 20 years of physics and materials research and is the author of hundreds of technical articles. When Dr. Kuhlmann-Wilsdorf, who had been a professor in the University of Virginia's Department of Materials Science and Engineering since 1963, officially retired, it was hard to tell. She continued to get up at 5 a.m. to prepare for her classes, which included not only physics and materials science, but also a seminar on science and religion. When Dr. Kuhlmann-Wilsdorf became interested in the relationship between science and religion, she pursued the subject with characteristic energy, concluding, "The two are not antagonistic, but complementary, the two sides of humanity's age-old quest for truth."

## Encouragement — a booster rocket

Many Achievement Award recipients had parents who valued education and encouraged their daughters to believe they could do anything they set their minds to. Irmgard Flugge-Lotz, Ph.D., grew up in Germany, where her mother managed a family construction business. She accompanied her mother to building sites and developed an understanding of construction techniques. Her parents encouraged her to study mathematics at the Technical University of Hanover. As a girl, Roberta Nichols, Ph.D., who became a groundbreaking automotive engineer, worked along with her father rebuilding and racing vintage cars and boats. "I just grew up not knowing that girls weren't supposed to do those kinds of things," she said.

Umit Ozkan, Ph.D., 2002 Achievement Award recipient, attributes her success to her parents' tireless support of her desire for an education and a career in chemical engineering. "As I was growing up, my parents kept telling me that anything boys could do, I could do better. They must have repeated this often enough that I believed them," Dr. Ozkan said.

The parents of Mitra Dutta, Ph.D., 2003 Achievement Award recipient, swam against the tide of public opinion in their small town in India to make sure their daughter could study science. Dr. Dutta recalled, "… my parents went to the school to ask them about offering that subject, and the principal was horrified. She did not think girls should study science." So Dr. Dutta's father arranged for her to be taught at home and attend a boys' college that had science classes and lab equipment. Dr. Dutta's mother was also a great influence. Her attempts at a career in both medicine and economics were thwarted, and she did everything in her power to make sure the same thing did not happen to her daughter, teaching her to read in two languages and helping her skip grades in elementary school. "Because of that start she gave me in life," Dr. Dutta said, "I have done well."

Dutta

Teachers and colleagues were also important influences. Meeting Rosalyn Yalow, Ph.D., winner of the 1977 Nobel Prize in Physiology or Medicine, changed the course of Mildred Dresselhaus's life. Dr. Yalow had just earned her Ph.D. in physics and was teaching at Hunter College in the late 1940s when Dr. Dresselhaus was an undergraduate there. Dr. Yalow convinced her to pursue a career in science rather than secondary-school education, which, at the time, Dr. Dresselhaus believed to be her most "practical" option. "Role models are so important for young people who want to go into science and engineering," said Dr. Dresselhaus. "Rosalyn Yalow took me under her wing and told me I had a talent for science. She was doing it, so I figured I could do the same."

## Taking risks, making mistakes, and succeeding

Barbara Crawford Johnson was the first woman to earn a degree in general engineering from the University of Illinois. She went on to supervise design and performance analysis for the Apollo space mission. She managed engineering systems for Skylab and Apollo-Soyuz; she oversaw shuttle/orbiter design and development; and she was responsible for the first lunar landing.

However, some of her early flights did not go so smoothly. The University of Illinois had a small airport, and Johnson learned to fly a friend's plane there. She admitted to "a few small accidents." Once she ran out of gas and had to land the plane in an orchard. "I sort of set it down on a tree," she recalled.

This drive to work at mastering new skills, make mistakes, and learn from them is characteristic of highly successful people and certainly describes Achievement Award recipients. It's another thing that makes this group of women extraordinary, because in general, women are not encouraged to take risks

## Achievement Award Recipients *continued from page 39*

### Yvonne C. Brill
**1986 Award for:**
Important contributions in advanced auxiliary propulsions of spacecraft and devoted service to the growing professionalism of women in engineering

**Education:**
M.S., Chemistry

**Contributions & innovations:**
Derived first industry standard to assess rocket propellant performance; advanced propulsive capabilities through integration of R&D concepts; won prestigious John Fritz Medal for advances in engineering

### Nance K. Dicciani
**1987 Award for:**
Outstanding research management leading to the creation of important new industrial products

**Education:**
Ph.D., Chemical Engineering; M.B.A.

**Contributions & innovations:**
Directed development of technologies, including a catalyst for production of benzene from coke and a product for recovery of landfill gas; has served as CEO and board member of several large corporations; ranked among The World's 100 Most Powerful Women by *Forbes* magazine

