FALL/WINTER 2017

ELECTRICAL AND COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN-MADISON

ALUMNA NIDHI AGGARWAL RECEIVES EARLY CAREER ACHIEVEMENT AWARD

CHAIR'S MESSAGE

John Booske

Best wishes to all of you who are prospering this winter 2017, and heartfelt thoughts and wishes for those of you coping with the daunting tasks of recovery from the forces of nature in Texas, the gulf states, Puerto Rico and the Caribbean islands, and fire-ravaged areas in California. I have been deeply humbled and privileged to lead this nationally elite department for the past eight and a half years. During that time, we have seen exciting growth in our faculty, hiring 17 great scholar-teachers, while seeing tremendous enrollment growth. I am proud of the fact that we have nearly doubled the percentage of women in our faculty from slightly more than 10 percent to almost 20 percent. As the stories in this issue attest, our faculty and students are national and international leaders in research, in award recognitions, in entrepreneurial innovation, and even in Congressional recognition for outstanding leadership and recognition. Our alumni continue their proud tradition of Badger excellence, starting with a nationally top-tier education, followed by exceptional professional success, followed with "giving back by paying it forward" through impactful gifts such as the one that made possible our Grainger Engineering Design Innovation Laboratory.

ON, WISCONSIN!

John Booske, Chair
Vilas Distinguished Achievement Professor,
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INTERDISCIPLINARY FACULTY BUILD DATA SCIENCE FUTURE IN NEW INSTITUTE

Data science has transformed fields from biology to astronomy, and social networks to politics, influencing most aspects of modern life. Now, to transform data science, a multidisciplinary team of researchers at UW-Madison aims to return to the fundamentals.

With a $1.5 million grant from the National Science Foundation Transdisciplinary Research in Principles of Data Science (TRIPODS), they have created the Institute for Foundations of Data Science, which is housed in the multidisciplinary Wisconsin Institute for Discovery and includes several faculty in ECE.

Researchers in the institute will play a key role in the future of data science, developing fundamental techniques for handling increasingly massive data sets in shorter times.

The institute has three research themes. Robert Nowak and Dimitris Papailiopoulos and Nigel Boston are leading projects under the algebra and optimization in data science theme. Rebecca Willett and statistics professor Michael Newton are leading projects in the graphs and networks in data science theme, while Po-Ling Loh and computer sciences professor Jerry Zhu are leading projects in the data acquisition theory and methods theme.

Researchers in the institute also plan to enrich graduate programs in data science and foster outreach to industrial partners with interests in fundamental data science research.

The institute could evolve into a larger phase-two NSF institute—a goal of its researchers as they rally around activity they see as critical to the future of data science.

Read more about this effort:
www.engr.wisc.edu/interdisciplinary-faculty-build-data-science-future-new-institute/

COMPUTER 'ASSISTANT' CAN SIMPLIFY COMPLEX DESIGN CHALLENGES

Zongfu Yu in the UW-Madison Center for High Throughput Computing

Photo: Stephanie Precourt

With applications in such devices such as lasers or solar panels or as alternatives to the curved lenses in powerful microscopes or telescopes, metasurfaces—flat, optical chips—offer unparalleled control of light.

Created through a monolithic process, each tiny feature on a metasurface can perform its own unique light-scattering task—yet all of those features work together to perform a unified optical function.

However, because of the size, versatility and complexity of a metasurface, one of the greatest challenges for engineers is the enormous computational power and time required to model their desired surface on a computer.

Yu is using the power of machine learning to make the design process more efficient—and in the process, more accurate and cost-effective.

As a result, researchers mainly design metasurfaces experimentally, based on their own experience and knowledge—and even for experts, that's somewhat of a hit-or-miss process. "It's challenging that experience-based design can't explore a huge design space and on the other hand, entirely computationally driven design is prohibitively expensive," says Dugald C. Jackson Assistant Professor Zongfu Yu.

Yu is pursuing a much more reliable, time-saving solution that will shake up this very traditional design process.

With a prestigious young faculty award and $500,000 through the U.S. Defense Advanced Research Projects Agency, Yu is using the power of machine learning to make the design process more efficient, more accurate and cost-effective.

Think "virtual design assistant."

Drawing on the unique and powerful computational resources in the UW-Madison Center for High Throughput Computing, Yu is "training" the computer by providing it with the information and examples it needs to make quick, informed metasurface design decisions.

And though this training is no small feat, Yu says even a large up-front time commitment in creating the huge data sets required will save countless hours in the long run. "It's just a one-time investment," he says. "Once the machine is trained on this data, this 'machine learner' will never cease to improve as it sees more and more metasurface examples over time. If you rely completely on computational design, you will need to do lots of extensive computation with no learning—there's no buildup of knowledge."

