

SPRING/SUMMER
2017

CIVIL AND ENVIRONMENTAL ENGINEERING



UNIVERSITY OF WISCONSIN-MADISON



RESEARCH IS CRITICAL
TO THE FUTURE OF OUR WATER

BUILDING ON OUR EXCELLENCE



David Noyce

GREETINGS! We recently celebrated more than 125 students who graduated this year with majors in civil engineering, civil and environmental engineering, geological engineering, and environmental chemistry and technology.

Some of these students will pursue graduate degrees; others are planning to enter academia, while even more have excellent positions in industry at companies around the country. In fact, our students receive multiple job offers; representatives of the hundreds of companies that recruit on our campus tell us they seek our students because they are very high-quality, well-rounded engineers who are prepared to contribute to their companies right away.

Our students stand out in large part because of the resources and opportunities they have available to them throughout their education. Our world-class faculty are among those resources!

You might be surprised to learn that our department is made up of nearly 70 faculty members in three different groups:

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We have **29 tenured or tenure-track faculty members**—and these professors are at the leading edge of their fields and conduct research at national and international levels. As a result, they also expose our students to the issues, context and expertise they need to make contributions that help to change the world.

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An **additional 13 affiliate faculty members** from other departments, schools and colleges at UW-Madison also are engaged in research and teaching in our department. They contribute breadth and diverse perspectives to our students through the courses they teach and as colleagues and collaborators in our research. *You can read about some of these people on page 4.*

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Beyond these faculty, we have **27 adjunct professors** who have enjoyed highly successful professional careers and who now enthusiastically contribute their invaluable knowledge and experience as educators and mentors in our department. As a result, our graduates are fully prepared to take on leadership roles and to succeed at challenging assignments right away.

We are looking toward a very bright future: We are seeking to add as many as five new tenure-track or tenured faculty members to this mix. And, our total enrollment now exceeds 600 students. It's no wonder that students continue to show very strong interest in our department; we provide them an unparalleled educational experience that leads to very rewarding careers. And, given their investment—at less than \$11,000 per year, our undergraduate tuition is seventh-lowest among public Big Ten Universities—their education also is an incredible value.

And, located on 936 acres on the wooded shores of Lake Mendota—in a city consistently ranked among the best places to live in the nation—our campus is among our greatest assets. Our main campus is home to top business, law, medical, veterinary medicine and engineering schools. As a university, we cherish collaboration, dialog and diverse perspectives—and we dare to do what nobody else can.

If you think we're one of the best-kept secrets in the country, please help us change that. Tell everyone you know about our forward-looking, groundbreaking, world-changing University of Wisconsin-Madison Department of Civil and Environmental Engineering.

ON, WISCONSIN!

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Less than 6% of our CEE alumni provide annual gifts. Our alumni giving rate is one factor that's considered in our department's ranking. Please consider a gift to CEE, which will support our department in many ways.

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Jim Hurley is a busy man. In addition to conducting research as a CEE associate professor, Hurley chairs the department's interdisciplinary Environmental Chemistry and Technology (EC&T) graduate program and directs two federal-state research partnership programs for the UW System—the Wisconsin Water Resources Institute and Wisconsin Sea Grant, which are administered by the U.S. Geological Survey and NOAA's Office of Oceans and Atmospheric Research, respectively.

"It's a perfect position as far as I'm concerned," says Hurley of his interrelated roles on campus. "I get to be not only a part of cutting-edge research, but I get to run statewide programs that people are just passionate about."

The passion for these programs and what they represent—clean water, thriving coastal communities, innovative problem solving—runs deep among both the stakeholders the programs serve and the scientists whose research they fund. A lot of that important research is done by Hurley's CEE colleagues.

For instance, Wisconsin Sea Grant has funded research by Professor Chin Wu that is addressing Lake Michigan's coastal bluff erosion. It's an urgent problem for many of Wisconsin's coastal communities.

"Three years ago we were near record lows on Lake Michigan, and in the three years since the lake came up almost 4 feet and is now close to record highs," Hurley says. "That puts tremendous stress on coastal bluffs and shores. It's important that we understand it and work with people who own property near the bluffs to suggest ways they should respond to it."

Other CEE faculty with research funded by Wisconsin Sea Grant include Steve Loheide, who is researching green infrastructure that can mitigate the damage of large storms on Wisconsin's harbors and coastal infrastructure; Christy Remucal, who is studying photochemical degradation of pharmaceuticals and certain pesticides in Wisconsin surface waters; and Matt Ginder Vogel, who is working with researchers from Minnesota on mercury dynamics.

Hurley himself studies mercury in the Great Lakes as part of his faculty research role, and some of his latest research funded by EPA has applications far beyond the Great Lakes. Together with EC&T graduate

student Ryan Lepak, Hurley has developed a method that can tell the general origin of mercury contamination based on its isotopic ratios. Understanding the local sources of mercury contamination can help resource managers develop better mitigation practices.

