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IMMERSIVE TECHNOLOGY

2020 IEEE AWARDS

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Dear IEEE Members, Honorees, Colleagues, and Friends:

Welcome to the 2020 IEEE Vision, Innovation, and Challenges Summit & Honors Ceremony!

On behalf of IEEE's Board of Directors, we would like to extend our sincere gratitude to our generous awards sponsors and to all of the nominators, endorsers, volunteers, and professional staff for their dedication to making our Awards Program, along with the annual IEEE Vision, Innovation, and Challenges Summit, such a success.

Most importantly, we would like to acknowledge all of this year's well-qualified nominees—the diverse array of engineers, scientists, technologists, and practitioners who exemplify the mission of the IEEE of advancing technology for the benefit of humanity.

There are amazing technological innovations and cutting-edge engineering research happening across the spectrum of technology today, some of which was discussed and explored at today's summit. Much of the work being done was made possible by the achievements of those we are recognizing this evening. Tonight's award ceremony is a celebration of the contributions of some of the greatest minds of our time who have made a lasting impact on society.

Thank you all for joining us as we acclaim those visionaries, leaders, and legends—our members and colleagues whose achievements have shaped our lives. May they serve as an inspiration to the next generation of disrupters whose future innovations will continue to move technology forward across the spectrum of fields of interest.

Toshio Fukuda,
2020 IEEE President and CEO

Richard V. Cox,
IEEE Awards Board Chair

IEEE Awards Program Diversity Statement

IEEE awards recognize exceptional contributions to all IEEE fields of interest (technical and nontechnical) made by organizations and individuals regardless of nationality, gender, age, religion, ethnic background, or other personal characteristics not related to ability, performance, or qualifications. The IEEE Awards Program is committed to pursuing diversity in all its operations to help realize and maintain fair nomination and selection processes without bias or discrimination.

The Father of FinFETs

Chenming Hu took transistors into the third dimension to save Moore's Law

BY TEKLA S. PERRY

It was 1995. Advances in chip technology continued apace with Moore's Law, the observation that the number of transistors on a chip doubles roughly every two years, generally because of the shrinking size of those transistors.

But the horizon no longer seemed limitless. Indeed, for the first time, murmurs throughout the semiconductor industry predicted the death of Moore's Law. The golden days would be coming to an end, the predictions went, when the size of a critical transistor feature, then around 350 nanometers, reached below 100 nm. Even the U.S. government was worried—so worried that DARPA raised an alarm, launching a program seeking new chip technologies that could extend progress.

Chenming Hu, then a professor of electrical engineering and computer science at the University of California, Berkeley, jumped at the challenge. He immediately thought of a solution—actually, two solutions—and, on a plane ride a few days later, sketched out those designs. One of those ideas, raising the channel through which current flows so that it sticks out above the surface of the chip, became the FinFET, a technology that earned Hu this year's IEEE Medal of Honor "for a distinguished career of developing and putting into practice semiconductor models, particularly 3-D device structures, that have helped keep Moore's Law going over many decades."

The story of the FinFET didn't begin with Hu putting pencil to paper on an airline tray table, of course.

It started in Taiwan, where Hu was a curious child, conducting stovetop experiments on seawater and dismantling—and reassembling—alarm clocks. As he approached the end of high school, he was still interested in science, mostly chemistry. But instead of targeting a chemistry degree, he applied for the electrical engineering program at the National Taiwan University, even though he didn't really know what an EE actually did. It was simply a challenge—the electrical engineering program required the highest test scores to get in.

During his last year of college, Hu discovered the industry he would later shake up, thanks to Frank Fang, then a visiting professor from the United States.

PHOTOGRAPHY BY PETER ADAMS

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"It was 1968," Hu recalls, "and he told us semiconductors were going to be the material for future televisions, and the televisions would be like photographs we could hang on the wall."

That, in an era of bulky tube televisions, got Hu's attention. He decided that semiconductors would be the field for him and applied to graduate programs in the United States. In 1969, he landed at Berkeley, where he joined a research group working on metal-oxide semiconductor (MOS) transistors.

His career soon took a detour because semiconductors, he recalls, just seemed too easy. He switched to researching optical circuits, did his Ph.D. thesis on integrated optics, and went off to MIT to continue his work in that field.

But then came the 1973 oil embargo. "I felt I had to do something," he said, "something that was useful, important; that wasn't just writing papers."

So he switched his efforts toward developing low-cost solar cells for terrestrial applications—at the time, solar cells were used only on satellites. In 1976, he returned to Berkeley, this time as a professor, planning to do research in energy topics, including hybrid cars, an area that transported him back to semiconductors. "Electric cars," Hu explains, "needed high voltage, high current semiconductor devices."

Come the early 1980s, that move back to semiconductor research turned out to be a good thing. Government funding for energy research dried up, but a host of San Francisco Bay Area companies were supporting semiconductor research, and transitioning to corporate funding "was not very difficult," Hu says. He started spending time down in Silicon Valley, not far from Berkeley, invited by companies to teach short courses on semiconductor devices. And in 1982, he spent a sabbatical in the heart of Silicon Valley, at National Semiconductor in Santa Clara.

"Being in industry then ended up having a long influence on me," Hu says. "In academia, we learn from each other about what is important, so what I thought was interesting really came just because I was reading another paper and felt, 'Hey, I can do better than that.' But once I opened my eyes to industry, I found that's where the interesting problems are." And that epiphany got Hu looking harder at the 3D structure of transistors.

A field-effect transistor has four basic parts—a source, a drain, a conductive channel that connects the two, and a gate to control the flow of current down the channel. As these components were made smaller, people started noticing that the behaviors of transistors were changing with long-term use. These changes weren't showing up in short-term testing, and companies had difficulty predicting the changes.

In 1983, Hu read a paper published by researchers at IBM that described this challenge. Having spent time at National Semiconductor, he realized the kinds of problems this lack of long-term reliability could cause for the industry. Had he not worked in the

trenches, he says, "I wouldn't have known just how important a problem it was, and so I wouldn't have been willing to spend nearly 10 years working on it."

Hu decided to take on the challenge, and with a group of students he developed what he called the hot-carrier-injection theory for predicting the reliability of MOS semiconductors. It's a quantitative model for how a device degrades as electrons migrate through it. He then turned to investigating another reliability problem: the ways in which oxides break down over time, a rising concern as manufacturers made the oxide layers of semiconductors thinner and thinner.

These research efforts, Hu says, required him to develop a deep understanding of what happens inside transistors, work that evolved into what came to be called the Berkeley Reliability Tool (BERT) and BSIM, a set of transistor models. BSIM became an industry standard and remains in use today; Hu still leads the effort to regularly update its models.

Hu continued to work with his students to study the basic characteristics of transistors—how they work, how they fail, and how they change over time—well into the 1990s. Meanwhile, commercial chips continued to evolve along the path predicted by Moore's Law. But by the mid-1990s, with the average feature size around 350 nm, the prospects for being able to shrink transistors further had started looking worrisome.

"The end of Moore's Law was in view," recalls Lewis Terman, who was at IBM Research at the time.

The main problem was power. As features grew smaller, current that leaked through when a transistor was in its "off" state became a bigger issue. This leakage is so great that it increased—or even dominated—a chip's power consumption.

"Papers started projecting that Moore's Law for CMOS would come to an end below 100 nm, because at some point you would dissipate more watts per square centimeter than a rocket nozzle," Hu recalled. "And the industry declared it a losing battle."

Not ready to give up on Moore's Law, DARPA (the Defense Advanced Research Projects Agency) looked to fund research that promised to break that barrier, launching an effort in mid-1995 to develop what it called the 25-nm Switch.

"I liked the idea of 25 nm—that it was far enough beyond what the industry thought possible," Hu says.

Hu saw the fundamental problem as quite clear—making the channel very thin to prevent electrons from sneaking past the gate. To date, solutions had involved thinning the gate's oxide layer. That gave the gate better control over the channel, reducing leakage current. But Hu's work in reliability had shown him that this approach was close to a limit: Make the oxide layer sufficiently thin and electrons could jump across it into the silicon substrate, forming yet another source of leakage.

Two other approaches immediately came to mind. One involved making it harder for the charges to sneak around the gate by adding a layer of insulation buried in the silicon beneath the transistor. That design came to be called fully depleted silicon-on-insulator, or FDSOI. The other involved giving the gate greater control over the flow of the charge by extending the thin channel vertically above the substrate, like a shark's fin, so that the gate could wrap around the channel on three sides instead of just sitting on top. This structure was dubbed the FinFET, which had the additional advantage that using space vertically relieved some of the congestion on the 2D plane, ushering in the era of 3D transistors.

There wasn't a lot of time to get a proposal submitted to DARPA, however. Hu had heard about the DARPA funding from a

THE ROAD TO FINFET: Chenming Hu joined the faculty of the University of California, Berkeley, in 1976 [bottom left]. His early research at Berkeley included hybrid cars, like the gas-electric car he presented at the University of California Board of Regents meeting in 1980 [above]. In his lab in 1997 [top left], Hu was deep in the development of the FinFET, with the help of a DARPA grant.

fellow Berkeley faculty member, Jeffrey Bokor, who, in turn, had heard about it while windsurfing with a DARPA program director. So Hu quickly met with Bokor and another colleague, Tsu Jae King, and confirmed that the team would pull together a proposal within a week. On a plane trip to Japan a day or two later, he sketched out the two designs, faxing his sketches and a description of his technical approach back to Berkeley when he arrived at his hotel in Japan. The team submitted the proposal, and DARPA later awarded them a four-year research grant.

Ideas similar to FinFET had been described before in theoretical papers. Hu and his team, however, actually built manufacturable devices and showed how the design would make transistors 25 nm and smaller possible. "The others who read the papers didn't see it as a solution, because it would be hard to build and may or may not work. Even the people who wrote the papers did not pursue it," says Hu. "I think the difference was that we looked at it and said, we want to do this not because we want to write another paper, or get another grant, but because we want to help the industry. We felt we had to keep [Moore's Law] going.

"As technologists," Hu continues, "we have the responsibility to make sure the thing doesn't stop, because once it stops, we're losing the biggest hope for us to have more abilities to solve the world's difficult problems."

Hu and his team "were well-poised to develop the FinFET because of the way he trains his students to think about devices," says Elyse Rosenbaum, a former student of his and now a professor at the University of Illinois at Urbana-Champaign. "He emphasizes big picture, qualitative understanding. When studying a semiconductor device, some people focus on creating a model and then numerically solving all the points in its 3D grid. He taught us to step back, to try to visualize where the electric field is distributed in a device, where the potential barriers are located, and how the current flow changes when we change the dimension of a particular feature."

Hu felt that visualizing the behavior of semiconductor devices was so important, Rosenbaum recalls, that once, struggling to teach his students his process, he "built us a model of the behavior of an MOS transistor using his kids' Play-Doh."

"These things looked like a lightning invention," said Fari Assaderaghi, a former student who is now senior vice president of innovation and advanced technology at NXP Semiconductors. "But his team had been working on fundamental concepts of what an ideal device should be, working from first principles of physics early on; how to build the structure comes from that."

BY 2000, at the end of the four-year grant term, Hu and his team had built working devices and published their research, raising immediate, widespread interest within the industry. It took another decade, however, before chips using FinFETs began rolling off of manufacturing lines, the first from Intel in 2011. Why so long?

"It was not broken yet," Hu explains, referring to the industry's ability to make semiconductor circuits more and more compact. "People were thinking it was going to break, but you never fix anything that's not broken."

It turned out that the DARPA program managers were prescient—they had called the project the 25-nm Switch, and FinFETs came into play when the semiconductor industry moved to sub-25-nm geometries.

FDSOI, meanwhile, also progressed and is also being used in industry today. In particular, it's found in optical and RF devices, but FinFETs currently dominate the processor industry. Hu says he never really promoted one approach over the other.

In FinFET's dormant years, Hu took a three-year break from Berkeley to serve as chief technology officer of semiconductor manufacturer TSMC in Taiwan. He saw that as a chance to pay back the country where he received his initial education. He returned to Berkeley in 2004, continuing his teaching, research in new energy-efficient semiconductor devices, and efforts to support BSIM. In 2009, Hu stopped teaching regular classes, but as a professor emeritus, he still works with graduate students.

