College of Engineering
UNIVERSITY OF WISCONSIN–MADISON

FALL 2022 NEWSLETTER

ELECTRICAL AND COMPUTER ENGINEERING

Wisconsin Electric Machines and Power Electronics Consortium

Celebrating more than 40 years of innovation

Greetings to our ECE Community

The beginning of the fall semester is such a great time to be on our engineering campus. There is vibrant excitement in the halls when our students, especially those in their first year, navigate their way into our ECE active-learning classrooms, instructional labs (for example, the James H. Thompson Electronics Design Studio, the Qualcomm Design Laboratory and the Plexus Collaboratory) and our research labs.

We were thrilled to welcome four new faculty members in August 2022. Assistant Professors Robert Jacobberger, Pedro Morgado and Eric Tervo have joined our department as tenure-track faculty, broadening and deepening our research expertise in low-dimensional materials for electronic, photonic and quantum devices; machine learning and computer vision; and semiconductor materials and devices for energy conversion and thermal management. In addition, teaching faculty Setareh Behroozi has made a quick transition from completing her PhD this summer to joining us this fall in support of our high-demand computer engineering BS degree program. The addition of these new faculty brings our roster to 51 with primary appointments in ECE—our largest cohort of tenure-track/tenured professors (44) and teaching professors/faculty (seven) to date. Sixteen of these faculty are tenure-track assistant professors whom we have recruited over the past six years, and 11 are women.

With our large and growing student body (1,065 undergraduate students and 341 graduate students this fall), we also have a vast alumni base—approximately 12,500 members strong. We want our alums to know what is new and exciting here, and we are equally interested in learning what is engaging and inspiring ECE Badgers when they leave campus. I enjoyed reconnecting with alumni in Austin, Texas, in September, and at the Memorial Union here in Madison in August. During our picture-perfect evening on the Terrace, I chatted with graduates from the classes of 1960 to 2021. What a joy to hear the stories shared among those retired from a long career and those just starting out in their first post-graduation jobs.

Chair Susan Hagness met with ECE alumni on the Union Terrace in August 2022.

We have two more alumni events before the end of the calendar year. First is the College of Engineering alumni tailgate prior to the Badger football game vs. Purdue on Oct. 22. Second, we will hold our next alumni town hall virtually Dec. 8 at noon, central time. I will give updates from the department and our guests will be a panel of current undergraduate and graduate students who are excited to share their Badger ECE experiences with those who have walked the halls before them. Keep an eye out for an email with registration information for this special event.

Thank you for making the effort to stay connected with our department. You are a valuable part of who we all are as ECE Badgers.

Hope to see you soon, and as always, On, Wisconsin!

Susan C. Hagness

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ECE at Wisconsin: Committed to ethics and diversity in engineering

NATIONAL PUBLIC RANKING
according to U.S. News & World Report

Electrical Engineering	Computer Engineering
9th UNDERGRADUATE	10th UNDERGRADUATE
9th GRADUATE	8th GRADUATE

Save the Date

College of Engineering tailgate
Oct. 22, 2022
Noon-2:30 p.m.
ECE virtual alumni town hall
Dec. 8, 2022
Noon CST, via Zoom

Support a STAR Scholar

Effective solutions to today's challenges arise when we bring the brightest people to the table. When you make a gift to our STAR Scholarship fund, you'll help our college recruit the nation's best students so that they can become tomorrow's problem-solvers and difference-makers. Thanks to a commitment from The Grainger Foundation, there's also matching support available—meaning that you can double the impact of your support.

We need your help growing this important scholarship fund. To make a gift, contact Kyle Buchmann, senior managing director of development, at kyle.buchman@supportuw.org or (608) 630-1679.

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On the cover: Wisconsin Electric Machines and Power Electronics Consortium faculty and staff.

Bhuvana Krishnaswamy earns NSF CAREER Award

In the future, farmers will be able to look at a tablet and see the nutrient, CO^2 and moisture levels of every individual acre in their fields in real time. This will allow them to irrigate and fertilize more strategically, reducing waste and increasing yields. But while there are all sorts of sensors to measure soil health, the long-range, low-power, cost-efficient wireless networks needed to transmit that data from the field to the barn don't exist yet.

Assistant Professor Bhuvana Krishnaswamy hopes that her work optimizing the algorithms used by such networks will help plant the seeds of a new agricultural revolution. Her research is supported by a five-year, $500,000 National Science Foundation CAREER Award.

"Right now, most farmers use one sensor to make decisions about their whole field. We want to deploy these sensors and collect data over long distances so we might be able to map out a farm and make decisions about irrigation and fertilizer distributions," she says. "There's a lot of heterogeneity across a field. This could provide farmers with more data."

When Krishnaswamy attended a welcome event after joining UW-Madison in 2018, she found herself chatting with a soil scientist. That person wanted to pick her brain about any available commercial wireless sensing technology that could cover a kilometer or more. Krishnaswamy didn't know of any off the top of her head, and when she looked further into the matter, she found that the few long-distance sensor networks out there were prohibitively expensive.

