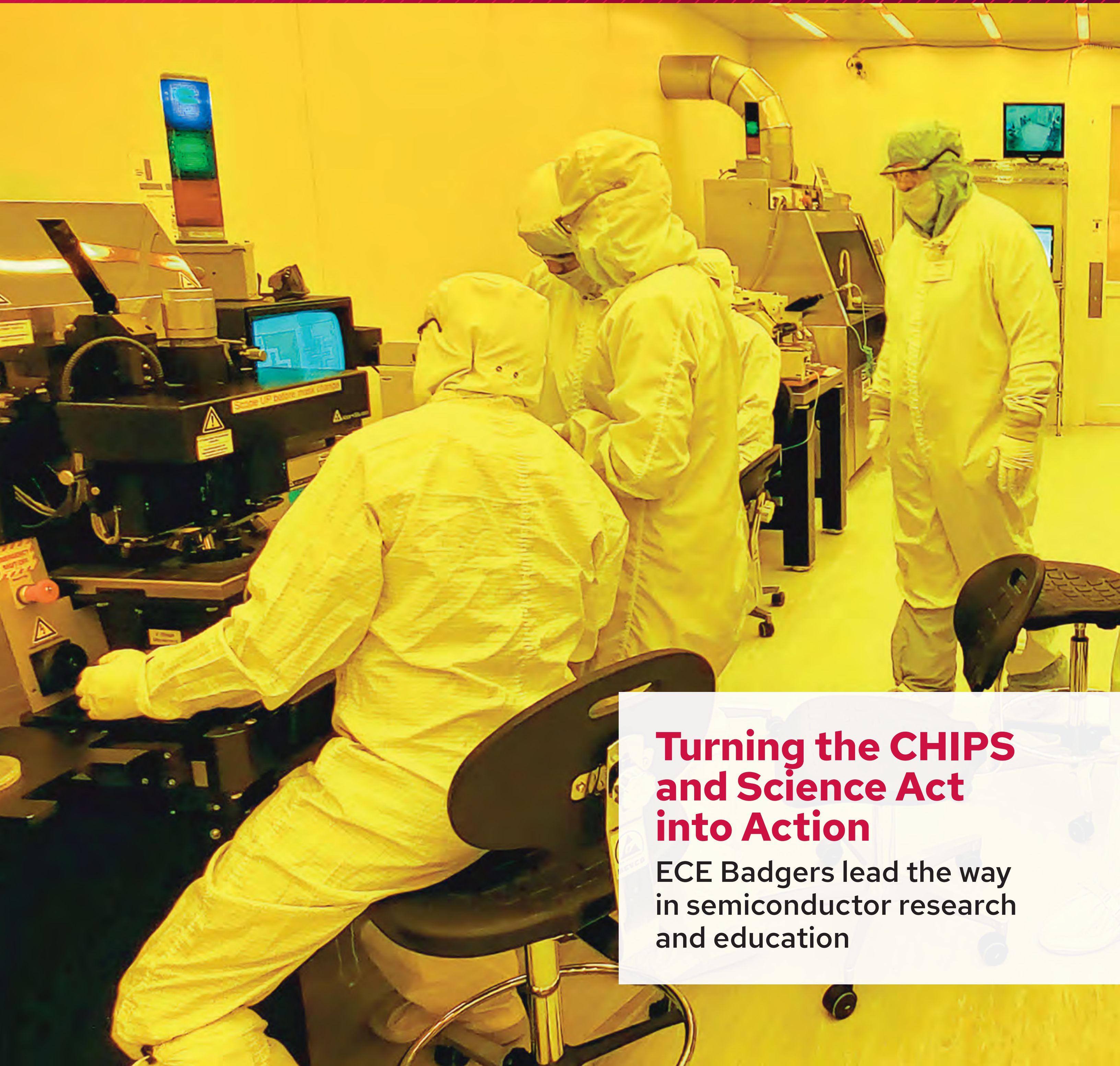
College of Engineering
UNIVERSITY OF WISCONSIN–MADISON

SPRING 2023 NEWSLETTER

ELECTRICAL AND COMPUTER ENGINEERING



Turning the CHIPS and Science Act into Action

ECE Badgers lead the way in semiconductor research and education

Greetings from Madison!

This is a year of exciting opportunities for our ECE community. As you may have read in the news, the bipartisan CHIPS and Science Act was signed into law in August 2022. With this law comes a renewed national investment in semiconductor research and workforce development for growth and innovation in microelectronics and broad impact across 5G/6G communications, clean energy, quantum computing, artificial intelligence and more.

Our faculty are conducting world-class research across the entire microelectronics innovation spectrum from semiconductor materials and devices to computer architecture. Recently, our faculty have been involved in leadership roles in national workforce development collaborations, including the American Semiconductor Academy Initiative. We're also undertaking a comprehensive curriculum and infrastructure expansion in semiconductor engineering to increase the number of students we can accommodate in popular courses like digital VLSI design and popular labs like IC fabrication in our Nanoscale Fabrication Center.

Demand for our public-top-10-ranked undergraduate and graduate degree programs is at an all-time high, and our department faculty is growing as well. We are in the midst of a tenure-track faculty hiring initiative that complements and builds upon our recent recruitment of 11 new tenure-track/tenured faculty over the past three years in semiconductor materials/devices and quantum technology; machine learning, robotics and control; and energy systems. This year, we are recruiting six new faculty in the following areas:

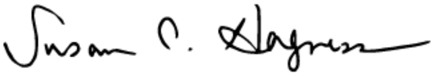
- Computing for autonomous systems
- Robotics and control of autonomous systems
- Energy and power systems engineering
- Artificial intelligence (AI) and medical imaging
- Machine learning and AI
- Applied electromagnetics and wireless connectivity

As we grow, we continue to be a leader among ECE departments across the country in the percentage of our faculty who are women (currently 25%). We celebrate that we currently have 30 fellows in IEEE, AAAS, National Academy of Inventors, Optica, and other societies, and with the most recent round of announcements from NSF, eight of our faculty have received National Science Foundation CAREER Awards since 2020. Our faculty, staff, and students are proud of the work we do here, and we hope you feel the same way.

I appreciate all of our alumni who stay connected with our department. In February, for example, three of our alumni—Martin Licht (BSEE '00, MSECE '01) from Intel, Carolyn Richards-Chacon (BSEE '93) from NXP Semiconductors and Susmit Singha Roy (MSECE '11) from Applied Materials—shared their experiences with our students and faculty via a virtual alumni panel on microelectronics, semiconductors and chip manufacturing.