Generally, mercury that accumulates in lakes originates from one of three sources: the atmosphere, by way of precipitation; on- or near-shore industrial discharge; or via rivers that drain surrounding watersheds into the lakes.

With the knowledge that the isotopic fingerprint of mercury found in Great Lakes sediments varies by location, Hurley and Lepak proposed a model that accounts for the three major sources of mercury. The three-end-member mixing model predicted that the site-specific contribution of these three sources to the Great Lakes sediment results in mercury deposition with distinct isotopic fingerprints.

Lepak and Hurley analyzed sediment samples taken by the USGS from sites all over the five Great Lakes. Their results confirmed their three-end-member mixing model, and thus provide a new tool for environmental resource and mitigation experts in their efforts to reduce mercury contamination in the Great Lakes and beyond. They show for instance, that most mercury in sediments of Lake Superior arrived by atmospheric deposition while mercury in sediments of Lake Ontario stems mainly from industrial contamination.

The mercury research illustrates why multidisciplinary research is critical for meeting the complex needs of Sea Grant's coastal constituents, which typically require expertise in biology, chemistry, engineering, the social sciences and many other disciplines.

"We're about identifying coastal problems and finding the best Wisconsin researchers to help solve those problems, and get those results to our stakeholders. That's the trust that we've built," Hurley says. "We do it as neutral brokers. We bring coastal science to the table and do it with a non-advocacy approach."

HURLEY'S MANY ROLES HIGHLIGHT IMPORTANCE OF SEA GRANT—AND INTERDISCIPLINARY RESEARCH

MORE: www.engr.wisc.edu/hurleys-many-roles-highlight-importance-sea-grant-interdisciplinary-research/



AFFILIATE FACULTY ADD HIGH VALUE TO CEE RESEARCH AND EDUCATION

The CEE department includes 29 core faculty members whose research impacts drinking water, energy systems, roads, bridges, infrastructure and more all over the world. But on top of that already impressive expertise, affiliate faculty members from a wide variety of other departments and colleges at UW-Madison tremendously enhance the strength of the department, says chair David Noyce.

"We have an even broader national and international research footprint through the relationship with our affiliate faculty members," Noyce explains. "In addition to expanding our research portfolio, they allow us to reach across the entire campus to touch many more students, including those in the College of Letters and Science and the College of Agricultural and Life Sciences."

The benefit of this relationship goes both ways. "My CEE affiliate appointment helps me connect my research interests to a much broader array of projects and expertise," says Tim Bertram, an associate professor in the Department of Chemistry. "It broadens my awareness to emerging questions that my research group may be uniquely equipped to contribute to and permits me to attract students I might not otherwise have access to."

The access to CEE students is also greatly valued by Tracey Holloway, a professor in the Nelson Institute for Environmental Studies and the Department of Atmospheric and Oceanic Sciences who leads the air quality research program in the institute's Center for Sustainability and the Global Environment (SAGE).

"Many of my graduate students take classes in CEE and my undergraduate research advisees draw from this and other engineering fields," Holloway says. "Having an appointment in CEE ensures that I'm connected with programs that support my research, teaching and advising and have frequent interactions with experts from other disciplines."

Michael Cardiff, an assistant professor of geosciences and a hydrogeologist who studies how aquifer heterogeneity influences groundwater flow and transport, couldn't agree more with Holloway.

"I appreciate my CEE affiliation for the access to the tools, facilities and faculty it provides," Cardiff says. "As a researcher at the bridge between hydrogeologic science and practice, working with engineers on applied scientific problems—such as geothermal energy optimization and the development of computational tools for environmental decision-making—is invaluable."

While Bertram, Holloway and Cardiff are in the College of Letters and Science, Joel Pedersen and Sharon Long, both professors of soil science, have academic homes in the College of Agricultural and Life Sciences.

Environmental chemistry expert Pedersen is a core faculty member in the department's interdisciplinary Environmental Chemistry and Technology graduate program and the university's transdisciplinary Molecular and Environmental Toxicology Center. "In these roles, I have strong intellectual affinities with CEE," says Pedersen. "As an affiliate, I value the access to excellent graduate students and the opportunity to collaborate with CEE faculty."

Pedersen's collaborations have included research with Professor Katherine (Trina) McMahon on the fate of infectious prion proteins in wastewater treatment plants and antibiotics in aquaculture facilities, as well as the management of fecal waste using human and bovine viruses, and other projects with Professor Emeritus Marc Anderson and former professor Craig Benson.

