SUMMER 2017

ELECTRICAL & COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN-MADISON

APPLYING IMAGE ANALYSIS FOR A HEALTHIER HARVEST

John Booske

GREETINGS! With all we've been hearing about "fake news" recently, I'm pleased to have this opportunity to share the *real* and *fantastic* truth that here at UW-Madison, the ECE department and the College of Engineering are at the top of their game, and have never been better!

There is much to celebrate, and I hope you will join me in spreading our great story around the country and the world.

Here are just a few of the many exciting highlights of our recent successful experiences in Madison:

- In the last several years, 11 exceptional new faculty have joined us. These people are national stars—leading innovations in the areas of mobile computing systems, nanophotonics and light control, power electronics for renewable energy systems, and information science, machine learning, and big data computation. The latter two hiring emphases have aligned our department's growth investments with the college-wide recruitment in energy and sustainability, and computational science and engineering, respectively, through the Grainger Institute of Engineering. And as a result of these hires, our department now is home to *six* of the world's top experts in researching optimization and machine-learning algorithms, while a seventh expert is researching computer hardware for big data computation, and two additional faculty members are applying optimization methods to smart electrical grid control. In combination with colleagues in computer sciences, statistics, other engineering departments and bioinformatics, our UW-Madison faculty lead the nation and world in research and education in optimization and machine learning.
- A multidisciplinary team of UW-Madison students, led by many of our own ECE students, competed as Badgerloop to win one of only two innovation awards presented at the recent international Hyperloop competition in southern California, sponsored by Elon Musk's SpaceX company. It was especially notable that our BadgerLoop team was the only group to submit a realistically sized pod, large enough to hold a passenger. In recognition of this exceptional accomplishment, Elon Musk honored our students by sitting and posing for photos inside the Badgerloop pod—the only pod in which he did so.

Many important recognitions of faculty excellence occurred throughout the year, including (but not limited to):

- Professors **Nader Behdad** and **Hongrui Jiang** were elected fellows of IEEE. Meanwhile, in an unprecedented recognition of exceptionalism, Jiang was also elected fellow of the Institute of Physics, The Royal Society of Chemistry, and the American Institute for Medical and Biological Engineering, while also receiving the prestigious Stein Innovation Award from the Research to Prevent Blindness organization.
- Professor **Nigel Boston** was honored as a Simons Fellow in mathematics.
- Professor **Mikhail Kats** received a prestigious Office of Naval Research Young Investigator Award and recognition among the *Forbes* "30 under 30" in Science.
- Professor **Daniel Ludois** was honored among the *Midwest Energy News* "40 under 40" for his innovations and impact in power machines and electronics (one of the few university faculty to be so honored, as the rest were selected from industry).

As I described in my prior chair's message, we just completed our 125th year of national excellence and leadership in ECE and now we look eagerly forward to the next 125 years.

THERE ARE THREE PILLARS REQUIRED FOR THIS SUCCESS:
1) Outstanding students. 2)Outstanding faculty and staff.
3) The resources that enable them to be among the best in the world.

As you must know by now, generous giving from our proud alumni is a critical component of sustaining our excellence. We are blessed by the large number of you who have stepped up to this calling. For example, since 2014, the number of our alumni and friends who donate to the ECE annual fund has doubled. Every dollar contributed to this fund comes directly to the department without fees or any retention by the UW Foundation.

This money funds incredible initiatives in the department—including lab renovations for new research projects, social events that build networks and community spirit among students, lectures by distinguished alumni who educate students, faculty and staff with the lessons they have learned from their professional successes (and important failures), and critical investments in education innovation that ensure our students get the best ECE education in the country.

If you have joined the ranks of those who give back to your department, thank you! If you have not previously done so, please recognize that *any* size gift is welcome and important. These gifts ensure that current and future ECE students receive the exceptional start to their career that you had (or even better), while ensuring that the brand value of your UW-Madison ECE degree always shines and never diminishes.

ON, WISCONSIN!

John Booske, Chair
Vilas Distinguished Achievement Professor,
Duane H. & Dorothy M. Bluemke Professor
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WORKING IN THE FIELD

App helps farmers make the most of their corn harvest

A new tool developed at UW-Madison could save farmers time and money during the fall feed corn harvest—and make for more content, productive cows year-round.

The innovation isn't a physical farm implement, but rather a smartphone app, available for downloading in 2017. With just a handful of harvested corn, the app allows farmers to gauge—right in the field—how effectively their machinery processes the corn so that they can achieve the highest quality cracked corn from their harvest. "We wanted to develop a product that would help the people of Wisconsin," says Associate Professor Rebecca Willett *(pictured)*, who is collaborating with Brian Luck on the project.

Cracked corn is one component of a healthy cow's diet.

Cracking corn breaks up the tough outer kernel, making it easier for cows to digest the nutritious starch inside. Cows with incomplete digestion cause financial headaches for farmers at milking time. "Cracked corn makes the feed easier to digest, so cows can produce more milk," say Luck, an assistant professor of biological systems engineering and a specialist with the University of Wisconsin Extension.

And excellently cracked corn can boost milk production by up to two pounds (or, about a quart) per cow per day, according to studies conducted by the UW-Madison dairy science department.

Forage harvesters crack corn by passing pieces of plant material between two grinding roller-wheels. Wear and tear on the machine can make it process less effectively, and some fields of corn resist cracking more than others.