Since Hu moved back to Berkeley, FinFET technology has swept the industry. And Moore's Law did not come to an end at 25 nm, although its demise is still regularly predicted.

"It is going to gradually slow down, but we aren't going to have a replacement for MOS semiconductors for a hundred years," Hu says. This does not make him pessimistic, though. "There are still ways of improving circuit density and power consumption and speed, and we can expect the semiconductor industry to keep giving people more and more useful and convenient and portable devices. We just need more creativity and a big dose of confidence." ∎

IEEE Spectrum Technology in the Service of Society Award	Philips
IEEE Spectrum Emerging Technology Award	Cerebras Systems, Inc.
IEEE Richard M. Emberson Award	John Vig
IEEE Haraden Pratt Award	Mary Ellen Randall
IEEE Honorary Membership	Borys Paton
IEEE Corporate Innovation Award	Apple
IEEE Theodore W. Hissey Outstanding Young Professional Award	Sampathkumar Veeraraghavan
IEEE James H. Mulligan, Jr. Education Medal	Leah H. Jamieson
IEEE Medal for Environmental and Safety Technologies	Nancy Leveson
IEEE Founders Medal	Jensen Huang
IEEE Richard W. Hamming Medal	Cynthia Dwork
IEEE Medal for Innovations in Healthcare Technology	Mark S. Humayun
IEEE Jack S. Kilby Signal Processing Medal	Ramalingam Chellappa
IEEE Jun-ichi Nishizawa Medal	Paul Daniel Dapkus
IEEE Robert N. Noyce Medal	Susumu Kohyama
IEEE Dennis J. Picard Medal for Radar Technologies and Applications	Joseph R. Guerci
IEEE Medal in Power Engineering	Rik W. De Doncker
IEEE John von Neumann Medal	Michael I. Jordan
IEEE Simon Ramo Medal	Byrana N. Suresh and K. Sivan
IEEE Alexander Graham Bell Medal	Rajiv Laroia
IEEE Edison Medal	Frede Blaabjerg
IEEE Medal of Honor	Chenming Hu

Note: Since these Awards Booklet covers—including the welcome letter from the IEEE President and Awards Board Chair—went to print, the 15 May 2020 IEEE VIC Summit and Honors Ceremony was canceled following the declaration by the World Health Organization (WHO) of COVID-19 as a pandemic. We are developing a virtual experience to acknowledge our esteemed recipients of the 2020 IEEE Medals & Recognitions who are normally recognized during the IEEE Honors Ceremony.

IEEE MEDALS, AWARDS, AND RECOGNITIONS

The following awards are recognized at the annual IEEE Honors Ceremony Gala

Also Featured in this Section of the Booklet

2020 MEDAL AND RECOGNITION SPONSORS

The 2020 IEEE Medals and Recognitions are supported by the generosity of the following organizations and societies

IEEE Spectrum Technology in the Service of Society Award

Sponsored by IEEE Spectrum

A traditional hospital ultrasound system sits on a wheeled cart, weighs 40 kilograms, can cost as much as $200,000, and requires a trained specialist to operate. Today, after decades-long development efforts, ultrasound transducers are available that connect to a smartphone or tablet, cost a few thousand dollars, and can be easily carried in a lab-coat pocket. The transducers are ergonomic, lightweight, use very little power (~2watts), don't overheat and were designed for rugged environments.

Philips Ultrasound, in Bothell, Washington, introduced one of the first app-based ultrasound systems, called Lumify, in 2015. Since then, portable devices such as Lumify have transformed healthcare in remote and rural villages, especially, where they have delivered powerful diagnostics capabilities and saved countless lives. In some communities in Africa, South America, and Asia, the nearest X-ray, CT, or MRI scanner is many hundreds of kilometers away. And yet an app-based, portable system can acquire images and instantly upload them to the cloud for further evaluation, by a human specialist anywhere in the world or, in some cases, a machine-learning program.

The Lumify system also has an included tele-ultrasound capability to let clinicians collaborate remotely in real time. While performing a scan on a patient, and while using the built-in Reacts tele-ultrasound capability, either device camera, voice and live ultrasound image can be streamed to a collaborator anywhere else in the world. The smartphone's front-facing camera can be used to show the position of the transducer alongside the resulting ultrasound. These features enable even relatively inexperienced users to provide better healthcare. In the developing world and other austere environments, these app-based systems have made particularly important strides not just in obstetrics but also in detecting diseases such as pneumonia and in scanning organs for evidence of goiter, cancer, and other diseases and injuries.

IEEE Spectrum Emerging Technology Award

Sponsored by IEEE Spectrum

In the 70-year history of the computer industry, the largest chip ever built contained 21 billion transistors and was about 814 square millimeters. In August 2019, Cerebras delivered a chip, named the Wafer Scale Engine (WSE), that contains 1.2 trillion transistors and is 46,225 millimeters square. The WSE is the first and only trillion transistor processor. It is 56 times larger than the next largest chip. It has 78 times more compute cores, with a whopping 400,000 compute cores compared to the next largest, at 5,280 cores. The WSE contains 3,000 times more fast on-chip memory than the nearest competitor and has 33,000 times the fabric bandwidth.

For artificial intelligence (AI) work, large chips process information more quickly, producing answers in less time. The WSE is built and optimized for AI work. AI work—specifically training neural networks--that before took months to compute, now takes minutes with the WSE. And problems that took weeks can now be done in seconds. This order of magnitude acceleration allows AI researchers to ask more questions and find more answers per unit time.

To learn more, read *IEEE Spectrum's* article: Cerebras's Giant Chip Will Smash Deep Learning's Speed Barrier.

IEEE Richard M. Emberson Award

Sponsored by the IEEE Technical Activities Board
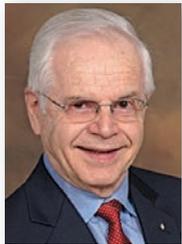
John Vig

For leadership, entrepreneurship, and perseverance in founding the IEEE Sensors Council and associated technical journals

John Vig has notably advanced the technical objectives of IEEE through continuously serving in numerous IEEE volunteer assignments for over 35 years, with accomplishments including establishing IEEE as a leader in publishing sensors research. Vig was the driving force in the founding of the IEEE Sensors Council. As an author, researcher, and manager of a group working on specific sensors, Vig felt that current IEEE journals didn't have any cohesive sensor focus. At this time, the IEEE did not have a journal or major conference devoted specifically to sensors. Papers on sensors went into the existing journals associated with their specific application (e.g., *IEEE Transactions on Nuclear Science*). This poorly supported the sensor community as a whole because it was difficult for researchers to find papers outside of their specific application area. Vig proposed the idea of the council and, despite initial opposition, he was able to shepherd it through the approval process and was named its first president. He then went on to develop the *IEEE Sensors Journal*, which launched in 2001 and now publishes over 10,000 refereed pages a year. He also oversaw the development of the Council's *IEEE Internet of Things Journal* and *IEEE Sensors Letters*. The IEEE Sensors Council now contains over two dozen societies and sponsors the annual IEEE SENSORS Conference. Vig has also contributed to IEEE in many other capacities. As IEEE President and CEO in 2009, he initiated and led efforts to improve conference quality and strengthen conference approval processes. He has also served as president of the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society; as IEEE Division Director; as Vice President of IEEE Technical Activities; and as journal editor, conference chair, member of the Investment Committee, and chair of a Standards Coordinating Committee.

An IEEE Life Fellow and member of the IEEE Technical Activities Board Hall of Honor (2014), Vig is a consultant for the DARPA Microsystems Technology Office and resides in Colts Neck, NJ, USA.

Scope: For distinguished service advancing the technical objectives of the IEEE.

IEEE Haraden Pratt Award

Sponsored by the IEEE Foundation

Mary Ellen Randall

For advocacy of member engagement through projects, social networking, awards, service to humanity, inclusion, and outreach in support of IEEE goals

Representing the very essence of "volunteerism in action" within IEEE, Mary Ellen Randall leads by example in inspiring IEEE members to advance technology for the benefit of humanity. A long-term volunteer who has served IEEE in many capacities, Randall has been dedicated to increasing member participation and engagement within the Institute through collaborative design, coaching, and leadership. One of her most well-known initiatives is the IEEE MOVE (mobile outreach vehicle) program. MOVE involves a disaster assistance vehicle and a team of IEEE volunteers who respond to crises throughout the United States. She and a team of volunteers have personally assisted the Red Cross and other organizations by providing power, cell phone charging capabilities, communications, networking, and other services to both disaster victims and relief workers. A prime example of IEEE member engagement in action, the vehicle itself was designed, is maintained, and operated by IEEE members. MOVE allows IEEE members to volunteer in areas that resonated with their passions to keep them engaged in IEEE activities. She was the leader in bringing the IEEE MOVE concept forward and bringing it to reality. The MOVE truck has been used at science expos to show students and parents how engineering and science can be used to better the communities around them. Randall was also a leader in IEEE's Women in Engineering (WIE) program. Her leadership in developing WIE groups at the local levels to foster engagement and instilling a spirit of inclusion and diversity have led to WIE's success. Other initiatives that reinforce a culture of engagement include the Senior Member Roundup, which has been successful in helping elevating IEEE members to the Senior Member grade. Randall is currently a member of the IEEE Member and Geographic Activities Board and director of the IEEE MOVE Community Outreach Program.

An IEEE Fellow and recipient of the IEEE-USA George F. McClure Citation of Honor (2016) and IEEE MGA Innovation Award (2018), Randall is the founder and chief executive officer of Ascot Technologies, Inc., Cary, NC, USA.

Scope: For outstanding volunteer service to the IEEE.

IEEE Honorary Membership
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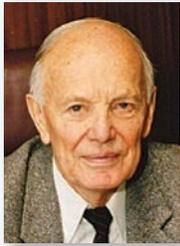
Borys Paton

For lifetime achievements within IEEE technical fields of interest in the development of processes of electrometallurgy, materials science, electric welding of metals, and biological tissues

With countless pioneering achievements in electrometallurgy and materials science, Borys Paton has developed electric welding technologies that are widely used for performing complex operations in space, under water, and in other critical environments including medicine/surgery. His fundamental research into the interaction of welding heat sources with molten metal laid the foundation for a new avenue of metallurgy called special electrometallurgy, which has made possible the casting of super clean special steels and alloys, nonferrous metals, and unique composites. This work has opened prospects for creating advanced structural and functional materials for the 21st Century. Paton was among the first engineers to develop welding processes for space technologies, which were used by cosmonauts first in orbital flights and then in open outer space. He helped develop several devices for welding in space, including the Vulcan (1969), Zarnitsa (1974), and the Isparitel (1979). Paton led the development of electroslag welding in the early 1950s. This progressive method of joining metals has made it possible to fundamentally change the production and installation of large machines and structures, allowing the welding parts of practically unlimited thickness to the assembly site without subsequent machining. Paton has also applied advances in electric welding to medicine, providing a new direction in surgery with tissue-preserving welding and processing of live tissues. Now widely used in practical surgery for over 15 years, this method allows for a quick and almost bloodless cutting and joining of biological tissues. Wound healing after such operations is much quicker compared to conventional surgery, the duration of surgical procedures is considerably shorter, there is less hemorrhaging, and the postoperative rehabilitation of patients is quicker. The results demonstrated by Paton have spurred further development in this important technology for healthcare.

Recipient of the Hobart Memorial Medal from the American Welding Society (1983), Paton is president and academician of the National Academy of Science of Ukraine and director of its E.O. Paton Institute of Electric Welding, Kyiv, Ukraine.

Scope: For those who have rendered meritorious service to humanity in the IEEE's designated fields of interest and who are not members of the IEEE.

