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women in engineering MAGAZINE

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WePower Women

Innovating in Academia

Fostering Diversity, Inclusion, and Equity

Looking Beyond Technology

The Educating Apple

IEEE

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Kristina M. Johnson believes that the United States faces a significant challenge in "the ability to utilize its total domestic talent as well as continuing to be a beacon to those from other countries who want to come to the United States."

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WePower Women

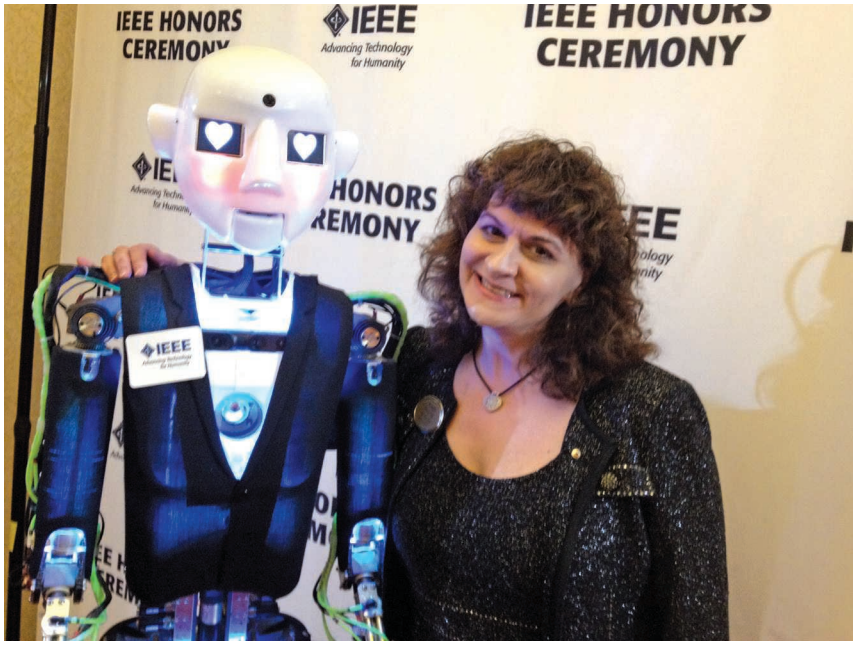
As the IEEE Awards Board chair, I had a virtual front row seat at the 2021 IEEE Vision, Innovation, and Challenges (VIC) Summit & Honors ceremony [1]. I have attended many of these ceremonies before, including the ceremony when the first female IEEE Medal of Honor recipient, Dr. Millie Dresselhaus, was honored, whom we featured in the June 2016 issue of *IEEE Women in Engineering Magazine*. I thought nothing could possibly top that ceremony. After all, it was an in-person event that was accompanied by a "robot thespian," which interacted with the audience throughout the ceremony.

When I saw the roster of the 2021 IEEE Award recipients, I knew we had hit a milestone that IEEE had never before achieved, namely, the largest number of female IEEE Award recipients in our organization's history! IEEE Women in Engineering (WIE) has undoubtedly moved the needle for the advancement of women in IEEE and women and young girls around the world. The impact from our members' tireless volunteering efforts and commitment to promoting equality in the science, technology, engineering, and math (STEM) fields is now visible at the highest echelons of society. Our IEEE WIE approach of working with aspiring engineers by showing them role models and the impact of their work is a proven, winning recipe that brings more diversity into the STEM fields.

Although Dr. Dresselhaus is no longer with us, her legacy was truly honored when the first inaugural recipient of the IEEE Mildred Dresselhaus Medal, Dr. Kristina Johnson, gave her acceptance speech at the 2021 IEEE VIC Summit & Honors Ceremony. The passion and inspiration she shared throughout her speech created one of the most powerful moments of any IEEE Awards ceremony. The ceremony was conducted virtually and reached thousands as it continues to reach global audiences that will surely be the gold standard for acceptance speeches. Great communication skills are not Dr. Johnson's only forte, she is the complete package, embodying the diversity it takes to bring innovation to life and change the world. Congratulations Dr. Johnson!

Karen Panetta

In this issue of *IEEE Women in Engineering Magazine*, we celebrate "WePower" women, that is, women who empower, innovate, and are bold enough to take the risk to make global change happen through their talents to collaborate, communicate, and lead. Dr. Johnson, Dr. Andrea Goldsmith, Dr. Maxine Savitz, Dr. Lisa T. Su, Dr. Sharon Nunes, and Dr. Linda Katehi are all



A robot thespian entertained guests, including Karen Panetta, at the 2015 IEEE Honors Ceremony.

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IEEE Women in Engineering Magazine **Editor-in-Chief Karen Panetta with IEEE Medal of Honor recipient Dr. Millie Dresselhaus.**

members of the National Academy of Engineering. They are entrepreneurs, business and academic leaders, and exemplary agents of change. As powerful and successful as these brilliant women have become, they remain committed volunteers, mentors, and passionate philanthropists.

One of our most precious IEEE WIE gems of a volunteer is past WIE Chair Ramalatha Marimuthu. She continues to innovate new programs and initiatives that help IEEE WIE evolve to best serve communities and our mission. In this issue, she shares her experiences with the Women in Power Sector Network in South Asia initiative, which we hope will inspire other volunteers to emulate this program as a best practice in their own communities.

As IEEE WIE continues to drive diversity and inclusion initiatives, I bring to your attention one area of diversity that has not received much attention or awareness. It is what I call *institutional diversity*. We tend to focus on our individual institution's internal diversity population, but when hiring or recruiting for

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our institutions, it seems that there is a bias toward individuals who have attended the larger or designer-brand organizations, especially in academia. Review the faculty rosters of your own organization, and look at the schools they attended. Do you see institutional diversity? Look at the leaders in your country's government. Do you see institutional diversity among your leaders' alma maters? There are many wonderful schools and universities that help craft diverse types of graduates, and having people with different educational experiences on our teams means we add another dimension to diversity that will inevitably foster innovation.

Our IEEE WIE approach of working with aspiring engineers by showing them role models and the impact of their work is a proven, winning recipe that brings more diversity into the STEM fields.

I was reminded of this when I had the pleasure of speaking with Janet Wozniak, who epitomizes what it means to be well rounded and have interdisciplinary expertise. She is a brilliant computer scientist, biologist, mathematician, and educator. She pursued all of these subjects in college, long before interdisciplinary studies were mainstreamed into academic programs.

During my conversation with Wozniak, it was evident that she was proud of her alma maters, namely, her undergraduate institution, Baker University in Baldwin City, Kansas, and the University of Kansas, where she did her graduate work. She spoke enthusiastically about attending a small undergraduate institution, which her parents had also attended. She detailed how wonderful institutions like her own are often overlooked. To this day, she is passionate about conveying how she truly valued and appreciated the opportunities and experiences she gained at these institutions. This reminded me of how important and powerful having institutional diversity is, and Wozniak is a living testament to it.

We are honored to celebrate Wozniak as one of our IEEE WIE WePower women. She is all about empowering others, and together with her husband, Steve Wozniak, continues to inspire youth to overcome adversity and embrace their own passions. Despite their grueling schedules and overwhelming speaking requests, they always keep students at the forefront. For instance, Steve was the keynote speaker at the October 2021 IEEE-HKN Student Leadership Conference, for which I was honored to moderate. Thank you so much to you both!

Finally, *IEEE Women in Engineering Magazine* is happy to announce that once again, the magazine has been awarded an APEX award for publication excellence. The magazine has a flawless track record of continually receiving awards throughout its 14-year history. This unprecedented winning streak has been possible only with the collaboration and dedication of our members and *IEEE Women in Engineering Magazine* production team: Craig Causer, Geraldine Krolin-Taylor, Janet Dudar, Gail Schnitzer, Theresa Smith, Dawn Melley, Kevin Lisankie, Peter Tuohy, Felicia Spagnoli, and Mark David; writers Katianne Williams and Leslie Prives; editorial board members Supavadee Aramvith, Holly Cyrus, Denise Griffin, Pamela Jones, Leda Lunardi, Laura Margheri, Kate McDevitt, and Carolyn McGregor; and WIE staff members Charmain Williams, Paola Bringas, and Georenda Brown Onyesoh. A special thank you to IEEE WIE Chair Jenifer Castillo and the entire IEEE WIE Committee. Our journey toward a diverse and inclusive world is well underway thanks to your collaboration, passion, and commitment. Thank you!

Karen A Panetta

—Karen Panetta, Editor-in-Chief
IEEE Women in Engineering Magazine

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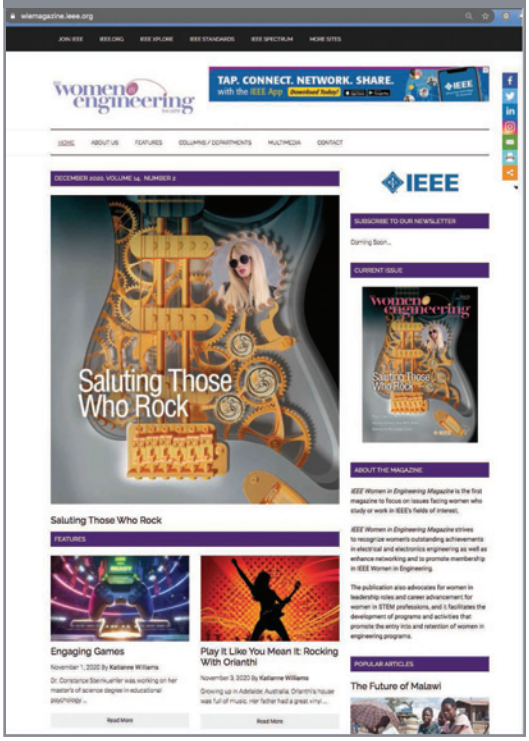

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[1] "2021 VIC summit & honors ceremony gala." IEEE Awards. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjSwO6eks_yAhUMGFkFHbilBv4QFnoECAUQAQ&url=https%3A%2F%2Fcorporate-awards.ieee.org%2Fevent%2F2021-vic-summit-honors-ceremony-gala%2F&usg=AOvVaw1agN03NNwFtf1B6R7H0zlI

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Lifting Humanity From Serious Problems

Scaglione continually adapts and explores new research areas

If it seems like Dr. Anna Scaglione has jumped on many different topics in her research, that was by design. "I appreciate people who have the patience to drill down and remain in one area for their scholarly career, but I've moved my research interests and work areas quite a bit to develop new expertise, hoping to bring a fresh point of view," she says. "There may not seem to be a clear logic, but there's a method to the madness." She has also been on an interesting career journey in academia, having been a faculty member at four different institutions before landing at Cornell Tech this past fall as a professor of electrical and computer engineering.

Scaglione's research is at the intersection of signal processing, network science, and energy systems. The group she directs, the Signal Information Networks and Energy (SINE) lab, is divided into two parts: "my students call themselves the *low-voltage* and *high-voltage* sides," she laughs. The low-voltage work encompasses signal processing and data science, communications, and complex network modeling. *High-voltage* refers to sustainable physical infrastructures, particularly energy-delivery systems.

Scaglione shares one problem the team is evaluating—the incoming "elephant in the room" as she says—is how we are going to be able to handle millions of control points to support lower emissions and integrate more renewable power. Another great challenge the two parts of her group seamlessly connect to tackle is addressing physical infrastructure cybersecurity threats and the confidentiality of data.

Dr. Anna Scaglione

To secure the grid, Scaglione relies on her knowledge in electric and, more recently, gas grid systems as well as expertise in machine-to-machine communications and data science. Although encryption and password protection are the first lines of defense, Scaglione's work goes beyond that to research how to detect security events and mitigate them. "It is a fascinating combination of algorithms and applications, not broadly understood because people focus on the network side and not the physical infrastructure," she describes. "But the need is growing because we're already faced with problems and more will come if we don't do something soon."

An Unexpected Path

This may not have been the destination Scaglione predicted, but her journey makes sense. When deciding what to study, she recalls, "I wasn't interested in law, I wasn't interested in liberal arts, though I loved history. I sketch and draw but didn't think that was a good idea either. I liked science but was extremely squeamish, so biology or medicine were not good professions. I wanted something that was creative and was intrigued by computers and the advances in communications, so I thought of engineering. I know a lot of people think engineering is not creative, but it was clear to me that it had to be."

Scaglione received bachelor's, master's, and doctoral degrees in electrical engineering with a focus on signal processing from the Università degli Studi di Roma "La Sapienza." In between each degree, she considered job offers in Italy but felt there was more creative work to be done in academia, joking "I was trying to escape the jobs I'd worked so hard to qualify for." Although it was not exactly a call to teaching at first that caused her to pursue a Ph.D. degree, she saw the research work available by going that route was ultimately what she wanted to do.

She next moved to the United States, taking an offer of a postdoctoral researcher at the University of Minnesota, Twin Cities in 1999 with someone she had collaborated with as a Ph.D. student. During the year in Minnesota, she applied to a number of academic jobs back in Italy, but fortuitously, nothing worked out there. The wireless industry was booming at the time, but "many dot-coms crashed two years later, so it was good I didn't get a job at the time and get derailed in my scholarly pursuits," she recalls.

Scaglione later applied to and ended up receiving multiple offers from universities in the United States, opting to join the University of New Mexico as an assistant professor for one year before moving to the same position at Cornell

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University, where she stayed for seven years and received tenure. Then, she moved across the country to join the University of California (UC), Davis as an associate professor, moving up to professor, for a few reasons. "It was a *classic two-body problem*, as they call it in academia," she explains. "I had met my husband in Minnesota and we needed to converge somewhere," making California the place.

After close to seven years, however, the couple was ready for something different. "I had developed an interest in energy, but UC Davis wasn't doing much in that area," says Scaglione. "There was a vibrant program in energy and power systems at Arizona State University, so it was a clear choice to move." She was also happy to return to the southwest, which she has loved since her time in New Mexico, but she now hopes that New York City will be home forever. "I feel that Cornell helped launch my scholarly career in the past and am excited to be back there after 13 years and help develop the department on the New York campus," she says.

All along the way, Scaglione had been adjusting not just her geography but her research areas too. Originally focused in wireless communications, she authored some impactful papers that led to new developments in standards for personal communications. "The evolution from 3G to 4G was a leap, whereas 4G to 5G was a development," she explains. "But I'd predicted it would happen earlier than the long time it ended up taking."

By the time 3G became a reality, Scaglione was already more interested in connecting machines. "At that time, we didn't call it the *Internet of Things*, but basically, that was the idea: machine-to-machine communication and creating wireless networks that cover entire neighborhoods," she says. "Those were difficult problems, so I worked on bringing modem design to the applications, but the end goal is not actually the communication, it's to perform some task." Looking for applications, she stumbled upon energy systems right as the prevailing thought was beginning that systems needed to be upgraded to incorporate renewable energy.

From there, Scaglione developed an interest in decentralizing systems. "Instead of doing only purely local processing, I was interested in how you combine the idea of communicating within a network and solving a decision or an inference problem where you have to understand what is the state of the system," she says. "These are the kinds of questions I was trying to address with algorithms."

Scaglione describes a way of approaching her work that appears atypical: she often goes from modeling to define some control or optimization task to the machine learning formulation, rather than the other way around, considering abstract problems unrelated to application.

Scaglione with her dog, Patata, which means *potato* in Italian. Scaglione is reading Patata a book she coauthored with University of California, Los Angeles Prof. Christina Fragouli called *Information in Small Bits*, an information theory book for children.

"Having analyzed and modeled many distributed network algorithms, I'm interested in data that originates from dynamics that occur in networks not necessarily made by engineers, like social or gene networks," she explains. "In these cases, it's interesting to infer the supporting underlying structure of the data and equations. It's not trying to create an algorithm but to understand what explains the data and enables making predictions."

This approach is referenced in her work with the SINE lab, where the team looks at both the signals and physical connectivity of a network. When it comes to the expected proliferation of electric vehicles, for example, Scaglione says one algorithm the team is working on is how to make all of the charges happen in such a way that people are happy, such as a car being fully charged but no blackout occurs. "If the peak of the solar power is not coincident with the peak of demand, you can use control algorithms to get people what they need but also efficiently use the power when it is there," she explains. "It is not just building the energy sources but controlling when the energy is drawn."