If you would like to explore opportunities to give back to our department, or are in the Madison area over the coming months and would like to say hello, please reach out.

On, Wisconsin!



Susan C. Hagness
Philip Dunham Reed Professor
and Department Chair
(608) 265-5739
susan.hagness@wisc.edu
ECE at Wisconsin: Committed to ethics and diversity in engineering

On the cover: Students in ECE 549: *Integrated Circuit Fabrication Laboratory* work in a cleanroom in the Nanoscale Fabrication Center using an aligner to position patterns on a silicon wafer during the photolithography process.

engineering.wisc.edu/ece
facebook.com/uwmadisonece
twitter.com/uwmadisonece
go.wisc.edu/linkedin-ece
@uwmadisonece

Stellar cohort of undergrads supported through generous scholarship awards

In October 2022, ECE recognized more than 100 undergraduate students at the department's annual scholarship reception. In total, we awarded $399,400 to ECE students at every stage of their undergraduate journey, including $129,500 awarded to first-year students.

Scholarships are funded through a variety of sources, including many alumni who are eager to support the next generation of Badger engineers. For instance, Nana Murugesan (MSECE '01), vice president of international and business development at Coinbase and a former member of the ECE advisory board, recently established a scholarship in automation in honor of his father, Dr. R. Murugesan, a distinguished engineer in India. The inaugural award went to Mason Crooks, an electrical engineering junior who recently completed an internship in laboratory automation at Exact Sciences.

Madison McKinney is the recipient of an Ernest W. Reynolds Scholarship, one of more than 100 scholarships presented to ECE undergraduates.

Mason Crooks is the first recipient of an automation scholarship established by ECE alumnus Nana Murugesan.

Interested in supporting outstanding undergraduates by contributing to an existing ECE scholarship fund or establishing a new scholarship? Contact directors of development:

Valerie Chesnik
valerie.chesnik@supportuw.org

Courtney Spilker
courtney.spilker@supportuw.org

Tom Van Wyhe
tom.vanwyhe@supportuw.org

FOCUS ON NEW FACULTY

Jeremy Coulson is making smart systems smarter

New Assistant Professor Jeremy Coulson uses data driven control and machine learning to make robots and autonomous systems safer and more reliable.

Autonomous systems are becoming part of our everyday life, from smart homes that learn a family's routine to delivery robots that can safely cross an intersection on their own.

However, the type of control systems that run these gadgets aren't powerful enough to run next-generation autonomous systems, which will need to handle changing environments and complex uncertainties, all in real time while guaranteeing safety—like an autonomous car headed for an interstate pileup or a delivery drone caught in a flock of geese.

But Jeremy Coulson, who started as an assistant professor in spring 2023, is finding ways to make these smart systems even smarter. He specializes in data-driven control, a framework that enables autonomous and robotic systems to learn from their past and make intelligent decisions in real time.

"Control theory has been built on the use of mathematical models describing exactly how things work," Coulson says. "But now, as these systems become more and more complex—for example, autonomous driving or complex robots—you don't necessarily have access to these models or the expert knowledge needed to understand how these systems work under the hood. So you want to try to learn how to control these systems without such models. And the way you do that is through data."

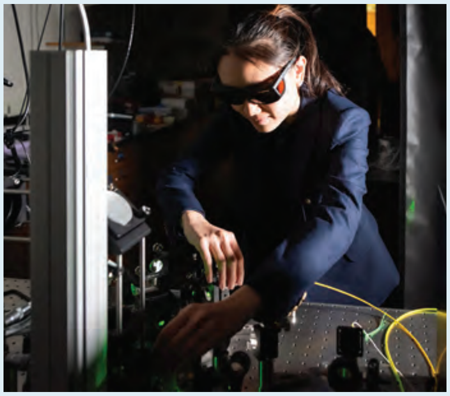
Coulson grew up near Toronto in Ontario, Canada, and received a bachelor's degree in mechanical engineering and applied mathematics and a master's degree in mathematics and engineering from Queen's University in Kingston, Ontario. He then traveled to ETH Zurich in Switzerland, where he recently completed his PhD, focusing on data-driven control.

Much of Coulson's work developing algorithms is mathematical. However, he says it's exciting to see how that work makes its way down the pipeline, eventually controlling real systems. "In my PhD, we developed this nice theory for data-driven control and developed a very powerful algorithm based on it," he says. "Then we actually implemented this algorithm on real physical machines, like quad copters, autonomous excavators and power grids, where you actually get to see the theory put into practice."

At UW-Madison, he says he wants to continue and expand this work. In the past few years, these sorts of control problems have been approached from two different communities: the control theory side, which Coulson is a part of, and the computer science and machine learning/artificial intelligence community. He hopes to bring these groups together and also involve the robotics community at UW-Madison. "Together we can tackle new problems, open up new research directions and introduce disruptive ideas that might not be possible without such collaborations," he says. "Madison has a dynamic environment which is conducive to these types of collaborations."

Coulson is also excited to continue teaching at UW-Madison. In Zurich, he was nominated for a teaching award for an undergraduate course involving quad copters. During the COVID-19 pandemic, he redesigned the course from the bottom up under the concept: if the students cannot come to the lab, the lab can come to their homes! He modified the drones so that the students could take them home and perform hands-on experiments. Students worked in teams developing control systems that would allow the drones to fly autonomously. Coulson hopes to bring similar hands-on experiences to students in Wisconsin.

Choy adds quantum sensing expertise to ECE



Jennifer Choy has joined ECE's growing cohort of quantum technology faculty.