Farmers can fine-tune their harvests to a certain extent by controlling the width of the gap between the wheels: Narrower spaces squeeze kernels more strongly, but also slow down the equipment—and thus, the harvest; wider gaps allow the machines to move faster, but at the risk of leaving too many kernels intact. "The problem is that when the harvester goes through the field, there's no way for farmers to tell how well they cracked the kernels," says Luck.

Even though farmers can easily recognize whole, uncracked corn kernels in their harvest, it's almost impossible for them to tell at a glance what percentage of the cracked corn is just right. After the harvest, farmers send samples of their corn to commercial labs that dry and pass the grain through nine shaking and rotating sieves of varying sizes in a large proprietary contraption that eventually returns a number for the overall corn silage processing score.

And that score determines the corn's value as animal feed.

If 70 percent of the cracked corn fits through a hole the width of a standard drinking straw, then the corn receives an excellent score—fit for a dairy cow's feast.

Unfortunately for many farmers, the lab results yield merely adequate, or even poor, scores, meaning they must feed their cows much more grain every day to meet nutritional requirements.

The smartphone app is a convenient and accurate in-the-field alternative to after-the-fact processing scores. While farmers don't have access to lab equipment on their tractors, most do carry smartphones in their pockets—and those small devices pack more than enough computational muscle to measure corn kernels.

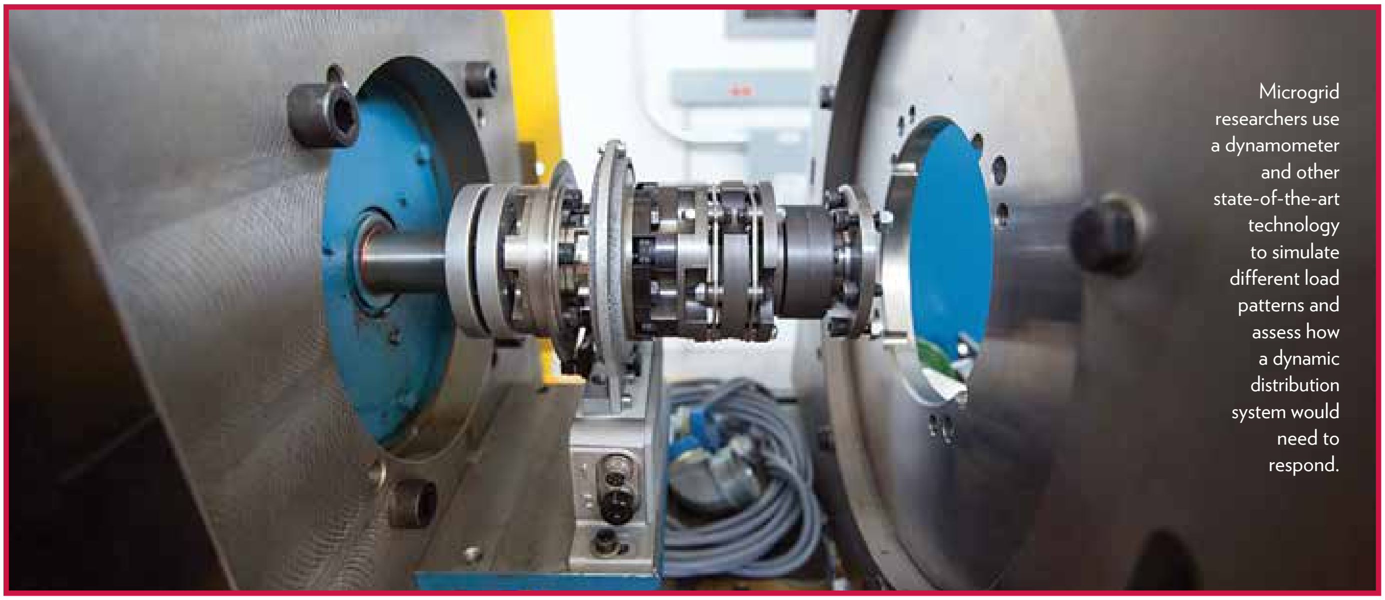
"The app is very efficient and fast; you get a response almost immediately," says Willett. "Producers can even use it throughout their fields to adapt to changing field conditions. Because it uses so little power, repeated use does not drain their batteries."

To use the app, farmers merely spread out a small sample of corn, set down a coin to calibrate for pixel size, and snap a photo with their phones. Image-processing algorithms then calculate kernel-processing scores right there in the field, instead of weeks after the harvest at an external lab.

Based on kernel processing scores and summary statistics from the app, farmers can fine-tune their machinery on the spot—rather than develop contingency plans after the harvest is well over. And initial results suggest that the scores returned from the app align very closely with official results from commercial corn silage processing score evaluations.

The app gives farmers information that frees them from the uncertain trade-off between creeping through the corn rows slowly to thoroughly pulverize every last piece of plant material or speeding up the process at the risk of harvesting an entire silo's worth of lower value feed corn. "It all comes down to data," says Luck. "How much data can people gather to assess their operations and maximize efficiency?"

The project was funded initially by a grant from the Midwest Forage Association. Luck and Willett recently received funding through the Ira and Ineva Reilly Baldwin Wisconsin Idea Endowment at UW-Madison to fine-tune the app and ready it for download in August 2017. The Baldwin funding also will enable them to produce a UW Science Narrative video for farmers and the broader Wisconsin population that highlights the app and the benefits of using it.