On the security side of things, Scaglione's current work looks at merging what is observed from physical sources with what is happening over the network. "How do you merge the information to identify the source of the problem and what is the action that you perform?" she asks. "These are really complex infrastructures, so you don't want to do damage and you don't want to send too many alerts for things that don't have much impact. These are areas I've been working on quite a bit."

In retrospect, Scaglione says hers has been a good path because "as research in certain areas becomes more incremental, it's more exciting for me to move into different ones." Although she is quick to note that she has made contributions in a variety of areas rather than, say, an educational textbook that distills the fundamental concepts of an established technical area, it works for her because "I tend to develop interests in new areas and explore, and that's more my MO [modus operandi] at this point."

She also points out, however, that this route is not easy. "This suited me and I was lucky enough that I could do it but, I would not recommend it, particularly pretenure," she advises. "People want to see you pursue an area. There is a learning curve that slows down productivity in some ways and slows down acceptance into a 'technical home.' For me that home is signal processing, and so I can publish in signal processing publications, but if I do research more suited to energy problems, then in that case, I publish in power systems or automatic control or networking publications. I've published extensively in those other venues and learned that trying to establish yourself in all these different groups is not for the lighthearted."

Regardless of whether the work is considered signal processing, energy, networking, control systems, or any combination thereof, Scaglione is proud to be an engineer. "I can't think of any other areas that have this power to lift humanity from serious problems," she shares. "Science and technology cannot solve everything, but one can do a lot, and as an engineer this hard work gives you some sense that you're helping."

Continually adapting her research and exploring new areas has kept the work exciting and creative for Scaglione, as she initially sought to do. "It is heavy, but it gives me a lot of joy to do this work together with my students and collaborators," she says. "It was a really good profession to choose."

—Leslie Prives

The Intersection of Science, Math, and Problem Solving

Centeno working to improve health outcomes

Dr. Grisselle Centeno always knew she wanted to help people. And while she drew on the examples set by family members' careers, friendly advice, and inspiring mentors, Centeno carved out a career path uniquely her own: one that has allowed her to impact students, patients, women, the Hispanic community, and even, yes, Mickey Mouse.

Growing up in Puerto Rico in a family of mathematicians, Centeno recalls playing math games and puzzles with her father while traveling 45 min into the city for school. As she grew older, she opted not to follow in her family's footsteps toward business or accounting, but instead saw herself at the intersection of science, math, and problem solving. "A friend told me industrial engineering was about problem solving, working with people to make things better, and that was all it took," she says. "I love the versatility of what industrial engineering brings. You never get bored because you can apply the concepts to any industrial setting."

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Centeno received her bachelor's degree in industrial engineering at Universidad de Puerto Rico at Mayagüez, then continued on to pursue her master's and Ph.D. degrees from the University of Central Florida. "When I decided to go for my master's and Ph.D., it was because I knew I enjoyed teaching and wanted to teach adults," she describes. "Two of my sisters are educators and becoming a professor was a passion of mine."

Dr. Grisselle Centeno

Advancing Health Care With Technology

Another passion was health care, a field to which Centeno has dedicated more than 15 years. This combination made the University of South Florida (USF) a perfect choice for her first role in academia: although she was a part of the Department of Industrial and Management Systems Engineering, Centeno could also do projects with the USF Morsani College of Medicine and the College of Nursing. Throughout her 18-year tenured career there, Centeno shifted toward work predominantly in health care.

A few years ago, Florida Polytechnic University was looking to launch a program that connected health care and engineering, and Centeno's experience and research background made her an ideal candidate to bring this vision to life. She was hired as director for the new Health Systems Engineering program and full professor in the Department of Data Science and Business Analytics.

Due to its large senior population, Florida pays significant attention to health care; however, the incorporation of ever-changing technology into health delivery services is something that needs to be reviewed frequently. "Look at all the tech we have available for treatment and diagnosis," says Centeno. "Then when you examine health-care delivery, you realize it is stuck in the 1980s: we still fax things, systems are disconnected, and most units operate in silos. This is where we see the need and believe it could be very fruitful for our engineers and data scientists to really connect and improve health-care delivery."

Continues Centeno, "building this program has been the most exciting opportunity in recent years." Beyond that, because she, her husband, and their kids have lived in Lakeland, Florida, for more than 20 years, Centeno felt that taking this role would be giving back to her community.

Community, in this sense, means her neighbors and the health-care patients in central Florida as well as women and Hispanics. "When we look at the statistics of health-care engineering, it's no secret that women are underrepresented," says Centeno. Although women make up a large composition of the health-care workforce, believed to be driven by a natural inclination toward care professions, "my hope is that coming up with a program that has health care at its heart shows women they can be engineers and STEM [science, technology, engineering, and math] professionals. They don't have to be in supporting roles."

As Centeno points out, women have specific needs in terms of health care, and think differently, so it is important to have their perspective represented at all levels of the health-care system. To encourage this, she and the affiliated faculty to the Health Systems Engineering program bring former students and other women in the field to the classroom so female students can meet role models doing the work they strive to do.

Centeno takes a similar approach to encouraging underrepresented minorities, such as Hispanics. "Florida Poly has a large number of Hispanic students, and I'm introducing them to people they can relate to and whose stories encourage them," she shares. "I was a first-generation college student and the first engineer in my family. Although I received all the support in the world from my parents, I couldn't talk to them about many challenges or decisions I needed to make because they could not relate." With many of her students also first-generation engineers, "representative role models are super important because they validate your thinking and your direction."

With her deep passion for connecting health care and engineering across all populations, it is no surprise that Centeno's research interests also center around ways to improve health outcomes, particularly via optimization -based modeling and capacity planning. A current project she is working on involves wearable devices for fitness analysis and hypertension detection. "The intention is to enable data collection to design and validate mathematical models that could help us identify factors that could be correlated with undiagnosed and untreated hypertension," describes Centeno, noting that this study differs from the majority of hypertension research because it focuses on a younger population, ages 18–39 years old. The noninvasive wearable device allows for the collection of vital information such

Centeno teaching her students.

as pulse, blood pressure, and sleep diagnostics as a snapshot every 15 min. "We're growing this immense amount of data to analyze it and develop predictive models in order to identify some of the characteristics of people who may be at risk for hypertension," she says.

Another project is geared toward predicting how someone will respond to radiation therapy. Working with a group at Tampa's Moffitt Cancer Center with expertise in prostate cancer, Centeno and her team are developing analyses using gene expression profiles and machine learning to identify the most appropriate course of action for patients based on need and whether they are radiosensitive or radio resistant. "This is important because not everyone benefits from radiation therapy," says Centeno. "If you put someone through that process and nothing is gained, then not only is it expensive for the patient and the health-care system, but the emotional toll is costly as well."

Into the Disney "Lab"

With so much of her work seemingly focused on Florida-centric populations and industries, it was a natural extension for Centeno to team up with perhaps Florida's most famous locale: Walt Disney World (WDW). She served as a part of Disney's industrial engineering consulting and advanced analytics teams working on a variety of projects for more than 16 years, up until the time COVID-19 hit. "Disney's issues are similar to those in health care: both are service industries, 'guests' are equivalent to 'patients,' reducing wait times is always a goal as is optimizing the use of limited resources while meeting high demand," she explains. "These all fit under capacity planning, which is what I call my *umbrella of research*."

Projects she worked on included scheduling dancers for the various shows around the theme park, which needed to be optimized for efficiency while also accommodating the required breaks, as well as supporting a simulation project for effective laundry operations. "How do we best deal with the logistics of bringing all the sheets and towels from multiple resorts, then effectively scheduling what to wash first, determining order and time to dry and fold them, how to send them back so that every day you can have clean sheets and towels in every room? We take all this for granted," describes Centeno. "I considered WDW my lab; there I was not a professor but another industrial engineer and, as such, I dealt with all of the issues my students deal with when trying to solve a problem. That enriching opportunity made me a relatable and relevant teacher."

Leveraging Strengths

Alongside her teaching and research responsibilities, Centeno has branched out into philanthropic efforts, including efforts promoting women's initiatives, engineering ethics, and K–12 engineering education. Recognizing her work both in the classroom and outside, she has won numerous awards and honors, including the distinction of being the first Florida Polytechnic professor and the first Hispanic chosen for the Executive Leadership in Academic Technology, Engineering, and Science (ELATES) program in 2019. ELATES at Drexel University is a prestigious fellowship designed to advance senior women faculty in academic STEM disciplines into effective leadership roles, and Centeno is firmly on that path.

It is a path she blazed for herself—although she did not do it alone. "I would not be where I am if not for my great teammates, leaders, and mentors throughout my career," she says. "Having a good network of people that support you is really key, especially for women. But do not wait for them to come to you, you have to look for them." She also makes sure to point out that so many of her colleagues are doing magnificent, meaningful work related to health care.

Centeno continues to pay it forward, advising the younger generations to take the time and learn about the many opportunities out there. "You don't have to stick to the regular mold; educate yourself so that you can make decisions about a career that really speaks to you," she says. "We are all so pressured and stressed and think we need to deliver all of the time, but everyone deserves a little bit of grace, and I'm speaking to myself here too."

She goes on to chip away at the traditional advice about finding work that makes you happy. "I get that, but a job is something that you get compensated for, so don't think it has to be 'Disney World' all of the time," she says. "Instead, identify what your strengths are and leverage those to define your career. You don't have to have it all figured out at the beginning and not every decision is one you make for forever."

Coming from someone whose area of expertise is literally optimization and decision making—as well as someone who has created an impactful, fulfilling career thus far that serves her communities and furthers our health-care system—we would be wise to listen to Centeno.

—Leslie Prives

Centeno in the classroom.

Back in the Lab

Katehi tackles research in embedded intelligent chips

In the fall of 2019, Dr. Linda Katehi joined the faculty at Texas A&M University as a professor of electrical engineering and computer science. One year in, she couldn't be happier. Throughout the course of her successful career in academia, Katehi has been dean of engineering, provost and vice chancellor of academic affairs, and chancellor, but at Texas A&M, Katehi has recaptured the energy of her first teaching position at the University of Michigan. The students are bright and curious. The faculty is engaged. The weather is beautiful. Most importantly, after more than almost two decades of administrative roles, Katehi is back in the research lab and classroom. She continues to be a mentor and advocate for women in science, technology, engineering, and math while embarking on new research in embedded intelligent chips that could change the way we interact with technology.

A Focus on High Frequency

On 16 July 1969, Katehi was a young girl watching the moon landing from her hometown on the Salamis Islands in Greece. It wasn't the grainy image of the Eagle spacecraft that captivated her, it was the rows of men managing the flight from their computers at Mission Control in Houston. That scene inspired Katehi to become an engineer, and she left the island to attend the National Technical University of Athens. There she received her bachelor's degree in electrical engineering and began her work in high frequencies. This research area was mainly chance—in undergraduate research, where "your knowledge is limited and limiting," the student doesn't get to do the selecting—but she enjoyed it and excelled at it. Katehi was on her way to becoming a pioneer in the field, with 19 patents.

While working on her research, she met her first mentor, Prof. Alexopoulos, who was spending his sabbatical from the University of California, Los Angeles (UCLA), in Athens. Later, when Katehi left Greece for graduate school at UCLA, he would become her advisor. In graduate school, Katehi worked on radar systems, then on radar antennas. In the early 1980s, she moved into integrated circuits, and through her faculty years she moved higher and higher in frequencies, working with millimeter-wave circuits and on "everything that goes behind the antenna." She focused on both modeling and experimental work in that area, and throughout her career, Katehi has specialized in energy-efficiency issues and has seen the development and manufacture of innovative materials for the aerospace, transportation, and industrial sectors.

Dr. Linda Katehi

Today, Katehi is intrigued with the idea of designing hardware with an inherent learning capability—circuits with embedded intelligence. She is occupied with defining intelligence and then figuring out how to translate that into the area of high-frequency chips. She has spent the last few years reading, researching, and investigating. Early on, she connected with R. Stanley Williams, an engineer at HP Research Labs who was working on memristors, a type of computer memory device that can exist within an integrated circuit and that functions more like the neurons of the human brain, with an inherent capability to learn from past patterns. Katehi was curious if she could use those devices for the types of circuits she had in mind, but over the years, she and Williams lost touch. Then Texas A&M reached out to Katehi, and chance struck again. When she realized Williams was in the process of also moving to Texas A&M, that sealed the deal. She and her husband, Chemical Engineer Prof. Spyros Tseregounis, planned their move and Katehi began preliminary work on her research.

Katehi's son was born while she and her husband were graduate students at UCLA in the 1980s.

Embedded Chips

"In Cartesian philosophy, Descartes said, 'I think, therefore I am,' indicating the brain was our only reason for our intelligence. Today, however, the much older, prevailing philosophy of Aristotle says no, it's not just the brain that works, but it is the body that is an equal contributor because without a body that has the capability to interact with its environment, learning would be different," explains Katehi.

Take the octopus. The octopus has an advanced nervous system of more than 500 million neurons, but unlike humans and other animals, two-thirds of those neurons are found outside of the central brain. The majority are found in the arms, allowing octopi to perform basic movements without input from the brain. This allows the octopus, with its soft legs and lack of a skeleton, to explore its environment very effectively and gives it the ability to acquire advanced intelligence. The octopi's intelligence is integrated into its body.

If intelligence is your acquired capability to learn from experience and apply learning to new situations, then, "usually, to be intelligent, you need a brain, but you also need the body that gives you all of the sensory signals that your brain is using and processing," Katehi says. You need images from the eyes and readouts of texture or temperature from skin. Similarly, all electronics systems have a body, made of components such as the antenna and sensors, which interact with the environment. "We wanted to

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introduce intelligence in electronics and we'd like to introduce it so we can do two things: allow electronics to perform very fast in real time, and allow them to make decisions autonomously and not have to rely on a third entity, which makes things much slower," Katehi says.

In our everyday tech life today, we have artificial intelligence (AI), suites of algorithms and codes that introduce processes in a given piece of hardware. Think of the complicated algorithms used in Facebook and Google search engines, or the AI that is used in phones for facial recognition. AI, however, is like the software brain sending directions to the hardware body.

In her research, Katehi is studying how to move beyond this—how to design hardware in a sophisticated way so that it can play a key role in facilitating intelligence in the electronic. Step by step, she is trying to embed the software in the hardware, making one part of the other, so that the brain is like the octopi neurons embedded in the body.

"An interesting example might be reception with our phones," Katehi says. "If we have an issue with reception, we need to troubleshoot that on our own. If the phone had fundamental intelligence, it would be able to indicate where it should be for the best reception, or would even be able to make connection decisions. It would be able to foresee my needs and be able to respond."

The lab that Katehi and her team are putting together is specialized, and because Katehi joined just a few months before the COVID-19 pandemic, the labs are not yet being utilized. Still, the team has been busy modeling, which is where circuit work always starts. Now they are preparing for the next step—fabricating circuits—and they are growing their team while "being very selective in finding the people who really want to do this type of work."

"It is so exciting to be back full time doing research," Katehi says. For the last 20 years, she has been involved in either part- or full-time administration, and full-time research is something she has missed. She missed teaching and being fully dedicated to her research. She especially enjoyed building relationships with her students and postdoctoral researchers For all Katehi's contributions as a scientist and engineer, she considers her students her greatest accomplishment.

Katehi, shown here as an assistant professor at the University of Michigan, understands the effect mentorship can have on a young woman's career.

A Dedicated Mentor

"Professions are not learned from books and courses," Katehi says. "Books and courses don't show you what it means to actually be a circuit designer. You have to find people who will take the time to help you learn, give you useful information, and be your advocate when you need it."

In her own career, Katehi searched for her own mentors. She was often the only female in the room, but it's not gender that matters, Katehi says. She looked for men in her field whom she respected and who were doing work that genuinely interested her. "You approach people and show them you're interested in what they're doing. And you have to actually be interested. Otherwise, it's opportunistic and it shows," she says. "You also have to admire them. I never approached someone I didn't admire even if that person could have helped me in one way or another."