Long studies problems that can often be solved with a combination of applied microbiology and environmental engineering. "As a CEE affiliate, I am able to

recruit and fund students to work in interdisciplinary research groups," she says. "For example, a CEE master's student is currently working with a microbiologist whose expertise is in public health and infectious disease to assess whether adenovirus genotypes of human, bovine and porcine origin can be used in source-tracking applications for drinking water wells that are contaminated with a variety of pathogens."

Other affiliates are part of the College of Engineering. James Tinjum, an associate professor in the Department of Engineering Professional Development, works with many CEE professors each year to teach internationally attended courses on topics ranging from slope stability and landslides to pavement system design to foundation engineering and design.

"On the research side, I collaborate with CEE faculty in geotechnical, geoenvironmental and transportation engineering and have several students who are majoring in CEE and geological engineering," Tinjum says. "As the faculty advisor for the energy sustainability certificate, I interact with several dozen geological engineering undergraduates every year, some of whom conduct independent research with me as an option for their capstone requirement."

For Industrial and Systems Engineering Professor John Lee, the main benefit of his CEE affiliation is the exposure to ideas and perspectives that complement those of his own discipline. "It seems that every project meeting and dissertation defense helps me learn to see the world a bit more through the eyes of civil engineers," Lee says. "For example, my collaboration with Associate Professor Soyoung Ahn has taught me to think of traffic as an entity with properties and behaviors of its own—not just a collection of cars."

Lee, who directs the Cognitive Systems Laboratory, frequently collaborates with Noyce on projects that draw on their shared Driving Simulation Laboratory, which features a full-scale vehicle and a 270-degree screen. Noyce's interest in the interaction between infrastructure and driver, and Lee's in the relationship between driver and vehicle technology, nicely complement each other, especially now that traffic signs and lights are beginning to send information directly to cars.

"I think this kind of future requires an increasingly tight collaboration between Civil and Environmental Engineering and Industrial and Systems Engineering," Lee says.



Tim Bertram



Tracey Holloway



Michael Cardiff



Joel Pedersen



Sharon Long



James Tinjum



John Lee

THE SUPERCHARGED FUTURE OF WASTEWATER TREATMENT PLANTS

Wastewater treatment plants have a PR problem: People don't like to think about what happens to the waste they flush down their toilets. But for many engineers and microbiologists, these plants have been a hotbed of scientific advances, which has even prompted their trade organization to propose a name change to "water resource recovery facility."

That's because wastewater from our sinks, toilets, showers and washing machines can be turned into valuable products with the help of scientists and unique bacteria, some of which weren't even discovered—by pure chance—until the mid-1990s.

These latecomers to the research scene—anammox bacteria—are the subject of a new study led by Professors Daniel Noguera and Katherine McMahon, which was published in May 2017 in the journal *Nature Communications*.

The bacteria's name reflects their function: They turn

ammonium into nitrogen gas under anaerobic (oxygen-free) conditions. Researchers and treatment plant operators alike have been excited about these microbes because they have the potential to save a great deal of money.

"Being able to remove ammonium anaerobically is pretty important because about 50 percent of a sewage plant's operating cost is pumping oxygen into the water," Noguera says. "Some of this oxygen is needed to remove ammonium with the conventional method."

But anammox bacteria don't tackle their job in isolation. They are part of a community as complex as the microbiome in our gut that

breaks down food and keeps us healthy in many other ways. This community was the subject of the new study.

"We knew very little about the role of the bacteria that co-exist in anammox granules," Noguera says. "For the first time, our study identified detailed gene expression levels in these granules. This provides important clues on what the anammox bacteria and their partners might actually be doing and how they interact."

These partners are called heterotrophs since they rely on the anammox bacteria—which are autotrophs (primary producers), like plants capable of photosynthesis—to turn atmospheric

released into the atmosphere, while nitrate—an important plant nutrient—stays in the treated water. Regulations on the amount of nitrate that may be released vary by state, but excess amounts contribute to algal blooms in natural bodies of water, which may deplete oxygen levels for aquatic organisms.

An additional advantage of anammox bacteria, compared to conventional wastewater treatment, is that they convert a larger amount of ammonium to nitrogen gas.

Treatment plant operators now have to weigh the advantages of these new microbes against their implementation challenges.

Anammox bacteria grow very slowly, taking about seven days to double in number, and require closely monitored oxygen and temperature cycles, which increases operational complexity.

But anammox reactors are not the only option for the treatment plant

of the future to extract valuable resources from wastewater. In fact, some plants already produce more energy than they need to operate from the biogas that forms during the breakdown of organic material.

"Ten years from now, the typical treatment plant will probably look pretty different from today," Noguera says. "Recovered resources may not only include clean water and energy, but also a variety of chemicals, such as fertilizers and precursors of plastics and fibers. As part of this evolution, I believe anammox reactors will soon become conventional."