"Like everyone else, I wondered why they couldn't just use cellular networks, satellite networks, or Wi-Fi?" says Krishnaswamy.

It turns out, Wi-Fi is not optimized to cover dozens or hundreds of acres of remote land. And using cellular networks is prohibitively expensive, since each sensor needs its own SIM card with the associated data costs. The same goes with satellite connections.

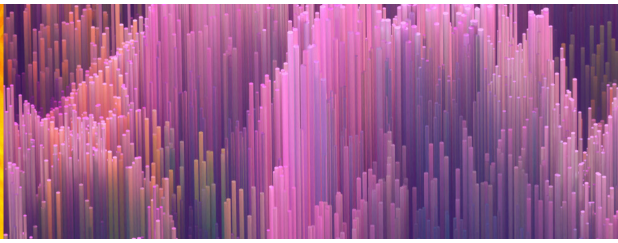
To create a cheap, reliable network that can handle data from dozens or hundreds of sensors, Krishnaswamy is designing algorithms both for the transmitting sensors and the receiving station that leverage the fact that each sensor only sends a tiny amount of data every 30 minutes or so. By using signal processing techniques, she will enable the receiver to listen to, and decode multiple signals in parallel. The project will also involve cloud computation that will use machine learning to fix any data lost in the transmissions. Altogether, these changes to the network will allow a large number of sensors to transmit tiny packets of data without draining their batteries.

While her CAREER proposal focuses on the algorithms, Krishnaswamy says the hardware side of the project is already moving ahead. Her team and her collaborators in soil science are currently building a "black box" that includes an array of off-the-shelf sensors that can collect data on moisture, CO^2 levels, pressure, temperature and other variables that they are field testing.

Eventually, the researchers hope they will be able to test a network of dozens or hundreds of sensors running Krishnaswamy's algorithms.

The networks have potential applications outside conventional farming. Other researchers have shown interest in using the long-distance, low-power networks to communicate with solar panels as part of a distributed power grid. Others are interested in using them to model microclimates in vineyards or in cities to create a large network of pollution sensors.

Focus on new faculty



A warm welcome for Eric Tervo and his quest to harness heat

In general, heat is the enemy of most technologies; engines and motors can fail when they overheat and computer components tend to fritz out when they get too hot. But for Assistant Professor Eric Tervo, all that excess heat is an opportunity.

Tervo specializes in developing semiconductor materials for energy conversion and thermal management. In practical terms, that means researching thermophotovoltaics, or devices that convert heat into electricity; thermoradiative cells, which convert infrared heat into electricity at night; and other technologies that harness and control heat.

For Tervo, joining UW-Madison is a homecoming. Raised in Plymouth, Wisconsin, he attended UW-Madison as an undergraduate studying mechanical engineering before completing his PhD at Georgia Tech. He then spent two years at the Southwest Research Institute in San Antonio, Texas. For the last three years, Tervo has worked at the National Renewable Energy Laboratory in Golden, Colorado, as the Nozik Postdoctoral Fellow, which has given him wide latitude to pursue his own research.

One of his major focuses is thermophotovoltaics. While photovoltaics produce electricity when bombarded by photons of light from the sun (that's the technology behind solar panels), thermophotovoltaic semiconductors produce electricity when exposed to light emitted by nearby hot objects. These devices have many potential applications, like making electricity from waste heat produced in steel or glass making, or in industrial engines or automobiles. The technology could also complement solar and wind by storing energy for use at night.

At NREL, Tervo was part of a group that improved the efficiency of thermophotovoltaic cells from 30% to 40%, making the technology commercially feasible. In fact, he is currently advising several companies hoping to bring the technology to market.

At UW-Madison, Tervo, who is both a theorist and experimentalist, will continue his work on thermophotovoltaics and also plans to push forward thermoradiative cells, which have not yet been demonstrated at the device scale.

But he also hopes to explore new avenues, including electroluminescent refrigeration, in which solid-state semiconductor devices provide cooling. He would also like to investigate ways to actively control heat transport using semiconductor materials. "We can create nanostructured materials to be used as thermal diodes and switches instead of traditional electric diodes and switches, making a material turn on and off a heat flow," he says. "This has many applications in thermal building management and in a variety of industrial processes. Essentially, it will allow heat to be controlled the same way we control electricity."

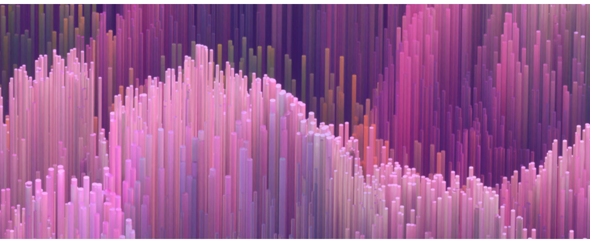
Pedro Morgado wants AI to see for itself

While artificial intelligence has made huge strides in recent years, there's actually a lot of human intervention going on behind the scenes; most AI relies on massive troves of labeled data annotated by humans to learn what a sunset looks like or to differentiate puppies from kittens.