Katehi's mother taught her to "never compromise about the things you care about."

A true mentorship built on respect and caring will last for a long time. Katehi has built these relationships with many of her students, and she still has those relationships with her own mentors. Mentors, she says, become like family, in large part because a true mentorship is an authentic relationship built with respect and admiration on both sides.

Throughout her career, Katehi came up against major barriers, and she credits her mentors with helping her bypass those barriers. Mentors helped her learn how to deal with issues and move on.

Katehi and her husband married and had their son while they were at UCLA in the 1980s. They were the only married graduate students, and yet, Katehi says, they "lived in a bubble" because their friends and advisors were so supportive. When they left that bubble, however, they realized that their experiences were the

exception, not the norm: A few years later when Katehi was at the University of Michigan and expecting her daughter, there was no family leave for female faculty. "You either took a cut in your salary or had your baby in the summer," Katehi says. When Katehi was recruited for a university faculty position, she was recruited at a lower salary than a male colleague with the same background and number of years of experience. "Your colleague has a family," she was told, although Katehi had two children. "What do I have, goats?" she remembers asking.

For all Katehi's contributions as a scientist and engineer, she considers her students her greatest accomplishment.

Today, many now recognize that women have been undervalued in the profession, but Katehi knows it is not time to let up. Thanks to her own mentors, she understands the importance of strong mentorship and the impact it can have on a young woman's career. Still, for all of the dedicated and impactful mentors she had, Katehi believes that a female mentor would have been able to help her in one area where male mentors could not—they could have helped her navigate some of the work-life issues she experienced: "You have similar interests, especially for a young professional. At a time in your life when you want to start a family, you want to see other people who have done this successfully. It gives you encouragement because there are so many questions. Can I do this? How do I do this? What will I lose in the process?" she says.

Katehi's first and most important mentor was her mother, who taught her to never compromise about the things that she cares about. Katehi relied on that advice throughout her career, and now she has this advice for those following her: "Mingle with people who care about you and you care about them. Find the right people, go after your mentors. Do it with integrity and with a goal, and it will help you," she says. "There are many good people. There are many good men and many more women now in our field."

—Katianne Williams

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BY
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Innovating in Academia

EXPANDING ACCESS TO HIGHER EDUCATION

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In May 2021, The Ohio State University put health and safety protocols in place to hold not one but two in-person commencement ceremonies, presenting 12,345 degrees and certificates to graduates. "There's really something to the Buckeye spirit," says Ohio State President Dr. Kristina M. Johnson. Johnson began her tenure at Ohio State in August 2020—the latest step in what has been a remarkable career spanning industry, government, and academia. She led a variety of innovative initiatives as undersecretary of energy at the U.S. Department of Energy (DOE); founder of clean-energy infrastructure company Hydrocube; and in her roles as professor, chancellor, provost, and senior vice president at universities including Duke University, the University of Colorado Boulder, and The State University of New York (SUNY).

Her arrival at Ohio State, though, was particularly notable. It was like coming home, she says, as she has strong Ohio roots, and her grandfather, an engineer like both Johnson and her father, graduated from Ohio State in 1896. She is excited to take all her prior experiences and put them to work. "Ohio State is a huge school, and its sheer size presents the opportunity to solve some of the world's biggest problems at scale," she says.

A Wealth of Experience

After receiving her Ph.D. degree from Stanford University, Johnson completed a postdoctoral fellowship at Trinity College in Dublin. In 1985, she was appointed assistant professor of electrical and computer engineering at the University of Colorado Boulder, where she was captivated by the school's spirit of entrepreneurship and its commitment to partnering with the community. While at Boulder, she was a part of the team that brought in the largest grant the university had ever received, cofounding the National Science Foundation Engineering Research Center for Optoelectronic Computing Systems.

Dr. Kristina Johnson

"I was center director for about four years, and during that time, we were averaging about half a dozen start-ups a year, just from our own center," Johnson recalls. "We moved the ball forward in a lot of different ways. We either started them or worked with those companies in the greater Boulder area."

Johnson says she "got the bug for academic administration and how you can work to make the lives better for faculty and students" while serving as dean of the Pratt School of Engineering at Duke University. Between 1999 and 2007, she increased the percentage of women on faculty at Duke from 6 to 19%. Under her leadership, the school doubled its graduate student population, quadrupled research expenditures, and quadrupled the physical plan with the addition of the Fitzpatrick Center for Interdisciplinary Engineering, Medicine, and Applied Sciences.

From 2007 to 2009, Johnson was provost and senior vice president for academic affairs at Johns Hopkins University. She collaborated with a team of vice provosts to lead the Framework for the Future strategic planning initiative, with the goal of positioning the university to "identify new cross-cutting opportunities and the ways and means to expand collaboration, and to lay the groundwork for strategic thinking." Her team also launched the Mosaic Funding initiative to bring individuals to Johns Hopkins to show their research while they, in turn, received an introduction to the university. This program enabled the school to hire outstanding faculty, particularly underrepresented minorities and women.

In 2017, Johnson became the 13th chancellor at SUNY the largest system of higher education in the United States, with 64 campuses statewide. While there, Johnson implemented the Promoting Recruitment Opportunity Diversity and Growth program, which set a goal of hiring 1,000 underrepresented minorities and women in science, technology,

Johnson is a member of the National Inventors Hall of Fame as well as the National Academy of Engineering.

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engineering, and math (STEM) by 2030, a goal SUNY is on course to achieve.

"That was an exciting time, operating a system at scale that's 64 campuses and 64 presidents, all dedicated," Johnson recalls of her days in New York, adding that the experience made her realize what she could potentially accomplish at Ohio State. "What I realized was that what I really loved about being in higher education is the impact you can make on a single campus. You can go deep but you can also scale up, and I think that's what made Ohio State so attractive."

"The goals I've set for the university are really trying to drill down on academic excellence. I learned about that as a student at Stanford. It's about doing convergent, cross-disciplinary research," Johnson adds.

Johnson has set an ambitious goal to dramatically increase research expenditures over her time as president. The current baseline is US$1 billion a year. "We're working on academic excellence. We're working on research and creative expression by doubling research expenditures but also by supporting scholarships in the arts and engineering and social sciences," Johnson says. She is also focusing on entrepreneurship and building partnerships in the community to fulfill the mission of the land grant university, which is to influence those the university serves and the communities in which they live.

"Ohio State is a huge school, and its sheer size presents the opportunity to solve some of the world's biggest problems at scale," she says.

Start-Ups and Government Service

Johnson is the first Ohio State president in decades to have a substantial nonacademic background. She holds more than 100 patents for her work in optoelectronics, which have changed the entertainment industry with its impact on 3D movies as well as the healthcare industry with significant improvements to mammograms and cervical cancer screening. She cofounded two companies and is a member of the National Academy of Engineering as well as the National Inventors Hall of Fame.

In 2009, President Barack Obama selected Johnson to serve as undersecretary of energy at the DOE, where she managed a US$10.5 billion energy and environment portfolio. On top of the department's annual budget, there was an additional US$37 billion in American Recovery and Reinvestment Act funding and US$56 billion in loans through the loan guarantee program. The department had to move quickly to disburse the funds on qualified programs that were all peer reviewed and set up through the regular funding mechanisms within 18 months.

While at the DOE, Johnson deployed the Strategic Technology Energy Plan in 2010, which laid out a map of how to achieve an 83% reduction in greenhouse gas emissions by 2050 compared to 2005. The 100-plus page report was the result of work by more than 100 scientists and engineers and was mentioned in Obama's 2011 State of the Union Address, during which he discussed his goal of achieving 50% clean energy by 2030.

While at Copenhagen 15, a part of the 2009 United Nations Climate Change Conference, Johnson noticed that many of the energy and environmental administrators internationally were women. She saw there was a need to "encourage more women to be in this field because a lot of women are responsible for the energy in their country and their continent." This led her to found CE3, a clean energy education and empowerment initiative that encourages women to enter careers in clean energy and build networks to help them reach success.

When she left the DOE, Johnson remained passionate about clean energy

Johnson is committed to expanding access to higher education.

and founded Cube Hydro Partners, a company that builds and modernizes hydropower plants at existing dams. "If a dam exists because it needs to be there for a source of water for a town, recreation, navigation, or irrigation, why not get clean energy from it?" she says. Under Johnson's leadership as CEO, Cube Hydro Partners operated 19 power plants on 10 rivers in five states.

The company took innovative approaches to building and modernizing the plants through the application of machine learning and other innovations, and it was this work that made Johnson realize that she wanted to return to higher education. "I realized that a lot of the innovation that I loved was working with students and faculty to come up with the next new thing," she says.

In 2019, when the company was sold, Johnson was presented with the opportunity to return to her true love, academia, and she accepted the SUNY job. "I wanted to get out and do something real and practical about putting more clean energy on the grid. After doing that, I realized there are other ways to influence the reduction in greenhouse gas emissions, part of which is through education and educating the next generation. That's how I found my way back," she says.

Johnson holds more than 100 patents for her work in optoelectronics.

Challenges in Higher Education

In 2021, Johnson became the first recipient of the IEEE Mildred Dresselhaus Medal. Dresselhaus was a pioneer in nanotechnology and also the first tenured female faculty member at the Massachusetts Institute of Technology. She paved the way for all women engineering faculty, including Johnson, who followed her. The award, which recognizes "outstanding technical contributions in science and engineering of great impact to IEEE fields of interest," is especially meaningful to Johnson, who knew Dresselhaus and spends much of her own time thinking about "how to inspire women and underrepresented minorities to have a wonderful career, which engineering really affords."

Johnson is the first Ohio State president in decades to have a substantial nonacademic background.

As she looks to the future of higher education, Johnson believes that the United States faces a significant challenge in "the ability to utilize its total domestic talent as well as continuing to be a beacon to those from other countries who want to come to the United States." Today, women currently earn approximately 58% of bachelor's degrees but only 36% of STEM degrees in the United States, a number which would be much lower still if it didn't include the social sciences as well as the physical sciences.

"I think that means we're not using the talent that we have here," Johnson says. "I think that we are a place people see as a beacon for freedom of thought and pursuit. If you look at underrepresented minorities, you see that science and engineering degrees are at less than 7% and 9%, respectively, for Black and Hispanic Americans, despite the population being 12% Black and 16% Hispanic. We're about half the representation. I think that's a loss."

As she prepares for her second year at Ohio State, Johnson remains committed to addressing these issues and expanding access to higher education. As she puts it, Ohio State was created to "allow people from ordinary backgrounds to do extraordinary things."

—Katianne Williams is a freelance writer specializing in the technology field.

BY
KATIANNE
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As Good as Goldsmith

FOSTERING DIVERSITY, INCLUSION, AND EQUITY IS A MARATHON, NOT A SPRINT

Andrea Goldsmith was one of those students who was interested in everything, and like many high school graduates, she didn't know what she was going to study in college. A gap year spent traveling made her even more interested in politics and languages, and when she began her freshman year at the University of California, Berkeley, she thought seriously about majoring in political science. Her father, though, advised her to enter the engineering school, reasoning that it was much easier to transfer out of than into engineering with its prerequisites, heavy course loads, and harsh grading. She followed his advice—he was, after all, a mechanical engineering professor at the school—and declared engineering math as her major.

Andrea Goldsmith

In her first year at Berkeley, Goldsmith took classes in physics, math, and computer science as well as political science, languages, and philosophy. She struggled in her science, technology, engineering, and mathematics (STEM) classes—she had been out of school for a year and now she was taking classes for which she didn't have prerequisites. She was also working full time because financial independence meant decision-making power. Her grades suffered that first year, and she questioned whether she should stay in STEM. There were very few women in her classes to begin with, and there were overtones that women struggling with engineering perhaps didn't belong in the major.

That summer, Goldsmith thought about whether she should return to engineering or switch to political science. She decided to give engineering one more semester.

As a sophomore, she was caught up with her prerequisites and was working fewer hours. All of this made school easier, but the real turning point came when she took an algebra class with a female teaching assistant named Elizabeth Strauss. "She was the first graduate woman I'd seen in a year at Berkeley in STEM," Goldsmith says. The two became friends, and Goldsmith was inspired. "It was wonderful to see a woman graduate student who was excited about math and doing math, and TA'ing (teaching assistant) the course," she says. Goldsmith did well in that course, but she also did very well in a course that studied the politics of Europe.

She still had a decision to make. In comparing the two, she realized that anything she could do with a political science degree, she could do with an engineering degree. This was not true the other way around. So, midway through her sophomore year, Goldsmith made

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the decision to stay in STEM. But she still didn't have a field of interest.

Goldsmith's academic advisor was an electrical engineer and statistician working in communications. Goldsmith was intrigued. She liked math, but wanted to be able to apply it to engineering problems, and he told her that communications was a very mathematical area of engineering. She began to gravitate toward classes in communications, probability, and statistics—all of the underpinnings of wireless technology.

When she graduated in 1986, first-generation cell phones were just starting to roll out, and the first Wi-Fi standard was more than a decade away. As a result, there were no jobs working on commercial wireless systems. Goldsmith took a job at a small Silicon Valley defense communications company where they were building antenna array systems and consulting for Lockheed on a satellite system. The company was a small, seat-of-the-pants operation staffed by Ph.D.s and fresh-faced college graduates. Goldsmith was suddenly a new hire with a tremendous amount of responsibility, tasked with coming up with the algorithms for the antenna array. She had no idea where to begin, so she headed to the Stanford library to learn all she could. There was no web browsing, or even the web, at the time.

As Goldsmith worked with her new team members, she became very interested in the way the Ph.D.s talked about and puzzled through problems. She could see that they had a different way of thinking, and she realized that even if she loved wireless technology, and even though she had basic knowledge and experience, she lacked the deep technical knowledge to build state-of-the-art communication systems. As the communications wireless industry began to get some traction, she returned to Berkeley for her master's degree. Goldsmith was so enamored with doing research in the field that she stayed on and received her Ph.D. degree in 1994.

Goldsmith began her academic career as assistant professor of electrical engineering at the California Institute of Technology, then moved to Stanford as an assistant professor in 1999. She would go on to launch two

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wireless start-ups, all while dedicating herself to mentorship and to "moving the needle on diversity and inclusion." Today, Goldsmith, a member of the National Academy of Engineering and the American Academy of Arts and Sciences, has taken on a new role as dean of the School of Engineering and Applied Science at Princeton University.

Goldsmith is dedicated to mentorship and "moving the needle on diversity and inclusion."

Start-Up Success

At the end of 2005, Goldsmith launched a Wi-Fi chip company, Quantenna Communications, her first of two start-ups. It was not easy to raise money for a hardware company at the time, given the technology "dot-com bust" a few years earlier, but she wanted to see if all the research she had been doing in multiple antenna wireless communications could translate into a compelling technology and product. Quantenna ended up building the best-performing Wi-Fi hardware on the market. She calls this experience both incredibly rewarding and challenging. There were issues with cofounders, with fundraising, and with the technology itself. There were business challenges. It was not an easy path, but the company went public 10 years after its founding. "I have tremendous satisfaction and pride in being the founder of a company that surmounted all those challenges to create the best Wi-Fi chips in the world in terms of performance and to maintain that competitive edge over a 10-year period," Goldsmith says. Quantenna was recently acquired by a larger company for over a billion dollars.

She began to gravitate toward classes in communications, probability, and statistics—all of the underpinnings of wireless technology.

Goldsmith returned to Stanford University as a faculty member in electrical engineering after her two-year leave of absence to found Quantenna. She was happy to be back doing research and teaching, and she had no intention of launching another start-up. A year later, she was approached about founding a company that would develop software in the cloud to manage cellular system base stations. She knew that if she could be at the forefront of that technology, it would be exciting. "You can say, 'yes,' or you can say, 'no,' to start-up opportunities. You can't say, 'come back in a year,' so I said, 'yes,'" she explains about her decision to found her second company. The company (Plume Wi-Fi, originally Accelera), ultimately pivoted to developing both hardware and cloud-based software to manage a network of Wi-Fi access points in the home. The company just completed a large round of funding and is valued at more than a billion dollars. "I'm very proud that I started two companies developing a core tech that was so valuable to the industry," she says.