He says that recent advances in machine learning—and in particular, in deep learning algorithms—are enabling this effort, which wouldn't have been possible even a few years ago. "People have used machine learning for designing radio-frequency devices, but because of the limited computational power and algorithms at the time, the results weren't great," he says. "Deeper networks trained with bigger data sets prove to be a game-changer."

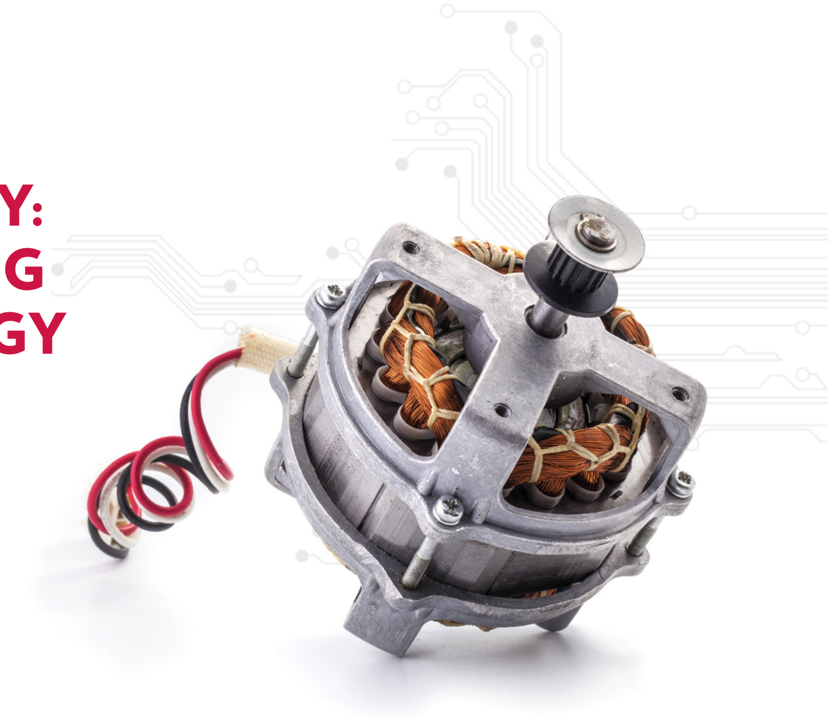
The technology isn't even remotely close to replacing human researchers, says Yu. However, he envisions it as an interactive experience between machine and researcher that will make metasurface design more reliable and efficient. "Basically, you have a very experienced designer sitting beside you," he says. "The machine facilitates the design process."

Eventually, Yu hopes to share the "assistant" through an open-source platform. He says the machine-learning algorithm and training data also could translate to other areas, such as solar-energy conversion devices, microwave sensing and imaging systems, and integrated photonics for on-chip communication, among others.

In addition to this research, Yu, his students and collaborators described, in the Nov. 9, 2017, issue of the journal *Nature Communications*, a new theory that could open revolutionary applications for light.

Learn more about that work here:
www.engr.wisc.edu/meets-eye-new-theory-open-revolutionary-applications-light/

FOCUS ON NEW FACULTY: ERIC SEVERSON, FINDING WAYS TO REDUCE ENERGY CONSUMPTION



Faster. Smaller. Smarter. For new Grainger Institute for Engineering faculty fellow and assistant professor Eric Severson, these three qualities are the key to reducing wasted electrical energy. Severson, who joined the department in fall 2017, is passionate about developing clean technologies and finding better, more efficient ways to use energy.

"Right now, there's a tremendous amount of energy in the U.S. that's wasted by motors in large industrial systems. In fact, 90 percent of our industrial motors consume up to 15 percent of U.S. electric energy and waste up to 80 percent of that," he says.

And with 45 percent of the world's electric energy being consumed by electric motor systems, the need to replace inefficient, outdated motor systems with new, highly efficient technology is a challenge he is excited to address.

Severson's current research has the potential to significantly reduce global energy consumption. "My focus area in the near term is on magnetic levitation," he says. "It's a way to take an electric motor's existing magnetic field and use it to create magnetic bearing forces—a technology I call bearingless motors."

Eliminating the bearings means that motors can operate much faster and be significantly smaller. Without bearings, there's no drag, or loss of energy, and more motors can fit into a compact area. And because bearings are typically the first component in a motor system to fail, the absence of bearings improves the durability and reliability of the motor.

The bearingless motor technology actually developed as a result of Severson's PhD research on flywheel energy storage at the University of Minnesota. Flywheel energy storage—when a motor stores kinetic energy by spinning a rotating mass up to a high speed—already has many advantages over other utility-scale energy storage technologies, like pumped hydroelectric, batteries and compressed air energy storage. Not only do flywheels allow renewable energies onto the power grid, but they're also highly responsive and environmentally safe. The disadvantages? The intrinsic loss and low durability of the motor's bearings. However, the use of bearingless motors in flywheel energy storage could have very meaningful societal impacts. Applications run the gamut from electric energy storage for autonomous vehicles to large industrial systems, like HVAC compressor chillers and wastewater aeration treatment.

