

INDUSTRIAL AND SYSTEMS ENGINEERING



**RIGOROUS
AND RELEVANT
RESEARCH**



Greetings from Madison!

It's an exciting time here on campus. Our students are preparing for careers that will position them to make important contributions to the world of engineering in the coming generations. Our faculty are engaged in critical, impactful research for the greater good. Our alumni are enhancing the reputation of #BadgerEngineers worldwide. And I get the honor of helming this incredible department.

There is plenty of important news to share with you in this newsletter.

New this fall, we are launching a certificate in engineering data analytics, which is available to all of our college's undergraduate students and will holistically cultivate an engineering mindset to solving problems through data science. This certificate, developed in collaboration with our friends in the Department of Electrical and Computer Engineering and housed within our department, cements our status as the "go-to" place for data science within the college.

Our graduate program now serves a record number of participants, both in our MS and PhD programs. These students are active and engaged, as evidenced through the awards they've received as individuals, and through our student organization chapters. This year, two of our graduate students were recipients of NSF Graduate Research Fellowships, which are among the most prestigious awards of their kind. The energy of these students, along with their undergraduate counterparts, makes for a very invigorating atmosphere on campus.

In response to the increased demand for an engineering education from UW-Madison, as well as our growing research footprint, we're adding faculty and staff. Ranjana Mehta, an expert in human factors, joins us this fall as a full professor. Her research is advancing our knowledge of cognition at the mind-motor-machine nexus. We're excited to have her here in Madison!

All of these accomplishments wouldn't be possible without the support of our ISyE community. We are grateful for you and your continued interest in our department. If you find your way to campus in the coming months, we'd love to have you stop by and visit us in person. Until then, please feel free to reach out by phone or email.

On, Wisconsin!

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Cover photo: PhD students Valerie Odeh-Couvertier (right) and Fernando Acosta-Perez both came to Assistant Professor Gabriel Zayas-Caban's lab from University of Puerto Rico-Mayagüez to pursue operations research. Photo: Joel Hallberg.



Accelerated Engineering Master's Programs

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“I always used to question myself, if I ever wanted to move, where would I consider moving? And UW-Madison would always come up top, for a lot of reasons.”

FOCUS ON NEW FACULTY

Mehta explores connections between mind, motor, machine

A worker wearing an exoskeleton can lift heavier objects without straining muscles, increasing productivity while reducing injury risk. At first glance, it’s a clear improvement, seemingly without any drawbacks.

But how does wearing such a device impact the worker’s cognitive abilities? Does it add a mental load that might distract attention from, say, an oncoming forklift?

“You have to develop new motor models for how you move, which takes up some cognitive resources,” says Ranjana Mehta, a neuroergonomics researcher who’s exploring these sorts of questions—ones that are often overlooked but carry serious ramifications for workers.

Mehta has brought her work investigating what she calls the ‘mind-motor-machine nexus’ to UW-Madison, joining ISyE as a professor in August 2023.

She arrives in Madison after 10 years at Texas A&M, where she had earned tenure. Prior to that, she was on the faculty at Michigan Tech.

Mehta’s research spans the fundamental and applied realms, from looking at the neurophysiological mechanisms of fatigue to assessing trust in collaborative robots and developing sensory and neural augmentation to enhance human performance. She’s particularly keen to study human behaviors under real-world stresses across representative demographics, all with the intent of enhancing health and safety.

“The world is changing; the present and future work now includes robotics and AI,” she says. “Research is still looking at how the human mind and body respond to these technological systems in silos. You have folks who do exoskeleton research, and they largely focus on biomechanical outcomes, but not how it impacts the user’s cognitive or social behaviors. And then you have folks who study extended reality applications, where they look at how augmented reality or any other interfaces support user cognition, but you don’t know how it’s impacting a user’s mind-motor interactions or diverse user demographics. These investigations are needed for fluent and more inclusive human-technology partnerships.”

Mehta joins her former colleague and current collaborator Tony McDonald in ISyE, where they’ll continue a project studying brain-behavior mapping of driver trust in autonomous vehicles. She’s honored to join the department’s group of human factors faculty, including longtime Professors John Lee and Robert Radwin. She remembers reading the latter’s papers as a PhD student at Virginia Tech.

“They are giants in human factors,” says Mehta, who also holds degrees from the University of Mumbai and the University at Buffalo. “I always used to question myself, if I ever wanted to move, where would I consider moving? And UW-Madison would always come up top, for a lot of reasons.”