Left: Graduate student Christopher Lawson samples biomass at an anammox bioreactor at Radboud University in Nijmegen, The Netherlands. (Photo courtesy of Christopher Lawson) Right: Daniel Noguera and Trina McMahon study how anammox bacteria may improve conventional wastewater treatment methods. (Photo: Stephanie Precourt)

carbon dioxide into organic carbon. Among the most intriguing results of the new study are novel hypotheses for the exchange of biochemical material between these two groups of microbes.

The heterotrophs receive the organic carbon they need to grow from the anammox bacteria, in the form of several specific molecules the researchers discovered in the study. In return, the heterotrophs convert nitrogen into a form that anammox bacteria require for growth.

A conventional wastewater treatment plant converts ammonium, which is toxic to fish, into nitrogen gas and nitrate. Nitrogen gas is



Image courtesy of UW Housing

WITTE HALL RENOVATION INSPIRED BY CEE CAPSTONE STUDENTS' DESIGN

The CEE senior capstone course gives undergraduate students the opportunity to take on real-world design projects much like they will encounter down the road in their careers.

Some of these senior design projects have an impact that is much closer to home. In fall 2012, Jimmy Schumacher, Tyler Hietpas, Kyle Busch and Yafei Zhang proposed a simple, yet viable, solution for renovating Witte Residence Hall, a two-tower student dorm on the southeast side of the UW-Madison campus. At more than 50 years old, the dorm needed a major update of its resident spaces, building systems and infrastructure.

The student team proposed that UW Housing connect Witte's two towers. That link would create large common spaces for students and eliminate the need to shut down the entire dorm for the duration of construction. "We were thinking that connecting the two towers would make everyone feel more at home, or together," says Schumacher, who graduated in 2013 and currently works for the Wisconsin Department of Transportation in Milwaukee.

For Associate Director of University Housing Mike Kinderman, the proposal was

an elegant solution. "When something like this pops up, you say, 'Why couldn't we think of something like that?'" Kinderman says. "It was the best design we looked at."

UW Housing, which operates 19 residence halls on campus, had considered different options and ultimately determined the CEE team's design was the most cost-effective and practical. In addition to the new common spaces on every floor, which will join the two towers, UW Housing also is adding an extra floor to compensate for any rooms displaced by the renovations. A number of additional updates will be made to the building, including new heating, ventilation and air conditioning systems, temperature controls in rooms, electrical systems, security and the like. Construction began in March 2017 and will continue through the summer of 2019.

At the core of these renovations is the hard work and ingenuity of CEE students. Schumacher, who lived in Witte Hall his freshman year, is

looking forward to seeing his team's design become a reality. "It's nice that instead of knocking Witte Hall down, UW Housing is making it better than when I was there," he says. "It's neat that I was lucky enough to have this project, and five years later to see that they're actually doing it, is rewarding. I can say that I had a little piece in it."

The students were guided through their project with the help of two mentors, an architect and a structural engineer. Mentorship is a key aspect of the CEE capstone course that offers an invaluable "real-world" perspective as the students create their designs.

"The mentors we had really cared about helping, and giving back to the school," says Schumacher. "They were always around to ask questions."

According to Charles Quagliana, an CEE adjunct professor and an architect by training, the project exemplifies how the capstone design course benefits students. "Our class has a focus on project-based learning, and this was an excellent real-world and open-ended project for our students," he says.

The final design of Witte Hall includes key elements of the students' design, and the collaboration with UW Housing has also yielded a design for the renovation of the Sellery Hall dormitory, scheduled to begin in 2022.

UW startup bringing high-speed gene sequencing to water purity tests

Access to clean water is a fundamental part of public health, yet tests for the bacteria, viruses and protozoans that cause water-borne diseases are fundamentally little changed since Robert Koch helped pioneer the germ theory of disease in the 1880s.

Now, a fledgling company that emerged from CEE promises to change that by applying high-speed genetic sequencing to the difficult problem of detecting—and for the first time counting—these pathogens.

Today's approaches are too slow and too specific, says Francisco Moya, CEO of Pathogenomica and PhD candidate in CEE. "The problem with current techniques is that they require specific tests to identify each pathogen. You need to look one by one."

Currently, organisms in samples are cultured in lab dishes, which can take up to two weeks. Then, after they have multiplied sufficiently, they are tested for pathogens. But each analysis aims at one specific pathogen.

There are many potential pathogens, but it's expensive to test for them all—a task Moya likens to trying to open hundreds of locks. "With current technology, you would have to design a different key for each lock. It's much simpler to come up with a master key. We call next-generation sequencing a master key because it can unlock all the known pathogens present in a sample."