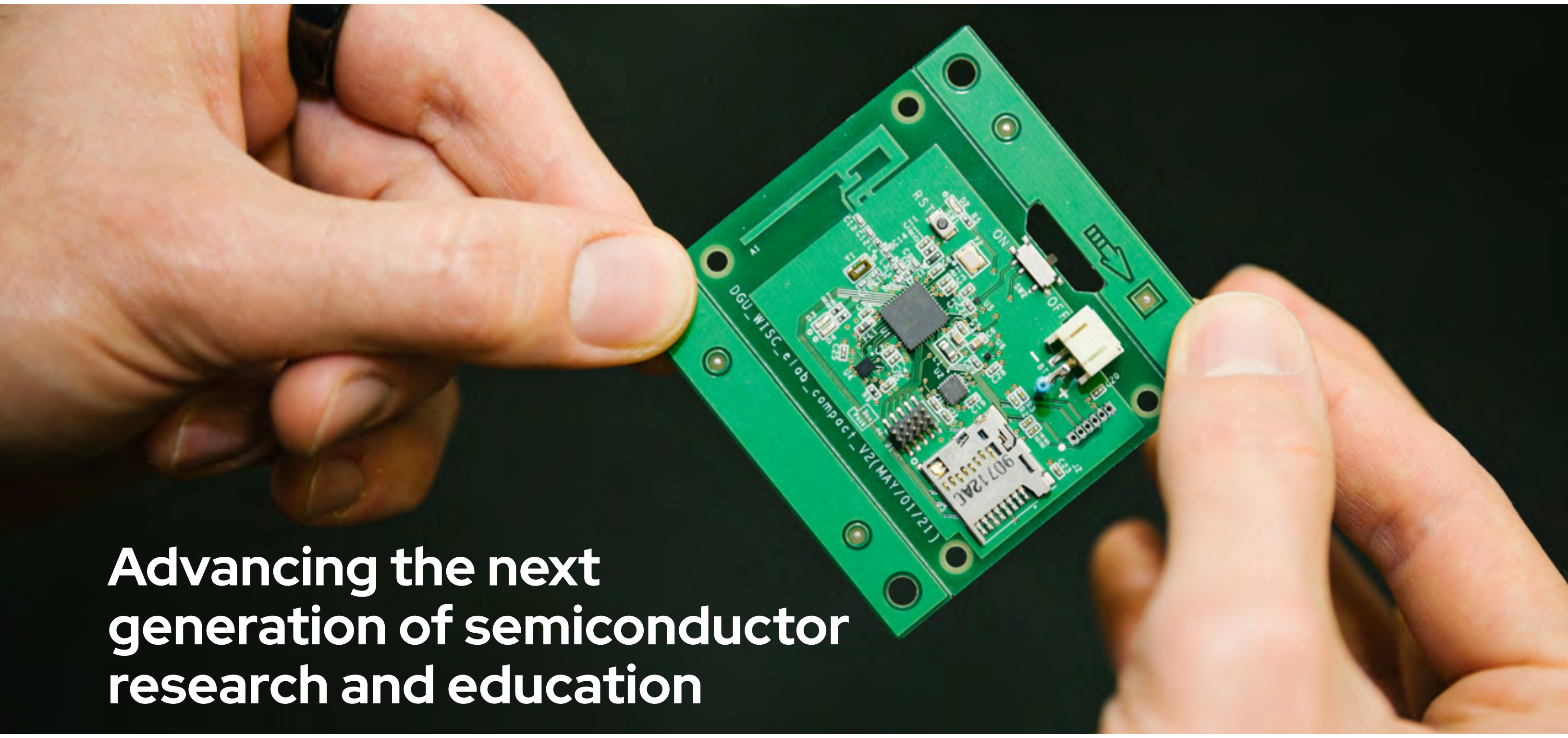
In spring 2023, Assistant Professor Jennifer Choy joined the department after four years in the Department of Engineering Physics, which has undergone a reorganization to focus on nuclear engineering and fusion energy. Choy's research focuses on developing quantum sensors and their miniaturization using nanoscale optics and photonics. This research could lead to advances in ultraprecise and compact accelerometers and magnetometers, which are useful in navigation and detecting miniscule changes in magnetic fields.

"ECE is a natural fit for my research," says Choy. "I'm very happy to join and support the growth of quantum research in the department."

Choy earned bachelor's degrees in physics and nuclear science and engineering from MIT before completing a PhD in applied physics at Harvard. After that, she was a principal member of the technical staff at the nonprofit Draper Laboratory in Cambridge, Massachusetts.

Since joining UW-Madison, Choy has focused on developing sensors that use an atom's quantum properties to take measurements with incredible precision and accuracy.

In particular, Choy's lab is working on two complementary quantum platforms. Solid-state color centers use electrons trapped in vacancies in diamonds as sensors and are very sensitive to local changes in temperature, strain and magnetic field. Choy and her students are developing techniques to create stable color centers and improve their sensitivity for material characterizations at the nanoscale. Her group also works with cold neutral alkali atoms and is developing chip-scale, near-infrared polarization optics for atomic magnetometers. These could enable compact, sensitive magnetic-field-imaging devices.



Advancing the next generation of semiconductor research and education

Researchers and students at UW-Madison can take semiconductors from design to fabrication, like this device designed in Associate Professor Umit Ogras' lab.

In August 2022, Congress passed the bipartisan Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act, a package that authorizes tens of billions of dollars to boost the U.S. semiconductor industry, catalyze research and development, create regional high-tech hubs and improve STEM workforce development.

It's a monumental, once-in-a-generation investment that will transform the American tech sector and accelerate many different types of research. As implementation of the act begins, ECE is taking a role in new multi-institutional R&D efforts and developing new pathways for students to take advantage of emerging opportunities.

"We're being stretched, as a discipline, to be responsive to the world around us and the CHIPS Act has brought this home in new ways," says Professor Daniel van der Weide, who is involved in several of ECE's CHIPS-related projects. "As a faculty, we are confronted with these challenges, and I think it's our responsibility to respond to them in creative ways."

Making an impact

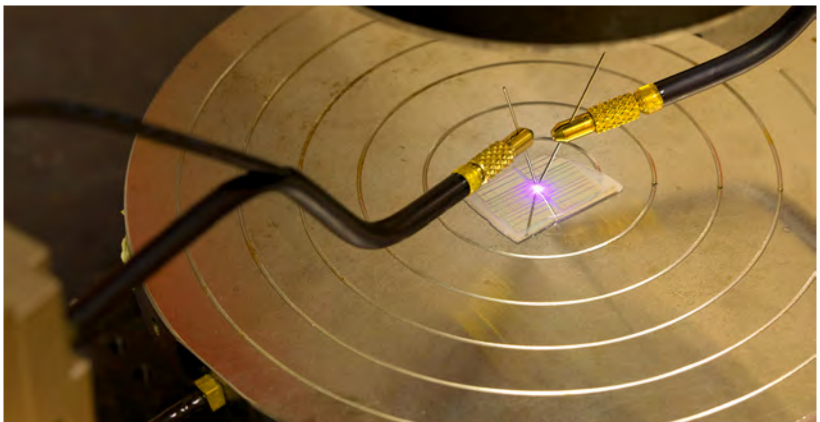
In total, ECE has 23 faculty members working in solid-state electronics/quantum technologies and computer systems/architecture, including seven new tenure-track and tenured faculty hired in the past three years. Among those are Associate Professor Umit Ogras, an expert in multi-core computer chip architectures and former research scientist at Intel; Assistant Professors Shubhra Pasayat and Chirag Gupta, experts in wide-bandgap semiconductor materials and devices; Assistant Professor Ying Wang, who is leading advances in two-dimensional semiconductors; Assistant Professor Eric Tervo who engineers semiconductor materials and devices for energy conversion and thermal management; Assistant Professor Bobby Jacobberger who explores 0, 1 and 2D materials for next-generation semiconductor devices; and Assistant Professor Jinia Roy (joining in summer 2023) who brings industrial expertise in power electronics.