But for AI to make the next steps, it needs to figure some things out on its own. That's why Assistant Professor Pedro Morgado is working on ways to teach artificial intelligence to understand unlabeled visual and audio information.

"I really believe that this area, called self-supervised learning, or learning by just looking at the data itself without asking humans for annotations, is the future of computer vision," he says. "We'll never be able to tell the computer everything it needs to know. That's why I'm really interested in pushing this area."

Morgado earned his undergraduate degree at Instituto Superior Técnico, now part of the University of Lisbon in Portugal, eventually completing a master's degree in machine learning at the same school. His



research focused on using computer vision to diagnose Alzheimer's disease from medical images.

He stayed on as a staff scientist for a couple of years before moving to the University of California-San Diego, studying computer vision and machine learning for his PhD. "From the beginning, we were very much into figuring out how we can build the same AI systems, but with much less human supervision," he says.

Rather, in self-supervised machine learning, the AI learns via observation and association, similar to humans. It learns by trying to predict the future—to predict what sound the object it's currently seeing should make, or how that object should feel to the touch. Morgado, who was also a postdoctoral researcher at Carnegie Mellon University in Pittsburgh in 2021 and 2022, is applying similar self-supervision concepts to audiovisual and multimodal AI as well.

At UW-Madison, Morgado plans to continue both the computer vision and audiovisual research thrusts, and believes the technologies have a lot of potential applications, including reading medical images as well as aiding self-driving vehicles and robots that interact with people. "Self-supervised learning is basically just a backbone technology that will enable a deep understanding of various sensory inputs," he says. "But we're still just scratching the surface."

Morgado says UW-Madison will be a great place to pursue this research. "One reason I chose Madison is because I saw a vision across different departments on building this area of computer vision and machine learning. I was inspired by that, and thought it would be great to be a part of," he says.

Robert Jacobberger is designing next-gen electronics with atomic precision

Assistant Professor Robert Jacobberger is no stranger to UW-Madison. He earned his PhD in 2016 working with Michael Arnold, a professor of materials science and engineering, and spent four more years in the lab as a postdoctoral researcher.

Jacobberger is an expert in 2D materials—materials just one atom thick—that have unique electrical properties. That makes them ideal materials for next-generation electrical devices. "The overarching goal of my group is to develop industry-compatible approaches to engineer 2D materials and devices with nearly atomic precision," says Jacobberger. "That will enable a high degree of control over their properties as well as their integration into next-gen electronic, optoelectronic and quantum technologies. My research will run anywhere from synthesizing and characterizing new materials to fabricating and measuring devices and circuits."

A major focus of his group will be using 2D materials to enhance qubits, or quantum bits, which are the basic unit of information in quantum devices. "Quantum technologies are exciting," Jacobberger says, "because they promise vast improvements in performance over traditional technologies. These improvements include solving certain problems thousands of times faster than state-of-the-art computers, communicating information in a way that cannot be hacked, and detecting stimuli with ultra-high sensitivity and resolution."

His group aims to create arrays of millions of atomically identical qubits, an enormous obstacle that has prevented the full potential of quantum technologies from being realized.

Jacobberger grew up in Nebraska and attended the University of Nebraska-Lincoln before coming to UW-Madison, where his PhD research focused on synthesizing graphene nanoribbons, or extremely small strips of the 2D material graphene. When the strips are narrow enough, they can be used as transistors that are faster and more energy-efficient than silicon, the material that forms the basis of nearly all modern electronics.

After UW-Madison, Jacobberger worked as a postdoctoral researcher in the Center for Molecular Quantum Transduction at Northwestern University. There, he designed and manipulated molecular systems that produce qubits using light.

At UW-Madison, he plans to continue these various thrusts, collaborating with colleagues in the Wisconsin Quantum Institute, Materials Research Science and Engineering Center and the Grainger Institute for Engineering.

Jacobberger says he's also excited by the opportunity to teach. His first teaching assignment is ECE 745, a graduate course on solid state electronics. It's a course he also took from Patricia and Mike Splinter Professor and Vilas Distinguished Achievement Professor Irena Knezevic. "She was one of the best professors I've ever had, and it was a great experience taking that course from her," he says. "And now I look forward to being able to teach the same material."

In an image from 1982, WEMPEC co-founders Tom Lipo (left center) and Don Novotny (right center) meet with two of the earliest WEMPEC graduate students, Takayoshi Matsuo (left) and David Brod (right).

WEMPEC celebrates 40 years of industry collaboration

In the 1970s, electrical engineering departments across academia were transitioning away from studying "copper wire" technologies like motors and electrical systems in favor of silicon-based tech like computer chips and other microelectronics. Leaders and faculty in the UW-Madison College of Engineering, however, believed there was still a strong need to push the state of the art in electric machines and power electronics, especially since many of those manufacturers were and are based in Wisconsin.

That's why, in 1981, Professors Don Novotny and Thomas Lipo founded the Wisconsin Electric Machines and Power Electronics Consortium, also known as WEMPEC. Funded by more than 70 industry partners, the industry/academic consortium has a broad mandate to train the next generation of electric machine and power engineers, advance the state of the art in the fields it covers and share that knowledge with industry.