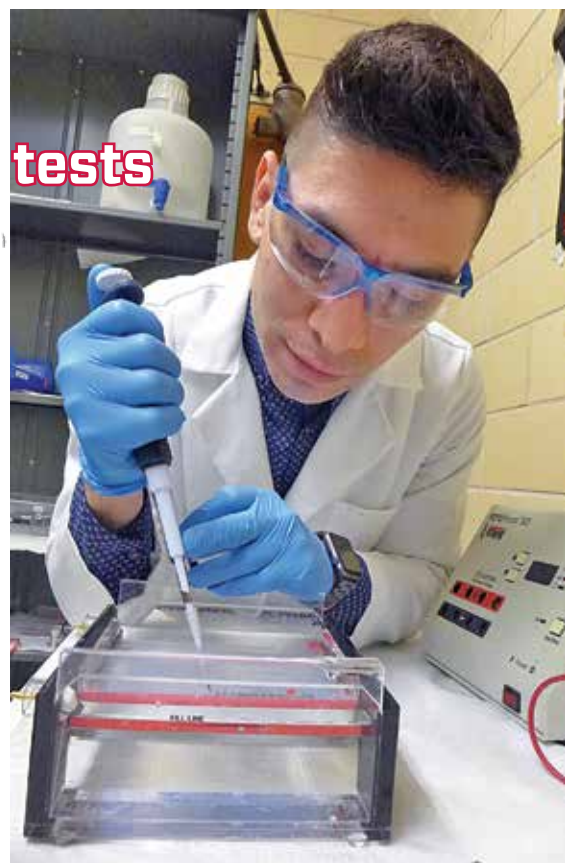
The battle for clean water is far from over, says Moya. The World Health Organization estimates that 842,000 people die each year due to problems with water supply, sanitation and hygiene.

Pathogenomica's better idea focuses on telltale strands of genetic material that can be used

Improved
detection of
waterborne
pathogens



Pamela Camejo injects microbial samples into a library for sequencing.



Francisco Moya loads DNA into gel for a quality-assurance procedure. (Photos by David Tenenbaum)

to pinpoint the identity of bacteria, viruses and protozoans. One of these strands, called 16S rRNA, has been used for about 25 years to identify bacteria. But until recently, the necessary sequencing process has been too slow and expensive for routine use in a water quality lab.

No longer, says Moya. Once the company starts operating in a year or so, it will be a very simple process, he says. "The customer sends a sample, we do the sequencing, and we compare the results to a proprietary database to classify the microbes as pathogenic or non-pathogenic—a bad guy or a good guy."

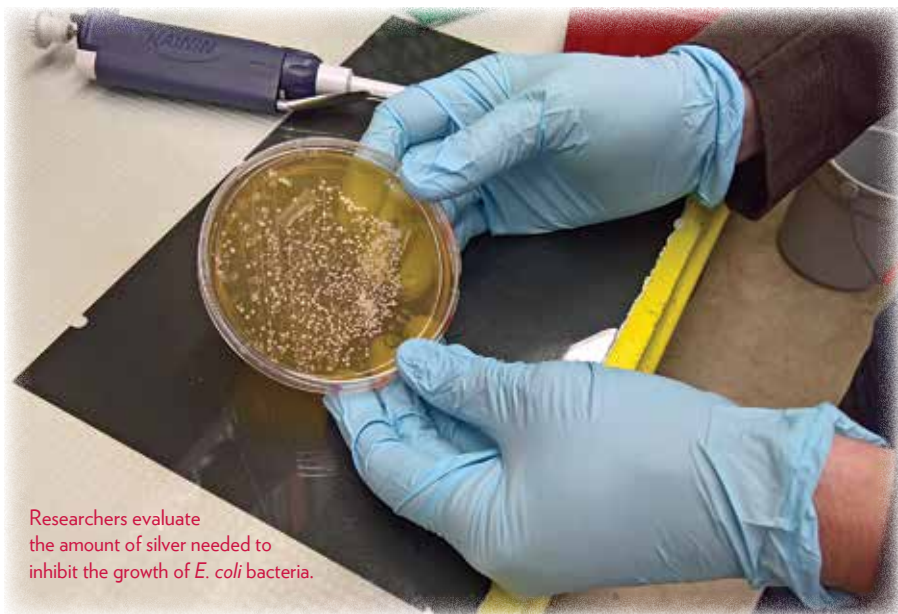
At that point, the customer receives a report, showing the identity of pathogens present, along with a risk assessment and an interactive diagram showing the classification of the microbes. The entire process should take no longer than a week, Moya says.

The need to detect a broad range of pathogens was reinforced at the end of 2015, when a bacterium called *Elizabethkingia*, which is not detected in current water quality screens, made 63 people ill in Wisconsin. Most of the patients were elderly, and 18 of them died. Although it's not clear if the fatalities were due to the bacteria or underlying medical conditions, the outbreak does illustrate the importance of screening drinking water for a wider range of pathogens, Moya says.