An Opportunity at Princeton

In 2020, Goldsmith was appointed dean of the School of Engineering and Applied Science at Princeton University. Throughout the pandemic, she maintained her group of postdoctoral researchers (postdocs) and graduate students between New Jersey and California. Her team's research is focused on the wireless technology of the future as well as the on applications it will enable. This means that they are doing work in distributed learning, controlling robot teams over wireless networks, and even neuroscience as they try to understand the signaling mechanisms in the brain, how they break down with degenerative diseases like epilepsy, and how signal injection into areas of the brain can treat such diseases.

Goldsmith is bringing her start-up experience to Princeton, where she is leading efforts to grow the engineering school by significantly increasing the number of faculty and students, building a new engineering neighborhood on campus, creating interdisciplinary initiatives

and institutes, and fostering significantly more entrepreneurship, innovation, and ties with industry. As a two-time entrepreneur, Goldsmith is "excited about creating a diverse and inclusive technology hub in the tri-state area with Princeton as catalyst."

"If you're a good mentor, then your mentees will be good mentors to their students and postdocs, which magnifies the impact of your mentoring."

She sees tremendous opportunities in Princeton. The plan is to grow the engineering school while focusing on research excellence in the most exciting areas of engineering right now, including bioengineering, robotics, data science, resilient cities, mitigating climate change, and quantum engineering. She looks forward to creating programs and platforms to foster innovation and to entering into partnerships with companies as well as government to create a technology hub around Princeton.

In her first year, which she calls "fun and exciting," Goldsmith spent the majority of her time focused on strategic planning and putting initiatives into play as soon as she could. She's ambitious and aggressive. There were changes she could implement right away, and there are many other initiatives in the works.

Goldsmith is already making important progress on plans to increase diversity and inclusion in the engineering school. "If you don't have diverse perspectives and experiences in the engineers who are building technology to benefit humanity, then you will not be able to achieve the maximum potential of that technology, its impact, and positive change," she says.

A Focus on Diversity and Inclusion

Goldsmith first engaged with diversity and inclusion across IEEE in 2016 when she was chair of the Alexander Graham Bell Medal Committee. As chair, she solicited nominations for diverse candidates, but as the committee discussed those candidates it was clear that they "were not getting the same consideration that they may have gotten otherwise." When the winner was not a diverse candidate, Goldsmith spoke her mind: The discussions for the medal had shown her that diverse candidates were subject to implicit bias.

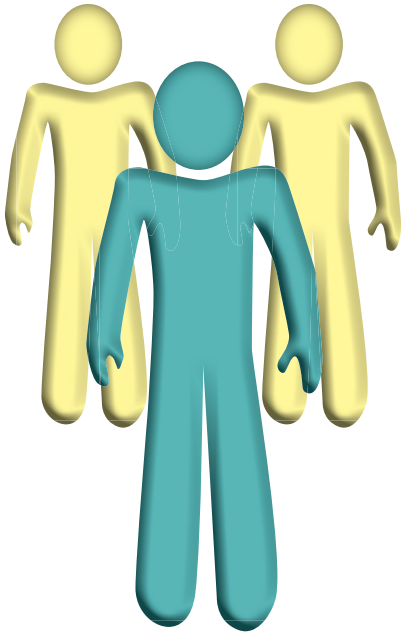
Dave Messerschmidt, chair of the Medals Committee, asked her to partner with him to create a set of documents on implicit bias to be used across IEEE awards committees. As she spent hours reading the research on implicit bias toward women and minorities, not just in STEM awards but more generally, she came to a realization: "I realized that if I, personally, given where I was in my career, was not willing to devote significant time to move the needle on diversity and inclusion in IEEE and in the profession, then we would not make progress because we hadn't really made much progress since I was an undergrad, when my experience as a female freshman engineering student nearly caused me to leave engineering."

When the documents produced by Messerschmidt and Goldsmith attracted the attention of José Moura, vice president of the IEEE Technical Activities Board (TAB), Moura asked Goldsmith to chair an ad hoc diversity and inclusion committee. This turned into a standing TAB committee that Goldsmith chaired until 2020. In 2019, Moura was elected IEEE president and asked Goldsmith to chair a new committee at the Board of Directors level focused on diversity, inclusion, and professional ethics. Incorporating professional ethics into the committee's charter was needed because

A two-time entrepreneur in the field of wireless technology, Goldsmith is a member of the National Academy of Engineering and the American Academy of Arts and Sciences.

to create a diverse and inclusive environment, IEEE needed people to abide by a code of ethics to safeguard against issues such as discrimination, sexual harassment, and bullying. "Raising up the importance of ethical behavior and processes to ensure people behaved ethically and, if not, there were consequences became part of the charter of that committee," Goldsmith says.

Today, Goldsmith and her team at Princeton are developing best practices around faculty hiring based on similar work she did at Stanford. There she led a committee in the Leadership Academy on recruiting and retaining a diverse faculty and was on a school-wide committee that advised the provost and president on faculty appointments, promotions, and related processes. At Princeton, she has initiated a set of best practices on how to ensure that there is a diverse pool of candidates for positions and how to evaluate applications to minimize the impact of implicit bias. For example, she explains, semifinalist rounds of interviews will often mitigate the implicit bias that can appear in applications and recommendations "because these special candidates just bowl you over in semifinalist interviews in ways that are not apparent from their applications."



Since becoming dean, Goldsmith has increased the set of graduate student application slots and has made incentivizing diverse applicants one of the criteria used to assign them to different departments. She also introduced a one-year postbaccalaureate master's of engineering program for Princeton undergraduates, a far more diverse set of students than the graduate pool to give those diverse students pathways into the academy and pathways into higher positions in industry when they graduate. She is also looking forward to building on existing programs that support students from groups that are underrepresented in engineering by providing avenues into the academy for exceptional graduate students and pathways into graduate school for exceptional undergraduate students.

Goldsmith is already making important progress on plans to increase diversity and inclusion in the engineering school.

"Fostering diversity, inclusion, and equity is a marathon not a sprint," Goldsmith says. "There are so many things we need to do to bring up diversity in constituents in the school, and then to ensure that we're not just bringing in those diverse people but we're creating an environment where everyone can maximize their success within the School of Engineering at Princeton, and in their subsequent professional journey."

Paying It Forward

Throughout her career, Goldsmith has had a number of incredible mentors. Outside of networking technology pioneer and Silicon Valley entrepreneur Judy Estrin, though, all of Goldsmith's mentors have been men, giants in the field of communications who shared their experiences and advice with her, and promoted her for honors, awards, and professional opportunities. There were no women in those higher positions for Goldsmith, and she is doing what she can to change that.

"Mentoring students is so rewarding," Goldsmith says. "It's got to be the most rewarding part of my job and why I wouldn't give up my research group. You have the opportunity to pay it forward. If you're a good mentor, then your mentees will be good mentors to their students and postdocs, which magnifies the impact of your mentoring."

One of the awards Goldsmith is most proud of is the inaugural postdoc mentoring award she won at Stanford. In 2020, she also received the Kirchmayer Graduate Teaching Award from IEEE for "educating, developing, guiding, and energizing generations of highly successful students and postdoctoral fellows."

When she was a freshman advisor, Goldsmith made it a point to request women and minorities interested in engineering. She knew how discouraging it was to her as a first-year undergraduate not to have cheerleaders and people telling her to not worry about her grades and to help rebuff the notion that women did not belong in engineering. "Engineering needs you. That's what I tell my diverse freshmen, graduate students, and postdocs. Even if you're struggling, the profession needs diverse people. And even if you're struggling, other people struggle, too—they just don't look like it," she says. Today, she amplifies that message as dean.

—Katianne Williams is a freelance writer specializing in the technology field.

BY KATIANNE WILLIAMS

Innovating for Energy Efficiency

When Dr. Maxine Savitz headed to the Massachusetts Institute of Technology (MIT) for graduate school in 1958, she found life in Cambridge different than what she had known as an undergraduate chemistry major at Bryn Mawr College. The biggest change was sheer size: she went from a campus of 600 students to one of 6,000. But there were other differences. She had left the all-women's school, one of the Seven Sisters, for one where there were only 30 women in the undergraduate school and another 30 in the graduate school, and suddenly she was a teaching assistant in a chemistry department where the head of the department refused to let women teaching assistants into the labs.

MIT looks very different today. Roughly 45% of undergraduates and 35% of graduate students are women, Susan Hockfield served as the university's first president from 2004 through 2012, and there are many women faculty members. "Things have changed," Savitz says, "but nevertheless, the fact that I had a degree from MIT opened a lot of doors, all through the 60s and the 70s."

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Dr. Maxine Savitz

SAVITZ LOOKS BEYOND TECHNOLOGY

After leaving MIT, Savitz went on to make major contributions in the area of energy efficiency both through R&D and the shaping of American energy policy. Her early work was instrumental in moving the United States through the energy crisis of the 1970s, and some of her later work has focused on the pressing issue of climate change.

Savitz served two terms as vice president of the National Academy of Engineering. She is a fellow of the American Academy of Arts and Sciences and served on the President's Council of Advisors for Science and Technology (PCAST) from 2010 to 2017. Now retired, Savitz's main advice for women starting their careers in science, technology, engineering, and mathematics is this: Don't be too fixed on what you want to do 30 years from now. If Savitz had been fixed on what she wanted to do upon leaving MIT, she likely never would have taken her first job at Fort Belvoir where her physician husband was stationed as a captain.

Her early work was instrumental in moving the United States through the energy crisis of the 1970s, and some of her later work has focused on the pressing issue of climate change.

In 1963, the U.S. military was interested in studying fuel cells, which NASA was developing to provide internal power for Project Gemini, and Savitz was hired to help establish a fuel cell research lab at Fort Belvoir. This is how Savitz began working in electrochemistry, even though that wasn't her field of study. "Things come up that you don't expect, and you need to take advantage of those things," she says.

The Demand Side

At Fort Belvoir, Savitz was given a portfolio of external projects, including General Electric and the University of Pennsylvania, contractors who were going to push the research, such as commercialization of the fuel cell. This work helped Savitz realize that she was more interested in managing R&D than performing it.

In 1972, she moved to the National Science Foundation where she was to be responsible for battery and fuel cell research as part of the Research Applied to National Needs (RANN) operation, a new federal endeavor intended to focus research more on applied engineering than basic science. This RANN program would disappear after a decade, but it was successful in shining a light on issues such as energy, which the government hadn't yet tackled. It was here that Savitz began working alongside an economist on a new venture: looking at the demand side of energy.

In the early 1970s, there were energy programs dedicated to making advances in supply, such as solar, geothermal, coal, and nuclear energy, but very few programs and models at that time studied how people were actually using energy. There just wasn't a pressing need at a time when you could fill your tank for US$.20. But Savitz began to study how energy was being utilized in buildings, industry, and transportation. Her interest grew and she began developing programs related to energy use.

Then came 1973 and the oil embargo. At the time that the United States found itself blocked off from the Middle East's oil supply, half of the electricity in the United States was generated by oil. Savitz's programs became vitally important.

The Federal Energy Administration (FEA) was formed in 1974 in response to this energy crisis. Its purpose was to promote energy conservation, study supply and demand, and encourage the R&D of energy sources such as renewables. When scientist Jack Gibbons came to head FEA's programs, he asked Savitz to join him. They set up an R&D program, which at that point didn't exist on the demand side, and began developing complementary policies.

In the mid-1970s, the World Trade Center, lit up 24-7, was using as much power as the city of Schenectady, New York. Savitz and her team implemented programs in energy conservation and efficiency and, as a part of that, they worked at reducing the lighting levels in buildings using techniques including delamping (removing unnecessary lamps) from areas such as hallways, where lighting needs were lower.

Upon this success, Savitz created a memo during the 1973 oil embargo to be sent to President Nixon suggesting that the private sector undertake the same conservation steps as the government. "There was instant gratification," she says with a chuckle. "I wrote it, it was reviewed, and two days later, I'm called into the acting head of the FEA to talk about this because the head of the three lighting divisions in the United States contacted his office because this lighting policy was going to cause unemployment in the lighting industry." Because of this, she says, she learned an important lesson: "You can create policy but you also need to work with industry, the private sector, and the other people that are involved."

Savitz moved on to head up the buildings and industry program of a new government office called the *Energy Research and Development Administration* (*ERDA*), an offshoot of what had previously been one arm of the Atomic Energy Commission. Then, when the U.S. Department of Energy (DOE) was formed in 1977, both the FEA and ERDA were moved into the new department, and Savitz ultimately became the assistant deputy for the energy-efficiency programs. The program's goal was to find ways to make energy more efficient in buildings, industry, and transportation that went well beyond suggestions of raising or lowering the thermostat. With very little funding, the program set out to develop new technologies, and Savitz and her team were very successful.

The National Research Council 2001 study "Energy Research at DOE: Was it Worth it?" found that DOE energy-efficiency programs had hit some real home runs, including many innovations that are still in use today, such as low-emissivity glass, programmable thermostats, and more advanced refrigerators. Moving lighting from a mechanical ballast to an electronic ballast was another success. Since then, electronic ballasts have been in all fluorescent lighting. Under Savitz's leadership, the DOE developed the curlicued compact fluorescent lights that are 75% more efficient than their incandescent cousins. More recently, the DOE partnered with industry for the development of LED lamps, which produce 125 lumens per watt as opposed to 40 lumens per watt.

The U.S. Congress passed legislation in the 1990s that still exists today, such as the Weatherization Assistance Program, which helps weatherize low-income homes to improve efficiency and lower energy costs. It launched the yellow EnergyGuide labels for appliances so that consumers would see up-front energy usage and costs, and they set standards for appliance efficiency.

Savitz's portfolio of projects also included the transportation sector, where the DOE looked at various new power plants for propelling the automobile. They had their eyes on electric vehicles and the initial 1970s battery work started under this program. This initiative helped lay the groundwork for the goals presented in President Joe Biden's infrastructure plan: two percent of new cars sold in the United States today are electric, and under the Biden plan, that number will need to grow to between 40 and 50% by 2030 to meet emission goals.

The DOE also had a gas turbine program that aimed to take aerospace turbine technology and put it into automobiles. The thinking was that it could be more efficient and have multifuel capabilities. This led to the development of new materials, chief among them silicon nitride, a material that allowed for higher temperatures on the small turbine engines. Savitz became interested in new materials that could reach higher temperatures, and she hoped to investigate how they compared with metals and how they could be put to use.

Savitz was elected to the American Academy of Arts and Sciences in 2013.

When she left the government, she joined Garrett Corporation, the aerospace company that would become Allied Signal and then, eventually, Honeywell. Garrett had been working on the gas turbine program at the DOE, and even though the DOE program was winding down, Garrett was still interested in pursuing ceramic turbine technology for the small engines on planes that provide the environmental control systems and start-up functions.

Any silicon nitride being used in aerospace at the time was predominantly supplied by Japan. In the mid-1980s, Japan had initiated an R&D program that followed that of the United States. Garrett was concerned about the eventual competition that would surely come for the turbines and aerospace parts, and so they decided to set up their own division to make silicon nitride components within the United States. "I had a lot of flexibility in bringing people from within the company who were good material scientists and hiring people with experience who were working in industry," Savitz says.

With the team assembled, they got to work. The issue with a ceramic such as silicon nitride is that it breaks easily—"You drop it and it breaks," Savitz explains—and so her team not only succeeded in bringing silicon nitride development to the United States, but with the corporate research laboratory, they also developed a higher strength and tougher silicon nitride. "We ended up going from a start-up to having one of the best materials," she says.

Shaping National Policy Through Leadership

PCAST was commissioned by President George H.W. Bush in 1990 to provide advice and policy recommendations in the areas of science and technology. Under President Bill Clinton, John Holdren, who became the science advisor and head of the Office of Science and Technology Policy under President Barack Obama, was a member of PCAST.