Microgrid researchers use a dynamometer and other state-of-the-art technology to simulate different load patterns and assess how a dynamic distribution system would need to respond.

Matt Wisniewski, Wisconsin Energy Institute.

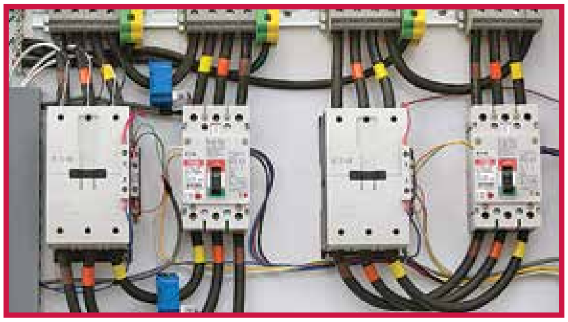
AN EMPOWERED ELECTRICAL SYSTEM: EXPANDING THE MICROGRID

Ask microgrid pioneer Bob Lasseter about the origins of the microgrid and he cuts straight to the engineering, talking about a small but powerful generator he saw once in 1998 and how it got him thinking.

"Up to this point I was basically working on utility-scale energy and here I was looking at this small thing that generates a lot of power,"says Lasseter, a professor emeritus.

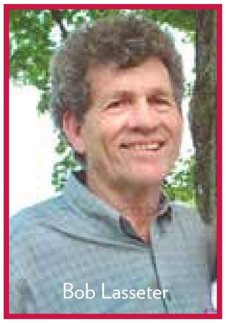
That small thing, of course, was both an engineering problem and an opportunity. "If these machines were going to be competitive and we were going to have tens of thousands or a hundred-thousand of them, how in the world was the grid going to handle that? That's the germ of where the microgrid started out," says Lasseter.

Tom Jahns



Adding new sources of locally produced energy is a challenge for the traditional utility grid, which relies on its central distribution of power to maintain a strict equilibrium in all seasons and at all times of the day between electricity supply and electricity demand.

Lasseter's innovation, which he worked on more than a decade ago with the support of the U.S. Department of Energy and the Consortium for Electric Reliability Technology Solutions, was to create a small, self-contained electric power grid that connects and disconnects from the traditional grid seamlessly, or without disruption. This "microgrid," as Lasseter dubbed it, was ideally suited to providing high quality, reliable power to smaller consumer bases such as hospitals, universities, or neighborhoods.



Bob Lasseter

This marriage of the microgrid with the traditional grid is an efficient one. Move your energy source closer to you, and you lose less energy in distribution while creating other opportunities (such as combined heat and power) for the more efficient use of energy. Microgrids can more easily integrate clean energy resources into their energy supply. And microgrids also provide added reliability, functioning as a form of back-up power should the central grid experience an outage.

Today, microgrids are up and running in countries all over the world. But basic research questions on microgrid design and functionality are now giving way to broader questions about scale and implementation.

Tom Jahns, the Grainger Professor of Power Electronics and Electrical Machines, is one of the engineers who is asking big questions about the future of the electric grid, as well as trying to move Lasseter's original vision—of thousands or hundreds of thousands of microgrids—from idea to reality.

Alongside Lasseter and other collaborators, Jahns is seeking to transform our current electricity infrastructure from a system that relies on fossil fuels and centrally distributed power to one that more fully and systemically integrates microgrids and other distributed energy resources technology.

Such a transformation, he says, is necessary if we're serious about producing a reliable system that also

FELLOWSHIP WILL INCREASE DIVERSITY OF ECE GRADUATE COHORT

DIVERSITY

A new gift has bolstered an existing electrical and computer engineering graduate fellowship meant to assist people of color in gaining access to increasingly important research opportunities and jobs in the STEM (science, technology, engineering and math) fields.

ECE alum Winslow Sargeant originally provided funding for the Wisconsin Distinguished Graduate Fellowship in the early 2000s to help make a graduate degree in ECE attainable for underrepresented minorities. Sargeant recently made another gift, allowing the funding of two ECE graduates concurrently.

Sargeant's motivation is simple but powerful—as a black man who has experienced success following his academic career at UW-Madison, he wants to help young people from similar backgrounds achieve success themselves.

"There's a tremendous amount of opportunity in the STEM fields, but when you look at it, there's not a lot of diversity in STEM," Sargeant says. "This fellowship is meant to help those with the know-how to follow the path that I did and attend a high-quality institution like UW-Madison."

Sargeant remembers fondly his time at UW-Madison, where he met his wife and launched his career following the completion of his PhD degree. He says he feels a responsibility to help lift barriers for a new generation of young academics with big dreams.

"There's a big discussion in STEM and technological fields with ethnic and gender diversity. We see where technology is going and where it's affecting the workforce and society, and it's incumbent upon us to make sure that the playing field isn't behind a barrier," Sargeant says.

Ideally, Sargeant says, graduate students funded by the fellowship will engage with all the ECE department and UW-Madison have to offer, receive a quality education and have the opportunity to network and build professional relationships.

"I learned a tremendous amount from friends and colleagues in Madison," Sargeant says. "I want these fellows to graduate and go off and use their talents for good, and ultimately be a part of the Wisconsin Idea."

Winslow Sargeant

In 2017-2018, the fellowship will fund two students, Michael Shiferaw and Oghenefego Ahia. Shiferaw, a native of the Washington, D.C., metro area, will pursue a PhD focusing on computer science and cyber security. He recently received his bachelor's degree in electrical and computer engineering from Morgan State University in Baltimore.