Photo: Stephanie Precourt

For example, one aspect of the U.S. Clean Water Act dictates that we treat our sewage by injecting air into it to help bacteria biodegrade organic waste. There are about 15,000 treatment facilities in the United States and the motors currently used for wastewater aeration treatment fall into the category of motors that waste 80 percent of their energy. Not only that, but these motors are sized for sewage flow in the event of a hurricane or other worst-case scenario, injecting more than quadruple the flow of air needed a majority of the time. "We need more intelligent motor systems with the ability to vary the power output instead of always drawing fixed power from the grid," says Severson. "I'm working on solving challenges like these to help us be more sustainable and have cleaner energy sources, as well as use our energy more efficiently."

Severson is very interested in shaping technology and the way we use it. That's why, after spending some time in the private sector and considering starting his own company, he ultimately decided to return to research. "The ability to collaborate with people and not worry about competition, as well as the freedom to bring a vision to fruition, is all very exciting to me," he says. "I'm very excited about the multidisciplinary mission of the Grainger Institute for Engineering, an idea that's also wholeheartedly embraced by the entire university. Exciting things can happen when you collaborate and work together."

In fall 2017, Severson is teaching *Fundamentals of Magnetically Levitated Motor Systems*, a special topics graduate student course based on his research.

NEW FACULTY PROFILE: KASSEM FAWAZ, BRINGING SECURITY AND PRIVACY PROTECTION TO THE MASSES

Photo: Stephanie Precourt

Kassem Fawaz has a photo of himself as a 1- or 2-year-old playing with a keyboard. Not surprisingly, as a kid, he loved spending time on his family's computer and as a high school student, he dabbled in computer programming.

He says it was only logical to enter the computer engineering program as an undergraduate student at the American University of Beirut, where he did research on web system change detection and vehicular networks. Now, after earning his PhD at the University of Michigan and studying the problems related to location privacy and user security, he joined the department as an assistant professor in fall 2017.

He's focused on bringing security and privacy protection to users interacting with their personal devices.

"Our smartphones are always collecting data about us," he says. "Our apps know where we live, where we work, where we eat, and our religious places of significance. All of this data is bought and sold and used to draw inferences about us. It's really frightening."

In other words, nothing is free. Not even "free" apps.

Fawaz says that one way to protect your privacy is to not use a smartphone—but these days, that's not necessarily a realistic solution. That's why some of his research is focused on ways to better protect smartphone users without compromising the usability of their apps.

Branching out from the location privacy issues associated with smartphones, he also explores how we can secure the interactions between users and their Bluetooth devices—things like smart appliances, fitness tracking devices, and a range of health monitoring devices. The average person interacts with up to 10 devices per day, all of which are constantly collecting data and are easy to access.

Bluetooth devices work by periodically sending wireless beacons. Anybody can scan for these wireless beacons and find your devices—even very personal devices like pacemakers or blood glucose monitors. To keep those devices secure, Fawaz designed a system to jam their signals so that others cannot scan for them or gain access to them.

Fawaz also seeks to improve the security of voice interfaces—think Siri or the Amazon Echo—with voice authentication technology. Because voice is currently an open channel, it's easy to gain unauthorized access to voice-activated devices. "Anybody can talk to your phone," says Fawaz. "Anybody can say, 'Hey, Siri.' In fact, I was able to imitate my sister's voice after three tries and gain access to her phone. And if I hadn't been able to imitate her voice, I could have just recorded it and played it back."

Voice authentication technology takes advantage of the phone's accelerometer. Currently, these accelerometers take 200 measurements per second to determine how quickly we accelerate. But if they took 12,000 measurements per second, they could measure the vibrations of a person's voice, making it harder to imitate and, therefore, increasing the security of voice-controlled devices.

Another aspect of Fawaz's research centers around privacy policy analysis. Because most people—Fawaz included—do not read privacy policies, he is developing a Q&A interface, or chat bot (like Siri), to automatically answer users' questions about those policies. For example, users can ask the chat bot, "Does this app share my location?" or "Will this app share my information with third parties?"

Fawaz is most interested in developing systems that people can actually use. "I develop security and privacy systems that help people protect themselves," he says. "Everything has to have the person—the user—in mind. If we don't develop systems with the users in mind, then we're not really protecting them."

The average person interacts with up to 10 devices per day, all of which are constantly collecting data and are easy to access.

HSX FUTURE FILLED WITH OPPORTUNITY

David Anderson wants to help bring the energy source of the sun and stars home to Earth.