Coming out on the other side of what had been a substantial amount of turmoil at the DOE in the 1990s, PCAST was concerned about a balanced R&D agenda. Holdren brought Savitz in as an external member of the committee to help determine what the energy budget should be for energy-efficiency programs. She compiled the budgets for energy efficiency—budgets that would increase in the Clinton administration but not under the George H.W. Bush administration before being reviewed

under Obama where it was found that they "still had some life."

Savitz was a member of PCAST for eight years under Obama. The 21-member team put out 36 reports in those two terms, and many are still relevant today, including one she cochaired with Ernie Moniz on accelerating the pace of change of energy technology through integrated energy policy, which became an important part of Obama's Climate Action Plan and led to the issuing of two quadrennial energy technology plans and a quadrennial energy plan. "The technologies talked about are very relevant to many of the things that we need to do to address climate change regarding modernization of the grid and the vital need for storage, for renewables due to their intermittency, and for batteries for the transportation sector for electric vehicles," she says.

In the summer of 2020, in the midst of the COVID-19 pandemic, Holdren contacted nine of the individuals who had been involved in health-related studies during their PCAST years. Savitz had been a cochair of a study about bringing systems engineering to health care in the same way that it had been brought to manufacturing. During the Obama administration, PCAST had issued several health-related reports: one related to the H1N1 pandemic, another accelerating the development of vaccines.

They formed a subgroup called *OPCAST* to develop suggestions about how the U.S. response to COVID-19 could be improved. Through weekly Zoom meetings and with no support staff, they wrote six papers to be found on OPCAST.org, including the National Strategic Stockpile, the role of contact tracing, and the importance of public health data. Each report was distributed to President Donald Trump's administration and the Biden campaign as well as to the transition team, the U.S. Congress, and state and local officials. "It was an intellectual opportunity for us to reunite after not working together for almost four years," Savitz explains.

Savitz speaks to the National Academy of Engineering.

Today, she is excited about the Biden climate program, whose proposals address not just climate but also equity issues. "I think that's a very important issue that hasn't been considered. If I go back to energy, I was an advisor on a recent California study of carbon capture and utilization from California power plants in industry, oil refineries, and natural gas plants. These are often right next to a residential community. That technology is very important, and equity issues, along with technologies and policies, need to be addressed in order to make carbon capture happen," she says.

There have been suggestions for US$10 billion over 10 years for technology innovation in the energy area. "There's a lot of receptivity there. Not just what kinds of technologies can we see that we don't have now, but there are a lot of technologies that we have now that we need to make sure we implement and make available, and make sure people understand them," she says.

And all of this new technology means jobs too, Savitz explains. The reports at the end of 2019 showed that there were 8.2 million people working in clean energy in the areas of electricity generation, energy efficiency, and fuels. "A good half of those jobs were in the energy-efficiency area," adds Savitz.

Advocating for Diversity

Throughout her career, Savitz has made a point of hiring diverse teams when she was putting together divisions and R&D programs. She hired women scientists and engineers, but she also looked for diversity in educational backgrounds because she knew it was important to "look beyond the technology." While at the DOE, she hired social scientists, psychologists, those with masters' in business administration, and urban planners. These were the people who knew how to convince consumers to use the technology and how to convince manufacturers to make the products. They were the ones looking at and studying the communities. "We were the model division for having diversity," she says. She also instituted flexible time for her team before it was popular and before there were daycare centers.

When Savitz joined Garrett, there were very few women in aerospace companies. When she formed her division, she was fortunate to bring in a team of 20, about half a dozen of whom were young women engineers who had just finished master's programs. In the summer, she hired women interns and eventually offered some of them full-time jobs.

The DOE formed the U.S. Clean Energy Education and Empowerment Initiative in 2010. This was a joint DOE-MIT initiative that is now also sponsored by Stanford University and Texas A&M. Savitz worked with the DOE to help set this up. This initiative addresses and supports midlevel women in industry, government, and academia. There are awards for best entrepreneurship, best R&D, and so on and one for lifelong contributions to sustainability, which Savitz won in 2013.

In her acceptance speech, as she looked out at the crowd of people at the annual meeting, she said, "When I first started working in this field in the 60s, you couldn't find 20 women working in the fields of renewables and energy efficiency, and now, here today, you have 250."

—Katianne Williams is a freelance writer specializing in the technology field.

BY KATIANNE WILLIAMS

Getting Out of Your Comfort Zone

For a long time, Dr. Sharon Nunes wanted to be a teacher, but when she graduated from high school and entered a teaching program, she quickly realized it wasn't right for her. At a time when it felt like she was supposed to have her future figured out, she didn't. A math teacher suggested a math major, but Nunes had no idea what she would do with a math degree—besides teach.

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Nunes remembered that when she was in her high school chemistry class, a professor from the chemistry department at a nearby university spoke at her school. She had always loved both math and science and applied to the school on a whim. She transferred during her sophomore year and became a chemistry major. Then, during her senior year, a young professor encouraged her to look into the polymer engineering graduate program at the University of Connecticut (UConn), the school where he had received his Ph.D. degree. Nunes went

NUNES EXCELS IN NEW ENVIRONMENTS

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on to receive her master's and her Ph.D. degrees in materials science from UConn.

Nunes has always looked back at this path and called herself an *accidental engineer*. Truthfully, her path is not that different from many female engineers who have found their way into careers because of the combination of the guidance of others along with their own openness to opportunities and new experiences. Her path, she says, came to be because of "people who believed in me, who saw something in me," including the professors who encouraged her during the times when she wanted to quit.

This means that Nunes, who went on to spend 28 years at IBM, during which she launched the IBM Research Computational Biology Center and later led its Big Green Innovations organization, understands the importance not just of full-scale mentorship but of the seemingly small suggestions, comments, and recommendations that can have a big impact on a woman's career. "Sometimes it's just someone who reminds you that you can do it," she says. "If somebody puts something in your brain, even if it comes back a few years later, it can serve as a spark that gets you to think about doing something a little outside of what you might normally do." "And then," she adds, "the best thing you can do is go for it and get outside of your comfort zone."

Nunes was elected to the National Academy of Engineering in February 2019.

Diving Into New Opportunities

Nunes started at IBM as a process engineer, working with materials, processes, and equipment to improve processes in the R&D lab. After five years, her area in IBM reorganized, she had the opportunity to move to a group tasked with bringing IBM's IT know-how to education. She was a hardware person with no software background, but because she was a manager, she hired the experts she needed in software and networks.

In the early 1990s, this remarkably innovative group partnered with a local cable company to build a cable network connecting IBM Research, the local high school, a teacher's home, and the cable company. "This was before cable modems were used as network hubs in the home, and we believe this network was the first of its kind in New England if not the country," Nunes explains. The cable network connected IBM with the high school and a teacher at home; an exciting first was having a student at the high school remotely turn on a light bulb at the IBM lab

"I didn't know anything about software at the time, but I read anything I could get my hands on, and that was the first time I really went outside of my comfort zone," Nunes says. In turn, she enjoyed learning about an entirely new area and was fascinated to discover there was an entire world out there that she had known very little about.

A few years later, Nunes had the opportunity to move into another new role as a senior manager overseeing a group of software managers who were computational scientists. "One was doing computational linguistics, one was doing computational biology, and one was doing networks, so at least I had a little knowledge about networks," she says with a laugh.

She dove in. And as she traveled and talked to partners and customers, as she gave demos and ran pilot programs, she listened to what her end users were saying. One day as she worked with a team of biologists, she heard them remark that they had made the decision to shut off their robots because they couldn't manage the massive amounts of data the robots were producing. A light bulb went off and Nunes saw an opportunity: Managing data was what IBM did really well.

Nunes returned to her team and announced that they had a new name. "We're going to be IBM's Computational Biology Center," she told them. The group ordered new business cards and changed their letterhead. The team quickly realized that they needed to hire a biologist to extend the computational focus of the initial group. Ajay Royyuru, a young computational biology Ph.D. graduate, was a key hire who later became director of the Computational Biology Center as it continued its growth. Within its first five years, IBM's Computational Biology Center had created a world-renowned reputation as a think tank that also had the ability to help solve real-world problems with their business partners and research collaborators.

In 2000, IBM started its Life Sciences business unit. Nunes moved there and headed up its software development group, where she again made it a priority to hire a talented team. "Sometimes there's just an opportunity available and you have to seize it, even if it's beyond your comfort zone, and then you have to surround yourself with people who know

more than you do, who are smarter than you, who make you look good," she says.

This takes having the vision and being able to get the people who will help you to execute. That's what happened with Nunes and Big Green Innovations in 2007, a program she launched at IBM to use information technology to solve environmental problems. It all started with an opportunity—another light-bulb moment—during a water-monitoring research project on which IBM was collaborating. "There was a research project with reams of data coming from all of the sensors that were monitoring the river. We realized there was a growing need to analyze and manage high volumes of data related to water systems, including private (business) and municipal systems," Nunes says.

And they did. Early on, the group developed a partnership with the Nature Conservancy to perform water basin management and modeling in Brazil. In Ireland, they collaborated with the Marine Institute managing Galway Bay, working to understand the water, tides, and aqua systems as well as the food, boating, and fishing issues in the bay. They partnered with well-known water management companies to build and support the IT side of the initiatives.

This became the basis for a new business focusing on municipal water needs, and in 2009, Nunes was named one of the "Women Taking the Lead to Save Our Planet." Nunes served as vice president of the Big Green Innovations group until 2010. At that time, she made one last move before retirement when she became vice president of Global Government and Smarter Cities Strategy and Solutions, a group focused on creating solutions for governments and cities, "focused on improving efficiency, saving money, and bringing greater value to constituents."

A Mentor and Volunteer

Nunes retired from IBM in 2012. In February 2019, she opened her mail to discover that she was one of 104 candidates from around the world who had been elected to the National Academy of Engineering. "It totally blew me off my feet," she says. She attended the induction ceremony in the fall of 2019.

Today, Nunes volunteers with the Cape Cod Foundation, a community foundation that provides student scholarships and nonprofit community grants totaling approximately US$6 million a year. (Source: Greg Anderson.)

In recent years, the National Academy of Engineering has increased its focus on supporting women by bringing more women into the academy and making sure that they are considered fairly. Today, Nunes helps with that by sitting on the review committee for nominations, where the people nominated are "all so phenomenal" that even Nunes admits she has had "imposter syndrome moments."

Today, Nunes volunteers with the Cape Cod Foundation, a community foundation that provides student scholarships and nonprofit community grants totaling approximately US$6 million a year. She served as chair of the board for a number of years and is now chair of the Falmouth Town Fund, which has a particular focus on raising and distributing money in Falmouth, Massachusetts. The focus is on supporting health and human services, environmental initiatives, arts and culture, and education and youth services. At the annual grant review in January, US$100,000 was awarded to more than two dozen nonprofit organizations around Falmouth.

Recently, she and the board have been looking at the challenges the COVID-19 pandemic has brought to the community. These challenges include homelessness, mental health treatment, and substance abuse, and the focus has been on nonprofits working on these issues. Another US$100,000 was awarded in June 2021 to nonprofits working on these issues.

Through her volunteer work in town, Nunes has found herself in the company of three young women, all high school juniors who plan to study mechanical, aerospace, and biomedical engineering. She has put them in touch with other engineers, encouraging them to find mentors, and informing them about the social networks and professional organizations that exist on campuses for women engineers. She has been talking to them about getting outside of their own comfort zones.

It is important to Nunes to mentor young women and minorities. Her main message is always that "there are other people who have been through it and have found it difficult—but you can do it." She knows it is important to give students the encouragement they need to stick with it. She sees how students today want to tackle the challenges the world faces, and she knows that engineering is the way to do that.

> "Water, energy, food insecurity, cybersecurity, infrastructure, environmental, and social justice issues. These are all aspects of engineering that are both challenging and fascinating and offer opportunities for engineers to have significant impact on our world. Just about every area you can touch, you can use engineering skills," she says. "It's a great career."

—Katianne Williams is a freelance writer specializing in the technology field.

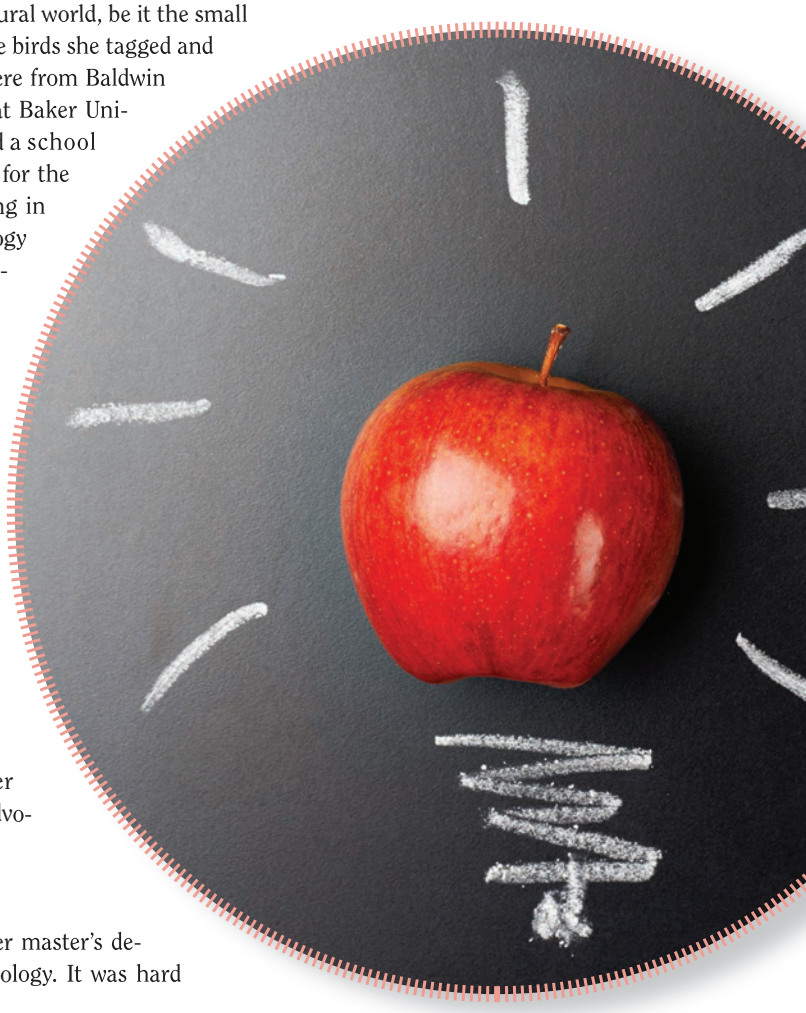
BY
KATIANNE
WILLIAMS

The Educating Apple

WOZNIAK SUPPORTS INNOVATIVE GLOBAL TECHNOLOGY PROJECTS

Janet Wozniak is enamored with the natural world, be it the small animals in her California backyard or the birds she tagged and studied in Mexico when she traveled there from Baldwin City, Kansas, while an undergraduate at Baker University. The daughter of a teacher and a school superintendent, she possesses a passion for the biological sciences and a love of learning in general. She studied both math and biology and received a master's degree in education at the University of Kansas before becoming a teacher, a career she picked for herself in second grade, ready to follow in her parents' footsteps.

Wozniak taught science and computer science for 12 years, and although she left teaching eventually, she didn't leave education—she went on to work for Apple's Education division. Wozniak, who is married to Steve Wozniak, "Woz," the brains behind the Apple computer, still possesses a teacher's guiding belief that the world needs all types of people with different talents and skills. Over the years, Wozniak has been able to use her platform to amplify this message and advocate for children on a larger scale.



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Meaningful Ventures

Wozniak left teaching after receiving her master's degree in instructional technology and biology. It was hard

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to say goodbye to the classroom, but the position with Apple offered her the chance to have a broader impact. At first her role, she supported Apple's educational projects within Kansas, but her territory quickly expanded until she was supporting innovative technology projects around the country. For her last five years at Apple, she supported educational projects around the world, from one-room schoolhouses in Nebraska to the 500 high schools and 1 million-plus students in New York City.

These projects were 1:1 projects, based on the idea that giving each student their own device facilitates learning, motivates students, and bridges digital equity gaps. Although these programs are standard now, they were very new at the time, and complexities ranged from infrastructure and network issues to teacher training.