### Roberta Nichols
**1988 Award for:**
Worldwide leadership in promoting the use of alternative fuels in transportation vehicles

**Education:**
B.S., Physics; Ph.D., Environmental Engineering

**Contributions & innovations:**
Led development of alternative fuel vehicles at Ford; holds 3 patents for flex-fuel vehicles; helped launch California Energy Commission

### Doris Kuhlmann-Wilsdorf
**1989 Award for:**
Pioneering and preeminent contributions to the understanding of the mechanical behavior of solids

**Education:**
D.Sc., Physics; Ph.D., Materials Science

**Contributions & innovations:**
Clarified plastic deformation of solids through concepts of crystalline defects; named 2001 Christopher J. Henderson Inventor of the Year; holds 12 patents related to microfiber electrical brushes, which improve engine performance

### Lynn Conway
**1990 Award for:**
Essential contributions to very large-scale integrated (VLSI) circuit and system design methodology, and for rapid propagation of innovations throughout the engineering community

**Education:**
M.S., Electrical Engineering

**Contributions & innovations:**
Helped develop superscaler computer architecture; pioneered development of simplified methods for VLSI chip design, which fueled Silicon Valley's chip design revolution; invented "dynamic instruction scheduling," fundamental to modern computer architecture; won 2009 IEEE Computer Pioneer Award

### Julia Weertman
**1991 Award for:**
Pioneering research on the failure of materials at elevated temperatures

**Education:**
D.Sc., Physics

**Contributions & innovations:**
Developed and experimentally confirmed the theory of grain boundary cavitation; pioneered materials characterization by small-angle neutron scattering

### Evangelia Micheli-Tzanakou
**1992 Award for:**
Outstanding contributions to understanding and modeling of visual systems with neural networks

**Education:**
Ph.D., Physics

**Contributions & innovations:**
Applied neural networks to engineering in medicine and biology; developed a set of algorithms for modeling the visual system

### Elsa Reichmanis
**1993 Award for:**
Design, synthesis, scale-up, and process engineering of new polymer resist systems useful for manufacturing integrated circuits

**Education:**
Ph.D., Organic Chemistry

**Contributions & innovations:**
Development and commercialization of photo-resist polymers for deep-UV photolithography; holds 10 U.S. patents

### Elsa Garmire
**1994 Award for:**
Breakthrough contributions in optical science and engineering, particularly in non-linear optics

**Education:**
Ph.D., Physics

**Contributions & innovations:**
Discovered and explained key features of simulated light scattering and self-focusing; president of the Optical Society of America and director of the Center for Laser Studies at the University of Southern California

### Manijeh Razeghi
**1995 Award for:**
Leadership and contributions to optoelectronic devices research and education

**Education:**
Ph.D., Physics; Ph.D., Materials Science

**Contributions & innovations:**
Holds 32 patents; initiated design and implementation of epitaxial growth techniques; developed semiconductor structures for advanced photonic and electronic devices; pioneered growth of (Ga,In)(As,P) based structures

### Barbara Liskov
**1996 Award for:**
Significant contributions to computer system design, especially development of data abstraction, aka "object-oriented" or "modular" programming

**Education:**
Ph.D., Computer Science

**Contributions & innovations:**
Researched Venus operating system; developed data abstraction concept and CLU programming language; researched Argus distributed programming language and operating system; invented many practical distributed algorithms

### Ilene J. Busch-Vishniac
**1997 Award for:**
Outstanding achievements in acoustics, transducers, and microautomation, and for significant contributions to engineering education

**Education:**
Ph.D., Mechanical Engineering

**Contributions & innovations:**
Led efforts on 9 U.S. patents for sensors for teleconferencing, blood pressure monitoring, miniaturized microphones, and optical position detection

### Lisa C. Klein
**1998 Award for:**
Breakthrough contributions in sol-gel science and engineering, particularly applications in electrolytes, electrochromics, membranes, and nano-composites

**Education:**
B.S., Metallurgy; Ph.D., Ceramics

**Contributions & innovations:**
Researched synthesis and processing of ceramics using sol-gel process; holds three patents on electrochromic coatings

*Continued on page 43*

or view mistakes as opportunities to learn.