Meanwhile, Ahia, a first-generation immigrant who was born in Lagos, Nigeria, will pursue a master's degree in ECE. He recently received his bachelor's degree in computer engineering from Tufts University in Boston.

"Receiving the Wisconsin Distinguished Graduate Fellowship will provide me the flexibility to achieve my goals. I am grateful for this opportunity," Ahia says.

incorporates a large amount of clean energy produced in and for local markets.

To make that transformation possible, Jahns and collaborators are developing what they call a "dynamic distribution system" (DDS), a system in which many thousands of microgrids or other DERs would work as seamlessly on a large scale as the microgrid does on a small scale—becoming, as Jahns puts it, "good citizens" of a new and improved grid.

DDS is essentially a new architecture for powering and controlling the grid. And in reworking the nature of the relationship between DERs and utilities, DDS also seeks to tinker with the current economic model, making it possible for its functional clusters and microgrids to sell excess power back to the grid. The existence of these local markets would make investing in DERs increasingly attractive to third-party investors and spur a faster transition to a cleaner, more distributed power grid.

If this all sounds complicated, that's because it is. As Jahns quips: "This work is not for the faint of heart." It's not that the idea of distributed control is a new idea—it's already being used very effectively in many industrial applications. "But the scale of this is beyond what anybody's ever done before," he says.

MORE: www.engr.wisc.edu/micro-macro-uw-madisons-expansion-microgrid-idea/

Smartphones, smartwatches, laptops, Fitbits—all consumer electronics rely on the physics of things you cannot see. And Irena Knezevic seeks to better understand this nanoscale physics to improve our lives.

Professorship aids Knezevic's quantum mechanics research

She recently received the Patricia and Michael Splinter Professorship in Electrical and Computer Engineering to support her in that endeavor.

The Splinter professorship, created by alumnus Michael Splinter (BS '72, MS '74) and his wife Patricia, supports Knezevic as she studies quantum mechanics, the physics of things at atomic and subatomic scales. Specifically, she works to understand how charge, light and heat interact in nanoscale systems. To do so, she makes mathematical models to explain the physics in these systems and writes computer code to solve the models. "Quantum mechanics is the physics of things you can't see," says Knezevic. "And the best way to deal with the things you can't see is with math."

Knezevic focuses on the behavior of electrons. What makes small objects like electrons differ from large objects is that they behave more like waves than like particles. Knezevic works to understand what happens when you confine the dynamic wavelike behavior of electrons to nanoscale dimensions.

One area of her research focuses on quantum cascade lasers, which can emit more energy in the form of light than more standard lasers. Knezevic simulates the physics of these devices and shares her findings with collaborators who then apply her work to build improved quantum cascade lasers that eventually can be used in imaging, telecommunications, trace gas analysis—anything with a sensor that has a light emitter.

Worldwide, few researchers are doing similar microscopic quantum cascade laser modelling. Although some other groups are researching the lasers, what sets Knezevic's work apart is that her models are multi-scale and multiphysics models. Multiscale means she studies the lasers from the atomic level of photon and electron behavior all the way up to the micron level of the whole laser; multiphysics means she investigates the interplay between charge, light and heat within the entire system.

Since other groups studying quantum cascade lasers often look primarily at electron transport, Knezevic's holistic inquiry is state-of-the-art.

While quantum cascade lasers are practical devices, Knezevic also studies nanomaterials such as graphene and carbon nanotubes. Graphene is a nanomaterial comprising a single layer of carbon atoms. This thinness makes graphene behave differently on different surfaces. "One of the coolest things about graphene is understanding how it behaves when you put it on different materials," says Knezevic.

When you take graphene and roll it up like cannoli, you create a carbon nanotube. Knezevic studies how carbon nanotubes capture light energy by temporarily binding it into ephemeral particles known as excitons. She explores the physics of excitons in disordered nanotube systems to better understand how light energy moves from nanotube to nanotube on the way from where it was absorbed to where it is being collected. Currently, carbon nanotube films are an inexpensive way to harvest solar energy, but they are also inefficient. Knezevic hopes that her research will lead to more efficient solar cells that can be implemented on a global scale.

In addition to these ongoing research projects, the Splinter professorship provides Knezevic with support to venture into new research areas, like nanoscale antennas. Nanoscale antennas are just like typical radio antennas, but much smaller. This makes them behave unexpectedly. "When you make antennas small, there is physics that arises that wasn't there when the antenna was bigger," says Knezevic.

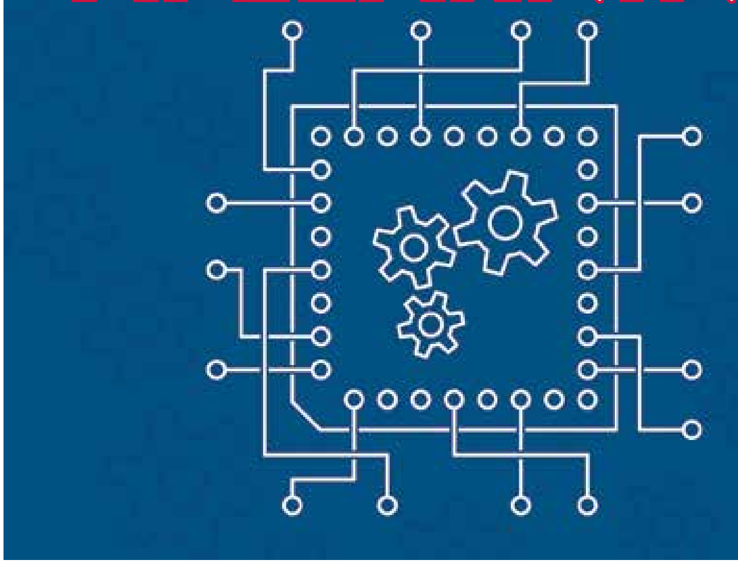
By marrying her knowledge of light emission at the nanoscale with her knowledge of quantum transport, Knezevic aims to better understand the physics of nanoscale antennas. This research will help to shape the future of telecommunications and sensing.