"I wasn't engineering and creating products; I was working with schools," says Wozniak, whose work with lead districts like Westside 66 in Omaha, Nebraska, allowed Apple to set up exceptional 1:1 programs that became the models for other schools. "It was a nontraditional job. The job description could never be written. You did what had to be done. You did something different every day, but that's what I loved. I'd go in and analyze and figure out what pieces a school was missing and see how I could tweak that."

At Apple, Wozniak found something that had been missing in her teaching career—the lack of a ceiling. "At Apple, I felt valued every day, like I could push, like there was no glass ceiling, like I could push as hard and fast as I wanted. There was nobody holding me back," she recalls.

Much of that is because of the Apple culture. The striking thing about Apple, Wozniak says, was the support and the camaraderie. She never searched for new positions on her own, but she had many different roles that her managers shared with her because they knew that helping her ultimately helped the company. "At Apple, you have a boss that mentors you, helps you, guides you, and is also always looking for how your skills can best help the company," she explains. "The one thing I'd say about Apple is it's full of incredibly bright people, and they tend not to worry about if someone else is bright too. They just work to get stuff done. The teams I worked on were fun to work on. I dedicated a lot of my life to work just because I was interested in it."

Janet Wozniak, wife of Steve Wozniak, is an accomplished biological scientist, mathematician, and computer scientist as well as a philanthropist.

As Wozniak's career progressed, her work often took her overseas, partnering with schools in places such as Singapore, Hong Kong, and Prague. The projects were novel and innovative, and an important aspect of any project was returning postimplementation to measure the impact. "We'd help them develop all kinds of things and then we'd have an event a year later where we'd invite people in from around the world to see what was happening at that school," Wozniak says.

Apple was "a dream company to work for," says Wozniak, who can't recall a single issue where she thought she wasn't respected or listened to. "I think they really care. I think Apple, from the getgo, was very equitable and fair minded and nondiscriminatory. That's just in Apple's DNA," she says. "It's cool to work for a company where it doesn't matter what you wear or what color your hair is, but what matters is your brain and your intelligence."

Wozniak was very at home in this environment. The accomplished biological scientist, mathematician, and computer scientist enjoyed working for a company where intelligence and collaboration were both so valued. She especially appreciated being in an environment where people's unique talents were cultivated and put to use. This, she says, is how it always should be.

"Look at the challenges the world faces with climate change, energy consumption, and pollution," she says. "We need a scientist to think about it and to work on solving those problems. We have to develop every person who has that capacity no matter whether they are male, female, gay, or straight. You were born to do something. I love science. I love math. I love computers. I was one of the lucky people who got to do what I love. But someone else wants to do something else, and that's okay. We need all kinds of people. We don't need everybody to be a science, technology, engineering, and mathematics [STEM] person, but the people who we do develop to be STEM people, we need them to be exceptionally bright. We don't need everyone to be a Woz or

Wozniak dedicates plenty of her time during retirement to charity work but still finds time to relax and recline (although space can be limited).

invent the next computer, but we need somebody to do it. We don't need everybody in STEM, but we need everybody to do what they were born to do—whether that's STEM or being an artist."

She knows that not everyone is encouraged in this way—that many American young women today are still dissuaded from entering into STEM fields that they are drawn to, and this is where Wozniak's educational philosophies shine through. "Every person has something that they are passionate about and that they want to do, and if you're a woman and you're interested in science, math, or computers—the male-dominated fields in the United States—then you should still do that," she says. "You shouldn't do something else because it's more accepted."

She need only look to her own family, to the parenting of her own mother and father, to see the benefits of allowing people to pursue their interests, no matter how specific they are. Her mechanically minded older brother, who could take anything apart and put it back together, was not very academic. He followed his interests, became a mechanic, and ran a very successful shop. When Wozniak was five, her middle brother, then seven, sat down with her every Saturday and budgeted her allowance. He had three piggy banks: one each for a future house and car and one for education. She wasn't the least bit interested in saving, but he was, and to date, her brother has started four banks. "He has been very successful at it, but it's a very specific area. He has excelled at it, and he has become what he was meant to be," she says.

"Computers," she says, "are a marriage of math and science."

Don't Be Pigeonholed

Wozniak can pinpoint the moments in her own life when her interests were born. When she was a sophomore in high school, she enrolled in a biology class. It was a new, independent course where students went at their own pace. "I am positive I drove this poor teacher crazy because I loved it so much that I went home and studied it for hours. I was done with the book that was supposed to take a year after about a quarter," she says. For the rest of the year, the teacher let Wozniak help other students with their experiments. That experience enforced her desire to be a teacher, and it also made her want to be a biologist. Then, years later when she "discovered" computers, it was a perfect marriage. "Computers," she says, "are a marriage of math and science."

Her advice to young women today is to not be pigeonholed. "You don't have to have just one area, but when something engages you, pursue it," she says. And to those who might have themselves convinced that they 'aren't smart enough,' to those who think Wozniak was just born a good scientist, or naturally good at math, she wants them to know that this is not the case. "No. I went home, and I spent a lot of time doing it, and that's how I became good…I put in my 10,000 hours just like anyone who's great at something," she says.

Wozniak retired eight years ago. Today, she and her husband focus much of their time on charity work through the requests that he receives. A favorite is Jewel's Inspiring Children Foundation, which helps at-risk children in Las Vegas by providing mentorship and teaching the game of tennis alongside teaching lifelong skills in areas such as mental health and education. Ninety-five percent of the children earn college scholarships. For Steve Wozniak's 70th birthday, Wozniak organized a 2-h event with musicians, magicians, and artists. The couple auctioned off paintings and accepted donations, and altogether succeeded in raising roughly US$300,000 for the foundation.

—Katianne Williams is a freelance writer specializing in the technology field.

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Five Tips for Navigating the Workplace

Value your rights and identity while maintaining the rights of others

As a woman and a Muslim, with a hijab, who works in engineering, specifically in academia, I am a minority from many perspectives. As such, I have always been asked at events, and on a personal level, how did I manage to survive all the differences and succeed. That was why I would like to take the time to reflect on some key points that are useful for minorities and racialized communities as well as for anyone navigating the workplace. Here are five main guidelines on how to navigate through life challenges.

Number 1: Have Your Own Definition of Success

People have different priorities, goals, and things that make them happier. It is nearly impossible to agree on the criteria that make a person successful. Along the way, you will ask for advice and some people will share their tips and opinions. Their advice will be valuable; however, note that they are speaking from their own experience and based on their own preferences, which are highly likely different than yours. Some people find success in total dedication to their careers. Others strive for balancing family life and work, and some people choose to devote all their time to their families. There is no right or wrong; there is what is right for oneself.

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In short, stop looking for a recipe for success in others' success stories. Instead, tailor your own definition of success. Only then can you come up with the recipe and ingredients to be successful. Know your goals, your preferences, and what makes you happy. Then be flexible enough to tweak all of this as you and your priorities evolve in life. Finally, be content with your choices and their outcomes and respect your choices as well as those of others. This unique vision of individuals builds stronger communities.

Number 2: Do Not Make Assumptions

One of the incidents that taught me not to make assumptions occurred on a business trip a while ago. I spent two weeks in a town where I had not spotted a single woman with a scarf. Contradictory to my normal self, of being resolute, I felt alienated and was too reluctant to ask for a place with some privacy to pray. I finally asked, and unlike what I expected, with some explanation from my side, I was faced with immediate support and granted my meeting room for the whole two weeks to pray whenever needed. Do not assume that just because you are different your needs or rights will not be valued.

The only way we can identify commonalities that are not obvious is by getting to know one another.

Number 3: Stand Up for Your Rights

I believe that I am blessed by living in an environment that values diversity as a source of strength. However, that has not always been the case. I am one of those people who gets "randomly" checked in airports four times in one trip and picked out of a long line to show my passport on an internal flight. Like many others, minorities or not, there were times when I had to stand up and fight for my rights. It is not always the case that everyone you meet will be understanding and supportive or that all the doors will be open for you. In many cases, one will need to stand up for her/his rights to get them. Usually, this paves the way for others as well to receive the treatment they deserve. In such cases, the solution is to be proactive. It could be a misunderstanding, and it could be a case where you need to escalate, not only for the sake of yourself but for the sake of others. Act based on your evaluation of the situation. Nevertheless, always be proud of your identity and stand up to preserve it.

Number 4: Be Approachable

People may not know your limits and what would make you comfortable or not, and that is natural. We are attracted to people who have more in common with us. Before we have a chance to communicate, the only type of similarities we can spot is in appearance. The only way we can identify commonalities that are not obvious is by getting to know one another.

Be approachable and talk to others so that they can focus on commonalities among all of us humans rather than

differences, which may make someone cautious to approach. I have learned through my interactions that, at first, the difference in appearance creates a barrier. Once we get to know one another, in many cases, the barrier is broken, and people focus more on the common core rather than the different appearance. Be a person who unites by focusing on commonalities rather than a person who divides. People's differences are one aspect that should encourage us to try to build bridges and acknowledge those differences.

Do not assume that just because you are different your needs or rights will not be valued.

Number 5: Networking Is Important But …

Recently, I was nominated for my first job by a colleague from school. Then I got nominated for my postdoctoral (postdoc) position by my Ph.D. supervisor and my first teaching job by my postdoc supervisor. You get supported by people from the network you build over the years. However, as helpful and supportive as they are, those people are also honest, and they have integrity. They would not risk their reputation or cause harm to others by nominating someone unworthy. So while building a network, make sure you do your job thoroughly and honestly. In brief, although networking is essential to landing jobs and finding opportunities, it will only work for your benefit if you do your best in your job and have your unique imprint.

An overarching principle that guides the aforementioned list is that while valuing your rights and identity, maintain the rights of others.

—Hoda Khalil

The Women in Power Sector Professional Network in South Asia Initiative

Increasing the participation of women in South Asia's energy and power sector

When the World Bank was looking to build an initiative aimed at promoting female engineering in South Asia, it contacted Ramalatha Marimuthu for assistance. Marimuthu is world renowned for her support of women in science, technology, engineering, and math (STEM) fields as a retired professor, an IEEE Impact Creator, former chair of IEEE Women in Engineering (WIE), founder of IEEE's international talent show Youth Endeavours For Social Innovation Using Sustainable Technology (YESIST12) and the Returning Mothers Conference, and a leader of and participant in numerous other women's-empowerment activities. All of this work made Marimuthu the perfect central contact with whom to kick off the idea for the Women in Power Sector Professional Network in South Asia (WePOWER).

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WePowering Up

WePOWER is an initiative that was started by the South Asian Gender and Energy group of the World Bank in May 2018, jointly managed by the World Bank's South Asia Energy and Social Development Units, and funded by the Energy Sector Management Assistance Program. The goals are to increase the participation of women working within South Asia's energy and power sector and to change the gender balance within the STEM education system there.

The first step was to create a baseline assessment, so the World Bank surveyed women about their experiences in the energy/power sector. Contributors such as Marimuthu were asked to share the survey with their networks to support the collection of information. From there, the team gathered for conversations about the results at a partnership forum hosted at the World Bank headquarters in Washington, D.C., in September 2018.

The group noted in the forum documents that, "energy access and infrastructure development are critical elements in South Asia's regional development strategy; however, women's opportunities to contribute to the energy sector are limited, with a visible lack of gender diversity in technical and senior management positions." Furthermore, shares Marimuthu, "the underrepresentation of women in these fields was causing an economic downfall throughout the world. The areas earmarked actually produced more engineers than countries in the West. Still, the underrepresentation continued, mostly due to the social and cultural factors of these countries, I would say."

She elaborates that this is because the environment for women in the sector can be challenging given the cultural expectation that their work adapts to allow them to be primary caregivers for their families. "Working in a remote place not able to visit the family for a week or so is difficult for a young girl, and more difficult if she is a mother," says Marimuthu. "But jobs without a field application are rare in power and energy sector and might not be interesting."

To address these challenges and more, the WePOWER network was officially launched in February 2019 at a conference in Nepal and attended by more than 250 engineers and energy sector professionals from all over South Asia. At the conference, each WePOWER partner—11 organizations signed on for that first year but this number has increased to 28 as of summer 2021—committed to specific activities along the five pillars identified to most positively impact the representation of women in the energy and power sector. The pillars are STEM education, recruitment, development, retention, and policy and institutional change. The examples of activities within the pillars include workshops, field visits, and scholarships

Marimuthu (left) moderates a panel at the Returning Mothers Conference in 2019. The speakers from left to right: Gunjan Gautam, Kavita Saraswat, and Kanchan Parmar from the World Bank and Dr. Rajashree Jain from Symbiosis Institute of Computer Studies and Research.

(STEM education), job fairs and internships (recruitment), professional development training and mentorship matching (development), female-friendly facilities and policies (retention), and lobbying (policy and institutional change).

Partners are encouraged to commit to as many target activities within these pillars as they can reasonably achieve but also to connect with other partners so that these opportunities can be amplified to larger groups of women. The WePOWER group tracks progress and shares results to encourage this collective growth.

Surpassing Expectations

Although the COVID-19 pandemic certainly placed hurdles on the types of activities that could be held within the WePOWER network, the work has continued in a strong way; The 2021 targets for hiring, online/webinar training for female professionals, and personal training for returning mothers all saw increased commitments over 2020. A project piloted this year was a professional communications workshop with the Alan Alda Center for Communicating Science at Stony Brook University in New York for female STEM graduates and young professionals within the energy sectors in India and Pakistan called *STEMCOM*. "We planned to do a skill-development workshop that would increase the confidence of women who return to work," explains Marimuthu. Although the workshop had to be held online due to the pandemic, "I would say there was a positive impact because the cost was reduced and the time for planning the participants' travel and other formalities were not required," she adds.

Another development was the signing of a memorandum of understanding (MoU) between WePOWER and WIE, underscoring WIE's commitment to WePOWER. WIE has been involved since the beginning, when Marimuthu invited then-Chair Bozenna Pasik-Duncan to the partnership forum in Washington, D.C., because she recognized an alignment of objectives. "I was of the idea that this could be a big breakthrough if we can have collaboration of WIE and the World Bank, and Bozenna was very much interested and enthusiastic," shares Marimuthu. Pasik-Duncan is now the WIE representative to the WePOWER steering committee and the shepherd of the MoU and other activities related to WIE Central, while Marimuthu works alongside her as the WIE India representative for WePOWER.

When Marimuthu took the role of WIE India representative, she had already been running YESIST12 for a few years and saw an opportunity to connect the two programs. "I decided to introduce the WePOWER track with the idea that project-based learning is always a good idea for inspiring STEM girls to have a sustained career," she shares. "We conduct boot camps for school children hoping to give awareness on the sector and STEM education in general."

Minu, a young mother who works in the IEEE Bangalore Office, with her husband and daughter. Minu spoke about her experience returning to her job seamlessly to Returning Mothers Conference attendees.

Attendees at the first regional WePOWER conference, Nepal, 2019.

YESIST12 encompasses a variety of activities that encourage young people to consider engineering-based solutions to humanitarian problems. The flagship event is an international talent show, which is a global competition with challenges along different tracks: the Innovation Challenge, Maker Fair, Junior Einstein, and Special Track. "WePOWER track was added in 2019 with the stipulation that at least one girl should be on the team to enter the competition. But even that I am finding to be a bit of a challenge," says Marimuthu.

The Mother of All Ideas

For college students and working women, there are panel discussions with speakers along the themes of work-life balance, women's and empowerment, and returning to work. This last piece is so important to Marimuthu that, separately, she has organized a recurring workshop called *Returning Mothers*.

Started in 2014, the conference has been embraced by the World Bank and WePOWER teams. "When I mentioned it during the 2018 forum in Washington, they were so excited and promised to support it," says Marimuthu. "True to their word, they designed the logo. The conference was a physical one in 2019 in Bengaluru for which the WePOWER committee from the World Bank came down from Washington." Most recently, the 2021 Returning Mothers Conference emphasized the various avenues for women who want to sustain or even change their careers.

Marimuthu highlights the support of WIE in this effort in particular. "WIE Committee Representative Bozenna Pasik-Duncan has been a constant supporter of both the programs, and with her collaborative nature, she has been instrumental in bringing them to limelight with the WIE members and other IEEE Society members all over the world," she says.