"Nuclear fusion is the holy grail of energy research," says Jim and Anne Sorden Professor David Anderson.

However, replicating the process that takes place at the core of our sun—where enormous amounts of energy lead hydrogen nuclei to fuse into helium—is a tremendous challenge. "But the payback is huge," Anderson says.

Indeed, within the realm of existing and potential energy sources, nuclear fusion is unique. If the technology were to become commercially viable, it would likely have profound impacts on the world economy and geopolitics. That's because unlike fossil fuels, nuclear fusion's fuel—isotopes of hydrogen: deuterium from seawater and tritium from lithium—is nearly limitless. And fusion doesn't produce greenhouse gasses.

For these reasons and others, the National Academy of Engineering has identified the development of nuclear fusion as an energy source as one of its "grand challenges" to solve in the 21st century. And some of the foundational research that could one day lead to that solution has been ongoing down the hall from Anderson's first-floor office in Engineering Hall for some-16 years. That's where his Helically Symmetric eXperiment, or HSX, whirrs away.

Fusion energy research can be divided into two broad categories that revolve around devices whose names sound straight out of Star Trek: tokamaks and stellarators. Both machines use powerful magnetic fields to contain very high-temperature thermonuclear plasmas. The HSX is a stellarator—one of a handful around the world and the only device with its special kind of magnetic field structure. International collaborations are common, Anderson says, including his close collaborations with German and Japanese researchers.

The HSX is a 30-ton mass of metal and magnets the size of a garage, yet the undulating magnets that coil around it are precisely engineered to within a couple millimeters. This coiling and undulating creates a powerful magnetic field that contains plasma within the vacuum inside. Research by Anderson and his colleagues since the HSX first came online in 2001 has centered on experimentally verifying the predicted improvements in plasma confinement expected from its unique shape.

For years, tokamaks were considered by many researchers to be more promising devices for nuclear fusion energy production, and there are many more tokamaks around the world than stellarators. But tokamaks have stability issues that appear increasingly insurmountable, Anderson says, and a 2015 article in Science magazine titled, "The bizarre reactor that might save nuclear fusion," describes stellarators like the HSX as the best hope for fusion energy dreamers.

Now after 16 years of successful research, Anderson and his colleagues would like to build another stellarator—and to address critical issues for fusion, bigger is not only better, it is necessary.

Additionally, he says a larger experiment could draw the university's diverse fusion programs—in the departments of physics, electrical and computer engineering, and engineering physics—into one large experiment with a much wider scope. A large steady-state stellarator has come online in Germany, and UW-Madison graduate students and scientists have already traveled there to collaborate in research.

However, while the German stellarator was designed based on physics known in the 1980's, Wisconsin researchers want to take advantage of more recent breakthroughs in science and advanced manufacturing. They have been in conversation with the U.S. Department of Energy—and those talks have been positive so far in regard to the possibility of building a larger and more advanced version of HSX.

The machine Anderson envisions likely would cost $50 to $100 million and take six or seven years to build. However, he notes that if the United States wants to remain on par with European and Asian countries in the development of fusion research, it must make that type of investment somewhere. And in Anderson's mind, UW-Madison is the obvious place to make it. "Since the 1960s, Wisconsin has been a key leader in fusion research and the premiere university plasma physics research locale in the U.S.," he says.

Investing in a larger stellarator would help cement the university's legacy, he adds.