One of those reasons is the opportunity to build collaborations across departments and campus. She’s particularly interested in connecting with researchers in the School of Medicine and Public Health’s Department of Emergency Medicine to further her work regarding emergency medical technicians—a context where stress and fatigue test mind-motor interactions.

Mehta will bring her research into the classroom in a new graduate-level course, ISyE 859: *Mind-Motor-Machine Interaction*. She’s also planning to develop a new undergraduate lab-based course on human factors and ergonomics that will allow students to actively try out a range of different methods, including eye tracking, electromyography, wearables and more.

Beyond specific tools, though, she’s keen to instill the value of bringing a ‘convergence mindset’ to sociotechnical problems. It’s an approach she’s cultivated since being simultaneously captivated by courses on human information processing and biomechanics as a first-year PhD student. Those two seemingly disparate fields have become the intersection for her research.

“Working at the intersection of different disciplines is challenging, sometimes frustrating, but quite rewarding at the end,” she says. “I really love where I am in terms of the work I’m able to do—by leading use-inspired research in human factors and ergonomics, and teaching and mentoring the next generation of human factors engineers.”

New certificate instills data science skills

Hailey Mendola is a junior whose penchant for crunching numbers is leading her toward a career in manufacturing—ideally as a plant manager someday.

“I love looking at data,” says Mendola, a native of Oak Creek, Wisconsin, who spent summer 2022 interning at Lavelle Industries, a rubber and plastics manufacturer in Burlington, Wisconsin. “Being able to pinpoint and use those numbers to find new ways to do things and be able to manipulate data to figure out things easier, quicker, more efficiently.”

In order to realize her career goals, though, Mendola realizes she needs to build out her data science skillset, along with credentials to entice future employers. To help prepare students like Mendola for the evolving workforce, the college launched a new undergraduate certificate in engineering data analytics in fall 2023.

“Data is everywhere,” says Amanda Smith, an assistant teaching professor in ISyE who’s helped lead efforts to develop the certificate program. “Everything now is really based on data—collecting data, analyzing data, interpreting data and using data to make decisions. Regardless of industry, regardless of the specific job, having a basic understanding of how to do those four key things with data—you basically can’t be a successful engineer without those skills. And what we’re hearing, especially from a lot of the bigger-name employers that hire our students, is that they’re really not even considering candidates who don’t have a sound background in data science, data analytics.”

While the new certificate program is a joint effort between ISyE and the Department of Electrical and Computer Engineering, it’s open to all undergraduates across the college who are interested in augmenting their education.

To reach the required 15 credits, students will choose courses in four categories—foundations of data analytics, applications of data analytics, data science, and machine learning—before taking a required capstone course, *Ethics of Data for Engineers*. Kangwook Lee, an assistant professor of electrical and computer engineering whose research includes improving fairness in machine

learning, is developing the new course, which will launch in spring 2024.

“The ethics component is very important,” says Eduardo Arvelo, an assistant teaching professor of electrical and computer engineering who’s helped create the certificate program. “I think these next few years will be a very clear demonstration of the impact of these tools in everybody’s lives, from the bad actors who can use this technology for harm. And I think having this understanding from an early age in people’s careers will set them up for success and for the good of society as well.”



While students will learn programming in languages such as Python and Julia, database management skills, and the mathematical fundamentals underpinning modern analytical techniques, Arvelo says the program will more holistically cultivate an engineering mindset to solve problems through data science. He and Smith are hopeful more departments across the college will add course offerings that apply data science to different engineering domains in the coming years.

“Our program will tailor to engineering situations,” Arvelo says. “There will be many paths for students to take. I think as the program develops over the years, there will be a lot of engineering-focused courses that will enrich students’ experience beyond just pure data science or pure data analytics courses.”

Students work in ECE 532: *Matrix Methods in Machine Learning*, one of the courses that’s part of the new undergraduate certificate in engineering data analytics. Photo: Tom Ziemer.



Assistant Professor Gabriel Zayas-Caban (right) works with PhD students Valerie Odeh-Couvertier (left) and Fernando Acosta-Perez. Photo: Joel Hallberg.

Zayas-Caban industrious in efforts to open STEM doors

When Gabriel Zayas-Caban arrived at UW-Madison as an assistant professor in 2017, he was already familiar with the campus. His sister, Teresa, had earned her PhD from ISyE a little more than a decade earlier.