Over the last 40 years, WEMPEC has been wildly successful, training more than 600 graduate students and hosting just as many visiting scholars whose impact is felt throughout industry and academia. Its research has led to new generations of electric machines, and in recent years, as the need for renewable energy, electric vehicles and energy efficiency has increased, WEMPEC's advances and students have become even more influential.

We spoke with current WEMPEC director and ECE Professor Giri Venkataramanan about the consortium's legacy, and where it's headed over the next 40 years.

Why do you think WEMPEC has remained relevant over the decades?

One of the most unique features of WEMPEC is that it is not mission-centric. At other institutions, research groups get funding to study one thing, like wireless charging for electric vehicles. WEMPEC does not have a defined focus. It's adaptable with the needs of society and the interests of faculty and students. That freedom has allowed us to work on different projects and take major risks to prepare engineers and leaders for this industry.

What do you consider WEMPEC's greatest accomplishment?

Our No. 1 contribution is our graduates. Whether they go into the energy industry, solar power, trucking, electric transportation, industrial drives or grid controls, it is our excellence in training students that is perhaps the thing that sets us apart from any program anywhere in the world.

What is the impact of WEMPEC on industry?

Our innovations range across the board in wind power, power supplies for motor drives and controls, variable speed electric motor drives, electric transportation and the design of machines that are now in all electric vehicles today. In the future, we're looking into microgrids and solar inverters.

Do you know how computers have little stickers that says "Intel Inside?" If we had a similar sticker that said "WEMPEC Inside," it would show up in many places you wouldn't expect. You could see it many brands of electric cars, electrified mining trucks, high efficiency air-conditioning systems for commercial buildings, pumps used in sewage treatment plants and building elevators, to name just a few.

What impact has WEMPEC had on Wisconsin?

Geographically, we are at the center of an arc around Lake Michigan that represents the electric machines industry. This is where it happens. We're a global organization with an international reputation, but we are in Wisconsin. We are constantly working with companies in Milwaukee and other parts of the state, as well as Illinois, Indiana and Michigan, to improve these technologies.

Over the last 40 years, our industry sponsors have pledged $20 million to our gift fund along with about another $20 million for specific projects and we've received the same amount from government grants. We've been really good stewards of that money in training our students to advance these technologies, and that's why sponsors keep coming back year after year.

Where does the consortium go from here?

Our next generation faculty leaders include Professor Bulent Sarlioglu, Jean van Bladel Associate Professor Dan Ludois, and Assistant Professor Eric Severson, who are all growing their academic careers. I'd say that we are entering our next phase of growth, and will not be surprised if we hit 100 sponsors before WEMPEC reaches its 50th anniversary.

At a certain point, many universities stopped studying electric machines to focus on silicon. Forty years ago, the leadership on our campus had the foresight to say this is worth keeping. They made that choice. Because of the support ECE and the College of Engineering have given us, we've been able to continue our excellence over the years and it's continuing to pay off. Other places are scrambling to get federal and state resources to come up to the level where we are. We got a 40-year head start, and we are continuing to add to our momentum.

Submitted photo

Remembering Don Novotny

Professor Emeritus Donald Novotny passed away on May 7, 2022, at age 87. Novotny was a highly respected visionary in the field of electric machines, variable-frequency AC drive systems and power electronic control of industrial systems. He was an inspiration to innumerable UW-Madison students and colleagues during a career that spanned more than a half-century. “His legacy lives on through the generations of ECE faculty who have followed in his footsteps and contributed to our strong record of teaching excellence,” says Chair Susan Hagness.

Novotny, raised on the south side of Chicago, received his bachelor’s and master’s degrees from the Illinois Institute of Technology before moving to UW-Madison in 1958 to pursue his PhD in electrical engineering. He joined the faculty of UW-Madison in 1961, working with the University Industry Research Program. In 1965, he co-authored his first book, *Introductory Electromechanics*, which is still considered a classic in its field. By 1968, he had risen to full professor, serving as ECE associate director from 1972 to 1974 and ECE department chair from 1976 to 1980.

In 1980, Novotny created a proposal for the Wisconsin Electric Machines and Power Electronics Consortium (WEMPEC) that was ahead of its time. With an initial grant of $25,000, the program set ambitious goals to expand research and teaching efforts that would strengthen interactions between academia and industry. In January 1981, WEMPEC officially launched, and to this day, it remains a premier think-tank where industry partners, ECE faculty, staff, students and international scholars collaborate on research and develop the newest technologies and techniques in electric machines, power electronics, actuators, sensors, drives, motion control and drive applications. Novotny was director from 1981 until his retirement in 1996.

Throughout his illustrious career, Novotny was an educator of the highest caliber who was recognized with many teaching awards, including UW-Madison’s William H. Kiekhofer Teaching Award in 1963, the College of Engineering Benjamin Smith Reynolds Teaching Award in 1984 and the ECE Gerald Holdridge Teaching Award in 1995.