To assist with Knezevic's diverse research, the Splinter professorship also allows her to fund a graduate research assistant and share her passion for the beauty of quantum mechanics. And, at the end of the day, she aims to share that passion not only with her students, but with us all. "Beautiful math and physics underlie all of engineering," says Knezevic.

WIRELESS HOTSPOT HERE

The need for advances in wireless communication and mobile systems is stronger than ever before, especially as people continue to expect anytime, anywhere access through myriad devices such as smartphones. And our researchers are fast becoming leaders in technology to enable this increasingly interconnected world. MORE: www.engr.wisc.edu/wireless-hotspot-here/

ADVANCE AIMS TO ACCELERATE AI LEARNING



Artificial intelligence holds great promise in solving some of the world's biggest challenges in healthcare, energy, security and other areas.

It can help healthcare providers develop the right drug to treat an individual person's illness. It is key to technologies in self-driving cars and is embedded into consumer electronics like smartphones *(think: Siri)*. Essentially, it is all around us, transforming the way businesses operate and how people interact with the world in everyday life—for example, enhancing our online search-engine experience, translating text into other languages, recognizing faces in photos and videos, and more.

The computer platform itself—the hardware and software—plays a major role in enabling ubiquitous artificial intelligence applications.

And our engineers have developed a method that will enable artificial intelligence applications to learn faster, with less energy.

The method centers around the researchers' discovery that a key performance bottleneck in "learning" using the deep-learning neural network—one type of artificial intelligence—is how quickly information can be read from or stored in the processor's own memory. "Artificial intelligence is the next big wave in computing, but our computers are not designed for artificial intelligence," says Jing Li, the Dugald C. Jackson Faculty Scholar and an assistant professor. In other words, even state-of-the-art machine-learning algorithms—the "soul" of artificial intelligence—cannot make the best use of their hardware resources.

Currently, they are out of sync. "For this process to work efficiently, different aspects of the computer (software, hardware and algorithms) need to work collaboratively," says Li. The solution she and graduate student Jialiang Zhang developed aims to bring them back into balance.

For their research, they used a state-of-the-art reconfigurable integrated circuit known as a field-programmable gate array, or FPGA—essentially, a DIY computer chip they could program to suit their needs. Companies including Microsoft, Amazon, Baidu and Alibaba, among others, have recently deployed this promising post-computer-processing-unit technology into their cloud and data centers for everything from web search ranking to machine-learning applications such as image and speech recognition.

To program the FPGA, Li and Zhang employed the popular programming language framework OpenCL, which recently was enabled for FPGAs and greatly reduces programming time and complexity compared with the lower-level hardware description languages in traditional tools.

Jing Li

OpenCL is the interface that allows programmers to develop kernels, which are individual tasks that run on the FPGA. Kernels are the heart of the computer, performing the "heavy-lifting" jobs—such data-processing and memory tasks—using the computer's resources.

What Li and Zhang found is that in implementing a convolutional neural network—one of the dominating machine-learning algorithms—on a state-of-the-art FPGA, the bottleneck is the on-chip memory bandwidth. And that's caused by a mismatch between the FPGA's available memory resources and the resources required by the kernels.

Consequently, on-chip computational resources are underused—therefore limiting the overall system performance. "We invented techniques to address the bottlenecks by developing a 2D multicast interconnection between processing elements and local memory to effectively improve the memory use," says Li.

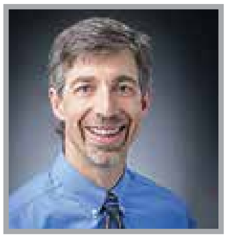
She believes their demonstration achieves the best power efficiency and performance density compared to existing work—including that of industry giants. Li and Zhang published news of this advance in the Proceedings of the 2017 ACM/SIGDA International Symposium on Field-Programmable Gate Arrays.

BOOT CAMP FOR SOLDIERS' BRAINS

With up to $9.85 million in funding from the U.S. Defense Advanced Research Projects Agency, Justin Williams, the Vilas Distinguished Achievement Professor in biomedical engineering and neurological surgery; Jack Ma, the Lynn H. Matthias professor and Vilas Distinguished Achievement Professor in ECE; colleagues from UW-Madison, and neuroscience experts from around the country, will develop a low-cost, easy-to-use system (*think: "learning goggles"*) that aims to accelerate learning by stimulating nerves in the head and neck to boost neural activity in the brain.