The siblings followed in their parents' footsteps in attaining doctoral degrees, and Gabriel used to rely on his sister—who's six years older and now assistant director for policy development at the National Library of Medicine—to proofread his graduate school admissions essays. Suffice to say, the family was well-acquainted with academia.

"You kind of see how the system is navigated," says Zayas-Caban, "and that helps a lot."

But he realizes many students, particularly those from groups traditionally underrepresented in STEM fields, don't approach college with those same advantages. And he's keen to play his part in opening the pathway to an advanced education to a broader swath of students,

including those from underrepresented identities and rural Wisconsin.

In between teaching and applying data science methods such as causal inference to hospital admissions decisions and other healthcare research questions, Zayas-Caban has prioritized diversity, equity and inclusion outreach at the intersection of industrial engineering and applied mathematics.

He's recruited students in new places, such as the University of Texas Rio Grande Valley and at the Math Alliance Field of Dreams Conference. In 2019, he developed a bootcamp, with funding from the Institute for Operations Research and the Management Sciences (INFORMS), to expose undergraduate students from smaller schools to research work and graduate-level courses in both ISyE and math at UW-Madison.

He currently advises three graduate students from the University of Puerto Rico-Mayagüez, the city where he was born on the island commonwealth. One of those students, Fernando Acosta-Perez, is

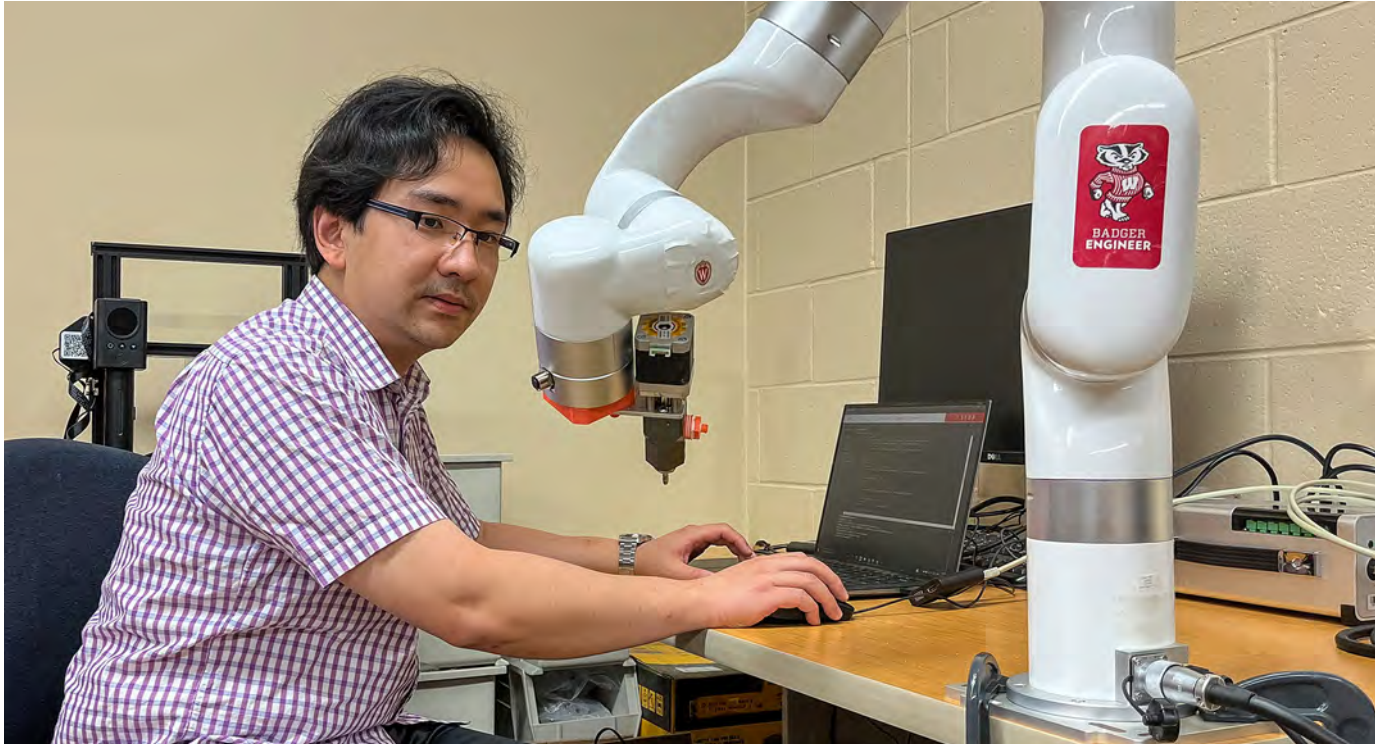
part of the college's Graduate Engineering Research Scholars program for students from underrepresented backgrounds and received a National Science Foundation (NSF) Graduate Research Fellowship.