IEEE Corporate Innovation Award
Sponsored by IEEE

Apple

For innovations in the design of high-performance and energy-efficient custom silicon for mobile applications

Apple's focus on creating custom silicon technologies has enabled innovations producing energy-efficient yet increasingly powerful mobile devices featuring simple and seamless human-friendly interfaces and unprecedented mobility, connectivity, and computing capabilities. The innovations in chip designs achieved by Apple's Hardware Technologies (HWT) team are the foundation of Apple's highly impactful product line featuring the iPhone, iPad, AirPods, Apple Watch, iPod, and Apple TV. These products have profoundly transformed the music, digital media, computing, and communications industries and are leading the smartphone, tablet, and smartwatch segments in functionality, performance, and energy efficiency. Historically, most mobile phone handset system manufacturers have relied on merchant silicon to embed within their phones, even if they developed their own system designs. In contrast, Apple took a bold approach to assemble a design team to create its own in-house custom application processors optimized for the customer experience. The breakthrough custom silicon technologies designed by the HWT team include a family of application processors, power management ICs, storage controllers, wireless communications, and sensors. Apple's quest for energy-efficient computing while attaining higher levels of performance and functionality, including privacy-preserving on-device artificial intelligence capabilities, is observable in Apple's application processors ranging from the single-core A4 (2010) to the six-core A12 Bionic processor (2018). Over that time frame the computing performance of these processors increased about 37-fold while also enhancing energy efficiency. Apple launched the Secure Enclave for higher levels of security in mobile devices, such as Touch ID and Face ID, and also introduced its Neural Engine for on-device machine learning. Apple's HWT team also pioneered the system-in-package S-series to support the stringent requirements on functionality, connectivity, and battery life in the Apple Watch. The HWT team also delivered design innovations in systems-on-chip for Bluetooth and WiFi connectivity (known as the W and H series), which are key enabling components in the Apple Watch and AirPods.

Apple's Hardware Technologies group is led by Senior Vice President Johny Srouji. With over 100,000 employees worldwide, Apple's headquarters are located in Cupertino, CA, USA.

Scope: For an outstanding innovation by an organization in an IEEE field of interest.

IEEE Theodore W. Hissey Outstanding Young Professional Award

Sponsored by the IEEE Young Professionals, IEEE Photonics Society, and IEEE Power & Energy Society

Sampathkumar Veeraraghavan

For inspiring leadership, exemplary innovations, and pioneering contributions to addressing global challenges through technology-driven IEEE humanitarian programs

Sampathkumar Veeraraghavan's development of large-scale computing systems; advanced software; and systems engineering technologies addressing humanitarian challenges including healthcare, disability, and education, has facilitated highly impactful programs benefiting people in developing nations. He has successfully introduced and pioneered efforts in creating and implementing IEEE humanitarian initiatives geared toward improving the quality of life for underserved populations. He is the founder and president of the technology-based humanitarian program "The Brahmam" (meaning "knowledge") which aims to address pressing global and local humanitarian challenges in developing nations through advanced technological innovations. His unique autism screening technology enabled physicians and educators to collect clinical data on autism to achieve detailed and holistic views of children's medical conditions to provide appropriate diagnosis in developing nations like India. This screening technology made significant field impact in India and was adopted by over 20 screening sites such as schools and special educational centers to provide early intervention programs. Many leading researchers and institutions around the world have leveraged his groundbreaking work to further advance the field. He has also led a major initiative in the research, design, and development of the Information System on Human and Health Services (ISHHS). ISHHS is a health information system that tracks over one million disabled individuals in India. This technology helps healthcare providers, policymakers, governmental agencies, and disabled individuals to understand disability prevalence patterns and initiate disability prevention measures, address the needs of disabled citizens, and facilitate the creation of equal educational and employment avenues. ISHHS has been widely implemented by governmental and nongovernmental agencies in Southern India. He has also chaired the IEEE Special Interest Group on Humanitarian Technology (SIGHT), spearheading global initiatives that have demonstrated how engineers can help solve critical global humanitarian issues using technological innovations.

An IEEE and Eta Kappu Nu member and recipient of the 2016 IEEE MGA Larry K. Wilson Transnational Award, Veeraraghavan is a senior technical program manager in the Alexa Artificial Intelligence Group at Amazon, Boston, MA, USA.

Scope: For contributions to the technical community and IEEE fields of interest.

IEEE James H. Mulligan, Jr. Education Medal

Sponsored by MathWorks, Pearson, and the IEEE Life Members Fund

Leah H. Jamieson

For contributions to the promotion, innovation, and inclusivity of engineering education

A champion of promoting and advancing engineering education, Leah H. Jamieson has devoted much of her career to establishing innovative education programs in engineering, attracting women to computing disciplines, and increasing public understanding of engineering. Jamieson cofounded the Engineering Projects in Community Service (EPICS) program at Purdue University to ensure that the technical education of students occurs alongside the development of professional and leadership skills in teamwork, creative problem solving, and ethics. EPICS is a service-learning program that connects teams of engineering students with community organizations to define, design, build, test, deliver, and support engineering projects that address community needs. EPICS programs have been implemented at colleges and highs schools in the United States and around the world, enabling an estimated 70,000 students to experience the transformative societal impact of engineering. Jamieson has been a leading voice on issues affecting women and minorities entering academic careers through programs including outreach and leadership development efforts with AnitaB.org and mentoring programs through the Computing Research Association's Committee on the Status of Women in Computing Research. At Purdue, she was a member of Purdue's Presidential Task Force on Women's Issues, a co-convener of the Committee on the Status of Women, and founding chair of the Purdue Women Faculty in Engineering Committee. Jamieson has helped build public awareness of engineering by serving on the U.S. National Academy of Engineering committee that produced the influential report "Changing the Conversation: Developing Effective Messages for Improving Public Understanding of Engineering" and promoting its findings nationally to attract young people to the discipline. She also led the creation of IEEE's Committee on Public Visibility and helped expand the Institute's involvement in K-12 outreach and other humanitarian programs.

An IEEE Life Fellow, Eminent Member of IEEE-Eta Kappa Nu, and member of the U.S. National Academy of Engineering and the American Academy of Arts and Sciences, Jamieson is the Ransburg Distinguished Professor of Electrical and Computer Engineering at Purdue University, West Lafayette, IN, USA.

Scope: For a career of outstanding contributions to education in the fields of interest of IEEE.

IEEE Medal for Environmental and Safety Technologies

Sponsored by Toyota Motor Corporation

Nancy Leveson

For contributions to software safety and for the development of system safety modeling

Nancy Leveson's development of a revolutionary new approach to system safety modeling and analysis tools for real-time systems is helping to prevent loss of life and property in safety-critical industries including aerospace, transportation, petrochemicals, autonomous vehicles, nuclear power, and medical devices. Leveson spearheaded the evolution of software safety as a new area of research, but also considers all aspects of system safety including design, human-automation interaction, operations, management, and social aspects. Her System Safety Research Lab at MIT has created new approaches to system safety that handle the most complex systems being built today. Leveson's contributions include a system-theoretic model of accident causality called STAMP (System-Theoretic Accident Model and Processes). STAMP replaces the traditional chain-of-events model underlying most current accident investigation, prevention, and assessment procedures. This more powerful and comprehensive model includes software, organizations, management, human decision-making, and migration of systems over time to states of heightened risk. Tools based on STAMP have been created that can be used for both proactive hazard analysis and post-accident analysis and for new ways to perform risk analysis. STAMP and its tools have been widely adopted by the autonomous vehicle industry and aviation, are used in a wide variety of other industries, and have even been used in nonengineering applications such as hospital safety, pharmaceutical safety, and workplace safety. International standards for the tools are being created for automotive, aviation, and defense systems so her new approach to system safety can be used in the official certification of safety-critical systems.

An elected member of the U.S. National Academy of Engineering and recipient of the Association for Computing Machinery's Alan Newell Award, the Nico Habermann Award, the AIAA Information Systems Award, and the SIGSOFT Award for Outstanding Software Research, Leveson is a professor of aeronautics and astronautics with the Massachusetts Institute of Technology, Cambridge, MA, USA.

Scope: For outstanding accomplishments in the application of technology in the fields of interest of IEEE that improve the environment and/or public safety.

IEEE Founders Medal

Sponsored by the IEEE Foundation

Jensen Huang

For visionary leadership of NVIDIA and the development of GPU fueling the Artificial Intelligence revolution

Jensen Huang's leadership in developing graphics processing unit (GPU) computing has helped create entire industries, advance science and medicine, and transform the way people work and live. Huang founded NVIDIA in 1994 and continues to serve as its president and chief executive officer. Under his leadership, it developed the GPU in 1999 as a programmable logic chip for specialized display functions, such as real-time programmable shading. NVIDIA was the first to demonstrate ray-traced graphics running on GPUs, and today NVIDIA's tools are the standard for professional graphics used by major motion picture studios, automotive designers, and architects. Beyond graphics, Huang threw NVIDIA's full support behind the emerging field of GPU computing by developing the CUDA language, providing hardware support for scientific computing and developing numerical libraries. Through his vision and persistence, GPUs now power the fastest supercomputer in the United States (Titan, at Oak Ridge National Laboratory), in Europe (HPC5, at Italian energy giant Eni), and in Japan (ABCI, at AIST). Supercomputers use GPUs in tandem with CPUs to speed up calculations, where dramatically faster execution times are achieved by offloading parallelizable computationally intensive portions of an application onto the GPU while the remainder of the code continues to run on the CPU. Huang realized early on that GPUs are well suited for the kind of number-crunching math involved in deep neural networks and machine learning. GPUs were shown to accelerate training algorithms by orders of magnitude, bringing running times of weeks down to hours. As a result of his vision and commitment, NVDIA's GPU computing technologies are powering deep machine learning applications that are igniting the modern era of artificial intelligence, with the GPUs acting as the brains of computers, robots, and self-driving cars that can perceive and understand the world.

Named *Fortune* magazine's 2017 Businessperson of the Year, recipient of the Dr. Morris Chang Exemplary Leadership Award (2004), and named the world's leading CEO by *Harvard Business Review* in 2019, Huang is currently chief executive office of NVIDIA, Santa Clara, CA, USA.

Scope: For outstanding contributions in the leadership, planning, and administration of affairs of great value to the electrical and electronics engineering profession.

IEEE Richard W. Hamming Medal

Sponsored by Qualcomm, Inc.

Cynthia Dwork

For foundational work in privacy, cryptography, and distributed computing, and for leadership in developing differential privacy

With a long-standing commitment to applying computer science research to solve societal problems, Cynthia Dwork has made a significant impact on addressing hard-to-define and complicated issues including preserving individual privacy in data analysis and keeping digital communications secure. Dwork led the development of the foundations of differential privacy and has created tools that have changed how companies collect and process data. Prior to differential privacy, protection methods focused on avoiding specific classes of attacks based on previously identified flaws. However, Dwork saw the need for a definition of privacy that would be secure against *all* future attacks while still ensuring that much of the utility of the statistical data was preserved. Differential privacy avoids previous shortcomings by understanding the paradoxical nature of privacy where, on one hand, information about the data should be learned since that is the point of gathering statistics about the data in the first place, but also assuring that no additional information will be learned about an individual providing the data. Driven by the objective of giving a mathematical interpretation of this notion of privacy, she formalized what it means for the information released about a dataset to be nearly independent of whether any single person's record was used. Differential privacy became the centerpiece for future research in statistical data privacy and has been deployed by Apple, Google, Microsoft, and the U.S. Census Bureau. Dwork also helped change the field of cryptography by creating nonmalleable encryption schemes where ciphertexts cannot be meaningfully modified without detection, and by creating encryption schemes, based on lattices, for which randomly chosen instances are as hard to break as the hardest instances. Lattice-based methods have become an indispensable tool for constructing secure cryptosystems for varied tasks, and they are the leading technology for postquantum cryptography.

A member of the U.S. National Academy of Engineering, and a Fellow of the Association for Computing Machinery and multiple honorary societies, Dwork is the Gordon McKay Professor of Computer Science with the Harvard Paulson School of Engineering at Harvard University, Cambridge, MA, USA, the Radcliffe Alumnae Professor at the Radcliffe Institute for Advanced Study, and Distinguished Scientist at Microsoft Research.

Scope: For exceptional contributions to information sciences, systems, and technology.