“Professor Novotny was a consummate educator,” says Grainger Professor Emeritus of Power Electronics and Electric Machines Thomas Jahns. “His deep love for teaching was recognized by multiple generations of ECE students over a 57-year UW teaching career who fondly recall both his superb instructional effectiveness coupled with a seemingly endless collection of memorable anecdotes.”

Student solar project serves power accessibility need on State Street

For many members of underserved populations, cell phones are a lifeline, but finding places to charge them can be difficult. That’s why PhD student Maitreyee Sanjiv Marathe decided to develop a unique Little Free Library including a solar-powered cell phone charger as the capstone project for her Energy Analysis and Policy doctoral minor.

Marathe and a team of engineering students built the weatherproof unit, which was topped with solar panels and contained a lithium-ion storage battery and multi-tipped charging cables. In April 2022 they attached it to a light post in Lisa Link Peace Park on State Street after receiving permission from the City of Madison.

Door sensors and data trackers showed the kiosk was being used regularly to charge phones (and the books were popular too). Though the initial test run is now over, nonprofit organizations are interested in deploying the kiosks.

“It is rare that you can see tangible, real action happening within a semester or within a year of starting a project,” Marathe says. “But we had a prototype up on State Street, and people are considering changing zoning codes for us so the project can expand. In a way, it’s surreal and unbelievable. And I’m very grateful to the entire team.”

In spring 2022, PhD student Maitreyee Sanjiv Marathe collected data from a solar-powered charging kiosk on State Street weekly.

You're muted—or are you?

Kassem Fawaz's paper investigating muting on video chat applications generated lots of media interest, including an interview on the BBC News program Digital Planet.

Recently, ECE Assistant Professor Kassem Fawaz's brother was on a video conference with the microphone muted, when he noticed the microphone light was still on. Alarmed, he asked his brother, an expert in online privacy, to investigate.

Fawaz and ECE graduate student Yucheng Yang tried out many different video conferencing applications on major operating systems checking to see if the apps still accessed the microphone when it was muted. "It turns out, in the vast majority of cases, when you mute yourself, these apps do not give up access to the microphone," says Fawaz. "And that's a problem. When you're muted, people don't expect these apps to collect data."

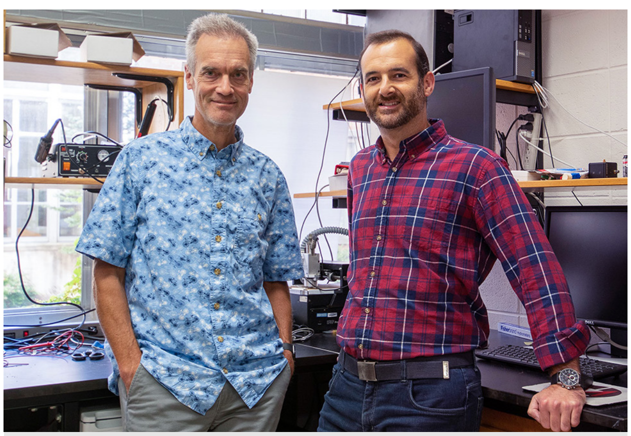
Working with colleagues from Loyola University Chicago, they investigated the actual behavior of the mute button on many popular apps, determining what type of data is collected and whether it could reveal personal information. They used runtime binary analysis tools to trace raw audio in popular video conferencing applications as the audio traveled from the app to the computer audio driver then to the network while the app was muted.

They found that all of the apps they tested occasionally gather raw audio data while mute is activated, with one popular app gathering information and delivering telemetry data packets to its server at the same rate—regardless of whether the microphone is muted or on. They also found it's possible to use the data to figure out what an individual is doing. "When you're cooking, the acoustic signature is different from someone who is driving or watching a video," says Fawaz. "So these types of activities can be distinguished just based on this acoustic fingerprint that was actually sent out to the cloud."

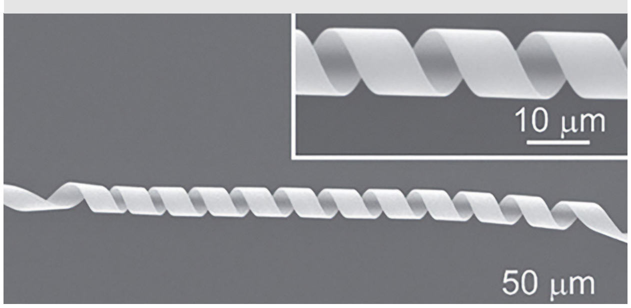
Whether or not the data is being accessed or used, the findings raise privacy concerns. "With a camera, you can turn it off or even put your hand over it, and no matter what you do, no one can see you," says Fawaz. "I don't think that exists for microphones."

Turning off a microphone is possible in most device operating systems, but it usually means navigating through several menus. Instead, the team suggests the solution might lie in developing easily accessible software "switches" or even hardware switches that allow users to manually enable and disable their microphones.

Big twist: A tiny helix could give us the ability to transmit more data



A self-winding helix developed by Dan van der Weide, Marcos Martinez and their colleagues could pave the way for new satellite-to-satellite communications. Smaller than a human hair, the helix could enable terahertz devices.