This reluctance to take risks may stem from what Stanford psychology researcher Carol S. Dweck, Ph.D., calls the "fixed mindset." This is the belief — particularly common regarding math skills — that abilities are inborn and that intelligence is static. Dr. Dweck has found that people with a fixed mindset tend to give up when confronted with a challenge, avoid risks, and ignore negative feedback. People with a "growth mindset," on the other hand, believe that intelligence can be developed. They believe in the power of effort, and they gain confidence by grappling with obstacles because they believe challenges make them smarter.

From left, 1973 Society of Women Engineers Achievement Award recipient Irene Peden, Ph.D., and future Achievement Award recipient (2005) Bonnie Dunbar, Ph.D., enjoy a conversation, 1980. Dr. Peden was on the faculty at the University of Washington when Dr. Dunbar enrolled there as an undergraduate.

### Stepping out of the comfort zone

Y.C.L. Susan Wu, Ph.D., 1985 Achievement Award recipient, earned her undergraduate engineering degree in Taiwan in 1955. Seeing no opportunities for her in China, she left in 1957 and came to the United States. Dr. Wu was the first woman to earn a Ph.D. in aeronautical engineering from the California Institute of Technology. For 25 years she was professor at the University of Tennessee Space Institute (USTI). Then in 1988, she left the security of USTI to revive a moribund consulting business she had set up several years before. The company had no contracts and no employees. She established herself as chairman and CEO, named the company ERC, and set about growing an engineering and scientific services business. Today ERC operates in five states and employs 900 people. Contracts with NASA, the U.S. Department of Energy, the U.S Air Force, and other agencies generate annual revenues of $100 million.

Dresselhaus

### Not the usual career path

Melanie Cole, Ph.D., 2008 Achievement Award recipient, has made a number of leaps in her career, but always landed on her feet. She has a bachelor's in geology from the University of Miami, a master's in geochemistry from Iowa State University, and a Ph.D. in oceanography/geochemistry from the University of Rhode Island. For the past 20 years, Dr. Cole has been a research scientist and team leader for the Active Thin Films Team at U.S. Army Research. She supervises design, synthesis, and fabrication of materials for next-generation electronic, microwave, optoelectric, and high-power devices.

After she finished her Ph.D., Dr. Cole found a job at the Army Research Lab in Monmouth, N.J. First establishing that she could not make coffee, she realized research would give her the freedom to write her own job description. "I took a walk down the hall and saw that they had a transmission electron microscope converted into a pattern generator," Dr. Cole recalled. This was one of the first e-beam direct-write systems for patterning electronic devices being made into now-ubiquitous, high-speed processing chips. She thought, "I'm pretty good at crystallography and a good physicist … I can do that." She learned everything she could about electron microscopy and thin-film electronics, apprenticing herself to several experts in the field. She has since built a highly regarded program that continues to perform a valuable service.

Johnson

### From academe to the Air Force and back

Sheila Widnall, Ph.D., 1975 Achievement Award recipient and holder of three patents in airflow technology, was the first woman to head a branch of the U.S. military. After working for 28 years at MIT, where she was a world-famous expert on fluid dynamics, she was appointed by President Bill Clinton in 1993 to Secretary of the U.S. Air Force. This was not the first time she had entered unfamiliar territory. In 1956, she was one of just 23 women in the MIT freshman class of 936. She earned all three of her degrees from MIT, completing her Ph.D. in 1964. Her work in aircraft turbulence and spiraling airflows has had a major impact on aircraft performance. Dr. Widnall designed MIT's advanced wind tunnel facility and in 1979, became MIT's first woman associate provost. As Air Force Secretary, Dr. Widnall was responsible for 400,000 active-duty forces, the 185,000-strong Air Force Reserve and Air National Guard, and a $62 million annual budget. She returned to MIT in 1997 and was named Institute Professor in 1998. In addition, Dr. Widnall was elected to the National Academy of Engineering in 1985 and received the Arthur M. Bueche Award for leadership in expanding the opportunities for women and minorities in engineering in 2009.