"One of my goals really is to question those beliefs that people have about merit," says Zayas-Caban. "Some people have been pushed out of this world. Does that mean they're less capable? I fundamentally don't think that's the case."

For his efforts, Zayas-Caban received the college's 2023 PPG Industries Inclusion, Equity and Diversity Award, to go along with an early career honor he garnered from the Minority Issues Forum of INFORMS in 2020.

In 2022, Zayas-Caban joined the Wisconsin Louis Stokes Alliance for Minority Participation (WiscAMP) as co-principal investigator. He'll be overseeing the grant renewal for the NSF-funded program, which connects colleges and universities across the state in an effort to bolster representation in the STEM workforce.

"It's a country full of talent, it's a state full of talent," he says. "It's just a matter of looking for that and giving them the chance."



PhD student Weijun Shen envisions this robotic arm working as part of an autonomous road repair system. Photo: Tom Ziemer.

Work of art: PhD student brings origami to 3D printing

At home, Weijun Shen enjoys crafting origami cranes and frogs for his 4-year-old daughter.

But the ISyE PhD student also brings his artistic curiosity into the research lab, in what might seem like an unlikely area: additive manufacturing, or 3D printing.

As part of Assistant Professor Hantang Qin’s lab, Shen is incorporating methods from origami and kirigami (a related Japanese practice of cutting and folding) to create biomedical tools—in addition to using other technologies and techniques to help develop an ambitious autonomous road repair system.

Shen transferred to UW-Madison in fall 2022, following Qin from Iowa State University. After applying origami and kirigami techniques to 3D printing structural reinforcements for oil pipelines, Shen has turned his attention to biomedical solutions.

He and Qin are trying to replicate their previous work at a much smaller scale to create stent grafts, while combining more flexible tubular origami structures with electrohydrodynamic jet-printed metal sensors to produce soft robotic components. Those could be deployed in the body to monitor various health conditions, such as acidity in the gastrointestinal tract, or for timed drug release and controlled externally.

“We can put that sensor into a capsule, you will swallow it, and according to the external stimulation, it can self-deform or shape into a predesigned structure for a sensor or an antenna to get some information,” says Shen, who’s also working on flexible sensors for wearable technology to monitor back and shoulder conditions.

Shen’s other research project doesn’t involve foldable structures but is unique in its own right. In collaboration with researchers from the

Department of Civil and Environmental Engineering, he’s devising a system that uses a 3D scanner and extruder to detect and repair cracks, potholes and other road damage. The researchers hope to mount the whole setup on an autonomous vehicle or robot to carry out less disruptive repairs.

“Our target is to repair the pavement during the night,” says Shen, whose group incorporated machine learning into the system after competing in a student data analytics competition sponsored by the Institute of Industrial and Systems Engineers. “Everybody goes to sleep, we release our robots, fix the pavement during the night without stopping traffic. When everybody wakes up, the road is done.”

Shen and the rest of the research team have met with officials from the city of Middleton, just west of Madison, to help inform the project. He says the notion of working on research that directly benefits the surrounding community—the Wisconsin Idea—is a big part of what’s made UW-Madison a good fit for him, along with educational opportunities for his daughter and weather that reminds him of his home city of Shanghai.

He plans to infuse the philosophy of service into his teaching when he pursues a faculty career after completing his PhD in 2024. Before starting graduate school, he spent six years working in a teaching lab at his alma mater, Shanghai Polytechnic University. He found he enjoyed working with students and wanted to extend his education.

“I love teaching,” he says. “I’m trying to think about the functions of a university—education, research, engaging with the community, and the cultural heritage. I think those four aspects are equally important.”

Faculty News



Harvey D. Spangler Professor **Jeff Linderoth** will lead a three-year project to build an automated planning tool to support complex decision-making in maritime operations centers in the United States Navy through a grant from the Office of Naval Research.