IEEE Medal for Innovations in Healthcare Technology

Sponsored by the IEEE Engineering in Medicine and Biology Society

Mark S. Humayun

For contributions to the treatments of retinal neurodegenerative diseases through the use of prosthetic devices

The driving force behind the retinal implant, Mark S. Humayun has profoundly impacted society by enabling partial restoration of sight to the blind, providing to patients with retinitis pigmentosa the capability to see large objects and letters and to avoid obstacles. Humayun used his deep knowledge in both the biomedical and bioengineering fields to develop and lead a consortium of investigators in diverse disciplines to further advance his efforts in sight restoration and coordinated with researchers in ophthalmic surgery and retinal physiology and pathology to develop a fully functional, multidisciplinary team. Humayun's pioneering contributions to the field of artificial sight started with his demonstration that surviving ganglion cells in blind subjects could be stimulated to elicit vision, despite these subjects having been blind for decades. Humayun's idea to pursue an epiretinal version of the artificial retina, controlled by an implanted microchip to "pixelate" digital images acquired by an external camera, led to the development of a 16-electrode device that effectively aided several blind patients beyond their expectations (known as the Argus I). Based on the success of this implant, Humayun led the development of the Argus II, which contains 60 electrodes and was found to be both safe and effective in restoring functional vision in a premarket approval clinical trial. The Argus II is now approved by regulators in the United States, Europe, the Middle East, and Asia Pacific and has restored vision to hundreds of patients. He continues to develop artificial retina technology toward the goals of providing color vision and the ability to read a smaller font.

An IEEE Fellow and a member of both the U.S. National Academy of Engineering and U.S. Academy of Medicine, Humayun is the Cornelius J. Pings Chair in Biomedical Sciences and professor of biomedical engineering and ophthalmology at the University of Southern California, Los Angeles, CA, USA.

Scope: For exceptional contributions to technologies and applications benefitting healthcare, medicine, and the health sciences.

IEEE Jack S. Kilby Signal Processing Medal

Sponsored by Texas Instruments, Inc.

Ramalingam Chellappa

For contributions to image and video processing, especially applications to face recognition

A pioneer in developing image, video, and multidimensional signal processing theory and methods for solving image processing, computer vision, and pattern recognition problems, Ramalingam Chellappa has profoundly affected the development of systems for face recognition and verification, image and video synthesis and analytics, real-time action detection, and active authentication. During the 1980s, Chellappa developed groundbreaking parameter estimation and neighborhood selection rules for Markov random field (MRF) models and developed algorithms for image restoration, texture analysis, and segmentation using MRFs. His linear discriminant analysis-based algorithm developed during the 1990s pioneered discriminative methods for training face recognition systems. Chellappa has also been active in creating tools for 3D recovery from one or more images using discrete and continuous methods. The Frankot-Chellappa algorithm was developed for extracting integrable 3D surfaces from a single image. He pioneered the area of video-based 3D modeling algorithms using batch and recursive estimation methods. He was also an early contributor to neural networks for image processing and computer vision applications. His recent work in this area includes deep-learning-based face, object, and activity recognition systems and methods that combat attacks against classification systems. Specifically, he has developed deep convolution neural network (DCNN)-based algorithms to help overcome the problems of aging, pose, and illumination, affecting accurate face recognition and providing results that rivaled human performance. His work on the HyperFace and UltraFace algorithms resulted in programs that perform not only face detection and classification but also gender recognition and age and pose estimation. The end-to-end system built by his group has been used for child exploitation/crime prevention and other U.S. homeland security applications.

An IEEE Life Fellow and recipient of the 2012 K.S. Fu Prize from the International Association for Pattern Recognition, Chellappa is a Distinguished University Professor with the Electrical and Computer Engineering Department at the University of Maryland, College Park, MD, USA.

Scope: For outstanding achievements in signal processing.

IEEE Jun-ichi Nishizawa Medal

Sponsored by the Federation of Electric Power Companies, Japan

Paul Daniel Dapkus

For the development of metal organic chemical vapor deposition and quantum well lasers

Paul Daniel Dapkus' pioneering efforts in realizing metal organic chemical vapor deposition (MOCVD) as a viable fabrication process and using it to develop quantum well (QW) lasers have resulted in the most efficient light sources for applications ranging from telecommunications and optical data storage to high-power industrial processes. MOCVD was developed in 1967, but no devices were created with it until after Dapkus and his team at the Rockwell International Electronics Research Center demonstrated that MOCVD growth technology was capable of producing high-quality layered semiconductor material in 1977. This was at a time when MOCVD was shunned as being not useful compared to molecular beam epitaxy (MBE) or liquid phase epitaxy (LPE). However, his group demonstrated high-performance solar cells and lasers, including ultrathin active regions that led to the first electrically driven QW lasers. MOCVD has since become the dominant technique for production of laser diodes and LEDs as well as photonic devices used in fiber-optic communications systems. His development of strained QW ultralow threshold semiconductor lasers, particularly his work on vertical cavity QW lasers, has led to their very rapid adoption in fiber-optic systems, often as the light source of choice for making low-cost data links. In 1982, Dapkus established a research group at the University of Southern California, where he has continued leading research on advancing the technology of QW devices through MOCVD. His research focuses on high-efficiency, low-threshold lasers; vertical cavity surface emitting lasers; and indium phosphide-based QW lasers at 1330 and 1550 nm wavelengths. Dapkus' contributions have also been implemented as key products in the diode-pumped fiber laser industry where CO_2 lasers used for cutting and welding steel and aluminum have been replaced by MOCVD-grown diode lasers.

An IEEE Fellow, a member of the National Academy of Engineering and recipient of both the IEEE David Sarnoff Award (2001) and the John Tyndall Award(2015), Dapkus is the William M. Keck Distinguished Professor of Engineering and professor of electrical engineering and physics and astronomy at the University of Southern California, Los Angeles, CA, USA.

Scope: For outstanding contributions to material and device science and technology, including practical application.

IEEE Robert N. Noyce Medal
Sponsored by the Intel Foundation

Susumu Kohyama

For global executive leadership in CMOS technology development, and for standardization of design methodology and its impact on the semiconductor industry

An influential leader during a critical time in the semiconductor and electronics industry, Susumu Kohyama's role in the shift to CMOS helped enable the continuous scaling of semiconductor devices, leading to higher performance and lower power consumption with high packing density. Kohyama's pioneering efforts at Toshiba in the late 1970s transformed the embryonic low-power, low-yielding CMOS process to a mass production technology. Conversion to CMOS was critical to the industry, avoiding the serious chip power problems that would have limited performance and integration level. As one of the early CMOS manufacturers, Toshiba was developing CMOS integrated circuits for the wristwatch and calculator market in 1970s, but the while the technology used in these devices was low power, it was slow and didn't provide much of a scaling benefit. Kohyama led the CMOS static-random-access memory projects inside Toshiba and provided CMOS technology with the ability to cover the high-performance market as well, leading to immense growth of the semiconductor industry. He also helped develop some of the most aggressive and advanced chips built during the 1980s and 1990s, ranging from static-random-access memories to the Sony PlayStation 2 chips (a forerunner of today's graphics processing units), as well as the MIPS R8000, the fastest and most sophisticated microprocessor of its time. He also drove the standardization of circuit design methodology, incorporating electronic design automation (EDA) tools, intellectual-property-based design, and hardware design language (HDL). This innovative work has improved productivity and expedited design capability, allowing complex systems and circuits containing over a billion transistors. He has also been instrumental in establishing strategic business and technology development alliances with many of the world's leading companies for memory, logic, EDA, and equipment. These alliances have led to the dissemination of leading-edge technology and increased semiconductor business opportunities at a significantly reduced cost with shared resources.

An IEEE member and recipient of the 1982 R&D 100 Award, Kohyama is president and chief executive officer of K Associates, Inc., Tokyo, Japan.

Scope: For exceptional contributions to the microelectronics industry.

IEEE Dennis J. Picard Medal for Radar Technologies and Applications
Sponsored by Raytheon Company

Joseph R. Guerci

For contributions to advanced, fully adaptive radar systems and real-time knowledge-aided and cognitive radar processing architectures

For over 30 years, Joseph R. Guerci has been responsible for the inception, research, development, execution, and transition of next-generation multidisciplinary radar technologies impacting government, industrial, and academic settings. Guerci made early and sustained contributions in the area of fully adaptive radar (FAR) during the late 1980s and early 1990s. FAR consists of both adaptive transmit and receive functions, in contrast to traditional adaptive radar for which adaptation takes place mainly in the receiver. In 2000, while a program manager with the U.S. Defense Advanced Research Projects Agency (DARPA), Guerci began the KASSPER project (Knowledge-Aided Sensor Signal Processing and Expert Reasoning) in collaboration with the U.S. Air Force Research Laboratory (AFRL). This was the first major project to develop a real-time, high-performance embedded computing architecture capable of implementing knowledge-aided and knowledge-based algorithms to greatly enhance adaptive radar performance in challenging environments. This multi-year project achieved significant milestones and was transitioned to major national radar systems. In applying knowledge-aided techniques to space-time adaptive processing (STAP), Guerci pioneered a powerful architecture that built upon advances in the field from AFRL and MIT Lincoln Laboratory to translate a largely academic exercise into a de facto standard requirement for every radar system. The performance benefits provided by knowledge-aided STAP enabled a 10-dB improvement in detection and a 50% reduction in false alarms. He has been one of the pioneers of waveform diversity (using various signals in both transmitter and receiver design for improving the overall performance amidst interference and noise) and was instrumental in establishing the Waveform Diversity Conference Series. His work in the area of cognitive radar has resulted in radar programs with the goal of making the radar fully adaptive to its environment by considering all available degrees of freedom on transmit and receive to maximize system performance.

An IEEE Fellow and recipient of the 2007 IEEE Warren D. White Award, Guerci is currently president and chief executive officer of Information Systems Laboratories, Inc., La Jolla, CA, USA.

Scope: For outstanding accomplishments in advancing the fields of radar technologies and their applications.

IEEE Medal in Power Engineering

Sponsored by the IEEE Industry Applications, Industrial Electronics, Power Electronics, and Power & Energy Societies

Rik W. De Doncker

For contributions to high-power and energy-conversion technologies

Dedicated to realizing a more efficient and integrated power grid, the groundbreaking power distribution and conversion concepts of Rik W. De Doncker have been integral to advances in power quality, energy savings, the use of renewable power sources, and development of electric vehicles (EVs). In 1988, during his postdoc at the University of Wisconsin, Madison, he developed a bidirectional DC-to-DC converter for the energy supply systems of the NASA space station. Now known as the dual-active bridge converter, it is one of the most efficient high-power, isolated DC-to-DC converters, and a 7-MW version was recently tested in a 5-kV multiterminal DC grid. His patented work on the auxiliary resonant commutated pole converter (ARCP) resulted in a high-power, yet highly efficient converter capable of pulse-width modulation. Multimegawatt ARCP converters have found use in uninterruptable power supplies, locomotive applications, and ship propulsion systems. His medium-voltage static transfer switch developed in 1993 was commissioned at more than 25 installations in the United States that are still operational today, keeping power up during voltage sags. His patented EV battery interface was licensed by General Electric and is used in the majority of golf carts and hybrid EVs worldwide, providing improved efficiency and a reduction in hybrid vehicle battery size, weight, and cost. His concept of modular multimotor propulsion systems and modular smart batteries further improved the interoperability of EVs with 150-kW DC fast chargers. This multimotor concept has also been implemented in the Audi Q6 eTron propulsion drive. As director of the Institute for Power Electronics and Electrical Drives at RWTH Aachen University, Germany, his current R&D activities focus on power electronic converters for, among others, household appliances, EV propulsion systems, switched reluctance drives, DC battery chargers and high power-density wide bandgap power converters. He is also director of the E.ON Energy Research Center of RWTH, where he conducts research on medium-voltage grid connected inverters and DC transformers.

An IEEE Fellow and the member of the German Academy of Science and Technology (ACATECH), De Doncker is currently Professor at RWTH Aachen University, Aachen, Germany.

Scope: For outstanding contributions to the technology associated with the generation, transmission, distribution, application, and utilization of electric power for the betterment of society.