Long term, the WePOWER team and its many partners are hoping to create a strong network of women in the energy and power sectors, resulting in transformational leadership and role models. Each partner has a different role to play. Marimuthu is engaging women using her own network and also her experience with South Asian culture. "As far as I can tell, the passion for sustaining a career has to come from the women. Women in South Asian countries are bound by traditional values and are expected to look after the household. This has led to an acceptance mindset for the women and they follow these ground rules of putting the family before their happiness, but I am trying to help them see that it is not criminal to be happy."

"This is one side of the coin," she continues. "The other side is the lack of support from the workplace. So I am also involving employers, calling on them to speak about the women initiatives in their workplace. But the problem is not forming policies, the problem is in enforcing them. The people who are in charge have to lead by example. The awareness of unconscious bias is creating a lot of noise, but there has not been enough change yet. Most of my activities are toward making the people aware of this need for impact and strategizing how to do it."

Still, Marimuthu and her colleagues in WePOWER and WIE remain optimistic and dedicated to the cause. "In the long range, I envisage that this social change will happen and we will see a balanced environment," she declares.

To learn more about the Returning Mothers Conference, please visit https://ieeeretu+rningmothers.in/. For information about YESIST12, please visit https://ieeeyesist12.org/.

—Leslie Prives

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Applying Machine Learning to Health Care

Improving access for all

Growing up in India, Dr. Jayashree Kalpathy-Cramer listened to her mother talk about her work as a physics professor who taught electronics, and it piqued her interest in engineering. She calls this a position of both privilege and good fortune, in that having a female role model so highly educated was not the norm. While at the time, the concept of education in India was seen as a ticket to a good life for anyone, Kalpathy-Cramer was in many ways a first-generation woman in her family to not have to fight for the opportunity.

"I grew up hearing stories about how my maternal grandmother was an excellent student in school but had to stop her education and get married because of prevailing norms at that time. She was an intellectual person with amazing math skills and world knowledge, especially for someone who had no formal education beyond eighth grade," shares Kalpathy-Cramer. "Later, my mother had to work really hard to get her family to agree to let her go to college, let alone grad school, even though it was assumed that both her brothers would go off to college." Although she was encouraged to go to college and graduate school, Kalpathy-Cramer was always aware that she was lucky to be born at a time where that was the expectation rather than an impossible task.

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She credits her parents not only with the support of her education but also setting an example for her future success. "Since both my parents worked so hard for their education (my mom, to buck societal norms and be allowed to live away from home for university) and my dad (who went to Germany for his Ph.D. degree and had to learn a new language and live exceedingly frugally), they led, by example, the need for a solid work ethic," she says. "My mom is one of the hardest-working people I know and always taught me to put maximal effort into everything I do."

Jayashree Kalpathy-Cramer

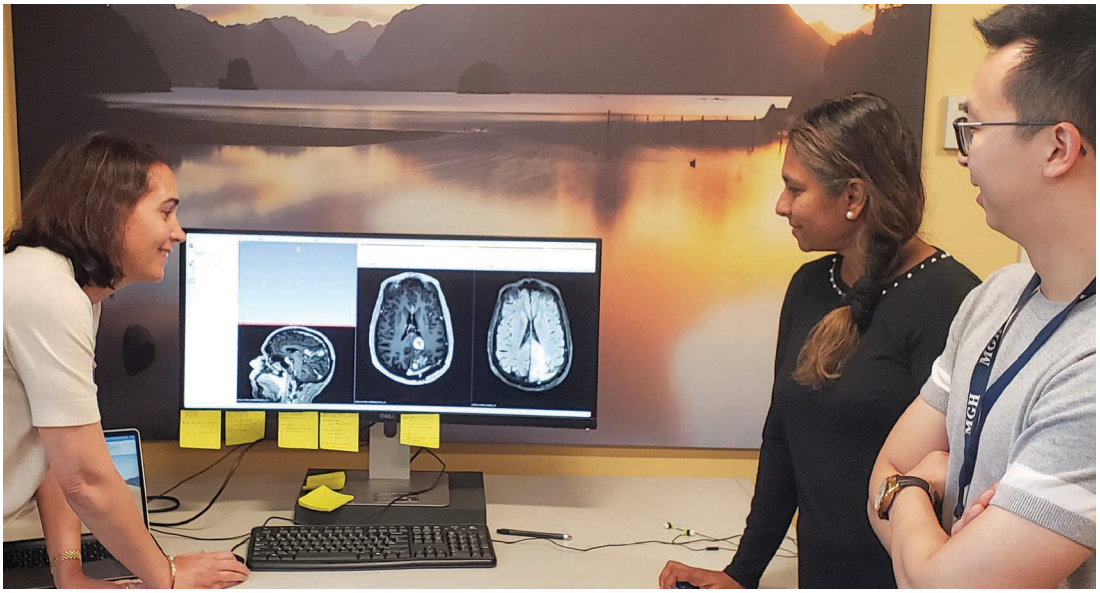
When it was her turn, a successful application through the Indian Institutes of Technology's (IIT)'s entrance exam placed Kalpathy-Cramer in her top choice location and subject, enabling her to pursue a degree in electrical and electronics engineering at IIT Bombay. From there, she joined a Ph.D. program at Rensselaer Polytechnic Institute in New York, earning a master's degree along the way.

An Addition to the Family

Before she could finishing writing her Ph.D. thesis, her son was born. "I planned to finish before he showed up, but he was a few weeks early," Kalpathy-Cramer says, laughing. "What was supposed to take me a few weeks ended up taking six months to complete." She took a career pause to stay home with him for a year and half, and then enrolled in a postdoctoral (postdoc) program. "I essentially did the postdoc because it was challenging to get back in the workforce," she admits. "But the experience helped me find a job in industry as a process and integration engineer, which was what I wanted at that time."

Her family moved to Oregon where her company was opening up a plant, living there for close to 10 years. Then, as luck would have it, her husband got an opportunity to go overseas for an expatriate posting around the time she was considering switching industries, giving her reasonable motivation to leave the industry role. "I had been thinking about how best to apply engineering principles to health care," says Kalpathy-Cramer. "Just as we monitor the health of our machines, I thought we should be applying those principles of data analytics to the health of people, looking for patterns and trends instead of waiting until things break."

Kalpathy-Cramer enjoying time in Hawaii.



Kalpathy-Cramer in the QTIM lab.

They moved to Singapore for one year and then to Germany for a year for her husband's job, and simultaneously, Kalpathy-Cramer completed another master's degree in biomedical informatics from Oregon Health and Science University. "I had wanted to pivot, and this provided a great opportunity to take some time off again and get officially trained and figure out what I wanted to do next," she explains.

That turned out to be academia. As the family returned to Oregon after two years, the program where she had done her distance learning invited Kalpathy-Cramer to join as a postdoc researcher and then as an instructor. During her training, Kalpathy-Cramer had done a project in medical image analysis and machine learning that sparked her passion, and she credits her engineering background with helping her get into the field. "In a lot of ways, it was the training in signal processing and other areas I'd studied during my undergrad and graduate studies in electrical engineering that helped me do this work," she says.

An opportunity with a grant allowed her to transition fully into faculty, moving to Boston in 2011 to become a researcher affiliated with Harvard Medical School and Massachusetts General Hospital (MGH). She is currently also the director of the Quantitative Translational Imaging in Medicine (QTIM) Lab and the Center for Machine Learning at the Athinoula A. Martinos Center for Biomedical Imaging, an associate professor of radiology at MGH/Harvard Medical School, and scientific director at MGH and Brigham and Women's Hospital Center for Clinical Data Science.

"We work in applying machine learning to health care, mostly to image analysis, though not exclusively. We have postdocs, Ph.D. students, undergraduates, and even high school students in our lab, all working on the development and application of machine learning and artificial intelligence (AI) in health care," she describes. Kalpathy-Cramer points out that her program tries to attract students at all stages of their education, and works especially hard at getting more women and diverse candidates into programs.

"Diversity of voices for any problem is important, not just women, but people of different backgrounds," she says. "If we have only one approach and one way of thinking, we don't have as rich a solution as we can get if we have people of different perspectives."

When the COVID-19 pandemic arrived, the lab pivoted to working on COVID-related research. The teams developed good ways of quantifying how severely impacted the lungs are based on chest X-rays, a useful tool for clinicians on the front lines. They also developed

Kalpathy-Cramer rock climbing in California at Joshua Tree National Park.

algorithms enabling them to see surges in areas, predicting when things were about to get worse. The teams are also interested in applications of AI in medical imaging as a lens on health disparities research.

Looking ahead, Kalpathy-Cramer is excited about the potential that machine learning and AI can have, especially in improving access to health care. "We're hoping to take the knowledge of the experts and our colleagues here in the best hospital systems in the country to guide decision making everywhere," she says. "I do a lot of work in low- and middle-income countries and am very aware of the potential for bias in AI algorithms. For example, algorithms developed using data from North America may not always work as well in India. Areas we'll be focusing a lot on this next year are the two sides of that coin: we can see how tech can be used to improve access to care but also how it might make things worse, so we're working on research to ensure that we're not making things worse first."

That applies on the home front, too. The ability to work from home during the pandemic highlighted disparities in the personal situations among members of her lab and institution, and Kalpathy-Cramer says she hopes moving forward, there is more support for everyone equally. "Some people are much better equipped to work from home than others for a variety of reasons," she shares. "While I'm not sure there's anything profound we can do besides provide a work environment that's safe and comfortable, we can try to be more mindful of the fact that people have different needs and abilities, and try to accommodate that as much as we can."

She credits her parents not only with the support of her education but also setting an example for her future success.

This mindfulness is important to Kalpathy-Cramer because she is so aware of the good fortune she has had in her own life. Between the examples set by her parents to the lack of pushback she received as a woman interested in studying math and engineering to the partnership with her husband that allowed her to make decisions in her career based on evolving needs and interests to supportive bosses throughout her journey, Kalpathy-Cramer is endlessly grateful and aware that she has been privileged.

Still, she hopes her experience can inspire someone else. "People think that once you start going down one path you're stuck there forever, and that's definitely not true. You can always find ways to pivot careers if you are open to the idea of learning throughout life," she says.

"One should be willing to take risks and make sacrifices if that's what it takes," she continues. "For instance, I took time off a couple times and took a pay cut when I went from industry to academia. At times, it felt like these choices set my career back as compared to someone who just stayed on one path. However, I am really happy where I am, and I think I am much better at what I do now having gone through the industry experience," she describes. "I highly encourage people to think about what they want, explore options, and not be afraid of midcareer changes even if it can sometimes seem like going backwards."

She also advises considering the work environment when people think about what they may want. "If you have the option, choose to work with nice people. One can do meaningful work anywhere. The reward (for me) of healthy collaborations far outweighs dysfunctional ones, even if the latter may result in higher impact publications or more prestige." Wise words of advice from someone who has had the opportunity to try multiple environments and learned to pivot when needed.

—Leslie Prives

Lisa T. Su Wins 2021 IEEE Robert N. Noyce Medal

She is the first woman to receive the honor

Congratulations are in order for Lisa T. Su, who was named recipient of the 2021 IEEE Robert N. Noyce Medal, sponsored by Intel Corporation, at the start of this year. The president and CEO of AMD Technologies, Su is the first woman to receive this award, underscoring her innovation as an engineer and skills as a leader. Upon being bestowed with the honor, Su donated her cash prize of US$20,000 from the Noyce Medal to the IEEE Women in Engineering Fund through the IEEE Foundation.

The medal was granted for Su's "leadership in ground-breaking semiconductor products and successful business strategies that contributed to the strength of the microelectronics industry." Largely credited with AMD's emergence as a leader in high-performance computing since she took the helm in 2014, Su is the first woman to become CEO of a major chip company. According to a *Bloomberg* article by Emily Chang and Ian King in May 2021, "the executive has restored AMD's reputation and performance at a critical juncture for the industry [because] the COVID-19 pandemic accelerated demand for remote computing via the Internet and for devices needed to support study and work at home."

To Su, however, this award is not only recognition of her work but a way to honor her own mentors and those who work alongside her. "One of the most appealing aspects of leadership is the power to bring people together," she shares. "What you can do as a single person is great, but what you can do when you can bring 10 or 10,000 smart people together, aligned to a vision, is incredible. I've benefited from being guided by some great leaders and being part of phenomenal teams throughout my career."

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This career began at IBM, where the Taiwanese-born and Massachusetts Institute of Technology-educated Su spent 12 years in semiconductor R&D, next taking leadership roles at Freescale and then joining AMD in 2012, first as senior vice president and general manager of global business units before stepping into the top role.

"It is an incredible privilege to be a part of this industry," continues Su. "Semiconductors do more than any other technology to connect the world and empower us, working behind the scenes to bring intelligence and new capability to every major product and service we all use. The industry as a whole had a vision that new innovation would continue to enable the performance and cost improvements to make semiconductors even more powerful and pervasive with each generation."

"Probably the most important advice I've ever been given is to 'run toward problems' because this is where you find the big opportunities."

Leadership and Collaboration

The immense innovation in semiconductors still did not account for a global pandemic, with its concurrent changes in human behavior and supply-chain challenges that led to chip shortages across the industry (not to mention issues in many other related industries). As CEO, Su had many needs to balance.

"When the pandemic began, our priority was first protecting the health and safety of our employees, partners, and communities," she describes. "At the same time, continuing to meet the commitments to our customers and partners was incredibly important. As a leadership team, we knew we had to act with urgency, communicate more often and with a great deal of transparency." Su says management relied on building even stronger connections within its teams, adding, "It has been amazing to see a company of more than 12,000 people transition to working from home so quickly."

But that was not all. "We also wanted to contribute support to our communities and within our spheres of influence," she shares. AMD made both medical supplies and financial donations to important pandemic-response needs, and established the AMD COVID-19 High Performance Computing Fund to donate petaflops of supercomputing power to organizations researching infectious disease.

Lisa T. Su

Although managing a global pandemic for her employees, industry, customers, and community may not have been in Su's plan, rising to the challenge was in her leadership wheelhouse. "Probably the most important advice I've ever been given is to 'run toward problems' because this is where you find the big opportunities," she explains. "As a result, I try to find the 'next big challenge' as part of helping to push myself, our team, and the industry forward."

Looking forward, Su predicts high-performance computing will be increasingly at the center of nearly every major trend shaping the future, whether in the cloud, at the edge, or across the growing number of intelligent end devices. "What the world has gone through in the past year proves just how important technology is to our daily lives—how we connect, how we work, how we learn, and how we play," she says.

As for what else technology may change, Su encourages anyone who has an idea to take a leap. "I believe we all should dream big and that we can help change the world," she advises. "When we have the courage to take risks and learn from our mistakes, just imagine what we can do." She challenges everyone in the science, technology, engineering, and math industries to do their part to support the dreamers and future risk takers, especially women, whether that be encouraging students to pursue engineering, mentoring, or providing networking support to women as they develop their careers.

"We all have insights, wisdom, and advice we pick up throughout our careers, and it is vitally important that we share that perspective with both female and male engineers," she says. "Ensuring we have the broadest, most capable, and most engaged set of engineers who wake up every day to build the products that will make the world a better place is really the only way we push the industry forward."

Congratulations again to Su, whose excellent leadership in bringing innovative visions to life and inspiring the engineers who help make those visions reality has won her the 2021 IEEE Robert N. Noyce Medal!

The IEEE Foundation routinely handles arrangements for awardees and speakers recipients who desire to "repurpose" their cash prize or honorarium for a good cause. If you would like to designate your award/speaker honorarium, please visit the Honoraria Giving page on the IEEE Foundation website (https://www.ieeefoundation.org/how-to-give/today/honoraria-giving) or reach out to a member of the IEEE Foundation team at donate@ieee.org.

—Leslie Prives

Su at the AMD Austin campus.