In preparing to take advantage of the CHIPS Act, ECE faculty are aggressively pursuing multiple academic and industry partnerships, the primary funding mechanisms for the act. One is the Department of Defense Microelectronics Commons, a $1.63 billion, five-year program that will fund up to nine regional hubs focused on creating direct pathways to commercialization for U.S. microelectronics researchers and designers, taking projects from "lab to fab."

ECE faculty are collaborating on proposals and white papers for various projects, with contributions from almost 20 College of Engineering faculty members. They bring a wide breadth of expertise to these efforts, including Lynn H. Matthias Professor and Vilas Distinguished Achievement Professor Zhenqiang "Jack" Ma who is developing next-generation semiconductor materials and Michael Arnold, a materials science and engineering professor with expertise in carbon nanotubes. Assistant Professor Bhuvana Krishnaswamy and van der Weide are focusing on 5G and 6G communication applications, with many others lending technical expertise and advice.

More than 20 ECE faculty are also participating in the American Semiconductor Innovation Coalition (ASIC), a group of 200 institutions guiding the development of the National Semiconductor Technology Center and The National Advanced Packaging Manufacturing Program, two public-private partnerships established by the CHIPS Act. These centers aim to develop and prototype advanced semiconductors, provide support for startups and small businesses, and develop workforce training programs.

Beyond those large-scale collaborations, many faculty members are developing new relationships with companies in the chips industry and pursuing research that will advance microelectronics. Van der Weide,



ECE researchers including Shubhra Pasayat (below) are using wide and ultra-wide-bandgap semiconductors to develop new devices, like this gallium nitride light emitting diode. Photo credit top: Todd Brown.

for instance, is collaborating with industry partners to develop the Wisconsin Integrated Semiconductor Collaboratory, a cloud-native design that will allow users to collaborate, test and visualize integrated circuits, bringing chip design into the modern era and providing a powerful new educational platform for students.

Professor Luke Mawst, Ma, Pasayat, Gupta and Tervo are collaborating with local semiconductor companies to advance novel III-V and III-nitride semiconductor devices, which could lead to brighter LEDs, high power electronics, new types of lasers and more efficient energy converters.

A teaching moment

The other significant element of the CHIPS Act is its commitment to workforce development, which for ECE means support for new elements of the curriculum and partnerships that give students opportunities to join the high-tech semiconductor industry.

ECE faculty are part of the planning team for the American Semiconductor Academy (ASA) initiative, a consortium of 200 universities and 1,500 corporations putting together a comprehensive workforce development program designed to close the microelectronics industry's widening talent gap. Ma, Jack St. Clair Kilby Associate Professor Mikhail Kats and Assistant Professor Jennifer Choy were part of a team that co-wrote an ASA position paper successfully lobbying for dedicated funds in the CHIPS Act for workforce development. ECE faculty are also positioned to be part of an ASA funding request from the National Science Foundation to establish exemplar courses and modernize curricula.

Though these initiatives are still in their early stage, ECE is already looking to the future. The department is developing a semiconductor engineering option for both electrical and computer engineering undergrads. And because the industry will have a huge need for all sorts of engineers, including students from chemical, mechanical, materials and industrial engineering, the department is working on an undergraduate certificate in semiconductor engineering for students outside ECE.

The act is also leading to other exciting changes; ECE is developing an exemplar course focusing on wide bandgap semiconductor materials for high power applications, a department strength. In spring 2023, the department also deepened its semiconductor offerings, piloting ECE 901: *Advanced Semiconductor Devices,* taught by Gupta, and Special Topics ECE/ME 601: *Printed and Flexible Electronics*, taught by Assistant Professor Joseph Andrews, giving students an opportunity to study fast-growing sectors of the industry.

Existing courses are also being refreshed, including ECE 555: *Digital Circuits and Components* taught by Ogras. Recently, that course received a design software upgrade, and in the future may expand, allowing students to design, fabricate and test chips over the course of two semesters. And a new semiconductor devices and fabrication track in the department's accelerated master's degree program will allow graduates to get a foothold in the semiconductor industry as well.

The result of these curriculum updates will be students who are workforce-ready and able to take advantage of new opportunities in the domestic semiconductor industry. "Companies will be looking to hire a lot of students and those students need to be educated in semiconductors," says Chirag Gupta. "I think the educational curriculum and framework are absolutely needed. I think this is great news for semiconductors as well as for students who are interested in them."

NSF CAREER AWARD RECIPIENT

Chu Ma takes a deeper look at acoustic imaging

Acoustic imaging has revolutionized medicine over the last few decades; anyone who has had an ultrasound to examine a baby in utero, check an organ or look at a bone has encountered the technology.

It's not just a medical miracle; the technology is important in mining and resource extraction, manufacturing, building inspection, and dozens of other industries.

While ultrasound in its current form is extremely useful, it does have limits: There's a big tradeoff between the resolution of the image and the depth of the imaging. To get around this, ultrasound sometimes relies on external "labels," like special materials or contrast agents deposited near the target area to improve the images. However, it's often not practical or safe to deposit these labels, meaning there are many situations in which it's hard to get good ultrasound images.

That's why Assistant Professor Chu Ma will use her NSF CAREER Award to develop a hardware and software acoustic imaging system that can look deeper without relying on these types of labels.