IEEE John von Neumann Medal

Sponsored by IBM Corporation

Michael I. Jordan

For contributions to machine learning and data science

Considered one of the most influential computer scientists in the world and a leader in advancing the field of machine learning, Michael I. Jordan helped develop unsupervised learning into a powerful algorithmic tool for solving real-world challenges in many areas including natural language processing, computational biology, and signal processing. A potent blend of computer science, statistics, and applied mathematics, machine learning involves the use of algorithms and statistical models that enable computers to carry out specific tasks without explicit instructions and to continually improve. Jordan helped transform unsupervised machine learning, which can find structure in data without preexisting labels, from a collection of unrelated algorithms to an intellectually coherent field that solves real-world problems. His pioneering work on latent Dirichlet allocation (or topic models) demonstrated how statistical modeling ideas can be used to learn, in an unsupervised manner, models of nontraditional data sets (such as documents) as compositions of different parts (such as topics), where the representations of the parts themselves are also learned simultaneously. In his work on topic models and beyond, Jordan augmented the classical analytical distributions of Bayesian statistics with computational entities having graphical, combinatorial, temporal, and spectral structure, and he then used ideas from convex analysis, optimization, and statistical physics to develop new approximation algorithms, referred to as variational inference algorithms, that exploited these structures. Variational methods became a major area of machine learning and the principal engine behind scalable unsupervised learning. Today, they transcend subdisciplines of machine learning and play an important role in both deep learning and probabilistic machine learning.

An IEEE Fellow and member of the U.S. National Academy of Sciences and the U. S. National Academy of Engineering, Jordan is the Pehong Chen Distinguished Professor in the Department of Electrical Engineering and Computer Science and the Department of Statistics at the University of California, Berkeley, CA, USA.

Scope: For outstanding achievements in computer-related science and technology.

IEEE Simon Ramo Medal

Sponsored by Northrop Grumman Corporation

Byrana N. Suresh and K. Sivan

For outstanding leadership in developing a national space program and pioneering space technology

Significantly impacting the development of launch vehicle technologies, the space systems engineering expertise and leadership of Byrana N. Suresh and Kailasadivo Sivan have been instrumental in the Indian Space Research Organization (ISRO) becoming one of the world's top space agencies known for launching successful missions at low cost. Suresh and Sivan joined ISRO in 1969 and 1980, respectively, and at different points in time served as Director of Vikram Sarabhai Space Centre, a lead center for development of launch vehicles. Suresh led the development of their navigation guidance and control systems, including the polar satellite launch vehicle (PSLV), which has been ISRO's workhorse for satellite launches. He led the design and development of the electrohydraulic and electromechanical control systems, which are flying in all launch vehicles. He was also responsible for establishing a full-fledged vehicle simulation laboratory with sensors and actuators for evaluating the vehicle system performance under varying conditions of flight. He also developed a number of critical components for actuation systems, eliminating the high cost of importing these components. Sivan was chief architect of the 6D trajectory simulation software SITARA used for mission planning of ISRO launch vehicles and of the day-of-launch wind-biasing strategy that has allowed all-weather launches. He guided the development of the reusable launch vehicle RLV-TD, which was flown successfully. He took over the GSLV project team and guided it to successful launches. Sivan also implemented the strategy for the upper-stage (PS4) restart capability for the PSLV, which improves mission versatility by injecting different payloads in different orbits during a single mission. The contributions of Suresh and Sivan have enabled ISRO to achieve success in several complex missions, including the 2014 Mangalyaan vehicle, which was successful in orbiting Mars in its very first attempt. Sivan played a key role in ISRO setting a world record by launching 104 satellites from a single rocket in 2017.

Recipient of the 2018 International Council of System Engineering's Global Pioneer Award and Lifetime Achievement Award for 2016 from the Space Department, Suresh is an Honorary Distinguished Professor with the Indian Space Research Organization, Bangalore, Karnataka, India.

Recipient of the 2018 Lokmanya Tilak Award and 24th HK Firodia Vijnan Ratna Award for the year 2019, Sivan is Chairman of the Indian Space Research Organization, Bangalore, Karnataka, India.

Scope: For exceptional achievement in systems engineering and systems science.

IEEE Alexander Graham Bell Medal

Sponsored by Nokia Bell Labs

Rajiv Laroia

For contributions to cellular wireless data systems

Rajiv Laroia's development of Flash-OFDM was integral to transitioning cellular voice access systems to the wireless data access systems that have mobilized our access to the Internet via smartphones, tablets, and wireless modems. He realized that the nature of Internet data traffic demanded a redefinition of wireless connectivity and thus developed Flash-OFDM (fast low latency access with seamless handoff—orthogonal frequency division multiplexing). Unlike voice calls, which require a persistent but relatively low rate connection, Internet traffic requires intermittent bursts at high rates, and the system needed to be agile enough to quickly reassign air-link resources according to widely and rapidly varying traffic demands. The key to Flash-OFDM is that the overall channel resource is divided into very fine-grained time-frequency slots that each user can access orthogonally without interference from another. Prior to Flash-OFDM, cellular wireless connectivity was circuit-switched. He saw that the migration from cell phones to smartphones was creating capacity demand that could not be met by circuit-switched networks and developed a packet-switched architecture. In patented work, he described a wireless system in which terminals support various states of operation (on-state, hold-state, sleep-state, and access-state). In the hold-state a mobile device is put into a low-power, passive state to free up system resources and preserve battery life but can quickly transition into a communicating state. Other patented work addressed assigning traffic resources by mapping active users to data resources so that users would not maintain an active uplink, fractional frequency reuse, and beacon signals that allow detection of hand-off candidates and timing correction at long range for efficient hand off between cells and across frequencies. These aspects of Flash-OFDM, plus many other concepts developed by Laroia and his teams, helped form the basis for the LTE and 4G systems that are powering today's mobile broadband communications.

An IEEE Fellow and recipient of the 2018 Eduard Rhein Technology Award, Laroia is the founder and chief technology officer of The Light Company, Far Hills, NJ, USA.

Scope: For exceptional contributions to communications and networking sciences and engineering.

IEEE Edison Medal

Sponsored by Samsung Electronics Co., Ltd.

Frede Blaabjerg

For contributions to and leadership in power electronics, developing a sustainable society

The pioneering and innovative accomplishments achieved by Frede Blaabjerg over the past 30 years in applying power electronics technology for efficient control and conversion of electric power are playing a key role in reliably connecting renewable energy sources to the power grid, thus helping to create a more sustainable society. The power converters he developed for wind turbine systems have addressed the challenges of scaling up from megawatts to multimegawatts. He also developed new topologies and interfacing techniques for photovoltaic (PV) systems that include both module-integrated inverters and string inverters. His grid-interfacing techniques for renewable energy systems such as synchronization, smart monitoring, and design and control of LCL filters have been implemented around the world. He has also proposed a power electronics-based active damper device to detect resonances in the grid and that can damp the oscillations at a specific frequency. This technology has provided more reliability in PV systems, wind farms, and transmission and distribution systems. His innovations involving adjustable speed drives include techniques for reducing noise in heating and cooling systems, and he has helped lower the cost of industrial drives by reducing the sensors needed while still maintaining failure protection. This work has helped save large amounts of energy and has enabled full-scale industrial automation. He has also developed several energy-optimal control strategies for induction motors, permanent-magnet motors, and switched-reluctance motors used for commercial drives that that have improved efficiency by 15% to 20% compared to standard control methods. Blaabjerg founded the Center of Reliable Power Electronics (CORPE) at Aalborg University, which is a strategic research center bridging academia and industry together to develop the next generation of reliable power electronics technologies.

An IEEE Fellow and recipient of the 2014 IEEE William E. Newell Power Electronics Award, Blaabjerg is a professor with the Department of Energy Technology at Aalborg University, Aalborg, Denmark.

Scope: For a career of meritorious achievement in electrical science, electrical engineering or the electrical arts.

IEEE Medal of Honor

Sponsored by the IEEE Foundation

Chenming Hu

For a distinguished career of developing and putting into practice semiconductor models, particularly 3-D device structures, that have helped keep Moore's Law going over many decades

Chenming Hu's pioneering achievements regarding transistor models and novel transistor structures have enabled the continued scaling of semiconductor devices that enable production of the smaller yet more-powerful and cost-effective computers and electronic devices proliferating society today. In the mid-1990s it became clear that two-dimensional, planar metal oxide semiconductor field-effect transistors (MOS-FETs) could not deliver continued performance improvements as dimensions were scaled down due to current leakage in short channel length transistors. This slowed channel length scaling and threatened to end the continuation of Moore's Law. Moore's Law is the concept that the number of transistors in compact integrated circuits doubles approximately every two years, enabling the personal electronics we continue to take for granted. To overcome this anticipated roadblock in scaling, Hu led the development of a revolutionary three-dimensional transistor structure known as the fin field-effect transistor (FinFET), named so because its thin vertical fin shape resembles a shark's dorsal fin. By reducing the thickness of the fin, etched out of the surface of a silicon wafer, the transistor channel length can continue to be scaled proportionally. Intel began using the FinFET for mass production of computer processors in 2011 and called it "the most radical shift in semiconductor technology in 50 years." Hu's FinFET innovation enabled the 22-, 16-, 14-, 10-, 7- and 5-nm technology nodes, which were unthinkable not long ago. Today practically all high-end computers, smart phones, and communications devices use FinFET technology, and it may add decades to furthering the state of the art in electronics evolution. Also important to the continued advancement of semiconductor technology has been Hu's contributions to device modeling. In 1996, Hu's breakthrough BSIM (Berkeley Simulation) transistor model was chosen as the first industry standard for linking the transistors/manufacturing and circuits/computer-aided-design aspects of semiconductor technology. BSIM models use original mathematical formulas based on transistor physics research. BSIM replaced dozens of in-house models because it's extremely accurate and highly computationally efficient. It can be used to simulate circuits containing hundred millions of transistors. BSIM also enables higher-level computer-aided integrated design tools to achieve first-silicon success without redesign. Hu has provided all the BSIM series of standard models to the semiconductor industry royalty free, and most integrated circuits created after 1996 have been designed using BSIM models. Hu and his students continue to develop new BSIM models today. Hu also made pioneering contributions to IC reliability modeling and design. His Berkeley Reliability Tool (BERT) allowed engineers for the first time to design for reliability so that manufacturers and IC design companies can be confident that what they produce will not fail in the field. The descendants of his original models are now embedded in integrated circuit design simulator tools, which has been integral to producing smaller yet more reliable and higher-performance integrated circuits.

An IEEE Life Fellow and recipient of the 2014 U.S. National Technology and Innovation Medal, Hu is the TSMC Distinguished Professor Emeritus with the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley, CA, USA.

Scope: For an exceptional contribution or an extraordinary career in IEEE fields of interest.

IEEE TECHNICAL FIELD AWARDS

The following Technical Field Awards are presented at 2020 IEEE technical conferences

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IEEE Biomedical Engineering Award

Sponsored by the IEEE Circuits and Systems, Engineering in Medicine and Biology, and Signal Processing Societies

F. Stuart Foster

For contributions to the field of high-resolution imaging

F. Stuart Foster's pioneering development of micro-ultrasound technology has enabled powerful high-resolution noninvasive imaging to better understand disease development and aid in the evaluation of new therapeutic treatments. He adapted his early high-resolution ultrasound work regarding miniature intravascular imaging catheters based on single-element mechanically scanned ultrasound transducers to larger external array transducers that could image small animals with high ultrasound resolution never before achievable. The visualization of tissue microstructure and functional status allowed by micro-ultrasound has found clinical applications in high-resolution prostate imaging, ocular imaging, dermatology, and guided neurosurgical interventions. His recent innovations include a photoacoustic system that combines the high resolution of ultrasound with the high tissue contrast provided by optical pulses.

An IEEE Fellow, Foster is currently senior scientist, Sunnybrook Research Institute and professor with the Department of Medical Biophysics at the University of Toronto, Toronto, Ontario, Canada.

IEEE Control Systems Award

Sponsored by the IEEE Control Systems Society

Anders Lindquist

For contributions to optimal filtering, stochastic control, stochastic realization theory, and system identification

Anders Lindquist's fundamental and seminal contributions to optimal filtering, smoothing, and stochastic control; stochastic realization theory; system identification; and modeling of time series have led to a conceptual understanding of several deep problems in systems and control. In particular, his contributions to the geometric theory of stochastic systems, which explain basic systems' theoretical concepts in geometric terms, has led to a deeper understanding of related algorithms. His contributions to the theoretical aspects of time-series analysis had a catalyzing effect. It led to a convex optimization approach for modeling and a unified view to a number of problems in robust control, system identification, and impedance matching. It also led to a novel framework for spectral estimation and the development of tunable algorithms known by the acronym THREE (for tunable high-resolution estimators).