Kristina Johnson, Ph.D., the 2004 Achievement Award recipient, is now Under Secretary for Energy in the U.S. Department of Energy. She articulated the growth mindset exemplified by so many Achievement Award recipients eloquently in her own acceptance speech: "I think we build confidence by tackling a task, failing or succeeding, and trying again until we do succeed. Persistence is a virtue." ■

## Achievement Award Recipients *continued from page 41*

### Shirley E. Schwartz
**1999 Award for:**
Outstanding contributions to lubrication technology, development of environmentally friendly products, conservation of non-renewable resources and significant achievements in promoting awareness of technical professions

**Education:**
Ph.D., Physical Chemistry

**Contributions & innovations:**
Developed patented device that tells drivers when engine oil should be changed; researched effects of alternative fuels on engines; development of non-ozone-depleting refrigerants

### F. Suzanne Jenniches
**2000 Award for:**
Outstanding leadership in manufacturing innovation and for setting the highest standards of excellence in producibility engineering

**Education:**
M.S., Environmental Engineering

**Contributions & innovations:**
Exceptional versatility in application of engineering skills; led operations for offensive radar for B-1B Bomber; produced first electronically scanned antenna for production aircraft in the world

### Judith A. Clapp
**2001 Award for:**
Significant contributions to technology for managing development and acquisition of large-scale command and control systems and establishing software engineering as a discipline

**Education:**
M.S., Applied Science and Computer Science

**Contributions & innovations:**
Developed first automated aids for writing and testing software for large-scale, real time command and control computer system; led development of one of first generalized computer database management systems; presided over application of artificial intelligence for space shuttle launch preparation

### Umit Ozkan
**2002 Award for:**
Outstanding accomplishments as an internationally recognized and highly respected researcher in heterogeneous catalysis; as an excellent engineering educator; as a dedicated leader in higher education and in professional societies; and as a true trailblazer in every aspect of her professional life

**Education:**
Ph.D., Chemical Engineering

**Contributions & innovations:**
Research in heterogeneous catalysis with many applications in environmental protection

### Mitra Dutta
**2003 Award for:**
Pioneering research in novel heterostructure optoelectric and electronic devices

**Education:**
Ph.D., Physics

**Contributions & innovations:**
Groundbreaking research on optical characterization of semiconductor heterostructures; leader in establishing important Army research programs in electronics and optoelectronics; holds 24 patents

### Kristina M. Johnson
**2004 Award for:**
Significant contributions to optoelectronic processing systems and liquid crystal devices

**Education:**
Ph.D., Electrical Engineering

**Contributions & innovations:**
Leading researcher and expert in optics, optoelectronic switching, and display technology; holds 43 patents

### Bonnie Dunbar
**2005 Award for:**
Visionary contributions ranging from ceramic shuttle-tile design to biomedical research; for efforts benefiting astronautics, humankind, and the future scientists and engineers she inspires

**Education:**
M.S., Ceramic Engineering; Ph.D., Mechanical/Biomedical Engineering

**Contributions & innovations:**
Developed ceramic shuttle tiles; established tile manufacturing process; mission control guidance and navigation officer at NASA's Johnson Space Center; played key role in five space flights

### Elaine S. Oran
**2006 Award for:**
Pioneering a computational technology that unifies engineering, scientific, and mathematical disciplines into a methodology for solving reactive flow problems

**Education:**
Ph.D., Engineering and Applied Sciences

**Contributions & innovations:**
Invented and implemented algorithms and computational methods for accurate numerical simulations of reactive flows; her work on deflagration-to-detonation process solved major problem in combustion theory

### Pamela K. Strong
**2007 Award for:**
Exhibiting world-class leadership in non-metallic technology and pioneering the use of non-metallic composites, which revolutionized the aerospace industry

**Education:**
Ph.D., Organic Chemistry

**Contributions & innovations:**
Provided all technical and design support for nonmetallic manufacturing processes and material parameters used in the B-1B Bomber, Delta rocket structure and motors, Titan, and Space Shuttle; developed first composite jet engine vanes good to 700 degrees Fahrenheit; helped convert the jet engine to 67.5 percent composites in 3 years

### Melanie W. Cole
**2008 Award for:**
Pioneering research contributions, experimental creativity, and innovation in developing a fundamental understanding of the complex relationships between the structures, processing, and properties in thin film electronic materials

**Education:**
B.S. Geology; M.S., Geochemistry; Ph.D., Oceanography

**Contributions & innovations:**
Responsible for research programs to develop electronic materials, including thin film ferroelectrics; shape memory alloys; piezoelectrics; III-V and wide bandgap semiconductors; and metallization technologies; holds 7 patents and 3 patent disclosures

### Aslaug Haraldsdottir
**2009 Award for:**
Accomplishments in and significant contributions to air traffic management, communication, navigation, and surveillance system design, greatly influencing the future worldwide air traffic management system

**Education:**
Ph.D., Mechanical Engineering

**Contributions & innovations:**
Pioneering work in fast-time modeling and simulation; identified need to incorporate human and subsystem performance in airspace models