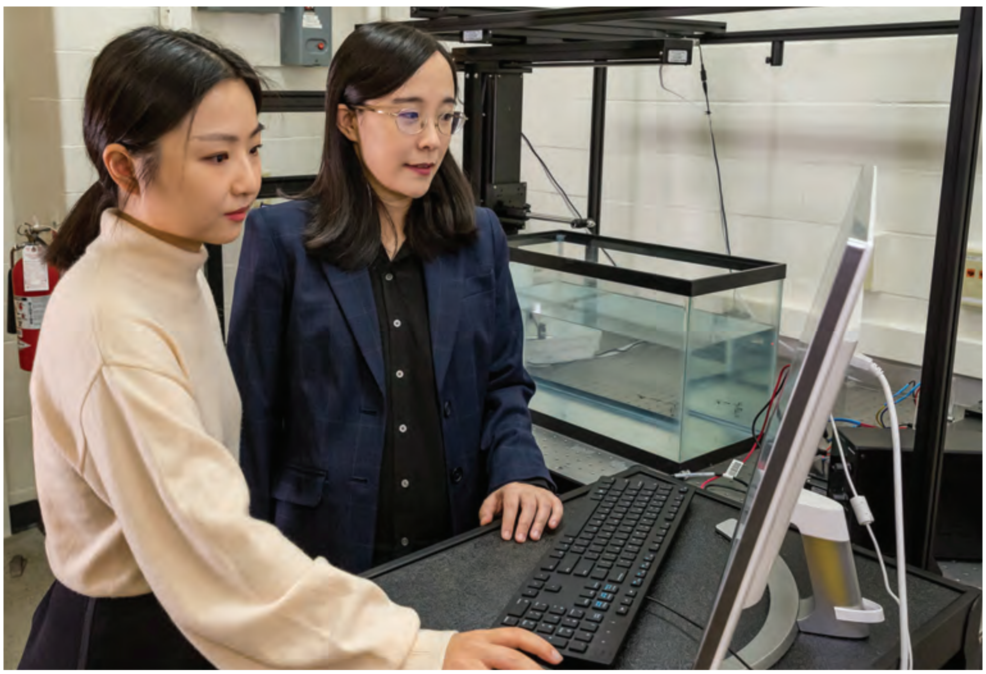
The new system, she says, will allow for imaging that ultrasound cannot currently do, such as looking into deep brain tissues, or spotting sub-millimeter kidney stones and lesions on blood vessel walls. It will also enable better sensing to guide underwater vehicles, help in marine biology, improve quality control inspections in manufacturing, as well as improve imaging in agriculture and mining.

The hardware side of the project will focus on spatial mixing, an image processing technique that uses what are called "blind labels." These are randomly spaced irregularities, like rocks in the soil or different types of tissues in the human body, that can be used as acoustic scatterers. These blind labels are able to send more signal data back to the sensor.

The second part of the project relies on computational signal processing and image reconstruction algorithms that can use these additional acoustic signals to improve the imaging. The algorithms will use statistical knowledge and data collected by the imaging systems, as well as machine learning and database methods, to decode more information and smooth the signals received by the sensors, creating higher resolution images.

"This is a hardware and software co-design problem," says Ma. "When we design the software, we will optimize it together with the hardware system so the two can work together nicely."

After developing the overall framework for this system, Ma and her team will then move into an application-driven validation stage, assessing the individual development needs for biomedical imaging systems, underwater imaging and non-destructive structural inspection. They will then build and test lab-scale versions of each of these imaging systems.



Chu Ma (right) and graduate student Jinuan Lin (left) are working on a new acoustic imaging system that has applications in medicine, mining and even underwater exploration.

As part of the outreach element of the CAREER Award, Ma is creating three pathways to get younger students involved in interdisciplinary acoustics research. She is developing a workshop for high school students to introduce them to the discipline. She is hoping to increase the pipeline of traditionally underrepresented students moving into acoustics research, in particular by using her introduction to acoustics class to encourage students to pursue research in her lab. And she is creating interactive and hands-on exhibitions for outreach programs open to the public, such as Wisconsin Science Festival and Engineering EXPO.

NSF CAREER AWARD RECIPIENT

Ramya Korlakai Vinayak makes machine learning models learn from diverse data

Even though you may not entirely realize it, artificial intelligence has a huge influence on our lives. The AI subfield of machine learning, in which computers learn from data, underlies social media algorithms and the recommendations we receive for everything from streaming content to shopping. It's also used to assess medical images, help banks make lending decisions, and it's the basis for autonomous vehicles, among countless other emerging uses.

Even as the field matures, it's become apparent that machine learning applications are only as good as the data they train on—and often that data is not very granular.

That's why Assistant Professor Ramya Korlakai Vinayak will use her NSF CAREER Award to build novel models and algorithms to help tease out the diversity hiding in these datasets and help preference and metric learning algorithms work better for diverse populations.

Metric and preference learning are very commonly used to learn how we represent different concepts and make preference judgements based on them. They are useful in a variety of applications, including recommendation systems, behavioral and cognitive psychology, individualized education, crowdsourced democracy, and aggregating preferences over populations in social science surveys and datasets.

Ramya Korlakai Vinayak is creating tools to capture diversity in societal-scale data sets.

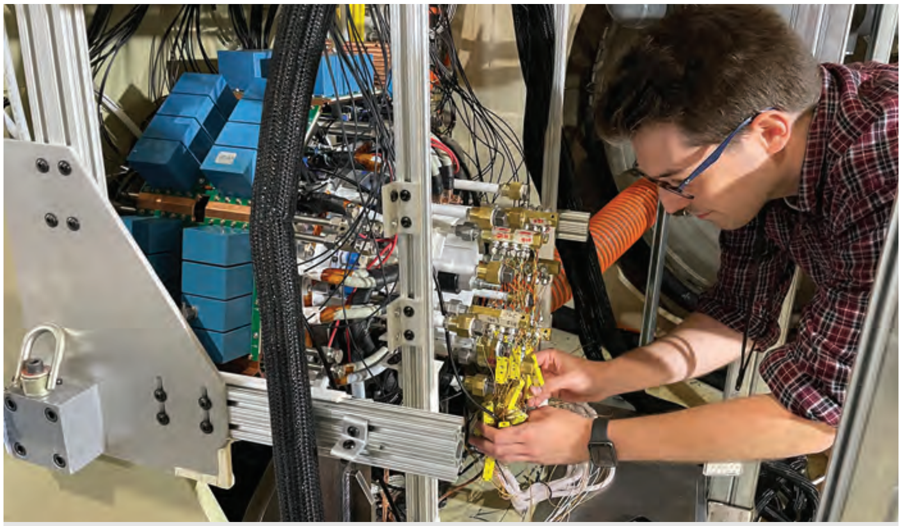
Vinayak says that many data collections involving people, like those from health and behavioral studies or social science research, contain societal-scale information from diverse populations, including people of different ages, backgrounds, income levels, and phenotypes. However, many off-the-shelf machine learning algorithms do not take such diversity into account. "Unfortunately, the existing tools and algorithms are inadequate because they focus very much on pooling everybody's data and learning a common model that works well on average," she says. "Furthermore, usually there is not enough data from each individual to learn separate personalized models. So, we need better machine learning models and algorithms that can actually capture the diversity in societal-scale datasets."