MORE: www.engr.wisc.edu/brain-boot-camp-new-technology-aims-accelerate-learning/

VAN VEEN RECEIVES COLLEGE BENJAMIN SMITH REYNOLDS TEACHING AWARD

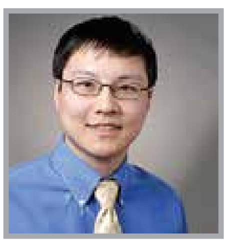


Lynn H. Matthias Professor Barry Van Veen is a highly accomplished researcher, but he also is known for his skill as an instructor. Recognizing that students learn in varying ways and at different paces, Van Veen began developing video lectures that allowed students to review material they missed. Based on feedback, he then strategically improved the videos, organizing them by topic and cutting them into 10- to 15-minute modules.

Van Veen also implemented a flipped classroom style, tailoring it so that concepts better learned online were taught online, and concepts better taught in person were covered during class meetings. Students responded well to this style, reporting feeling comfortable and confident in his classes, and appreciating the connections and relationships built there via the interaction of a flipped classroom.

Van Veen's passion for innovation in education extends to his leadership of the college Education Innovation committee and is evident in the widely read paper, "Flipping signal processing instruction," published in *IEEE Signal Processing Magazine* in November 2013. He also is committed to improving signal processing education worldwide through his website, allsignalprocessing.com, his YouTube channel, and the textbook, *Signals and Systems*, which he co-authored.

JIANG HONORED FOR VISIONARY RESEARCH



Hongrui Jiang has received a prestigious Stein Innovation Award from the leading voluntary health organization Research to Prevent Blindness. The award recognizes his cutting-edge research of enabling technologies for the prevention or treatment of blindness. Jiang, the Lynn H. Matthias Professor in Engineering and Vilas Distinguished Achievement Professor, is one of 10 researchers at nine institutions nationwide who have received this award.

The Stein award typically recognizes eye doctors and clinicians who study strategies to reverse blindness through medical interventions. Jiang, by contrast, works on technologies that could someday restore sight to people who have lost their vision. Support from Jiang's Stein Innovation Award will go toward developing implantable sensors for real-time measurement of intraocular pressure, which is an important aspect of evaluating patients at risk for glaucoma, a chronic degenerative eye disorder that affects millions of people worldwide.

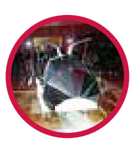
"We need a better understanding of the pathology and physiology of the disease to start working toward a cure," says Jiang.

He will collaborate closely on this project with Dr. Paul Kaufman, Mary Ann Croft and Dr. Michael Nork in ophthalmology and visual sciences at UW-Madison.

Jiang is not an ophthalmologist, but rather, an electrical engineer—and his unique perspective on engineering has led him to collaborate with clinicians in the Department of Ophthalmology and Visual Sciences at UW-Madison on several projects related to improving or restoring people's vision. His research often looks to natural systems for new approaches to developing optical technologies. Taking inspiration from such diverse creatures as lobsters, dragonflies, and elephantnose fish, Jiang has created sensors that do everything from seeing in the dark to magnifying miniscule objects with wide field of view.

The award will provide $300,000 of support over three years.

A SAMPLE OF OUR MENTIONS IN THE MEDIA



BADGERLOOP TEAM—UW-Madison students hope to create new high-speed transportation with Badgerloop pod *(Wisconsin State Journal)*

MIKHAIL KATS—Special glasses give people superhuman colour vision *(New Scientist)*; New lenses could give you super color vision *(Discover magazine)*; New color glasses created at UW-Madison allow us to see more of world *(WISC-TV3)*

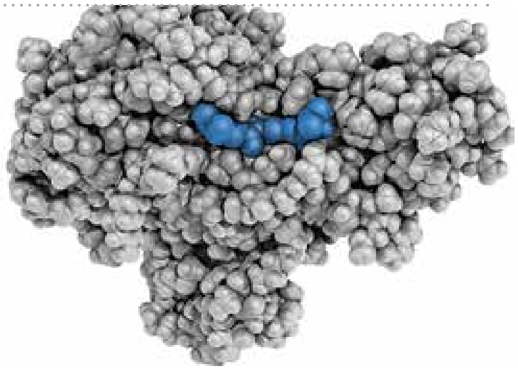
GIRI VENKATARAMANAN—2017's greenest states *(WalletHub)*

THE NEW QUALCOMM DESIGN LAB

Photos: Stephanie Precourt

On March 10, 2017, we were honored to host alum Jim Thompson *(above, left)*, **executive vice president of engineering and chief technology officer for Qualcomm Technologies, along with several of our students, to dedicate our new Qualcomm Design Lab.**

ALGORITHMS that improve drug discovery



The algorithms that use web search trends to predict our tastes in music, literature and other entertainment forms—known as "recommender systems"—are everywhere in e-commerce, often nailing preferences with eerie accuracy. Could the same approaches used by sites like Amazon and Netflix be applied to more imposing challenges—say, developing new disease-fighting drugs? Researchers funded through a new UW 2020: WARF Discovery Initiative project will explore the possibilities.

The project is led by Julie Mitchell, a UW-Madison professor of biochemistry and mathematics, along with input from ECE Professor Robert Nowak *(pictured)* and Stephen Wright, a professor of computer sciences and industrial engineering. Their goal is to create machine-learning tools that dramatically reduce the time and cost associated with screening chemical compounds for therapeutic drugs.

The problem today is that when researchers discover a protein that may play a role in disease, they face the daunting task of screening millions of single chemicals that might favorably interact. There are few ways of narrowing the search to a more feasible scale.