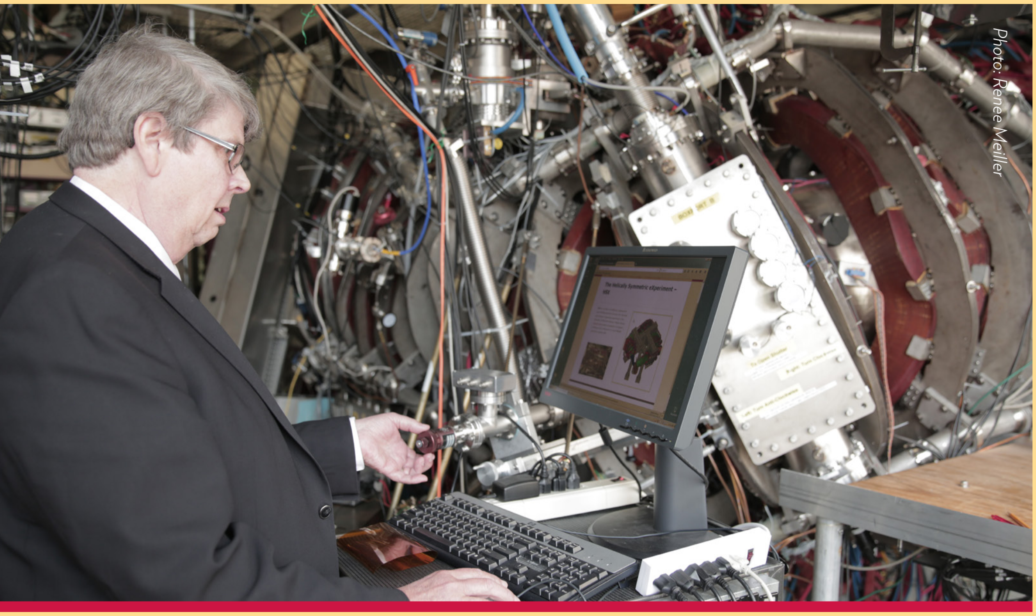


Photo: Renee Meiller

The HSX is a stellarator—one of a handful around the world and the only device with its special kind of magnetic field structure.

KIM AIMS TO MAKE OUR INTERCONNECTED WORLD A SAFER PLACE

In our modern interconnected world, we rely on cyber infrastructure in our daily lives. We have phones, medical devices, and cars that are connected to the internet—and this rise of interconnectedness creates vulnerability. Younghyun Kim works to minimize this vulnerability and to ensure security in our interconnected world, and a 2017 Grainger Institute of Engineering Faculty Scholar Award supports his efforts.

An assistant professor and head of the Wisconsin Embedded Systems and Computing Laboratory, Kim researches safety-critical cyber-physical systems—high-stakes systems that operate using computers and are connected to the internet—such as implantable medical devices.

Implantable medical devices must be open to doctors but closed to hackers—and being connected to the internet makes them inherently vulnerable to wireless infiltration. To circumvent this vulnerability, Kim developed a method of using a sequence of vibrational pulses to exchange encryption keys between doctor and device—somewhat like Morse code, but with vibrations. Hackers can only access this vibration-based communication channel through direct contact with the patient, so it is a way to safely initiate communication before transitioning to a wireless network to transmit a patient's medical information, such as vital signs.

In addition to the inherent vulnerability of devices connected to the web, extreme energy constraints increase the challenge of developing safe and secure implantable devices. For instance, you cannot recharge a pacemaker as you would a smartphone. A pacemaker should be able to operate for seven years on the same battery, yet should be as small and unobtrusive as possible. "If you have to replace the battery every year, that wouldn't necessarily be safe," says Kim.

One approach Kim takes to improve the security and efficiency of such energy-constrained devices is including a dedicated safety co-processor in addition to the main processor, which does the bulk of the work.

Photo: Stephanie Precourt

This allows Kim to incorporate the additional energy-intensive layers of protection only into the safety processer, resulting in a safer and more efficient device.

The Grainger Institute for Engineering Faculty Scholar Award supports Kim's excursion beyond energy-constrained medical devices into other areas of safety-critical cyber-physical research.

For instance, it will support Kim as he grapples with problems at the interface of computational engineering, safety and ethics that the nascent self-driving car industry introduces.

The award will also support Kim as he applies his research to the manufacturing industry. Meticulous orchestration in manufacturing is crucial for both profit and human safety because failure of one component can halt an entire manufacturing system and compromise product safety. And since the manufacturing industry is becoming increasingly connected to the internet, the potential for risk is on the rise. "Being connected to the internet expands the attack surface," says Kim.

The Grainger Institute for Engineering Faculty Scholar Award also will help fund a 'test bed' of model manufacturing machines to simulate industrial systems. These test beds will help Kim translate his ideas from theory to reality and offer a proving ground for manufacturers interested in what Kim's research could mean for their own operations.

From medical devices to self-driving cars to cyber manufacturing, Kim finds fulfillment in seeing his research applied in the real world. "It's rewarding when I see my work making the world a safer place," says Kim.

ENGINEER OF NEW ELECTROSTATIC MOTOR NAMED MOORE INVENTOR FELLOW

Submitted photo

When Assistant Professor Dan Ludois was growing up near Beloit, Wisconsin, he drew extension cords for fun. As a graduate student, he daydreamed about power conversion. "Electricity," he says, "has always been my thing."

Now, Ludois is a Moore Inventor Fellow and one step closer to bringing a potentially transformative invention into the world.

Presented by the Gordon and Betty Moore Foundation, located in the San Francisco Bay Area, the Moore Inventor Fellow award is in its second year of providing freedom and support to the nation's most promising inventors.

Ludois will receive $825,000 in research funding over three years to demonstrate the utility of his electrostatic motor.

"With the Intel Corporation, Gordon Moore changed the world," Ludois says. "We have smartphones in our hands and robots on Mars because of Moore. So to be selected, to be considered a 'Moore Inventor,' it's a little bit surreal."