One issue is that large datasets often lack individual identifiers and do not break people down into subgroups. One of Vinayak's aims is to develop tools that can pick these subgroups out of the larger pool of data, while still maintaining individual confidentiality and privacy.

For instance, the algorithm could look at a large dataset of individuals with different preferences and learn these diverse preferences, even if those differences are not explicitly part of the data.

"The algorithms I'm trying to build would leverage data from everybody for parameters that apply to everyone, but also simultaneously learn these other subsets of parameters that are more individual," she says. "So, in essence, these models are bridging the two extremes of universal modeling and individual modeling."

For the outreach portion of her CAREER Award, Vinayak is developing modules for undergraduate and graduate courses to discuss data diversity, which she says is rarely part of traditional machine learning curricula. She is also collaborating with the College of Engineering's inclusion, equity and diversity teams to increase mentoring opportunities for students from underrepresented backgrounds interested in computer engineering. "Thinking about learning from diverse data becomes more and more important as machine learning models and algorithms touch our lives every day and become more common," she says. "I want to prepare students to be able to think along these lines as they go out and make an impact in various fields."



Recent PhD graduate James Swanke tested a megawatt electric motor he helped develop as part of a NASA initiative to develop electrified aviation. Submitted photo.

James Swanke aims to get electric planes off the ground

In fall 2022, PhD student James Swanke spent several weeks at the NASA Electric Aircraft Testbed (NEAT) facility near Sandusky, Ohio, performing the final tests on a one-megawatt electric aircraft propulsion motor. His extended visit was the culmination of a five-year multi-university research project, a capstone of Swanke's PhD research and a promising step forward in the field of electrified aviation.

To foster the development of cutting-edge aerospace technology, NASA launched the University Leadership Initiative that is currently supporting several multi-university ventures aimed at advancing electrified aircraft technology. The megawatt engine project, spearheaded by Ohio State University and launched in 2017, is one of those projects.

Ohio State invited Grainger Emeritus Professor of Power Electronics and Electric Machines Thomas Jahns and Professor Bulent Sarlioglu to join the project team, working on the motor and motor drive configuration. They brought Swanke onboard when he was a master's student and also enlisted PhD student Hao Zeng to develop the controls for the motor drive.

"For electrified aircraft, you need to pack a lot of power into a small, lightweight electric propulsor. Essentially, we are being asked to challenge the power density of jet engines themselves. The thought of that boggles the mind a little," says Jahns.

The team worked on the design of the megawatt motor between 2017 and 2019 and has been constructing it and working out the bugs since then. The key to the design is integrating the power electronics with the motor into the same enclosure rather than packaging them separately. This is enabled by a new generation of wide-bandgap semiconductor materials, including silicon carbide and gallium nitride, which have made it possible to significantly shrink the size of the power electronics.

For the final tests at the NASA NEAT facility, Swanke and team members from other universities assembled the fully integrated motor drive system and attached it to a test dynamometer in a vacuum chamber, which simulates high altitude operating conditions that aircraft experience.

While the NEAT testing marked the official end of the megawatt motor project, Swanke sees it as a starting point. "I think it's becoming pretty clear we can build really light machines," he says. "But the next question is, how reliable are they? And how can we design them to minimize faults, and then minimize their impact if they happen? That's what I have focused on during my PhD research."

After graduation in late 2022, Swanke joined the Denver-based company H3X, a startup developing innovative large-scale integrated motor drives for aerospace applications founded by UW-Madison Wisconsin Electric Machines and Power Electronics Consortium (WEMPEC) graduates.

Building a better, smaller antenna

Nader Behdad Daniel Ludois

McFarland-Bascom Professor Nader Behdad and Jean van Bladel Associate Professor Daniel Ludois are part of a four-year research effort to significantly boost the performance of electrically small antennas—or antennas that are much smaller than the wavelength of signals they send and receive. The project is funded by the Intelligence Advanced Research Projects Activity, the research and development arm of the Office of the Director of National Intelligence.

The ambitious program, Effective Quantitative Antenna Limits for Performance (EQuAL-P), focuses on improving the performance of electrically small antennas by employing active and/or time varying solutions.

If successful, EQuAL-P will enable the intelligence community to better meet mission objectives that require electrically small antennas through several advancements. Improvements include smaller size, higher data rates of transmission and reception, broader bandwidths, lower radio frequencies of operation, reduced power consumption, and increased sensitivity. These factors will also improve the performance of many consumer products, like mobile phones.

Behdad and Ludois were selected as one of eight teams. During the first 18 months, they will focus on determining the viability of proposed approaches to improve antenna performance before developing a functional antenna prototype capable of achieving four-times improvement in effective bandwidth and efficiency. During the final 12 months, the teams will target a 10-times improvement.

Engineered sensors help take the guesswork out of finding insects

Joshua San Miguel

For several years, entomologists have rung the alarm bell about insect pollinator species—up to 40 percent of which are considered highly threatened. Current insect sampling methods, however, are labor intensive and make it challenging to accurately assess changes in insect populations.

Assistant Professor Joshua San Miguel aims to help improve that data using a noninvasive system to detect and identify pollinators in the field. He designed the system with UW-Madison entomology collaborators Assistant Professor James Crall and Professor Claudio Gratton.

This low-cost, low-power autonomous pollinator sampling, or AutoPollS, system provides researchers a fine-grained understanding of how these species move about and interact with ecosystems, collecting data in a non-lethal way. It consists of a group of solar-powered devices, each about the size of a tablet, with four flexible cameras attached. Each camera points at a flower or plant where insects might land, and the system takes periodic snapshots for identification purposes while also recording environmental data. When processed by machine learning algorithms, the data can reveal insect species and how they move through the environment, as well as information about microclimates, the time of day insects visit flowers, and other detailed findings.

In summer 2022, the team deployed 20 of the devices at the UW-Madison Arlington Agricultural Research Station, positioning them to monitor wildflowers, weeds and agricultural crops.

Taking what they've learned, the researchers have designed AutoPollS 2.0, which the team will deploy in spring 2023. San Miguel and his students replaced the off-the-shelf Rasberry Pi devices with low-power field-programmable gate arrays, which offer more computing power. They also developed algorithms for inference and image compression that will make the units more efficient and worked on other classification algorithms that can identify images of insect species.

San Miguel says he's proud to help in a project that could impact bee conservation. He's also looking forward to learning more about insect behavior through the AutoPollS system— especially how swarms of bees can complete very complex tasks on very small energy budgets. "I think we could engineer systems mimicking how these very cool animals behave, which is an underlying interest for me," he says.