An IEEE Life Fellow, Lindquist is a Zhiyuan Chair Professor at Shanghai Jiao Tong University, Shanghai, China.

IEEE Cledo Brunetti Award

Sponsored by the Brunetti Bequest

James H. Stathis and Ernest Yue Wu

For contributions to the understanding of gate dielectric reliability and its application to transistor scaling

James H. Stathis' and Ernest Yue Wu's expertise of gate dielectric reliability has permitted circuit designers to push transistor performance to the limit by continuing dielectric scaling while maintaining operation voltage sufficient to deliver high drive current integral to today's smaller yet more powerful devices. Their work has provided the ability to accurately predict the oxide lifetime at use conditions from accelerated stress data at elevated voltages, which has been essential as oxide thickness has scaled from ~10 nm to ~1 nm. Stathis challenged the semiconductor roadmap assumption that the constant-field scaling of gate oxides could continue without impacting transistor reliability. This motivated the industry to start looking for alternative (high-k)

dielectrics. He then helped discover "progressive breakdown" and showed how to confidently achieve better reliability margins. Wu developed a power-law model for voltage dependence of gate oxide breakdown that profoundly changed the landscape for semiconductor scaling. Building on the progressive breakdown concept, he created a failure-current-based methodology that led to a comprehensive understanding of transistor failure.

An IEEE Fellow, Stathis is a principal research staff member with IBM Research, Yorktown Heights, NY, USA.

An IEEE Fellow, Wu is a senior technical staff member with IBM Research, Essex Junction, VT, USA.

IEEE Electronics Packaging Technology Award

Sponsored by the IEEE Electronics Packaging Society

Mitsumasa Koyanagi and Peter Ramm

For pioneering contributions leading to the commercialization of 3D wafer and die level stacking packaging

Mitsumasa Koyanagi's and Peter Ramm's efforts in developing, demonstrating, and commercializing 3D integrated circuit (3DIC) integration processes have played a key role in enabling ever-smaller yet more-powerful devices especially important to mobile communications. 3D integration and packaging involves stacking silicon wafers and interconnecting them vertically so that they behave as a single device, which achieves performance at reduced power and with a smaller footprint than conventional 2D processes. Koyanagi succeeded in fabricating 3D stacked image sensor, 3D stacked memory, and 3D stacked microprocessor test chips using through-silicon vias (TSVs) for the first time. He also demonstrated a four-layer stacked image sensor with quarter video graphics array resolution, a four-layer stacked multicore processor, and a four-layer stacked heterogeneous image sensor with extremely high frame rate. Ramm developed and patented

3D integration approaches with particular focus on die-to-wafer stacking, using low-temperature bonding and vertical integration of IC devices with TSVs, and demonstrated a complete industrial 3DIC integration process. He also published results on key processes such as 3D metallization including robust IMC interconnections and on advanced sensor applications of 3D heterogeneous integration.

An IEEE Life Fellow, Koyanagi is a Senior Research Fellow at Tohoku University, Sendai, Miyagi, Japan.

An IEEE Senior Member, Ramm is the head of Strategic Projects at Fraunhofer EMFT, Munich, Bavaria, Germany.

IEEE Electromagnetics Award

Sponsored by the IEEE Antennas and Propagation Society, IEEE Electromagnetic Compatibility Society, IEEE Geoscience and Remote Sensing Society, and IEEE Microwave Theory and Techniques Society

Tapan Kumar Sarkar

For contributions to the efficient and accurate solution of computational electromagnetic problems in frequency and time domain, and for research in adaptive antennas

Known for his ability to reduce complicated theory and apply it to real-world challenges, Tapan Kumar Sarkar is bridging the gap between electromagnetics and communication systems to modernize applications ranging from wave propagation to smart antennas using real-time adaptive systems. He developed novel techniques for the solution of extremely large problems on parallel out-of-core solvers having millions of unknowns with reduced computational resources, a breakthrough in scientific computations. This helped the design of antennas for early warning radar systems and ultrawideband antenna systems, electrical characterization of printed circuits, and design of complex microwave systems with less interference. He has also applied electromagnetic technology to improve detection of improvised explosive devices in war zones and to improve food processing.

An IEEE Life Fellow, Sarkar is a professor with the College of Engineering and Computer Science at Syracuse University, Syracuse, NY, USA.

IEEE James L. Flanagan Speech and Audio Processing Award

Sponsored by the IEEE Signal Processing Society
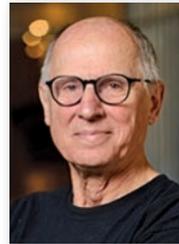
Hynek Hermansky

For contributions to speech processing and feature extraction for robust speech recognition

The pioneering speech processing methods developed by Hynek Hermansky are some of the most widely used in speech recognition, speech and audio coding, and speaker and language recognition. Known for innovative signal processing approaches that make speech parameters insensitive to channel variability and noise, his many accomplishments include Perceptual Linear Prediction (PLP) signal representation, Relative Spectral Analysis (RASTA) processing, and TRAP and TANDEM neural net based feature extraction technique.

An IEEE Fellow, Hermansky is the Julian S. Smith Professor of Electrical Engineering and director of the Center for Language and Speech Processing at Johns Hopkins University, Baltimore, MD, USA.

IEEE Fourier Award for Signal Processing

Sponsored by the IEEE Circuits and Systems Society and the IEEE Signal Processing Society
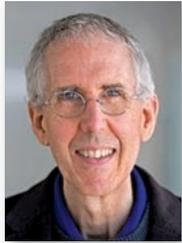
Alfred O. Hero, III

For contributions to the foundations of statistical signal processing with applications to distributed sensing and performance benchmarking

The statistical signal processing algorithms and numerical optimization methods pioneered by Alfred O. Hero, III, have become essential components of sensor networks important to the development of the Internet of Things and have led to advances in medical imaging, wireless communications, and deep learning applications. His work on signal processing for distributed self-calibration and tracking in sensor networks has driven the explosion in wireless network localization technology and its applications to data-in-motion, personalized health, security, and environmental monitoring. His development of the space-alternating generalized expectation-maximization (SAGE) algorithm has improved medical image reconstruction, and his averaged incremental gradient (AIG) algorithm has impacted tomographic imaging and machine learning.

An IEEE Fellow, Hero is the John H. Holland Distinguished University Professor of Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor, MI, USA.

IEEE Andrew S. Grove Award

Sponsored by the IEEE Electron Devices Society

Evelyn L. Hu

For pioneering contributions to micro-electronics fabrication technologies for nanoscale and photonic devices

In a career focused on developing techniques with high spatial precision to sculpt nanostructures from solid-state materials with minimal damage, Evelyn L. Hu's innovative micro- and nanofabrication technologies have enabled the continued shrinking of integrated circuits. Industrial and academic research groups use her methods to achieve nanometer-scale control over device geometries while maintaining excellent optical properties, impacting areas ranging from telecommunications to high-speed electronics. Her work has resulted in lasers with record low threshold values, single-photon sources, improved extraction of light from indium-gallium-nitride light emitting diodes (LEDs), and coupled light-matter states.

An IEEE Fellow, Hu is the Tarr-Coyne Professor of Applied Physics and Electrical Engineering at Harvard University, Cambridge, MA, USA.

IEEE Herman Halperin Electric Transmission and Distribution Award

Sponsored by the Robert and Ruth Halperin Foundation, in memory of Herman and Edna Halperin, and the IEEE Power & Energy Society

Dusan Povh

For contributions to the development and applications of HVDC and FACTS

Dusan Povh has played an essential role in laying the foundations for the high-voltage direct current (HVDC) and flexible alternating-current transmission system (FACTS) technologies that ensure secure and reliable power delivery. Povh helped introduce HVDC technology using thyristors and was responsible for system and filter design for the Cahora Bassa and Nelson River HVDC systems introduced during the 1970s. His pioneering work concerning FACTS includes damping of subsynchronous oscillations and realization of static Var compensators using thyristors. FACTS technology today helps increase the reliability of AC grids and improves efficiency and transmission quality. Povh's focus on the interaction between AC and HVDC systems has enabled the reliable operation of HVDC systems integrated with HVAC systems.

An IEEE Life Fellow, Povh is an independent consultant in power system analysis, HVDC, and FACTS residing in Nuremberg, Germany.

IEEE Masaru Ibuka Consumer Electronics Award

Sponsored by Sony Corporation

Eben Upton

For creating an inexpensive single-board computer and surrounding ecosystem for education and consumer applications

Confronted with declining interest in computer science programs, Eben Upton was inspired to create an inexpensive, fully functional, programmable computer to encourage students to engage with computers and learn to code. Upton's Raspberry Pi single-board computer combines embedded, low-power video and graphics cores with an ARM CPU to create a simple, standardized low-cost computer platform. With the addition of a keyboard, mouse, and monitor, the Raspberry Pi provides a complete 64-bit desktop computer with access to millions of Linux applications. Upton has allowed students, enthusiasts, and technologists to focus their creativity on their projects—whether it be a media player, laptop, lawn-sprinkler control, or robotic kits—to name just a few. Upton launched the Raspberry Pi Foundation in 2009 to promote the study of computer science and to put the fun back into learning computing.

Upton is currently chief executive officer with Raspberry Pi (Trading) Ltd., Cambridge, UK.

IEEE Internet Award

Sponsored by the IEEE Internet Award Fund

Stephen L. Casner and Eve M. Schooler

For distinguished leadership in developing standards for Internet multimedia, and formative contributions to the design of Internet multimedia protocols

The vision and leadership of Stephen L. Casner and Eve M. Schooler in developing multimedia standards and protocols for the Internet have driven the success of IP-based telephony, video streaming, and multimedia conferencing we take for granted today. Casner contributed to the first specification and implementation of packet voice on the Internet (the Network Voice Protocol). He later led the Audio/Video Transport (AVT) Working Group of the Internet Engineering Task Force (IETF) and coauthored the Real-time Transport Protocol (RTP). Schooler played a key role in the development and implementation of early multimedia signaling protocols. She also cofounded the IETF's Multiparty Multimedia Session Control (MMUSIC) Working Group. Under her leadership, this group developed some of the most influential multimedia signaling standards, including the Session Initiation Protocol (SIP), of which she is a coauthor; the Session Description Protocol (SDP); and the Real-Time Streaming Protocol (RTSP). RTP and SIP provide the foundation for media transport and signaling in many real-time multimedia applications and services. Casner's and Schooler's work on early prototype systems was instrumental in demonstrating the feasibility of packet audio and video, multicast teleconferencing and radio, IPTV, and even distributed music performance across the Internet.

Casner is a Fellow (retired) of Packet Design, Santa Clara, CA, USA.

An IEEE Senior Member, Schooler is a principal engineer and director of Emerging IoT Networks with Intel, Santa Clara, CA, USA.

IEEE Richard Harold Kaufmann Award

Sponsored by the IEEE Industry Applications Society

Kouki Matsuse

For pioneering contributions to the advancement of sensorless vector control of AC drives and multilevel inverters for industrial applications

Advancing the state of the art in sensorless control of alternating-current motor drives and multilevel converters, the pioneering work of Kouki Matsuse has enabled high-performance and high-efficiency drive systems for industry applications. In the area of sensorless control, which provides advantages including low cost, increased reliability, and less maintenance, he proposed a method using signal injection to simultaneously identify motor speed and rotor resistance now widely used in industrial drive systems. He also developed an adaptive observer for regenerating-mode, low-speed operation of sensorless induction motor drives. Regarding multilevel inverters, he developed five-level converters to overcome voltage imbalances, achieve unity power factors, and generate nearly sinusoidal input currents. This work plays a role in regenerating electric power back to the power grid.

An IEEE Life Fellow, Matsuse is an Emeritus Professor with Meiji University, Tokyo, Japan.