An estimated 46 percent of all the electricity generated in the world is used to power electric motors. These workhorses do the majority of our pumping, heating, cooling, drilling, pressing, cutting, grinding, and moving. But Ludois' invention represents a fundamental change in how these machines work, and could become a cheaper, more sustainable, and more efficient alternative.

Ludois's capacitive motor runs on electrostatic power conversion, or on the "static cling" force produced from electric fields. Compared to conventional motors that use magnetic fields to convert electricity into rotary force, Ludois's motor is more flexible in design, more powerful, and highly efficient. His motor has the near-term potential to produce three to 10 times more torque than magnetic field-based motors of the same weight, and doesn't require rare-earth materials. It could one day serve as a direct-drive machine for a range of applications, changing the way engineers design wind turbines, electric and hybrid electric vehicles, aerospace propulsion, energy storage, and energy infrastructure.

Ludois will use the Moore Foundation funding to demonstrate the motor's utility, or to prove that the electrostatic motor can do practical work.

The fellowship is special to Ludois for its focus on inventors. Though Ludois uses science and engineering on a daily basis, he mostly identifies as an inventor. But inventing, he says, is anything but the work of one person. "The invention may have originated with me, but my team is pushing it forward," he says. "People say Thomas Edison invented the light bulb, but it's more like Thomas Edison and his team of 12 people invented the light bulb."

MEET ANDREW LAMBERT: 2017 WINSLOW SARGEANT GRADUATE FELLOW

Andrew Lambert

Andrew Lambert is exactly the type of graduate student that alumnus Winslow Sargeant had in mind when he established a graduate fellowship. The prestigious fellowship awards a generous financial package to a highly motivated African-American PhD student in ECE.

While in pursuit of his master's degree, Lambert interned at Intel Corporation during the summer, and performed research on experimental quantum computing during the academic year. A native of Spring Valley, New York, he received his bachelor's degree in electrical and computer engineering from the New York Institute of Technology and a master of engineering degree from the Rochester Institute of Technology. He says his decision to move to Madison rested on the schools reputation as a research leader in quantum computing. "Madison has a strong effort in this area of research and is well-equipped with labs to fabricate the devices for the study of quantum computing," Lambert says.

His research is focused on engineering quantum bits ("qubits"), which will then be used to construct a quantum computer. "Quantum computers will enable us to solve problems that are intractable to current computing technologies," Lambert says. "This new class of computers will enable many breakthroughs in STEM fields."

Lambert's successful scholarship record and his progress toward building quantum bits has in part depended on the Winslow Sargeant Graduate Fellowship, which covers expenses related to tuition, healthcare and fringe benefits, and provides a stipend, and is currently his sole source of funding.

The fellowship, says Lambert, is an important part of a wider grassroots effort needed to make such scholarship a realistic possibility for the broader African-American community.

"The best way to build those opportunities is to have a strong effort on rebuilding the low-income black communities and focus on people in high school and younger," Lambert says. "For example, have extracurricular activities, an aggressive and competitive public-school system, and reestablish the importance of education by exposing youth to higher education and labs, as well as what can be accomplished if education is pursued."

RAJA TIMIHIRI: DAVE AND SARAH EPSTEIN ETHICS IN ENGINEERING FELLOW

PhD candidate Raja Timihiri's research is focused on power system optimization, but she also has a keen interest in the ethical implications of engineering research and technology. Timihiri received a fellowship funded by Dave (BS '76, MS '78) and Sarah Epstein to develop modules for an ethics in engineering course. We spoke to Timihiri about how her interests in course design and ethics led her to enthusiastically take on the task.

How did you become interested in developing the ethics in engineering modules?

I was first interested in applying for the Epstein fellowship because of the course design component; I had recently been part of teaching and designing online course components for an introductory course for undergraduate engineering students. I quickly realized that this fellowship wouldn't be just about course design. It has a nobler goal: introducing ethics to students in engineering. We started putting together introductory material on ethics that emphasizes the importance of ethical awareness in engineering and technology design. We're aiming to develop a mini course in ethics that allows undergraduate students to fully appreciate the seriousness of the ethical dilemmas that can face all engineers.

Why is an ethical approach to engineering important to you?

I believe that ethics are part of everyday life. Many issues today aren't considered or labeled ethical issues but in fact have ethical dimensions. For instance, distracted driving is a serious safety issue, but it's also an ethical issue. One popular topic these days is that of automated vehicles or self-driving cars. While this technology has the potential to speed traffic and decrease accidents due to human factors, it has many ethical issues that aren't usually considered. In fact, the ethics module I'm currently working on involves a case about the ethical implications of self-driving cars.