One of the most valuable commodities in the modern world is the electromagnetic spectrum—the bands of radio and microwave frequencies that cell phones, radio stations, satellites and other devices use to communicate and transmit data.

That spectrum is filling up quickly, but Professor Daniel van der Weide and postdoctoral research associates Matthew Dwyer and Marcos Martinez have developed a small, self-winding helix that can be easily mass produced, allowing manufacturers to develop devices that can use a large area of spectrum in the millimeter-range.

Accessing this spectrum requires incredibly small devices, which is a technical challenge. However, van der Weide believed it might be possible to use strain engineering to produce tiny helixes, which are a component of traveling wave tube amplifiers, needed for devices to access the millimeter wave spectrum.

Van der Weide worked with colleague Max Lagally, a materials science and engineering professor emeritus, and Francesca Cavalla, a strain engineering expert at the University of New Mexico. The team developed a photolithographic process to develop tiny strips that roll into helixes many times smaller than the width of a human hair when released from their substrate.

"We are winding the helix with a precision that is not achievable by any other means," says van der Weide. "So that's why this has people excited. There's really no way to build a machine to do this."

The team's elegant process for fabricating the helix shows there is a path forward for creating these millimeter-scale devices, which are ideal for satellite-to-satellite communications. "There's a lot of development that still needs to take place," say van der Weide. "But if you don't have a structure like the helix, none of that really matters. That's the exciting aspect of this strain engineering."

After two years of working remotely, Engineers Without Borders students were glad to finally visit and work the site of their resiliency project in Benitez, Puerto Rico. Photos submitted.

Engineers Without Borders returns to the field

One of the reasons students join Engineers Without Borders is to cross some actual borders; in most cases, participants travel abroad to help implement water, power or other development projects in regions far from the Badger State. But in the last couple of years, due to the COVID-19 pandemic, EWB's work has been mostly virtual.

In May 2022, however, after a multiyear hiatus, EWB sent a crew of students to Puerto Rico to begin planning for work on a resiliency center, and the organization, currently led by many ECE students, says it hopes to get even more members overseas in the coming year.

The team is working on a project for Benitez, a town of 1,500 that lost power for seven months after Hurricane Maria in 2018. When the pandemic shut down international travel, the students continued developing the plan from Madison, finding contractors and applying for permits for the project, which includes retrofitting a community center with solar panels and a rainwater catchment system.

In 2022, the EWB team finally made a visit to Puerto Rico to get feedback from the community and conduct a formal site assessment. "There's only so much you can do on paper. That's why it's extremely important to visit and to use your time down there as wisely as you can to plan things out," says Ryan Buchholz, a senior and manager for the Puerto Rico project, who participated in the trip. "There's always something that comes up that changes your initial thoughts or perspectives about the site."

Scott Woolf, a senior and president of the group, agrees that EWB's perspective on the project has changed after the site visit. "Remote work was definitely a big issue for our organization. Not being able to get to the communities even once a year and not being able to see the site and exactly what needs to be done messed things up a bit," he says. "So, it's great we're able to travel again, and a lot of good things are coming out of the trip."

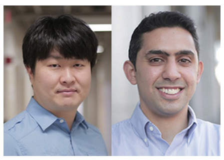
The Puerto Rico team hopes to finish its designs for the Benitez site by January 2023 and hopes to begin implementing its solutions by spring 2023.

Puerto Rico isn't the only project EWB is currently working on. Senior Brenna Buck is the manager for a project in the Bungangwe-Buyobo villages in the Kamuli District of Uganda. EWB is building two schoolhouses, two dormitories and a latrine to serve more than 240 students.

While the power-related elements of the Puerto Rico project have attracted many ECE students to EWB, Buck says there is work for students from all disciplines on their projects. "I was surprised by the immense variety of majors within this org," she says. "Our Uganda project is focused on civil engineering, but we have two civil engineers, a lot of biomedical engineering students, and computer and electrical engineers. My fellow project manager is from materials science. It has been something I've absolutely loved, because of all the different disciplines working together. They're learning the same things, which may be outside their own education, and finding ways to incorporate that back into the field they want to pursue."

Faculty News

Jack St. Clair Kilby Associate Professor Mikhail Kats received a 2022 UW-Madison H.I. Romnes Faculty Fellowship, which recognizes faculty with exceptional research contributions within their first six years from promotion to a tenured position.

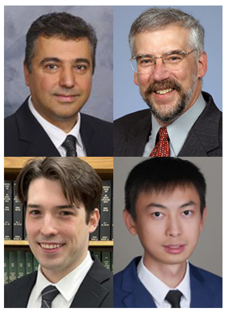


Assistant Professors Younghyun Kim and Kassem Fawaz received a research award from the Facebook Towards Trustworthy Products in AR, VR, and Smart Devices program. Their research proposal involves developing usable privacy controls for real-time eye tracking in AR/VR.

Assistant Professor Bhuvana Krishnaswamy was selected to the 2022 "Networking Networking Women" list of rising stars in computer networking and communications. The list includes 10 outstanding women researchers making an impact across academia and industry.