IEEE Joseph F. Keithley Award in Instrumentation and Measurement

Sponsored by Keithley Instruments, a Tektronix Co., and the IEEE Instrumentation and Measurement Society

Dario Petri

For contributions to measurement fundamentals and signal processing techniques in instrumentation and measurement

Dario Petri has made our world more accurate with pioneering digital signal processing (DSP) measurement techniques and by redefining the concept of soft measurements critical today where "everything" is measured. Petri developed several widely used DSP techniques suitable for real-time implementation in low-cost embedded systems. One of his methods for analog-to-digital converter dynamic testing and performance is referenced in the IEEE Standard 1057-1994 (Standard for Digitizing Waveform Recorders). His frequency-domain-based algorithms for real-time synchrophasors are playing an important role in tackling hard measurement problems in smart power grids. Regarding soft measurements (customer satisfaction, quality of service), Petri has developed a three-stage hierarchical model to support the identification and evaluation of measurement uncertainty sources for more reliable results.

An IEEE Fellow, Petri is a full professor with the Department of Industrial Engineering at the University of Trento, Trento, Italy.

IEEE Gustav Robert Kirchhoff Award

Sponsored by the IEEE Circuits and Systems Society
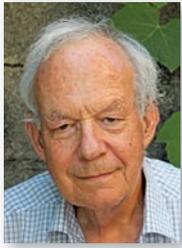
Martin Hasler

For fundamental contributions to nonlinear circuit theory and nonlinear dynamics

Using his expertise in theoretical physics, Martin Hasler has helped make sense out of chaos occurring in nonlinear circuits for applications including secure communications. Hasler was among the first researchers to discover that chaos is possible in simple nonlinear circuits. When circuit researchers had viewed the presence of small levels of chaotic behavior in circuits simply as noise that should be eliminated, Hasler demonstrated how chaos can be used to perform technical functions such as the transmission of messages. He showed that such functions rely on synchronizing two circuits, with one circuit encoding information in a transmitted "chaotic message" and the other extracting the information from the chaotic message. He also presented theoretical results and basic system structure for secure chaotic communication applicable to encryption in broadband communication.

An IEEE Life Fellow, Hasler is an Honorary Professor with the École Polytechnique Fédérale de Lausanne, Vaud, Switzerland.

IEEE Leon K. Kirchmayer Graduate Teaching Award

Sponsored by the Leon K. Kirchmayer Memorial Fund

Shu Lin

For transforming graduate education in the fields of coding theory, information theory, and digital communications

One of the world's most prolific authors of graduate textbooks focusing on coding theory, Shu Lin has for over 45 years impacted the education of countless engineers and scientists working in areas related to reliable data communication and storage. His *Introduction to Error Correcting Codes* (Prentice-Hall, 1970) coincided with the need for stand-alone graduate courses in coding theory, and the text is still a go-to reference today. He followed that text with three other best-selling coding books. In the classroom, Lin imparts his real-world experience to his students, having developed many coding schemes that have been adopted in communications standards. His students relate that he not only provides them with coding knowledge but also the methodology of engineering.

An IEEE Life Fellow, Lin is an adjunct professor with the Department of Electrical and Computer Engineering at the University of California, Davis, CA, USA.

IEEE Koji Kobayashi Computers and Communications Award

Sponsored by NEC Corporation

Balaji Prabhakar

For contributions to the theory and practice of network algorithms and protocols, in particular Internet routers, data centers, and self-programming networks

The network algorithms and protocols developed by Balaji Prabhakar are enabling more efficient operation of communications networks impacting the Internet, data centers, and societal networks. He designed the main switch scheduling and line-card algorithms for Nexus 5000, the flagship data center switch family for Cisco Systems and led the standardization of the QCN algorithm (IEEE 802.1Qau). His work on self-programming networks allows data centers and cloud computing platforms to adapt to varying load and network conditions by sensing, inferring, learning, and controlling network operations. A result of this work is the Huygens clock synchronization algorithm, which is impacting the financial industry.

An IEEE and ACM Fellow, Prabhakar is the VMware Founders Professor of Computer Science with the Electrical Engineering and Computer Science Departments at Stanford University, Stanford, CA, USA.

IEEE William E. Newell Power Electronics Award

Sponsored by the IEEE Power Electronics Society
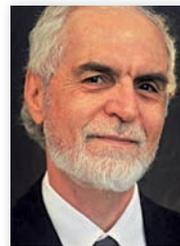
Ivo Barbi

For contributions to soft-switching converter technologies and power electronics education

Ivo Barbi's innovative concepts for soft-switching converter technologies have reduced the stresses encountered during operation of power equipment, providing smoother and more efficient results for applications including telecommunications, radar, and laser power supplies. Compared to hard switching, where stress occurs because current and voltage may not be at zero, soft switching enables switching at zero voltage (ZVS) and zero current (ZCS). He helped develop a three-level ZVS-pulse-width-modulation dc-dc converter, which changed the field by bringing the advances of ZVS to converters that can handle higher voltage levels. He also proposed new topologies impacting telecom energy systems including a three-phase/level unidirectional PFC rectifier for compactness and a two-state switching cell for one of the most efficient telecom power supplies over the last 10 years.

An IEEE Life Fellow, Barbi is an Emeritus Professor with the Federal University of Santa Catarina, Florianopolis, Brazil.

IEEE Daniel E. Noble Award for Emerging Technologies
Sponsored by the IEEE Daniel E. Noble Award Fund

Miro Micovic

For leadership in millimeter-wave Gallium Nitride (GaN) transistor and technology development

The GaN technology created by Miro Micovic is perhaps the most significant new development of the past 20 years impacting semiconductor technologies for the radio-frequency and wireless industries. His patented innovations have changed the competitive landscape for MMICs that operate at millimeter wave frequencies. He conceived a growth method that enabled the development of precisely engineered epitaxial structures that would prove to be essential for high-performance millimeter-wave devices. His creations helped convince the technical community that GaN technology could ultimately surpass existing state-of-the-art methods for millimeter-wave power amplification. Components made possible by Micovic's work have enabled sensors integral to 94-GHz imaging radar, point-to-point communication for emerging 5G networks, and satellite communication links.

An IEEE Fellow, Micovic is an Engineering Fellow with Raytheon, Tucson, AZ, USA.

IEEE Donald O. Pederson Award in Solid-State Circuits
Sponsored by the IEEE Solid-State Circuits Society

Klaas Bult

For leadership in embedded analog and mixed-signal integrated circuits

Klaas Bult's innovations regarding analog and mixed-signal integrated circuit design have enabled systems-on-chip technologies that have had great societal and economic impact. During the 1990s when there was skepticism whether sensitive analog circuits could be integrated on the same die as larger digital components, Bult saw that cointegration was an economic necessity and demonstrated how it could be achieved. The analog-to-digital and digital-to-analog chips he developed while working for Broadcom enabled single-chip, high-performance communication systems widely used for data transfer in set-top boxes, cable modems, Ethernet, and automotive applications. His work was key to Broadcom growing from a small startup to a world leader in broadband semiconductors. Today, it is practically impossible to transfer data over the Internet without utilizing Bult's circuits techniques.

An IEEE Fellow, Bult is a professor with Delft University of Technology, Delft, Zuid Holland, the Netherlands.

IEEE Frederik Philips Award
Sponsored by Royal Philips

Kazuo Yano

For leadership in the development and materialization of human-centric IoT technology in the electronics industry

Well before the wearable devices, smartphones, and Cloud services proliferating society today existed, Kazuo Yano had the vision that the knowledge and understanding of human logistics gained from monitoring human activity could improve everyday life. A pioneer of human-centric technologies, Yano not only designed wearable devices to collect user data but developed algorithms to analyze and determine the meaning of the data, a precursor to what is now known as data analytics and a key enabler of the Internet of Things (IoT). He also demonstrated the importance of applying the insights gained from the data for improving the way technology is used. Many companies now offer commercial devices that can monitor activity and track emotions, which has improved productivity and resource efficiency in numerous industries.

An IEEE Fellow, Yano is a Hitachi Fellow and corporate officer with Hitachi, Ltd., Tokyo, Japan.

IEEE Photonics Award
Sponsored by the IEEE Photonics Society

Christopher Richard Doerr

For sustained pioneering research, development, and commercialization of photonic integrated circuits and devices for telecommunications

During a career featuring over 180 patents, Christopher Richard Doerr has developed, demonstrated, and commercialized photonic integrated circuit technologies that meet the ever-increasing traffic needs of Internet users around the world. Prior to Doerr's work, it was believed that silicon integrated photonics were suitable only for low-cost, low-performance applications. However, with many industry firsts he demonstrated that silicon photonics can reliably provide the ultrahigh performance and compactness in addition to the low cost that advanced communication systems require. Among his innovations, Doerr developed a commercially viable, long-haul/metro silicon photonics-based transceiver featuring a single-chip transceiver exhibiting extremely low optical loss, high speed, low power, and low cost that has been manufactured in high volume and with high yield and deployed at speeds up to 600 Gb/s per optical carrier.

An IEEE Fellow, Doerr is the associate vice president of Advanced Development at Acacia Communications, Holmdel, NJ, USA.

IEEE Robotics and Automation Award

Sponsored by the IEEE Robotics and Automation Society

Vijay Kumar

For contributions to cooperative robotics; networked mobile manipulation systems, particularly unmanned aerial vehicles; and leadership in robotics research, policy, and education

Considered one of the top roboticists of his generation, Vijay Kumar's vision and technical accomplishments have shaped the fields of cooperative and networked robotics and autonomous micro aerial vehicles. He developed several novel capabilities for swarms of ground and aerial vehicles ranging in size from micro to macro that can move in formation, transport objects, and operate both indoors and outdoors. Central to his work is the synthesis of decentralized controllers that allow a group of robots to produce a desired global behavior by coordinating only with their immediate neighbors. Kumar has also served as an advisor in the White House Office of Science and Technology Policy, which was instrumental in increasing federal funding for robotics and cyber physical systems.

An IEEE Fellow and a member of the National Academy of Engineering, Kumar is the Nemirovsky Family Dean with the School of Engineering and Applied Science at University of Pennsylvania, Philadelphia, PA, USA.

IEEE Frank Rosenblatt Award

Sponsored by the IEEE Computational Intelligence Society

Xin Yao

For contributions to the advancement of the theory and applications of computational intelligence

Impacting both the foundational and practical aspects of computational intelligence, Xin Yao's accomplishments in advancing evolutionary computation and machine learning are making it easier to solve complex optimization problems. His approaches to fast evolutionary programming, in which he proposed a widely known mutation operator and an entirely new methodology for theoretical analysis of evolutionary operators/algorithms, have been applied to neural network structure learning, digital filter design, and design of new materials. His work on stochastic ranking, where he introduced a novel approach to deal with constraints in evolutionary optimization by balancing objectives and penalty functions based on a new ranking method, has had a major impact on solving constraint optimization problems in electrical, chemical, mechanical, and aeronautical engineering.

An IEEE Fellow, Yao is a Chair Professor of Computer Science at the Southern University of Science and Technology, Shenzhen, China.

IEEE Marie Sklodowska-Curie Award

Sponsored by the IEEE Nuclear and Plasma Sciences Society
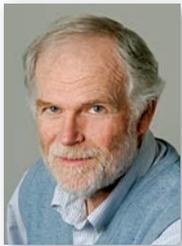
Michael A. Lieberman

For groundbreaking research and sustained intellectual leadership in the physics of low-temperature plasmas and their application

Michael A. Lieberman's advances in low-temperature plasma science have impacted integrated circuit fabrication, materials processing, and biomedicine. He developed and popularized global model conservation laws, which are used to predict plasma density and floating potential and electron temperature of plasmas. This was critical to the rapidly developing microelectronics industry being able to meet the challenges of continuing to shrink device size (Moore's Law). His work on pulsed plasmas is vital to the semiconductor industry, where pulsing the plasma is a powerful means of reducing surface charging damage during etching and deposition. His series of field-defining papers on the dynamics of radiofrequency-excited atmospheric pressure plasmas has had important implications in plasma medicine applications.

An IEEE Fellow, Lieberman is a professor with the graduate school in the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley, CA, USA.

IEEE Innovation in Societal Infrastructure Award

Sponsored by Hitachi, Ltd. and the IEEE Computer Society

Masaru Kitsuregawa

For contributions to big data collection and analytics of real-world problems with advanced data engineering technologies

Masaru Kitsuregawa has led the development and deployment of big data platforms on the environment and healthcare. Since the early 1980s he has accumulated earth environmental data from many real-time sensors. In 2019, his DIAS system grew to 35 petabytes, used by scientists and government agencies around the world for applications such as weather modeling and disaster management. DIAS provides satellite imagery, radar, and river water gauge data for real-time flood prediction and proactive dam discharging. He is building the SFINCS big data platform, with 200 billion medical claims records from Japan. SFINCS enables new discoveries on nationwide statistics for drug usage and time-series analysis after operation. These discoveries are being used to improve medical treatments and healthcare system efficiency.