AutoPollS is a solar-powered system for keeping track of important pollinators. Submitted photo.

Students take the lead in Women in ECE group

At the end of her junior year, Yasmine Abdennadher discovered Women in ECE, an informal organization that brings together undergraduates, graduate students and faculty members to build community and camaraderie. She attended one of the organization's first gatherings and connected right away.

"It's a good outlet to meet other women," Abdennadher says. "This group let me talk to individuals going down a similar path and get their advice. It also cut that barrier between students and professors, and I saw professors in a laid-back setting, just grabbing coffee or chatting about life."

In fact, conversations with faculty members at events hosted by the organization convinced Abdennadher to continue her education as a master's student. She has continued working with the group and is helping it to become a more student-driven organization by participating along with other undergraduate and graduate students on the new Women in ECE student board.

The group was formed about four years ago by Assistant Professor Line Roald with a focus on retaining women students in electrical and computer engineering. "The students that are here have trusted us with their education, and I want to make sure they feel welcome and have everything they need to thrive in our department," Roald says.

In the 2022-23 academic year Roald says that she and the department set a goal to let Women in ECE continue to grow by getting students more involved. Developing the student board has helped identify student leaders who now organize networking and social activities such as a cookie decorating event, and chats between professors and undergrads about research opportunities.

At Women in ECE events, undergraduates, graduate students and faculty take time to have fun and share their experiences. Submitted photo.

Abdennadher will graduate in spring 2023, but she says she hopes the initiative will continue to grow and have a positive impact on students, like it did on her. "I think we're gaining some momentum," she says. "We have freshmen joining and showing up consistently. I hope the undergrads get involved and continue on with the group."

Faculty News

Keith and Jane Morgan Nosbusch Professor John Booske was elected to the American Association for the Advancement of Science 2022 class of fellows for contributions to the fields of plasma science, vacuum electronics, and microwave-materials interactions, and for championing best educational practices for generations of students, both institutionally and nationally.

The Institute of Electrical and Electronics Engineers (IEEE) has named Professor Bernie Lesieutre to its 2023 class of fellows for contributions to electric power system dynamic modeling, simulation and power engineering education.

Philip Dunham Reed Professor and Chair Susan Hagness was elected to the 2022 National Academy of Inventors class of fellows for innovations leveraging microwave interactions with human tissue, including techniques to image, detect and treat cancers.

The National Academy of Engineering elected two adjunct professors, Vladimir Blasko and Hao Huang, and alumnus Longya Xu (MSECE '86, PhDECE '90) as members. Blasko was honored for contributions to the theory and practice of regenerative electrical drives and grid-tied converters. Huang was honored for contributions to advances in electric machines and power electronics technologies for aerospace electrical systems. Xu was honored for contributions to high-performance electric machines and variable-speed drives for aerospace and wind turbines.

Jack St. Clair Kilby Associate Professor Zongfu Yu was on the 2022 Clarivate Web of Science list of highly cited researchers—authors whose work appears in the top 1% of cited papers.

A paper co-authored by Associate Professor Umit Ogras and spring 2022 PhD graduate Sumit Mandal won the best paper award at the 2022 International Conference on Compilers, Architectures, and Synthesis for Embedded Systems.

A company co-founded by Jean van Bladel Associate Professor Dan Ludois won a 2022 Wisconsin Innovation Award, which recognizes the most innovative products and services from across Wisconsin. Ludois's company, C-Motive, develops novel electrostatic motors with very low carbon emissions. C-Motive was also recently named a 2023 Bloomberg NEF Pioneers Award Finalist.

Assistant Professor Line Roald is part of multi-institution team that received a $125,000 VMware University Research Fund grant to study ways of reducing the carbon footprint of large-scale data centers and digital services.

Assistant Professor Ramya Korlakai Vinayak and Keith and Jane Morgan Nosbusch Professor Rob Nowak are part of a National Science Foundation-funded multidisciplinary project investigating individual "neural fingerprints" in collaboration with researchers in the UW-Madison psychology department.

Student News

A team of PhD students, including Feida Chen, Sangwhee Lee and Ken Chen, and Professor Bulent Sarlioglu and Grainger Emeritus Professor of Power Electronics and Electric Machines Thomas Jahns, won second place in the student demonstration hardware competition at the 2022 IEEE Energy Conversion Congress and Expo.

PhD student Danica Fliss, who is being mentored by Robert Nowak, recently won an outstanding poster award at the 25th Conference on Satellite Meteorology, Oceanography, and Climatology and NOAA Satellite Meeting in August 2022.

PhD student Tessa Haldes, who is being mentored by Philip Dunham Reed Professor Susan Hagness, received a 2023 IEEE Antennas and Propagation Society doctoral research grant.

PhD student Varsha Pendyala and Professor William Sethares won a best paper award at the 2022 IEEE–EMBS conference on Biomedical Engineering and Sciences.

Alumni awards

Two ECE alumni earned College of Engineering honors in 2022.

Riki Banerjee, BSEE '00, received an early career achievement award. She is currently vice president of research and development for Synchron, a company that seeks to be the first in the world to commercialize implantable brain-computer interface products to help severely paralyzed people.

During her career, she has served as an engineer in corporate research and technology at 3M and worked as an engineer and manager at Medtronic Neuromodulation, helping to commercialize many neurotech products.

John Mulligan, BSEE '88, received a distinguished achievement award. He is currently executive vice president and chief operating officer at Target Corporation. Mulligan has proven himself an exemplary corporate leader and expert in large-scale merchandising operations and finance and global supply chain planning and design.

He joined Target in 1996 as a financial analyst, becoming chief financial officer in 2012, taking his current position in 2015. Mulligan is also on the boards of McDonald's and the same-day delivery service Shipt.

Retirements

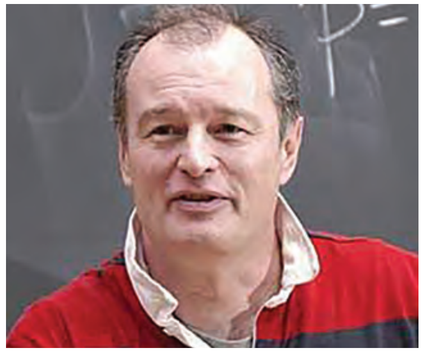
David Anderson

Anderson earned his bachelor's degree at UW-Madison and began designing and building stellarator projects here and abroad in the late 1970s and early 1980s. In 1984, after earning his PhD at UW-Madison, he was appointed an associate scientist and eventually a senior scientist. In 1990, he worked at the Max Planck Institute for Plasma Physics in Germany, developing the design for what would become the Helically Symmetric eXperiment (HSX). In 1999, he was appointed associate professor and became principal investigator on the Department of Energy-funded HSX project.