The researchers are hoping reduce that number to thousands, if not hundreds, of likely chemical candidates that give scientists a reasonable and more cost-effective place to start.

Optimization experts Nowak and Wright have experience with recommender systems and the ability to push them to new heights. They will use results from UW-Madison researchers who already have completed chemical screening projects of approximately 75,000 chemicals to help their systems learn.

Their recommender-system algorithm must look across many targets to search for the patterns of chemical activity and learn how a target may react to new chemical. "We may also be able to adaptively select specific experiments that will help to improve predictions about such chemical reactions—in a fashion similar to the adaptive recommendation systems we've developed to improve beer recommendations through beermapper.com," says Nowak.

In December 2016, the National Academy of Inventors (NAI) awarded alumnus **NELSON TANSU** (BS '98, PhD '03) the distinction of NAI fellow. The Daniel E. '39 and Patricia M. Smith Endowed Chair Professor and director of the Center for Photonics and Nanoelectronics at Lehigh University, Tansu was among 175 distinguished academics to receive the honor in 2016.

Election as an NAI fellow is bestowed upon academic innovators who are prolific in creating or facilitating outstanding inventions or innovations that have made a tangible impact on quality of life, economic development, and societal welfare. Academic inventors and innovators elected to the rank of NAI Fellow were nominated by their peers for outstanding contributions to innovation in areas such as patents and licensing, innovative discovery and technology, significant impact on society, and support and enhancement of innovation.

The 2016 fellows will be inducted on April 6, 2017, as part of the Sixth Annual Conference of the National Academy of Inventors at the John F. Kennedy Presidential Library & Museum in Boston, Massachusetts. U.S. Commissioner for Patents, Andrew H. Hirshfeld will provide the keynote address for the induction ceremony.

Tansu has made seminal advances in the invention and innovation, fundamental sciences, and device technologies of III-V and III-Nitride semiconductors. He has more than 16 U.S. patents and his work is integrated in today's state-of-the-art solid-state lighting technology. He has published in more than 114 refereed journals and more than 230 conference publications, and his work has been cited more than 5,350 times. He has received numerous awards for his teaching and research—including the Harold A. Peterson Best ECE Dissertation Award at UW-Madison and the Wisconsin Forward Under 40 Award for outstanding young alumni.

"As a Wisconsin alum (I am also married to another Wisconsin alum), I have always had a great passion for the institution," says Tansu. "I am truly humbled by this recognition as fellow of the National Academy of Inventors. It is incredibly gratifying even to be considered for such an honor, and it is truly humbling for me to be elected into this highly respected group. I sincerely thank my advisors, teachers and mentors at Wisconsin, and I still maintain close contact with many folks there. I had a wonderful opportunity to get an excellent education at Wisconsin, and this has a long-lasting impact."

In February 2017, ECE alumnus **MIKE SPLINTER** (BS '72, MS '74) was among the 84 new members and 22 foreign members elected to the National Academy of Engineering. Election to the NAE is among the highest professional distinctions accorded to an engineer. The academy recognized Splinter's leadership in advancing semiconductor manufacturing, quality and equipment.

Splinter retired in 2015 as chairman and CEO of Applied Materials and currently is co-founder and general partner of Los Altos, California-based WISC Partners, which provides strategic operating capital to promising Wisconsin entrepreneurs.

He is known as an innovator in electronics technology, but also in photovoltaic cells and solar solutions to reduce fossil fuel use. In fact, the Semiconductor Industry Association credits Splinter with transforming photovoltaic cell production from a "boutique" industry into a meaningful source of renewable energy.

As leader of Applied Materials, he also infused community service opportunities throughout the company and in his personal activities. This commitment to community service includes supporting food banks, launching a program to invest in local schools, and working with the Clinton Global Initiative to bring electricity to villages in rural India.

Before joining Applied Materials as CEO in 2003, Splinter worked for 20 years at Intel Corp., during which time the company became a leader in microchip technology. He previously held positions at the Rockwell International electronics research center.

Splinter serves on several influential industry boards, including the U.S.-India CEO Forum and Technology CEO Council; and the NASDAQ QMX Group, SEMI, Pica 8 Inc., and University of Wisconsin Foundation boards.

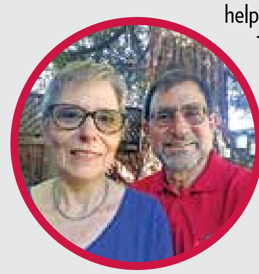
EPSTEINS AID ETHICS EDUCATION

David and Sarah Epstein have a long history of supporting UW-Madison—and with their recent gift, they are hoping to augment our engineering students' technical education in a way that will yield benefits far into those students' careers.

The Epsteins' recent gift to the College of Engineering established a suite of engineering ethics efforts aimed at helping our students gain practical experience in ethics.

David describes this "package" as an effort to raise awareness of the importance of ethics and to educate engineering students about how to think and act ethically in everything they do.

The Epstein's gift funds three initiatives aimed at this goal. The first is a curriculum designed to change from year to year, giving students more than just a short exposure to this critical mindset. The second initiative will fund three graduate students to help develop the course.



The third will support a lecture series, so that students can make meaningful connections with engineers who practice this material.

"The outcome that we want to see is that engineers think about what they're doing beyond the actual technical results," says David.

And, says Sarah, to prepare them. "To not feel afraid to speak up if they're thinking that something might happen that could have a negative consequence from an ethical perspective."