The Pathogenomica advantage rests on dramatic improvements in genetic sequencing. "This move to genetic sequencing is way overdue," says Moya's advisor, Professor Trina McMahon. "There is a lot of potential for much more sophisticated surveillance."

MORE: www.engr.wisc.edu/

[uw-startup-bringing-high-speed-gene-sequencing-water-purity-tests/](#)



Researchers evaluate the amount of silver needed to inhibit the growth of *E. coli* bacteria.

Ancient material, new technology: An engineer's perspective on using silver against microbes

Humans have appreciated silver's antimicrobial activity for millennia. Hippocrates used the precious metal for wound dressings while the pioneers of the American frontier placed coins in their water to guard against bacteria and algae.

But it takes 21st-century technology to push the amount of silver needed to combat disease-causing microbes into the nanoscale realm—something like a sheet of paper divided by 100,000. As researchers explore these limits, they are walking a fine line between silver's desirable properties and its potential toxicity to the environment.

A perfect case in point is a recent question that Assistant Professor Andrea Hicks and colleagues set out to answer: What is the environmental impact of nanoscale silver-coated reusable hospital gowns, compared to the single-use disposable gowns employed by 80 percent of our hospitals, when the goal is to reduce the incidence of hospital-acquired infections?

These nosocomial infections cause an estimated 99,000 deaths per year in the United States; combined with other forms of medical error, they are considered the third-biggest killer after heart attacks and cancer. "It's one of these silent things that most people don't think about," Hicks says. "But the rise of MRSA, or methicillin-resistant *Staphylococcus aureus*, a few years ago illustrates the importance of preventing hospital textiles from transmitting pathogens."

Since most nanosilver textiles lose some of their silver coating every time they're laundered, Hicks zoomed in on a novel technology that aims to solve this problem. "The nanosilver solution we studied is sold with a chemical linking agent," Hicks explains. "You put the silver and linking agent into an industrial washer, along with the reusable hospital gown, and it will re-coat the textile every time."

Hicks used a tool called life cycle assessment to model the energy required to produce the two types of hospital gown—silver-coated reusable versus disposable—and the energy needed to maintain and eventually dispose of them. The concept of "embodied energy" is a commonly used metric for



Andrea Hicks

comparing the environmental impact of different products.

After a single use, a disposable gown ends up in the landfill, while a reusable gown is laundered an average of 75 times before it is discarded. Taking into account the greater amount of energy needed to produce and maintain the reusable gown, Hicks found the break-even point, or environmental parity, to be about 12 wearings.

"After 12 uses, the reusable gown has a lower environmental impact than the disposable gown," Hicks says. "The longer it is in use, the greater the difference will be."

The exact difference depends on how often the silver has to be reapplied to maintain its antibacterial properties. For the current study, the researchers estimated this quantity from the amount of silver needed to inhibit the growth of *E. coli*, one of the best-characterized human bacteria. The environmental parity point would likely change if other pathogens were considered, and also depends on the chemical form in which silver is released during the gown's use phase.



Byce Richner

Disposable hospital gowns are ubiquitous, but leave a lasting environmental legacy in landfills. Nanoscale silver-coated reusable gowns may be an alternative.

While the environmental scale tipped in favor of nano-enabled reusable gowns under these assumptions, Hicks considers it premature to endorse their large-scale adoption. "We need to better understand how well they protect against hospital-acquired infections and how to prevent the silver from harming the environment or our own bodies before deciding whether the benefits outweigh the convenience and lower cost of disposable gowns," she says.

MORE: www.engr.wisc.edu/ancient-material-new-technology-engineers-perspective-using-silver-microbes/



WISCONSIN PROVING GROUND PAVES WAY FOR **DRIVERLESS VEHICLE RESEARCH**

A partnership including our engineers has been named one of 10 proving grounds for driverless cars and trucks by the U.S. Department of Transportation.

The future of transportation undoubtedly includes vehicles that operate with little or no input from human operators, according to Peter Rafferty (*pictured*), a program manager at CEE's Traffic Operations and Safety Laboratory (TOPS). Former Transportation Secretary Anthony Foxx, who announced the proving grounds in January, expects them to serve as a network of pooled expertise to speed the safe deployment of driverless vehicles.

"There are still a lot of questions of safety and human interaction and plenty of technological challenges that need addressing," says Rafferty. "The Department of Transportation wants to make sure the lessons learned in that work are being shared, and being involved in this network means Wisconsin has access to that knowledge and an opportunity to contribute."

The TOPS Lab and MGA Research in Akron, New York, led an effort to gather space and expertise to attract researchers testing autonomous vehicles (AVs) in all sorts of conditions.

