

INDUSTRIAL AND SYSTEMS ENGINEERING



UNIVERSITY OF WISCONSIN-MADISON

ALUMNA NANCY SPELSBERG
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CHAIR'S MESSAGE



Jeffrey Linderth

Greetings from Madison,

Spring has finally sprung here in Wisconsin, and the ISyE department continues to flourish! We just completed another round of hiring and will be welcoming our newest faculty this fall. We look forward to introducing them to you very soon!

In the meantime, you can read about how our faculty continue to thrive in research and innovative teaching methods. Assistant Professor Kaibo Liu is teaching a new online class, *Fundamentals of Industrial Data Analytics*, that provides students with the essential ability to make data-driven decisions. Professor Leyuan Shi's digital twin technology allows managers to use a digital representation of the physical production process to better track progress and adjust workflows.

Our alumni and student connections continue to blossom. A chance meeting at the advisory board reception in 2017 sparked a connection that continues to this day for the Badgerloop team and alumna Nancy Spelsberg. Nancy's company, BCP Transportation, graciously shipped the Badgerloop pod to the Hyperloop competition in California last year and will do so again this year for Competition III!

Speaking of alumni, we are very excited to introduce our new associate director of development, Tom Van Wyhe. Tom comes to us from the UW Foundation and is very eager to help our department and alumni find new ways to connect and thrive. Please drop him a line at tom.vanwyhe@supportuw.org.

Overall, it's been a great year. Both our undergraduate and graduate programs have gone up once again in the *U.S. News and World Report* rankings to Nos. 5 and 7, respectively. We are proud to celebrate our first group of graduates from our new named option master's degree programs this spring.

Summer is coming, but here at ISyE we aren't slowing down one bit. Make sure to stay up to date on the latest and greatest news from ISyE on our Facebook (@ISyE.UWMadison) and Twitter (@uwisy) pages. As always, if you are ever on campus, please stop by—we love reconnecting with you all.

ON, WISCONSIN!

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MEET OUR NEW ASSOCIATE DIRECTOR OF DEVELOPMENT

When Tom Van Wyhe first started working as a student telefundraising caller at the UW Foundation, he wasn't sure he was cut out for the job.

"It's tough. You face a lot of people not wanting to talk to you, because you sound like a telemarketer when you start," says the 2013 graduate, who majored in economics and journalism.

Seven years later, connecting with alumni is his job. After spending the past four years working in technical support at the UW Foundation, Van Wyhe started as the associate director of development for ISyE in February.

He's enjoying using the skills he honed during his Badger Call days—after pushing through those early reservations, relying less on a script and having real conversations with those on the other end of the line.

Now, though, he's excited his connection with those alumni won't simply cease at the end of a phone call.

"It's an ongoing relationship, and you really get to know the alumni and donors more as fully formed people," he says. "Meeting with alumni is great, but also being able to share with them the impact that their gifts, participation and involvement make on the campus is really cool."



WHEN DISASTER STRIKES, SHE HAS A PLAN

For almost 30 years, Professor Vicki Bier's career has focused on risk and decision analysis.

She has used complex mathematical models to improve nuclear safety and homeland security. She served as department chair for more than five years and has graduated 18 PhD students, two of whom organized an international conference to honor Bier's contributions to her field last July.

But Bier isn't ready to plan her retirement just yet.

Having worked as a consultant for the nuclear industry for the first six years after earning her PhD, she found herself revisiting that area of application after Japan experienced its first nuclear disaster at the Fukushima Daiichi power plant in March 2011.

This time, however, she became especially interested in the social and economic impact of the massive relocations of people who were directly affected by the accident. With funding from the Idaho National Laboratory, Bier and Professor Emeritus of Engineering Physics Mike Corradini studied the social disruption caused by Fukushima.

"We were surprised to discover that relocation, unlike short-term evacuation, has almost not been studied at all."

"We were surprised to discover that relocation, unlike short-term evacuation, has almost not been studied at all," Bier says.

Corradini and Bier evaluated how an accident of this kind would affect the United States, using five of the nation's 66 nuclear power plants as examples. They found that relocation needs varied greatly by area, primarily driven by population densities.

"Some of the impacts were as bad as, or even worse than, Fukushima," Bier says. "That was a pretty big deal and made me realize that we ought to study this problem in more detail so that we can better prepare for a potential emergency."

In thinking about the kinds of events that cause massive relocations, Bier noticed that some occurred more randomly than others. Nuclear accidents, large-scale terrorist attacks and natural disasters, such as earthquakes and hurricanes, are inherently less predictable than sea-level rise due to global warming. Yet, when people move in the aftermath of a crisis—as researchers found with Hurricane Katrina—they are less influenced by job opportunities

and housing costs and more strongly driven by proximity and existing social networks.

By using quantitative tools, Bier hopes to help people make choices that are more sustainable in the long term—



which may include incentives to deal with disaster by avoiding it. She argues that people, both individually and as a society, are often better off moving away from at-risk coastal areas before a disastrous flood occurs.