An IEEE Fellow, Kitsuregawa is director general of the National Institute of Informatics and professor with the Institute of Industrial Science at the University of Tokyo, Tokyo, Japan.

IEEE Charles Proteus Steinmetz Award

Sponsored by the IEEE Standards Association

Solveig Ward

For leadership in and contributions to protection and communication standards for improved power system reliability

A leading developer of and applications expert in the dramatic advances in protective relaying of power transmission lines based on data communications (teleprotection), Solveig Ward is enabling reliable and faster power system protection essential to preventing widespread power outages and equipment failures. She has chaired and contributed to many IEEE protection and communication standards invaluable to providing guidance to the utility industry for critical system protection applications. Combining her extensive knowledge of transmission line protection with telecommunications technology, she has bridged the gap between utility relay engineers and utility communications engineers. Her practical background with relay protection products has provided a useful perspective in standards development by considering the environment, restraints, and best practical solutions for protective relay deployments in the utility industry.

An IEEE Fellow, Ward is an executive advisor with Quanta Technology, Raleigh, NC, USA.

IEEE Eric E. Sumner Award

Sponsored by Nokia Bell Labs

Theodore S. Rappaport

For pioneering contributions to radio channel modeling and characterization, and millimeter wave communication systems

The leading-edge research of Theodore (Ted) S. Rappaport helped realize today's modern wireless communications systems and is paving the way for next-generation cellular networks. Reliable and accurate channel models are essential for wireless system design and deployment, and Rappaport's channel modeling and measurement work formed the foundation of radio propagation models in cellular systems, wireless local-area networks, and emerging millimeter-wave systems. He provided fundamental knowledge of indoor wireless channels used to create Wi-Fi standards, conducted research that led to the digital cellphone standards, and helped engineer public Wi-Fi hotspots. He also proved the viability of millimeter waves for mobile communications, which prompted the global wireless industry to adopt his vision for 5G cellphone networks.

An IEEE Fellow, Rappaport is the David Lee/Ernst Weber Professor of Electrical Engineering at New York University, New York, NY, USA.

IEEE Nikola Tesla Award

Sponsored by the IEEE Industry Applications Society and the IEEE Power & Energy Society

Akira Chiba

For contributions to bearingless and reluctance motors

Akira Chiba has been a driving force in motor design with game-changing innovations that have provided powerful and efficient alternatives to traditional motor constructions. Chiba is a pioneer of bearingless motor technology, incorporating additional stator windings for producing two-dimensional radial forces that act as magnetic bearings. Bearingless motors provide high rotational speed, compactness, and no wear particles compared to traditional motors. They are integral to specialized pump applications where ultraclean conditions are required, such as in semiconductor and liquid-crystal display manufacturing. He also addressed the concern for the scarcity of rare-earth metals used for permanent-magnet motors in automotive traction drives, developing a rare-earth-free switched-reluctance motor featuring competitive torque density and efficiency and enhanced output with rare-earth-based motors in leading hybrid vehicles.

An IEEE Fellow, Chiba is a professor with the Tokyo Institute of Technology, Tokyo, Japan.

IEEE Kiyo Tomiyasu Award

Sponsored by Dr. Kiyo Tomiyasu, the IEEE Geoscience and Remote Sensing Society, and the IEEE Microwave Theory and Techniques Society

Andrea Alù

For contributions to novel electromagnetic materials and their application

Andrea Alù's seminal research on metamaterials is impacting a broad range of scientific disciplines, including electromagnetics, radio science, nano-optics, photonics, and acoustics. Metamaterials are engineered to have properties not found in natural materials and can block, absorb, enhance, or bend electromagnetic waves. Alù pioneered plasmonic cloaking and mantle cloaking, showing that a metamaterial layer can be designed to largely suppress the scattering of an object in all directions. This has important implications for radar camouflaging and invisibility. His work on momentum biasing to break the natural symmetry with which waves travel in common materials has enabled magnet-free circulators and isolators. This presents exciting opportunities for full-duplex radio communications and improved ultrasound imaging.

An IEEE Fellow, Alù is the Einstein Professor of Physics and founding director of the Photonics Initiative at the City University of New York Advanced Science Research Center, New York, NY, USA.

IEEE Transportation Technologies Award

Sponsored by the IEEE Industry Applications, Industrial Electronics, Intelligent Transportation Systems, Microwave Theory and Techniques, Power Electronics, Power & Energy, and Vehicular Technology Societies

Markos Papageorgiou

For contributions to traffic flow modelling and operations

Markos Papageorgiou's vehicular traffic-flow modeling and control tools are making travel safer and more efficient and are helping save energy and reduce emissions. His local ramp-metering algorithm ALINEA (developed in 1987) is recognized as a milestone in the field and is used around the world. The macroscopic simulation software METANET (developed in 1989) for freeway networks is still one of the most widely used traffic-flow tools. He introduced the concept of feedback in driver information and route guidance systems and contributed to the deployment of a large-scale implementation of travel-time displays in Paris, France, involving approximately 450 vehicle management systems. Developed in 2005, his coordinated ramp-metering algorithm HERO is widely considered the most advanced and efficient approach in this area.

An IEEE Life Fellow, Papageorgiou is a professor at the Technical University of Crete, Chania, Greece.

IEEE Undergraduate Teaching Award

Sponsored by the IEEE Education Society

Rajesh Kannan Megalingam

For his exemplary role in encouraging undergraduate engineering students to take up research for developing innovative solutions for the society

Committed to research and development with a special focus on humanitarian needs, Rajesh Kannan Megalingam motivates his undergraduate students at Amrita University to take on research activities and projects that help improve the world. Student research at the undergraduate level in India is rare, but Megalingam established an engineering program that provides opportunities to publish papers and attend conferences around the world. As leader of the Humanitarian Technologies (HuT) Lab at Amrita, he also provides his students with invaluable experience in developing technologies that are making a difference. Humanitarian-geared projects created under his guidance include a hand-gesture-based wheelchair, a search-and-rescue robot, and an unmanned robotic coconut tree climber and harvester, all completed with the help of only undergraduate students.

An IEEE Senior Member, Megalingam is director of the Humanitarian Technology Labs at Amrita Vishwa Vidyapeetham University, Kollam, India.

2019 Joyce E. Farrell IEEE Staff Award

Sponsored by IEEE

Casey Schwartz

For embodiment of the IEEE Professional Core and dedicated service to the IEEE

Casey Schwartz is known as a diligent, strategic, and empathetic individual who puts the customer at the heart of the IEEE decision-making process. Responsible for the day-to-day business operations of IEEE *Xplore*, her work involves business prioritization, requirements analysis, competitive benchmarking, content management, usability testing, web accessibility, and digital advertising for the IEEE *Xplore* platform. She leads a group dedicated to optimizing the user experience for all IEEE *Xplore* customers, working closely with the technology teams and the IEEE user community to develop solutions to optimize the use and value of IEEE *Xplore*.

A graduate of Rutgers University holding certifications through the Project Management Institute and the Scrum Alliance, Schwartz is currently associate director of IEEE *Xplore* in the IEEE Marketing, Sales, and Design Department, Piscataway, NJ, USA.

2019 IEEE Eric Herz Outstanding Staff Member Award

Sponsored by IEEE

Jonathan Dahl

For leadership in and contributions toward the extraordinary growth in the awareness and reach of the IEEE's electronic libraries

Jonathan Dahl's leadership in growing IEEE's worldwide sales of digital intellectual property became a major part of the revenue that has been crucial to funding activities and programs the Institute offers its members. As Senior Director of IEEE Sales and Marketing for 16 years, Dahl helped navigate the often-tumultuous transition from print to electronic delivery of publishing content. He and his staff worked closely with IEEE volunteers to develop indispensable products for customers around the world, including the All Society Periodicals Package, IEEE Enterprise, and MIT eBooks collection. Most of the word's top universities became IEEE subscribers. When the academic market became nearly saturated, he and his team focused on corporate subscriptions.

Dahl retired from IEEE in 2019 as lead director of Continuing Professional Education and currently resides in Maplewood, NJ, USA.

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for contributions to evolutionary learning and optimization

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for contributions to the application of artificial intelligence methods in diabetic retinopathy

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for contributions to analysis, synthesis and quality improvement of speech signals

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for contributions to small multiband antennas for wireless telecommunication devices

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for contributions to radio frequency and optical communications circuits and systems

Jose Arroyo-Sanchez
for contributions to generation scheduling for electricity markets

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for contributions to resource allocation for optical and wireless networks

Amir Avestimehr
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Hari Balakrishnan
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for contributions to piezoelectric science and engineering resulting in novel high temperature ultrasound transducers

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Aude Billard
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Monica Blank
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Alexandra Boltasseva
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Geoffrey Burr
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Lin Cai
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Filippo Capolino
for contributions to development of electromagnetic phenomena in metamaterials and periodic structures

Walter Mark Carpenter
for leadership in standards development for power system protection

Ramon Carvajal
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Andrea Cavagnino
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for contributions to software-defined wireless networking technologies

Ting-Chang Chang
for contributions to non-volatile memory and thin-film transistor technologies

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for leadership in the development of reconfigurable radio frequency and microwave systems

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for contributions to spatial data visualization

George Chen
for contributions to space charge measurement and interpretation for dielectric performance improvements

Jiann-Fuh Chen
for contributions to power electronics in sustainable energy and high power systems

Lei Chen
for contributions to time series management and spatial crowdsourcing

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for leadership in standardization of wireless mobile systems

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for contributions to algorithmic development for influence maximization in social networks

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for contributions to optimization methods for electromagnetic inverse scattering

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for contributions to mobile computing and mobile security

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for contributions to multimedia data processing and their applications in autism interventions

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for contributions to convex analysis and optimization for blind source separation

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for contributions to wireless and battery-less medical implants

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for contributions to strain engineering in MOSFETs and to design-technology co-optimization

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for leadership and contributions to solid-state drive architectures and systems

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for contributions to high-mobility germanium metal-oxide-semiconductor devices

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for contributions to to the development of photosensitive optical fibers for fiber amplifiers

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for leadership in energy systems

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for leadership in interconnect technologies for electronics packaging and reliability analysis

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for contributions to laser material interactions

Satyandra Gupta
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for contributions to wireless and cellular communication technologies

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for contributions to design and analysis of mobile wireless communications systems

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for contributions to robust software development

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for contributions to data-driven learning and control with applications in transportation systems

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for leadership in the development of microprocessors in mobility products

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for contribution to fuzzy and grey modeling in intelligent healthcare systems design

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for contributions to flexible and stretchable electronic circuits

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for contributions to biorobotics for locomotion

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for contributions to wireless sensor network technology and its applications to advancing healthcare

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for contributions to high quality LED lighting and modeling and control of DC-DC converters

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for contributions to the understanding of magnetic oxides, interfaces, and nanostructure

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for contributions to real-time automatic image annotation and image retrieval

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for development of wireless and networked sensing systems

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for contributions to the theory of mismatched disturbance rejection in industrial systems

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for contributions to large-scale and particle swarm optimization

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for contributions to the application of synthetic aperture radar for ocean remote sensing

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for application of computational intelligence to system design and control

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for contributions to power electronics converters in microgrids and industrial drives

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for contributions to thin film transistor technologies

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for development of algorithms in evolutionary clustering and bioinformatics

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for leadership in stationary battery standards and energy storage industry

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for contributions to the electrical safety of low-voltage systems

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for contributions to optimal resource management in wireless networks and the smart grid

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for contributions to building spatially- and privacy-aware systems

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for contributions to modeling and design for cyber-physical-social systems

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for development of time-modulated antenna arrays

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for contributions to modeling and control of high-voltage DC and AC transmission systems

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for contributions to three-dimensional integrated circuits

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for contributions to resource management in wireless networks

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for leadership in the development of real time digital simulation in power systems

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for contributions to resource allocation and optimization in wireless communications

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for leadership in human language technologies

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