"AV technology in development ranges from one- and two-person vehicles and small buses for local trips up to platoons of trucks driving in tandem on the interstate," Rafferty says. "We have places to test most or all of them."

The Wisconsin AV Proving Grounds include MGA's site in Burlington, Wisconsin—400 acres of roadways and crash-testing facilities originally built as a proving ground for American Motors cars—and the 4-mile racing circuit at Road America in Plymouth, Wisconsin, which provide secure environments for AV testing. The



sprawling headquarters of Epic Systems in Verona and UW-Madison's own streets are also included in the proving grounds.

"There's evidence of unmet demand for these proving grounds—controlled roads where you can safely challenge a vehicle and figure out how to make it react differently to a big rock in its way than it would to a shopping bag in the street or to tell the difference between the ruts that develop in new snow and broken pavement," says Rafferty.

Madison roads, Wisconsin highways and the campus layout at UW-Madison and Epic would pose more public and realistically interactive situations for driverless vehicles. "An intersection in the middle of campus at class-changing time is a completely different—but equally important—set of challenges to address," Rafferty says.

Rafferty and the city of Madison are interested in the way the vehicles could be deployed to better connect people who cannot afford or otherwise operate their own cars to public transit and vital services like healthcare. Industry users of the proving grounds could also draw on UW-Madison experts in data collection, high-resolution mapping, computer and vehicle networking, and engine and power production.

"There are all kinds of concepts in formulation, and I really want to get those vehicles here to start working on proving their capabilities and user acceptance," Rafferty says. "And because we have this commitment to infrastructure, we can get them going here for thousands of dollars instead of millions of dollars."

Above: Autonomous vehicles range from interstate freight trucks to small people-carriers—like the Navya Arma (*pictured*)—that may prove useful on Wisconsin Proving Ground sites like campuses at UW-Madison or Epic Systems in Verona.

Graduate student **Nick Jordan**, who works in Professor Chin Wu's lab, won an award for the best student poster presentation at a conference held by the International Association for Great Lakes Research. The title of his poster was "Coastal Evolution Adjacent to Shoreline Protection Structures on Wisconsin's Lake Michigan Coast."

Renee Olley and **Morgan Sanger**, undergraduates in geological engineering, received a Wisconsin Idea Fellowship and an American Family Insurance Social Entrepreneurship Award from the Morgridge Center for Public Service. Mentored by researcher Angela Pakes, the students will collaborate with the Madison Metropolitan School District and the Wisconsin Concrete Pavement Association to encourage middle school girls to consider STEM-related careers with an interactive classroom exercise that fosters teamwork skills, logical reasoning capacity, and sustainability awareness.

GLE and geosciences undergraduate **Kyle Powers**, with fellow students Anna Ostermeier (geography, environmental studies) and Brooke Nelson (biology, environmental studies), also received a Wisconsin Idea Fellowship from the Morgridge Center for Public Service. Mentored by Nelson Institute for Environmental Studies professor Cathy Middlecamp, the students plan to introduce upcycling to rural communities in Costa Rica, promote sustainability leadership opportunities for young people, and support the region's socioeconomic development, in collaboration with a local community partner.



Beth Johnson, senior communications specialist, received the college's University Staff Distinguished Achievement Award for her

dedication, leadership and attention to detail. She is a welcoming presence for alumni, students, and friends of the department and she seamlessly manages numerous events like the CEE annual golf outing and the college's graduate recognition ceremony.



Professor **Trina McMahon** received the college's James G. Woodburn Award for Excellence in Undergraduate Teaching for her innovative

and engaging pedagogic methods, including a flipped classroom style and an infectious exuberance for the material she presents, and for promoting teaching excellence through college, campus and national efforts.

McMahon also received the ARCADIS/AEESP Frontier in Research Award from the Association of Environmental Engineering and Science Professors for her leadership in an innovative research area and her outstanding impact on environmental engineering.



Professor **James Schauer** was named director of the Wisconsin State Laboratory of Hygiene, established at UW-Madison in 1903

to improve and protect the human condition by providing accurate testing, service, research and education in environmental health, as well as occupational health and safety, in partnership with academic departments.

ALUMNI NEWS

Are you an alum who has news to share? Please contact Beth Johnson at beth.johnson@wisc.edu.



David Basco (BS '60, MS '62) was named the 2016 international coastal engineer of the year by the Coastal Ocean Port and Rivers

Institute (COPRI) of the American Society of Civil Engineers. He was also named a 2016 Distinguished Alumnus of the IHE Delft Institute for Water Education in Delft, The Netherlands, where he obtained a postgraduate diploma in hydraulic and coastal engineering in 1976, after receiving a PhD degree from Lehigh University in 1970. He retired in 2014 from Old Dominion University in Norfolk, Virginia, and continues to be active as a coastal engineering consultant.