We hear a lot on the news about companies introducing their version of a self-driving car in cities across the country. At first look, this sounds very exciting, especially for engineers. But we also hear about several instances where these vehicles didn't perform as expected, leading to several fatalities. A major ethical issue is the decisions that the vehicle's algorithms will be making about collisions. For instance, if an automated vehicle (AV) is about to crash into a motorcyclist, should it be programmed such that it saves the motorcyclist's life by instead crashing into a barrier? How about if doing this further risks the lives of the passengers in the car? Whose lives ought to be prioritized? Whose ethical responsibility is it to make such decisions? Can we ever create an "ethical algorithm" and what would such an algorithm actually do? Is it the engineers' responsibility to program an "ethical" algorithm? If not, whose responsibility is it?

What do you hope the course achieves?

We aim to increase students' ethical awareness and introduce some decision-making tools that can be useful in starting to answer some of these ethical questions. Most of the time there isn't a clear-cut solution that would satisfy all parties involved. But there's a process that must be followed to make sure that harm is minimized and safety is held above profit.

79 ECE STUDENTS RECEIVE $200K+ IN SCHOLARSHIPS

Scholarships mean so much in our students' ability to focus on their education and take advantage of all of the opportunities they have available to them! In early fall, our ECE Advisory Board attended our scholarship event and helped present scholarship awards to our student recipients. The board was so enthusiastic about the event that it also sparked new gifts and gift conversations.

(Top) ECE alum, board member and scholarship donor Joe Fourness pictured with ECE award recipient Dayton Lindsay.

(Bottom) ECE alum, board member and scholarship donor Nick Kamboj pictured with ECE award recipient Christopher Chu.

BADGERLOOP EARNS BACK-TO-BACK INNOVATION AWARDS IN HYPERLOOP COMPETITION

Our Badgerloop team—which is made up primarily of undergraduates—was among the top competitors at the SpaceX Hyperloop Pod Competition II weekend in August 2017. The competition challenged entrants to achieve the highest speed. It drew approximately 600 entrants from 25 teams around the world. The Badgerloop team cleared all of the competition's technical and safety hurdles and earned an innovation award for its elegantly designed and executed propulsion system, the foundation of which is nitrogen tanks connected to thrusters via carefully curved piping. Badgerloop was the only team to have received the innovation award in back-to-back competitions.

The students revealed their pod during a summer 2017 event in the Mechanical Engineering Building atrium.

FACULTY NEWS

At the 2017 IEEE/ACM International Symposium on Microarchitecture, Philip Dunham Reed Professor **Mikko Lipasti** received the Test of Time Award for his PhD thesis, "Exceeding the dataflow limit via value prediction." Published in the 1996 MICRO conference proceedings, the paper has received 147 citations and 864 downloads since its publication. The 2017 award recognizes the most influential papers out of 156 total published in the conference proceedings between 1995 and 1999. In the paper, Lipasti and coauthor John Paul Shen of Carnegie Mellon University proposed a new technique, called value prediction, for exceeding the limit that allows data-dependent instructions to issue and execute in parallel without violating program semantics.

STUDENT NEWS

The Directed Energy Professional Society has awarded PhD students **Ray Wambold** and **Patrick Forbes** $10,000 scholarships for the 2017-2018 year. In addition to their award, the students will participate in the society's education workshop during its annual symposium in February 2018. Wambold is a second-year PhD student in Assistant Professor Mikhail Kats' group; under Kats, he is working on a monolithic semiconductor platform for directing and reshaping infrared light. Forbes' advisors are Vilas Distinguished Achievement Professor John Booske and Professor Nader Behdad; his research centers around how metamaterials can be used in high-power microwave amplifiers to enhance gain and suppress unwanted backward wave gain and oscillation.

Lynn H. Matthias Professor and Vilas Distinguished Achievement Professor **Zhenqiang (Jack) Ma** is among five UW-Madison faculty named American Association for the Advancement of Science (AAAS) fellows. They join 391 other fellows who have been recognized by their peers for significant contributions to their fields and the scientific endeavor as a whole. Ma was chosen for distinguished contributions to the field of flexible electronics, particularly for inventing fast flexible electronics, flexible optoelectronics and nanomembrane-based photonics.

In addition, the American Physical Society named Ma to its 2017 class of fellows. The society recognized Ma for his seminal contributions to the development of flexible high- speed devices, microwave device technology, optoelectronics, and innovation in biodegradable environmentally benign devices. And almost simultaneously, the Optical Society has named Ma among 101 members of its 2018 class of fellows for his contributions to the advancement of optics and photonics—in particular, pioneering contributions to flexible optoelectronics and semiconductor nanomembrane-based photonics.

MEET NIDHI AGGARWAL: 2017 EARLY CAREER ACHIEVEMENT AWARD RECIPIENT

We honored Nidhi for her exemplary leadership and engineering innovation in the cloud computing and learning sectors, and for vigorous support of diversity in engineering education and practice.