HSX was the first fusion device in the world based on quasisymmetry in the magnetic field structure and served as a catalyst for a new and exciting renaissance in stellarator fusion physics. Over three decades, under Anderson's leadership, HSX, housed in Engineering Hall, has made major advances in stellarator physics, garnering $47 million in outside funding and attracting collaborators from around the world.

Anderson has supervised 15 PhD students and co-advised five others, many of whom have gone on to prominent positions in the fusion community. In 2012 he was appointed the Jim and Anne Sorden Chair in ECE, an honor renewed twice. He has served as president of the University Fusion Association, chair of the National Stellerator Coordinating Committee and is the Department of Energy's U.S. representative appointed to the International Energy Agency Executive Committee on Implementation of Stellarator Research Agreement, among many other roles with DOE.

Anderson recently co-founded Type One Energy, a company commercializing stellarator fusion technology as a pathway to fusion energy. He is the current Vice President and Chief Engineer. Other co-founders include UW-Madison ECE PhD alumnus Dr. John Canik.



William N. Hitchon

Hitchon received his PhD in engineering science from Oxford University, emerging as an expert in theoretical modeling of plasmas (ionized, electrically conducting gases). His early career focused on modeling how high temperature plasmas behave when confined by magnetic fields for the purpose of producing energy via nuclear fusion. After joining the department in 1982, he expanded his research into a broad and diverse portfolio of "kinetic" theoretical models and computational modeling tools for low temperature plasmas used in semiconductor fabrication and lighting, electrical behavior of semiconductor devices, and microscopic phenomena in magnetic computer storage devices and gas dynamics.

He became a full professor in 1994. During his career, he has published more than 100 journal articles and written three books, including *Plasma Processes for Semiconductor Fabrication.*

Hitchon has earned a reputation for outstanding teaching and mentorship. He advised more than 20 graduate students, many of whom have taken prominent roles in academia and industry. He taught 25 different ECE courses, including many that he developed, at both the graduate and undergraduate level, covering topics as diverse as his research interests, including electromagnetic field theory, semiconductor electronics, plasmas, and signal processing. He has been an ardent advocate for the welfare and success of all students. His dedication in the classroom and to students led engineering undergraduates to name him an outstanding instructor five times.

Hitchon served on the Graduate School research committee, as admissions chair of the Materials Science Program, and chair of the Physical Science Section of the Campus Fellowship Committee, among other activities. Between 1999 and 2002 he served as the ECE department chair.

Barry Van Veen

Van Veen earned his bachelor's degree from Michigan Technological University in 1983 and his PhD from the University of Colorado in 1986. The following year, he joined the ECE department at UW-Madison.

Van Veen's research has focused on statistical signal processing and its applications, including problems in adaptive filtering, adaptive beamforming, signal detection and estimation, equalization and sensor array signal processing. In recent years, he's focused on biomedical signal processing, including developing and analyzing algorithms for modeling electrical activity in the brain, studying fetal heart and brain measurements and for microwave-based detection, monitoring and treatment of breast cancer. Over his career, he won numerous awards, including an NSF Presidential Young Investigator Award.

Van Veen has been a dedicated educator who is among pioneers of the flipped (active-learning) classroom concept in the College of Engineering. He has won several teaching awards, including the 1997 Holdridge Teaching Excellence Award from the ECE department, the 2014 Harvey Spangler Award for Technology Enhanced Instruction and the 2017 Benjamin Smith Reynolds Award for Excellence in Teaching from the College of Engineering, and the 2015 Chancellor's Distinguished Teaching Award from UW-Madison.

He's also served the ECE department as associate chair for graduate and online studies, helping to rapidly grow the department's accelerated master's degree program. He spearheaded an overhaul of the PhD program, establishing uniform course requirements and replacing qualifying exams. Between 2015 and 2018, he led an education innovation committee that helped launch the College of Engineering makerspace and promoted research-based effective teaching practices.

Department of Electrical and Computer Engineering
UNIVERSITY OF WISCONSIN–MADISON

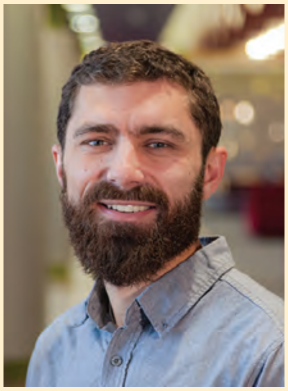
Department of Electrical & Computer Engineering
1415 Engineering Dr., Room 2415
Madison, WI 53706
engineering.wisc.edu/ece

ECE adds talented new teaching staff

Setareh Behroozi, who completed her PhD at UW-Madison in 2022 studying embedded systems and wearable and implantable devices, joined ECE as a member of the teaching faculty in fall 2022. She focuses on teaching core undergraduate courses, including intro to computer engineering and digital design fundamentals.

Behroozi has been teaching since high school, running sections as an undergraduate and teaching classes as a graduate student. Her long-time dual role as both a teacher and a student has honed her teaching philosophy. "Having that student viewpoint is essential for setting course material and policies and being successful," she says. "Their success is our success."

Behroozi says it's also important to engage students in hands-on activities and problem-solving during class – all of which she has done in the ECE 252 and ECE 352, courses she has taught this year. Over time, she hopes to help evolve and update ECE courses as the world of technology changes. But one thing that won't change is her commitment to students. "I find teaching the most rewarding job," she says. "Feeling you helped somebody learn something, earn a degree or win a competition is an awesome feeling. I can't compare it to anything else. For me, it's not just a job, it's what I love to do."



Nathan Strachen began as an assistant teaching professor in spring 2023. Strachen completed his PhD in 2021 at UW-Madison and worked at Sandia National Laboratories for a year. "I've always been a proponent of hands-on-learning," he says. "I started tinkering on things in my parents' garage and learned by doing. I think that's important for students."

For instance, an electromagnetic wave transmission class he taught as a graduate student called for the class to build an antenna over the course of the semester. Strachen says he's also a fan of employing intuitive explanations and real-world examples. "Engineering can be so theoretical; you can lose contact with reality," he says. "I like to start lessons off with these real-world connections to build interest, then go deeper into theory."

Eventually, Strachen also hopes to reimagine some of ECE's capstone courses with even more hands-on components. He will be piloting a new EE senior capstone design course on autonomous underwater vehicles this fall with "Robosub" project funding from Sandia.