Kevin Orner (BS '08) received a Fulbright U.S. student program award for an environmental engineering project in Costa Rica during

the 2017-2018 academic year. Orner is a PhD candidate in environmental engineering at the University of South Florida, where he studies resource recovery from wastewater treatment plants. After completing his UW-Madison degree, he was a Peace Corps volunteer in Panama for two years before returning to graduate school. In Costa Rica, Orner will be based at the University of Georgia-Costa Rica in Monteverde to conduct research on nutrient and energy recovery from pig and cow manure.

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UW-MADISON
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Named professorships honor faculty accomplishments



AWAD HANNA: Decades of leadership for construction engineering and management

In the early 1990s, Awad Hanna and his colleague Jeffrey Russell established UW-Madison's construction engineering and management (CEM) program. Today, more than a third of CEE's undergraduates pursue CEM as a career choice. As one of only six programs of its kind in the nation, it is highly ranked and especially proud of its high percentage

of female graduates. Hanna and Russell also co-founded the Construction Club, a popular student organization that provides leadership experience and industry networking opportunities.

Beyond his passion for teaching and mentoring more than 100 CEM trainees, Hanna—an elected fellow of the American Society of Civil Engineers—maintains a busy research portfolio. He received an outstanding researcher award from the Construction Industry Institute and the Thomas Fitch Rowland award for a paper that reflects his long-term partnership with the Boldt Company.

The company, which traces its origins to a small carpentry shop opened in 1889 in Appleton, Wisconsin, by Martin Boldt, has grown into one of the nation's largest construction contractors with

more than 2,000 employees at 13 locations and a portfolio spanning a wide range of industries. Honoring many years of productive collaboration, the CEE department has now awarded Hanna the Boldt Company Professorship.

"I am excited to continue to focus on lean value-driven construction and integrated lean project delivery, which are some of Boldt's core principles," Hanna says. "Boldt has been one of the most generous sponsors of the CEM program, and its students and faculty really appreciate the company's consistent and reliable support."



WILLIAM LIKOS: Seeing soil as spectacular

Dirt is anything but dull for CEE professor William Likos. He first became fascinated by soil as an undergraduate when he realized that the complex characteristics of an individual patch of dirt cannot simply be looked up in the appendix of an engineering textbook. Since then, his research has focused on processes near the soil surface that affect its mechanical and

hydraulic properties and help predict landslides and soil contamination.

Engineers can and should contribute to policy decisions, says Likos, who also directs the department's geological engineering program. "Investments need to be made, but the important question becomes how to make these investments with the right amount of foresight as the transportation, energy, and communication landscapes and new technologies continue to evolve," he says.

Honoring Likos's deep commitment to both teaching and innovative research, the department has now named him the Gary Wendt Professor. Wendt is a CEE alumnus who was the chairman and CEO at GE Capital Services for most of his career. He was also the CEO of CNO Financial

Group and co-founded Deerpath Capital Management. Though he lives in Florida today, his presence resonates across the UW-Madison campus through a long history of philanthropy.

With the flexibility that accompanies a named professorship, Likos looks forward to pursuing both applied research and "high-risk/high-reward" projects, for which the inspiration sometimes strikes him when he least expects it—during a shower, for example. His track record, which includes two Norman Medals from the American Society of Civil Engineers, indicates that those ideas often pay off.



BIN RAN: Driving the future of transportation

America is driving toward a future where autonomous vehicles will rule the roadways, and Professor Bin Ran has been a pioneer in steering transportation research for several decades.

Ran's far-reaching research interests span multiple aspects of moving people from place to place. His group develops technologies for intelligent transportation systems, models dynamic traffic patterns, creates mobile probes to estimate flow along roadways, and codes big-data algorithms to manage massive amounts of multi-modal transit information.

Currently, amidst growing public interest in autonomous vehicles—the driverless "smart" cars—Ran is working to give an intelligence boost to an often-ignored component of the transportation infrastructure: roads. "Smart cars will be much safer if they drive on smart highways," Ran says.

Communication between cars and the roads beneath their wheels will enable the most efficient traffic flow. Additionally, smart highways could potentially avert disasters by causing autonomous vehicles to slow down well in advance of danger. Ran has been developing theories about smart highways since the mid-1990s, and the Department of Transportation's recent announcement that

UW-Madison will become a testbed for self-driving cars will allow him to implement several of his proposals in real-world experiments.

Among all of his achievements—including holding several patents, having contributed to hundreds of referenced papers, and authoring a widely-used textbook about dynamic traffic networks—Ran is most proud of contributing to the academic development of legions of young scientists who spent time in his lab over the years, several of whom have gone on to establish their own research programs around the world.

To honor and augment his work, UW-Madison recently named Ran a Vilas Distinguished Achievement Professor.



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