The Women of the Vanderbilt Institute for Surgery and Engineering

Providing networks to connect and thrive

As they round the corner into their fifth year of existence, the Women of the Vanderbilt Institute for Surgery and Engineering (VISE) (or *WoV*, as they refer to themselves) are taking stock of all they have achieved. Led by students at VISE in Nashville, Tennessee, and made up predominantly of Ph.D. students, the group's goals are to foster community, discuss research, and promote the success of women in science, technology, engineering, and math (STEM) fields. And they are well on their way to making their impact even larger.

Providing a Forum

WoV was founded in 2017 by Michelle Bukowski, program coordinator and social media manager at VISE, after a guest faculty member mentioned a women's group at her own campus. Bukowski was inspired to reflect on the experience she had had as cofounder of a women's group while at Vanderbilt's Divinity School. "It was empowering and meaningful, and I am still friends with people from that group," she shares. Feeling that the engineers at VISE could benefit from something similar, Bukowski consulted all the women who had attended the luncheon with the guest faculty member, and everyone agreed it was a great idea.

"There was not some terrible problem we were trying to solve, but we thought it would be good to give women space to talk about their needs," says Bukowski. "The cohort at the Divinity School started when there was a group of maybe 100 women and just a few men and we broke up into small teams, and when it came time for the teams' spokespeople to present, it was always the men who spoke. That really blew us away."

Although VISE had no defining, mind-blowing moment, Bukowski and her colleagues recognized that similar feelings could occur when, for example, a male student walks into a lab where there is a female postdoctoral researcher (postdoc) but he will walk up to another male grad student, automatically assuming a man is in charge. "When you are siloed in your labs, you might not know there are other women feeling the same ways, and we thought a space specifically where women could come together without men present might change the conversations they felt comfortable to have," she says.

Students agreed. Kathryn Ozgun, who recently completed her Ph.D. degree at VISE, started out in computer science but switched her field of study when she found there was not another woman in her class of 50 people. "Until I had that experience, it wasn't tangible to me how that can wrack your confidence," she shares. "This group at Vanderbilt is really unique because it enables interactions with people at different stages of their careers and creates a community outside of that standard academic hierarchy. First-year students can talk to senior faculty or physicians who may be 10 years ahead."

Kathryn Ogun

WoV provided the network she and her fellow students needed to connect both in and outside the classroom or lab, whether around career or technical questions or perhaps around issues in life or family matters. Saramati Narasimhan, past president and current postdoc research fellow echoes, "The vast majority have male principal investigators, so it is nice to have an opportunity to ask questions we may not otherwise."

Faculty and Professional Support

In the years since its founding, WoV has become more structured, with a formal steering committee each year with an elected president, and faculty advisor Ipek Oguz, an assistant professor of computer science and computer engineering who is also an executive in the Women in Medical Image Computing and Computer Assisted Intervention Committee. Bukowski firmly believes that faculty support and an accompanying budget are essential. Not only do those elements indicate to students that the organization is legitimate, but the added flexibility from funding also provides for guest speaker expenses, swag bags, and the all-important food that should be present at a student event.

Faculty involvement is also valuable as the experiences of faculty can lend a nice perspective to the students and keep them encouraged; however, WoV operates as a student-run organization. "It is more organic that way, rather than top-down telling the students what they need," explains Bukowski.

Narasimhan, past president of WoV.

Narasimhan was one of the founding student members from the initial guest faculty luncheon, serving as president during the 2020–2021 school year. "I really treasured the opportunity to enact change in the Vanderbilt community, and WoV was a great way for me to get to know my fellow students." With her postdoc research set to complete in 2022, Narasimhan ran for president when she did as a way to "give back to a community that's been so beneficial to me," she says.

Of course, it is not just the community and network provided by WoV but the programming itself that offers a lot to students. Many members cite the signature coffee talks as some of the most impactful due to how personal they become. These are monthly meetings where an established female professional, generally a medical doctor or Ph.D., speaks about her career and takes questions from the students. These intimate conversations have helped the students find role models and learn from others' experiences.

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Some of the members of WoV. Back row, left to right: Bukowski, Margaret Rox, Abbie Weeks, Winona Richey, Caroline Martin, Colette Abbah, and Haley Adams. Front row, left to right: Katie Larson, Sarah Goodale, Nhung Hoang, Cailey Kerley, Dr. Catie Chang, and Bayrak.

Ozgun shares that Kathy Nightingale, a professor at Duke University who studies ultrasound engineering, was particularly inspiring to her. "She was one of the very first women to enter into that ultrasound engineering space, which is also what I study, and she's also in what we call a *dual-academic relationship*, so her husband also has an advanced degree. It was really interesting to talk to her about how she navigated that since I was in a long-distance relationship during my time at VISE."

Bayrak, 2021–2022 president of WoV.

Roza Bayrak, the 2020–2021 president of WoV, found her own personal connection during a coffee talk. When Amber Simpson from Queen's University in Canada spoke about her experiences in the lab and how she had to fight for everything—people speaking to her appropriately, hearing her, or giving her credit for her ideas—something clicked for Bayrak. "It made me feel like I'm not alone," she says. "Women are constantly put in positions where we're seen as demanding because we have to request what is given to a man freely, or we're abrasive if we have to say something repeatedly because we are not heard. This showed me that I'm not the problem, it's the position I've been put in."

Besides the coffee talks, other regular programming for WoV includes roundtable discussions and movie nights, where men are also invited to participate. As Bukowski points out, "women talking to one another is important, but if we don't bring our concerns to the attention of our male colleagues, they won't know how to support us." VISE students have also "paid it forward" by visiting local underserved high schools to offer advice on applying to college, finding scholarships, and the importance of STEM.

When the pandemic hit in spring 2020, most of these programs transferred online and, in some ways, became stronger. Although coffee talks had traditionally been in person, running them over Zoom meant there were fewer logistical challenges to having guest speakers who were not local to Vanderbilt. Narasimhan says the steering committee jumped into action, with consistent communication and brainstorming, to enable WoV to be a force of stability and support for its members during such uncertain times.

A new opportunity that came from this disruption was the creation of peer-to-peer groups, small groups of WoV members at different stages of academic study that formed their own minicommunities within the larger group. "It's really nice because to some people, I was a mentor since I was the oldest in my group, but in other general discussions, I could experience those as a peer," says Ozgun.

Narasimhan's group included someone who had just defended her dissertation and was working in industry, a first-year grad student, a research assistant, and herself as a postdoc, so the blend of different levels offered a variety of perspectives to each woman. Adds Bayrak, "There was such a strong bond in those meetings because we needed human interaction. Now some of those women are my lifelong friends."

WoV members at a Spring 2021 social event. The group believes creativity leads to a different way of thinking about work, so the steering committee added a number of events to encourage creative expression.

An additional event that had to be pandemic proofed was the group's third-annual Wikithon. Typically held at the start of the spring semester, the Wikithon is a one-day event where students get together to improve the Wikipedia pages of female scientists. Ahead of time, the steering committee reaches out to female researchers who either don't have pages or whose pages are sparse and gather information to create or improve the page's quality.

In 2021, the Wikithon was held virtually over the course of a week but the impact was massive: WoV added the equivalent of 15 pages of text, made 73 edits and uploaded nine photos. All in all, their contributions have received more than 300,000 views.

Rox and Andrea Ramirez prepping for a tour in the VISE space and getting ready to show off a robot designed to perform endonasal surgery. Demos such as this one often take place during a social hour between clinicians and students.

In the next five years (and beyond), WoV will continue to make significant contributions to the women at Vanderbilt and their colleagues across STEM globally. To that end, one thing they plan to do is become even more inclusive with their membership. The current members span undergraduate and graduate students, research assistants, medical students, residents, and faculty both on medical and university campuses, so there's already a lot of diverse experience brought to the conversations in WoV. However, the group hopes to integrate more students from other schools, increase male student involvement, and include those who do not feel comfortable identifying as either female or male, working with centers on campus to support that mission. Ultimately, members believe that, regardless of gender or area of study, groups like WoV can create a new dynamic among the next generation of professors and researchers.

Current President Bayrak, who also started the group's social media accounts, is looking forward to continuing to share people's successes with the world and bring more visibility to female scientists throughout her tenure. "What excites you resonates with other people, that excitement is contagious," she says. "If you are passionate about something, find other people who are passionate about those things because the collective knowledge is really important. It grows us both personally and professionally."

At this rate, that growth could be something others will read about on these WoV members' own Wikipedia pages someday.

—Leslie Prives

Sustaining Women in Technology

Hayashi continues to push boundaries

Kathy Herring Hayashi believes that, throughout their lives, people have different waves of time and energy to devote to personal and professional goals. Understanding this has allowed her to develop and adapt to her own timeline; when her children were young, she was a software consultant, which provided her with flexibility as a new mother. As they got older, she took on IEEE leadership, computer science teaching, and a full-time job, and most recently, used the extra time while staying at home during the pandemic to codevelop the SA-EDI standard.

But the science, technology, engineering, and math (STEM) world almost lost her—and her future contributions—when the challenges of being a woman in technology became too great. Now, Hayashi is dedicated to making certain other women don't miss out on their own opportunities to make an impact.

A Renewed Passion

Many years ago, at the point when Hayashi signed up for the 2013 joint Women in Engineering (WIE)/Google event "Enhancing the Sustainability of Women in Engineering," she was done. "I reached a point where I could see that my aspirations for my career were not going to happen in the semiconductor field," she recalls. "I loved the area I was in, but it just was not working, and I was ready to leave." But her passion for technology drove her to attend the event, cochaired by Ramalatha Marimuthu and Karen Panetta, and was the primary factor that she says "kept me in." Listening to the speakers share their love of STEM and the incredible work they were doing, coupled with feeling the sense of community from being among like-minded others, Hayashi was inspired.

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"I sat next to a woman who told me, 'Kathy, you aren't done yet. We need to recognize you for what you've done and give you the tools and support you need to keep going,'" says Hayashi. Upon returning home, she formed a San Diego WIE Affinity Group, became an IEEE Senior Member, a conference chair of the WIE International Leadership Conference (ILC), San Diego Section chair, and a member of the IEEE Board of Directors.

Kathy Hayashi

What she learned through that process was that a person needs what she calls a *portfolio* for her/his career. "It's not just your job, but you need to belong to your industry. "Being a Member of IEEE helped elevate me to that and allow for networking and recognition of who I am and what my impact can be in my field," she explains. Since then, she has chosen to pay it forward, taking on activities that help sustain women in technology. "The reason this is important to me is because I know what it feels like to want to leave, but I saw what amazing work others were doing that encouraged me to stay in, so I want to support other women the same way."

One of the ways she supports women is through teaching. Hayashi has been a computer science instructor at local community colleges for more than 13 years, choosing to teach introductory classes so that students would see a woman in the field early on in their studies. She has also stayed visible through multiple nonprofit board positions, speaking engagements, and local events at her alma mater, the University of California San Diego. For her activities, Hayashi has earned a number of recognitions, including being named a 2021 San Diego Business Journal Women of Influence in Engineering, the 2018 Athena Pinnacle Award Individual in Technology Award, and the 2017 Dr. Thomas Avolt Kanneman Outstanding Engineering Service Award.

Branching Out

On the IEEE front, Hayashi has served in a number of roles that further the ways women are able to connect and support one another. Since founding the San Diego WIE Affinity Group, she has led various committees and events, most recently as chair of the ILC. "Taking the reins of the ILC was ambitious because I was tasked with leading the conference through changes in location and committee," says Hayashi. "We moved it to Austin from San Jose, California, and had a very successful meeting there."

In the second year, however, she had to steer the ILC through COVID-19. As the pandemic hit early on in the planning phases, the team had to rework their contracts to ensure that the conference could be made virtual. "Women were so impacted by COVID that I was so glad we could keep the conference on and connect with women all over the world during a time we needed that interaction even more," Hayashi says. "People just wanted to talk and to connect, and we were able to provide that. We were one of the first conferences that transitioned to totally virtual." The pivot worked, as the committee estimates they were able to reach triple as many people from more than 70 countries compared to having the conference held only in person in San Diego.

Hayashi touts many of the changes IEEE has made, whether in response to external forces or just as a sign of the times, to show that the organization is continuing to evolve in ways that support women and inclusivity. This includes pushing for more diverse nominees for awards and enabling modifications to the metadata on someone's profile to allow a person to change their own name, whether they get married, divorced, or change gender identity.

These updates align with her own philosophy, which is that instead of advising someone that "in order to succeed you need to do 'X,'" everyone should just be themselves, and the organization should be adapting to provide the tools and opportunities that support individual success. Hayashi is proud to see IEEE making these changes at the global level, where they are the most visible and impactful.

Left to right: Qualcomm Technologies Executive Vice President of Engineering and CTO Dr. Jim Thompson, IEEE Region 6 (R6) Director Dr. Kathleen Kramer, IEEE R6 Historian Brian Berg, and Hayashi.

Hayashi with her husband, Jeff, and daughters Jen (left), an M.D. student at Tulane University School of Medicine, and Jules, a registered nurse and alumnus of the University of San Francisco.

Speaking of representation, Hayashi has racked up a few awards herself in recent years. She won both the IEEE MGA Innovation Award and the Region 6 Section Director's Award "for outstanding leadership and innovation," and was inducted into Eta Kappa Nu, the international honor society of IEEE.

These recognitions are not just for her volunteer work but her technical pedigree as well. Hayashi holds a bachelor's degree in computer science, a master's degree in organizational management, and is a certified scrum master. After graduating from the University of California San Diego with her computer science degree, Hayashi joined Unisys Corporation as a CAD software project lead, then transitioned to Cadence Design Systems as a senior member of the consulting team when they acquired Unisys, before taking a role as director of software development and the professional services group at Syntricity.

"I'm all-in on technology and have worn a lot of hats," she says. "When I was at Unisys, I worked with a small group that developed the first A-series mainframe on a chip, and I did it using my team's own custom electronic design automation software. Acquired by Cadence, software that I designed was put into production code that is still being used today. At Syntricity in 1999, we were part of the dot-com revolution in semiconductors for enterprise cloud-based yield analysis, and I was one of the original CAD people on that team."

Now, as a senior staff engineer at Qualcomm, Hayashi says she enjoys working at a company that continues to focus on innovation. "Our teams were some of the first to consider cloud-based initiatives for semiconductors," she shares. "Every day, we work on supporting the latest and greatest in innovation and technology."

In addition to her full-time position, Hayashi continues to push boundaries through other working groups, such as Accellera. On their own time, the working group developed a security-assurance standard. "This project kept me sane during the pandemic," she jokes. "We met twice weekly at 7 a.m. before our normal jobs started, and we worked to get our milestones for 2020." By mid-2021, the group learned the standard was approved, named *SA-EDI*, through Accellera.

> *"Instead, find the place where you know you can make the best impact and work together with the rest of the ecosystem and community to move the needle."*

"In software, we have always worried about functionality and performance issues, and now we are also looking at security and vulnerability. What our standard does is provide the basis for identifying hardware Internet Protocol security issues," explains Hayashi. "I know that security assurance is something that hardware needs, and being able to be on the team to make that part of the flow was a big deal for me and an important goal for the field I've been in since I graduated from college."

Combining her experience and opportunities thus far leads Hayashi to offer two main pieces of advice to others. The first is utilizing that portfolio approach, where at any given point, your energy is optimized across what matters to you most. "What is important to you will change over time," she says. "At times it was my career and the impact I wanted to make, and at other times it was my family, and now, with recent events, mindfulness is in my portfolio. I'm constantly modifying it to make sure it's the right blend for me, and every journey is unique, so you have to decide what is right for you."

The second piece of advice is to consider your scope, which Hayashi says is guidance she gives to her daughters, one a medical student and the other a nurse. "I know we all want to make changes and we can envision what we would like to see happen, but trying to make the largest changes can be frustrating," she advises. "Instead, find the place where you know you can make the best impact and work together with the rest of the ecosystem and community to move the needle."

Through all of Hayashi's experiences, there's another piece of advice that she has truly embodied and lived as an example: Find your community. People like Hayashi are working to make STEM fields more welcoming to all aspects of diversity and standing by to offer support to any women who may need it. "Find people to support where your passion lies," she concludes, "and when you are able to, turn around and support the next."

—Leslie Prives

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