Professor **Kaibo Liu** was among the 2023 Georgia Institute of Technology alumni "40 under 40." Liu's research focuses on system informatics and industrial big data analytics for quality improvement in complex engineering systems.



Liu will collaborate with Vilas Distinguished Achievement Professor **Shiyu Zhou** on a project funded by the Office of Naval Research applying artificial intelligence to prognostics. Liu is also working with Professor and David. H. Gustafson Department Chair Laura Albert to investigate technical solutions to unique cybersecurity challenges in the future microreactor fleet through a nearly \$1 million grant from the U.S. Department of Energy.



Assistant Professor **Tony McDonald** received a grant from the National Institute on Aging for a project focused on measuring driving performance of older adults after stays in intensive care units.



Professor **Ranjana Mehta** was elected a fellow of the Human Factors and Ergonomics Society. She joins a list of prestigious professionals holding this honor, including Duane H. and Dorothy M. Bluemke Professor **Robert Radwin**.



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Assistant Professor **Carla Michini** received a grant from the United States Department

of Defense that will fund work aimed at accelerating computation time for decision-making applications. This research has the potential to improve the decision-making capabilities of important and complex systems. Professor **James Luedtke** will collaborate on the project.



Assistant Professor **Yonatan Mintz** earned an American Family Funding Initiative grant to develop a framework that uses behavioral modeling to create personally tailored incentives and discounts for safer driving.



The Society of Manufacturing Engineers selected Assistant Professor **Hantang Qin** as one of its 2023 Delcie Durham Young Manufacturing Engineers. Qin is also one of this year's recipients of the Ralph E. Powe Junior Faculty Enhancement Awards, sponsored by Oak Ridge Associated Universities.



E-Business Chair Professor **Raj Veeramani** will lead a project supported by the American Family Funding Initiative to use electronic health record data to assess individualized mortality risk and life expectancy. Vilas Distinguished Achievement Professor **Shiyu Zhou** will collaborate on the project.



Professor **Doug Wiegmann** received funding from the Office of Naval Research to study factors in the workplace that negatively impact personnel safety and well-being.



Lei Lei



Maria Palma

Honoring exceptional engineers

Each year, our college's Engineers' Day celebration honors alumni who have taken their UW-Madison engineering educations out into the world and flourished. ISyE is thrilled to recognize two well-deserving graduates this year: Lei Lei (PhD '89), professor and dean of Rutgers Business School, and Maria Palma (BS '07), general partner at Kindred Capital.

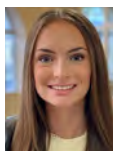
Lei, who oversees a highly ranked business school that includes 235 faculty members and roughly 10,000 students, is among the recipients of the college's Distinguished Achievement Award. The winner of numerous teaching honors, she was the founding chair of the school's Department of Supply Chain Management before taking over as dean. She's also a prolific researcher in the areas of supply chain network design and optimization, operations planning, scheduling, process recovery after disruptions, demand-supply planning, and resource allocation optimization.

"The UW engineering education, through its academic environment, student activities and school culture, prepared me to strive to be a person of good character—one who is willing to stand up and solve problems as an engineer, and who is also willing to go beyond the self and be responsible for others on the team, which I think is equally important for a successful career," she says.

Palma, whose firm invests in early stage startups, earns our Early Career Achievement Award for both her personal success and her extensive efforts to champion opportunities for underrepresented and underprivileged groups within the business world.

"I think it's an incredibly humbling and privileged position to be in to see the change that people are making," says Palma, who started her career working in operations management and supply chain at General Electric before shifting. "And technology is going to drive change one way or the other, and driving it in what I feel is a positive direction is really important."

Student News



Graduate students **Rayne Wolf** and **Fernando Acosta-Pérez** earned National Science Foundation

Graduate Research Fellowships, which are among the most prestigious fellowships for graduate research in the country. Wolf, who works in the lab of Assistant Professor Hantang Qin, focuses on the application of data processing skills to the manufacturing

arena. Acosta-Pérez, a PhD student studying with Assistant Professors Gabriel Zayas-Cabán and Justin Boutilier, seeks to improve patient flow across hospitals using operations research tools and techniques.

The Society of Manufacturing Engineers awarded silver status to our student chapter, while the Institute of Industrial and Systems Engineers and Human Factors and Ergonomics Society student groups each earned 2023 gold awards.



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ISyE welcomed its newest graduate students with food and fun on Engineering Mall. Our graduate program serves a record number of participants. Photo(s): Jane Feller.