David graduated with his bachelor's degree in electrical engineering in 1976, and completed his master's degree in ECE in 1978. Sarah earned her bachelor's degree in agronomy in 1978. Both are grateful to UW-Madison for the critical thinking skills the university instills in students.

"It is not enough to learn solutions. You have to learn how to think and how to solve problems. Wisconsin does a good job of that while being fun at the same time," says David. "Those qualities—being able to enjoy what you do and be serious about it—I think are crucial, and that's what drives me."

The Epsteins are particularly thankful to the team of faculty and staff at UW-Madison who helped them to turn their gift into something that will impact the lives of students. "It was really great the way they took this idea and ran with it," says Sarah.

Graduate Student Association BRIDGES students, faculty and alumni

Graduate students in ECE know how to get work done and succeed academically.

ECE Graduate Student Association members *(from left)*, Ayushi Rajeev, Jayer Fernandes, Jonathan Snodgrass and Yaman Sangar.

But being an engineering student can be stressful—and the Electrical and Computer Engineering Graduate Student Association cracks through students' innate crust of academic anxiety and models a balanced life for students as they transition from the structure of undergraduate life to the uncertain frontier of professional life.

The association is a group of graduate students who represent different research focus areas within the department, steward a supportive graduate student community, and help students better connect with faculty, alumni—and with each other.

GSA members serve as informal mentors; as a group, the GSA is a bridge between the student body and the ECE faculty, offering a way for students to offer suggestions to the department.

In addition, they help with administrative issues like noting redundant courses in the course catalogue and encouraging the department to offer high-demand required courses more frequently.

"Previously it was just a black box—here are the courses, pick some," says Ayushi Rajeev, the association's president. "But now students have direct access to what is being offered."

Department Chair John Booske acts as a sounding board for the GSA, supporting its members as they explore ideas for how to enrich the community within the department. "Having a visible and robust peer social community for support is an important component for a healthy graduate program experience," says Booske.

To this end, the ECE GSA hosts an array of activities to promote student engagement within the department's diverse student body."It is diverse however you define diversity—in pretty much every metric of diversity that you can find, academic, religious, social, socioeconomic background, you name it," says Jonathan Snodgrass, a GSA member.

To bring together this diverse community, the GSA organizes academic, social and networking events. "The thing that's uniting us all is electrical and computer engineering," says Jayer Fernandes, a GSA member.

However, as a whole, the mission of the GSA and the activities it organizes reflect a balanced lifestyle. "Your education should be holistic, not just academics," says Snodgrass.

By modeling a healthy balance of academic, social, professional and community involvement, the association gives students a voice and empowers them to take charge of their education and future. "They help to nurture a social peer network among grad students that later in life can be the beginning of a professional network of Badgers," says Booske.

2017 Grainger Power Engineering Awards

At an April 10, 2017, banquet, 11 undergraduate and four graduate students received prestigious Grainger Power Engineering Awards, which recognize their outstanding performance in the classroom or in research in the field of power engineering. The undergraduate scholarship and graduate fellowship provide substantial financial support to each recipient.

Electrical engineering alumnus David Grainger (BS '50) established the award program two decades ago through funding from The Grainger Foundation.

The 2017 recipients include undergraduates Joel Cruvant, Jake Cummins, Thomas Cunniff, Nicholas Dunn, Daniel Eckerson, Jonathan Herzog, Gabriel Kinzer, Andrew Lueneburg, Samuel Mattison, Matthew Smuda and Jay Zoborowski, and graduate-level engineers Kevin Frankforter, Philip Hart, Ryan Knippel and Michael Rios.

THANK YOU!

In early May, we wrapped up our yearlong 125th anniversary celebration, which included events both near and far in honor of the faculty, staff, students, alumni and friends who are at the heart of our great department.

As we visited with you during these events, we heard many, many positive comments ("the seminars are awesome," "we've really enjoyed ourselves," "what a fantastic way to celebrate 125 years of success").

And as our year of celebration ends, we want to thank all of you who hosted, attended, and quite simply, had fun. This was an amazing year—and with your encouragement and support, now we boldly embark on the next 125 years of excellence and leadership!

College of Engineering
UNIVERSITY OF WISCONSIN–MADISON

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BADGERLOOP EARNS INNOVATION AWARD

Our students won one of two innovation awards in the SpaceX international Hyperloop pod competition. The UW–Madison Badgerloop team competed against 30 teams from colleges and universities from around the world in the second phase of SpaceX's Hyperloop pod competition, which was held Jan. 27-29, 2017, outside SpaceX headquarters in Hawthorne, California.

In June 2017, the Badgerloop team revealed its second-generation pod, which is built for speed. The team will compete with the new pod in California in August 2017.

Elon Musk sits inside the Badgerloop pod. *(Photo courtesy of Badgerloop)*

The judges noted the team's innovative designs, including the virtual reality setup that Badgerloop created. (*Read more about our students Peter Procek and Cale Geffre, who played lead roles in developing the VR experience: www.engr.wisc.edu/virtual-reality-goes-hyper-speed-badgerloop/*)

Badgerloop, which won third place in the initial round of SpaceX's Hyperloop pod competition, now is refining its pod for the next installment of the competition, which is set to take place in summer 2017 at SpaceX's Hyperloop test track.

MORE: www.engr.wisc.edu/uw-madison-team-wins-innovation-award-hyperloop-competition/