Assistant Professor Kangwook Lee received a 2022 Korean-American scientists and engineers association young investigator grant. Each year, the grants recognize one engineer and one scientist who have demonstrated outstanding early-career development.

Assistant Professor Joshua San Miguel, PhD student Abhishek Bhattacharyya and alumnus Abhijith Somashekhar (MS '21) received the best paper award at the 49th ACM/IEEE International Symposium on Computer Architecture.

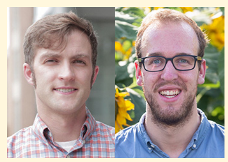


A team including Professor Bulent Sarlioglu, Grainger Professor Emeritus of Power Electronics and Electric Machines Thomas Jahns and PhD students Hao Zeng and James Swanke won the best paper award at the IEEE/AIAA Transportation Electrification Conference and Electric Aircraft Technologies Symposium.

Assistant Professors Ramya Korlakai Vinayak and Kassem Fawaz received grants from the American Family Insurance Data Science Institute. Vinayak is researching theoretical foundations for characterizing the performance of auto-labeling systems and Fawaz is studying algorithmic fairness and multicalibration error convergence bounds.

Our faculty also received 2022 WARF Accelerator Electrification Challenge Grants, which support work to help leverage electricity from sources other than fossil fuels.

Assistant Professors Chirag Gupta and Shubhra Pasayat and Jean Bladel Associate Professor Daniel Ludois are working on a streamlined transistor design that could improve the energy efficiency of power electronics.



Assistant professor Eric Severson and graduate student Nathan Petersen are researching a cost- and weight-saving design to sense rotor displacement in electric machines.

Several ECE faculty are part of projects selected during the second round of UW-Madison's Research Forward, a program supporting groundbreaking, collaborative work that spans disciplines.

Assistant Professor Joshua San Miguel is part of a project to apply a small, battery-powered device to transform the study of pollinators and the critical role they play in supporting crop yields and biodiversity.

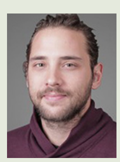
Assistant Professor Kangwook Lee is helping to develop a new technique to look back in time and reconstruct what happened at the Big Bang, aided by recent developments in machine learning.

Assistant Professor Eric Severson is working on a project developing new techniques for multi-material additive manufacturing of electrical machines.

Several faculty received promotions or named professorships in 2022:

Assistant Professor Jeremy Coulson, starting in January 2023, will be the Mark and Jenny Brandemuehl Assistant.

Bulent Sarlioglu has been promoted to full professor.



Dimitris Papailiopoulos has been promoted to associate professor with tenure. He was also named the Jay and Cynthia Ihlenfeld Associate Professor.

Luke Mawst has been named a Grainger Professor.

Giri Venkataramanan and John Booske have both been named Keith and Jane Morgan Nosbusch Professors.

Alumni News

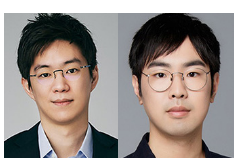
Chris Jenkins (MS ’08, PhD ’11) was honored at the 2022 Black Engineer of the Year STEM Conference with a research leadership award. Jenkins is an electrical engineer and computer scientist in the information operations center at Sandia National Laboratories in Albuquerque, New Mexico. He leads a cybersecurity team researching ways to protect critical infrastructure and other high-consequence operational technology. His work focuses on cybersecurity, cyber-physical cybersecurity and high-performance computing.

Student News

Graduate student Selvaraj Anandaraj received a 2022 Design Automation Conference Young Fellow Award to attend the conference in San Francisco.

PhD student Audrey Evans was one of six graduate students from around the world who received a 2022 IEEE Antennas and Propagation Society C. J. Reddy travel grant to attend the IEEE International Symposium on Antennas and Propagation. Evans was also selected to attend the EECS Rising Stars Workshop at the University of Texas-Austin, a highly selective program for graduate students in underrepresented groups interested in pursuing academic careers in electrical engineering and computer science.

Undergraduate researcher Silvia Iordache was chosen by Project Connect to attend the six-day IEEE MTTS International Microwave Symposium.



PhD students Kyuin Lee and Jingjie Li were selected as rising stars in cyber-physical systems research and were invited to the 2022 NSF-sponsored CPS Rising Stars Workshop at the University of Virginia.

ALUMNI SPOTLIGHT

Aref Chowdhury

When Aref Chowdhury (PhDEE ’01) was hired by the storied research firm Bell Labs, then part of Lucent Technologies, in 2001, his boss and renowned optics researcher Dick Slusher gave him one piece of advice. “He said: ‘I don’t care what research you do. But whatever you do, make sure you’re the best in the world at it.’ And with that, he sent me off,” remembers Chowdhury, who has spent that last two decades at the company, now known as Nokia. “Those words stuck in my mind. That’s an aspiration and a high bar. That is something I continue to strive for and still guides me.”