Nidhi Aggarwal

Founder, Qwiklabs

MSEE '06 (PhDCompSci '08)

Why did you choose to attend college at UW-Madison?

I actually was working at a company in India, working on virtualization, and I got very interested in looking for graduate programs. I saw that UW-Madison had Jim Smith who was leading some research on virtualization and it was all very new. So, that, and the fact that it's a great university with a strong engineering program, got me interested in UW.

Do you have a favorite engineering class from your time at UW-Madison?

I loved *Introduction to Computer Architecture*. I had done programming classes and I was a traditional electrical engineer when I came to UW-Madison. It was such a change for me in terms of coming from India and getting to do a class where I was building a whole microprocessor. I remember that I got very competitive. The challenge was to build a processor with the fewest number of electrical logic gates that also ran the fastest in the class. I spent endless nights trying to build that. I remember the TA telling me my solution wouldn't work, but I just bowled over the entire logic and proved the TA wrong. It opened my eyes to how learning could be: more interactive, applied, tactical, and creative. It wasn't about just getting direct answers, but about getting direct answers with the fewest resources and making it transparent.

What's your fondest memory of your time on campus?

When I was in the last two or three years of my PhD and done with my coursework, another student and I were some of Jim's last students before he retired. He would travel all the time, but during the summer he would come back to Madison and take us out in his canoe. We would canoe to the Union, discussing computer architecture, virtualization, and our PhD thesis, we would grab a beer, and then canoe back. I think that experience is just unmatched.

What are you doing right now?

I have an advisory role in a startup while I'm on a one-year sabbatical from full-time work. I sold my company Qwiklabs to Google last year and was working for another company, but I have a 5 $^{1}/_{2}$-year-old daughter and wanted to balance my personal and professional life to spend more time with her.

Of what professional accomplishment are you most proud?

Building Qwiklabs. Building a company whose software is used worldwide to learn about Amazon's cloud or Google's cloud is a very proud achievement for me. Amazon Web Services became our biggest customer, exclusively using our software to do all of their hands-on training. And now, the company is part of Google, which is something that I am really proud of. Everything I have achieved in my life is because of an emphasis on education and learning. To be able to give back in some form has been very gratifying for me.

What advice would you give students in electrical and computer engineering?

Take advantage of the incredible opportunities that UW offers. There's a broader world out there and UW has such a fantastic, rich, interdisciplinary environment. Get out and explore and then take advantage of all the resources. Take risks. UW has so many departments that are in the top 10. It's not just known for one thing. Don't try to optimize the shortest path to graduation.

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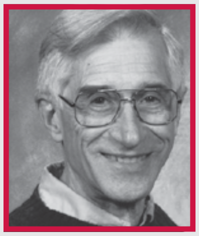
Burr Fontaine


James Nordman

Professors emeritus Arthur Burr Fontaine and James Nordman each were known for their creativity, kindness and zest for life.

Fontaine died Sept. 23, 2017, at age 90. During World War II, he enlisted in the U.S. Navy; afterward, he earned his bachelor's degree from the University of Wisconsin and attended graduate school at Ohio State University. He spent five years working for IBM before joining the ECE department. His research focused on areas that included antennas and signal processing.

Nordman died Nov. 21, 2017, at age 83. He earned his bachelor's degree from Marquette University and his PhD in electrical engineering from the University of Wisconsin. Following his PhD, he joined the ECE department. His research focused on low- and high-temperature superconductivity.

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WOODWORTHS PLEDGE $125,000 FOR CHANCELLOR'S SCHOLARS

John (BS '73) and Marsha Woodworth have pledged $125,000 to the University of Wisconsin-Madison Chancellor's Scholarship Program. The Woodworths' pledge is part of a $10 million matching-gift drive currently underway, making the total value of the gift $250,000.

After graduating from ECE, Woodworth went on to a successful 39-year career at 3M in Minnesota, where he eventually became senior vice president of corporate supply chain operations. He retired in 2013.

"I owe a lot of my success to UW-Madison and the education I received here," Woodworth says. "That education allowed me to be recruited by a major corporation, where I was able to spend my entire career."

Woodworth was a scholarship recipient himself, and he credits the scholarship with making his education possible. "I wanted to return the favor and hope others can benefit as well," he says.

The Chancellor's Scholars program began in 1984 and provides merit-based scholarships to UW-Madison students. The scholarships cover the full cost of tuition for both resident and non-resident students, as well as a $400 stipend each semester for textbooks.

In addition to the monetary assistance, Chancellor's Scholars gain access to a number of academic, social and volunteer opportunities. These opportunities include monthly meetings where they are able to network with their peers and develop their leadership skills; monthly "fireside chats" with distinguished faculty and staff; ongoing academic advising and individualized support service; and special events that promote supportive community-building and intercultural understanding.