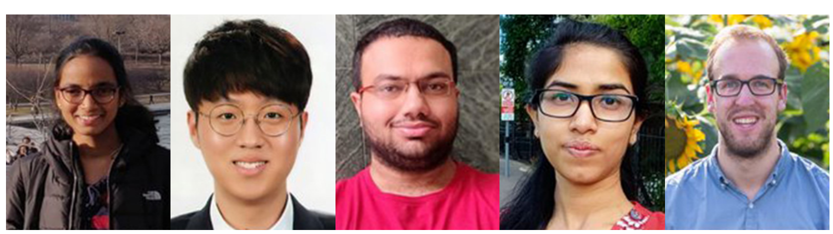
Chowdhury is currently vice president, strategy, and CTO, network infrastructure at Nokia and serves as chair of the ECE advisory board. From an early age, he knew he wanted to be an engineer and attended Stony Brook University as an undergraduate, where he was inspired by a course on optics. After working for Alcatel in Bangladesh for a couple of years after graduation, he came to UW-Madison to pursue his PhD in 1997, focusing on nonlinear optics with Professor Leon McCaughan.

He was then recruited by Bell Labs, where for almost seven years Chowdhury did fundamental research in nonlinear optics and its applications. He made good on Slusher’s request to be the best in the world, making many advances in the field. In 2004, he was honored with an MIT young innovator award. Years later he was also honored as a Bell Labs Fellow (2016) and OSA (now Optica) Fellow (2017).

In 2008, he decided to take a position in intellectual property and standards at the company. That, as well as his research background, prepared him to take on the role as CTO optics a couple of years later. Now in his current role leading strategy and CTO for network infrastructure, he helps guide the commercial development of IP routing, optical and fixed networks technologies. “In this position, you come across cool technology both internally and outside the company,” Chowdhury says. “You then have to envision whether this would be adopted by the market or why it wouldn’t succeed. That has been a learning experience, and I’ll humbly say that’s a skill that gets developed and honed every day.”

Chowdhury says his ECE experience helped lay the foundation for his success, and he hopes he can ensure the same experience for current and future students as well. “I think students from Madison come with a great foundation,” he says. “They have the preparation and background to do great things. And so, we want to make sure we prepare them accordingly.”

A team of PhD students won first place in the 2022 IEEE/AIAA ITEC+EATS Battery State of Charge Estimation Student Competition. The students were tasked with developing new algorithms to estimate the state of charge of a lithium-ion battery. The algorithm was tested against a high-quality dataset of Li-ion battery characterization and drive cycle test data over a wide range of temperatures. Team members included (from left to right) Varsha Pendyala, Sangwhee Lee, Nishanth, Shalini Manna and Nathan Peterson.



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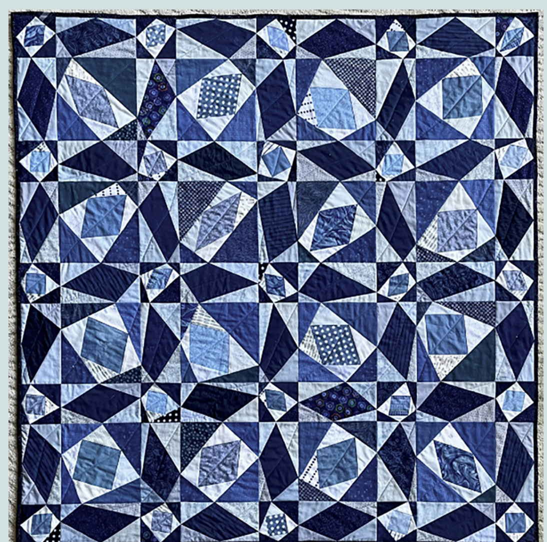
A technical textile

Amy Wendt

Besides serving as the UW-Madison associate vice chancellor for research in the physical sciences, Professor Amy Wendt is also an accomplished textile artist. One of her latest creations, a quilt, was selected for the Mathematical Art Galleries at the Bridges Conference, Joint Mathematics Meetings in Helsinki, Finland, in summer 2022. Here Wendt explains how math inspired her beautiful design, "'Storm at Sea' Plus Random Numbers: Illustration of Varignon's Theorem."

"My affinity for craft and passion for fiber and textiles arose growing up among talented family members and in an era that placed me among those students required as young teens to learn sewing. (My sewing cohort, including me, were also barred from classes where we might have learned certain other technical crafts.) Later on, I was fortunate to acquire university training in the skills and sensibilities of the engineering profession. While I am rooted in textile traditions, my technical background has led me to a point where creative impulses emerge now most strongly at the intersection, where textile crafting is both inspired in design and informed in process by science, engineering and math.

The perfect regularity and symmetry of the traditional "Storm at Sea" patchwork quilt block has been disrupted here by shifting, in tandem, neighboring vertices of only the white and navy blue quadrilaterals. Each pair of offset vertices is placed at a random position along the edge of the respective square or rectangle in which the quadrilateral is inscribed. The 41 light blue innermost quadrilaterals connect the midpoints of the edges of the white asymmetric quadrilaterals, and each is a visual illustration of Varignon's Theorem, which proves that its shape must be a parallelogram. Finally, it can be shown that the inner light blue parallelograms are not rhombi, although it appears that they might be."



Professor Amy Wendt transformed a traditional quilt pattern into a visual illustration of a mathematical theorem.