This behavior can be encouraged with a variety of policy tools, such as tax incentives or subsidies for public infrastructure development further inland. Regardless of the type of disaster, Bier believes some level of preparation is better than none and likes to drive that point home with a flu shot analogy.

"Every year, we have a plan ahead of time that can and will be modified based on the unique characteristics of the flu season's dominant strain," she says. "I think having better policies and procedures in place as a starting point for dealing with natural or man-made disasters would be very helpful as well."

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ALUMNA HAS DRIVE FOR CONTINUOUS IMPROVEMENT

Nancy Spelsberg will gladly nudge students toward industrial engineering.

And it's not just because she's a 1999 graduate and a member of the ISyE department advisory board.

"You can go into business, you can go into engineering directly or you could do just about anything," she says.

Spelsberg is living proof of those words. Never in her wildest dreams would she have imagined herself running a trucking company, but here she sits, president and part owner of BCP Transportation.

"Not until the opportunity ended up presenting itself was that even in the realm of possibility," she says.

Spelsberg had worked her way up at Alliant Energy during a decade-long tenure there after graduation, but she had dreamed of owning a small business, preferably in manufacturing, since high school—an ambition she traces to childhood visits to her uncle's road construction operation and limestone mine in West Virginia.

Spelsberg says BCP has established a family-oriented, fun culture while still relentlessly striving to create operational efficiencies and opportunities for improvement.

Her experience in the Evening MBA Program in the Wisconsin School of Business only strengthened her resolve. The trick? Finding the right opportunity. Spelsberg sent letters to around 75 small manufacturers across south central Wisconsin to inquire about buying them out. She heard back from a handful and, while most were non-starters, a call from Badger Custom Pallet led to a visit.

"At that point they had already grown beyond what I was capable of doing on my own," Spelsberg recalls.

But the two sides remained in touch and when the pallet manufacturer decided to revisit operating its own trucking company in 2011, BCP asked Spelsberg to join the ownership group and run the Deerfield, Wisconsin-based operation.

"It wasn't exactly manufacturing, but it was an opportunity to start something from scratch," she says. "I kind of thought, 'If I don't do it now, I'll always look back and wish I would have done something or tried it.'"

BCP has grown from four trucks and fewer than 10 employees to around 100 trucks and a team of 135, while also adding warehousing and an equipment maintenance and service shop along the way. The company hauls freight all over the lower 48 states for a wide range of customers, even delivering the UW football team's equipment for road games.

"There's definitely never a dull moment," says Spelsberg.

She has also introduced a number of sustainable strategies to reduce fuel costs and carbon emissions: All of BCP's trailers are outfitted with side skirts and trailer tails to

reduce aerodynamic drag, and the company has installed auxiliary power units in its trucks to provide electricity, heating and cooling without idling overnight.

Spelsberg says BCP has established a family-oriented, fun culture while still relentlessly striving to create operational efficiencies and opportunities for improvement. Every quarter, the company runs its financial and operational numbers, examining metrics such as out-of-route miles to hunt for potential cost savings.

She's even involved ISyE students in some of those efforts in recent semesters as part of the department's senior design projects. Teams of students have studied the company's warehousing operations and looked at how to optimize on-the-road fueling strategies.

"These are really bottom-line-impacting projects that we define and we have the students run with," says Spelsberg, who has also used BCP resources to support the college's Badgerloop team.

Those student projects hone the kind of continuous improvement mentality Spelsberg says she gained from her industrial engineering education.

"There's always something that could be done better or more efficiently," she says.



BADGERLOOP GETS A LIFT

When then-Badgerloop President Zuf Wang (BS '16, MS '18) attended the ISyE department advisory board meeting in April 2017, he had no idea where it would lead.

Wang and the Badgerloop team were in the midst of figuring out how to get their pod to California for the SpaceX Hyperloop Pod Competition II, the second edition of the worldwide competition created by Elon Musk to accelerate hyperloop transportation technology.

The team had hauled its pod to the first competition with a trailer on a 40-hour, cross-country trip that was costly—both monetarily and mentally. For Competition II, the students were eager to avoid a similarly grueling trek. But after discovering the costs of using a traditional shipping company, they were at a loss when it came to finding an affordable and time-efficient solution to getting the pod to California.

“For the longest time I thought that we couldn’t go to the competition even though we qualified, because we had no money to go and no means to go,” says Wang.

That’s when he remembered meeting ISyE advisory board member Nancy Spelsberg (BS '99), the president and part owner of BCP Transportation, at that April meeting. Wang got in touch with Spelsberg to see if BCP might be able to help. Sure enough, Spelsberg and BCP were happy to do so.

“I brought up Badgerloop during that first meeting as casual conversation, so I figured if anything that would be our best shot,” says Wang. “I reached out to her and she was really receptive, willing to help and was really excited.”

Spelsberg connected the team with BCP’s warehouse manager, Tim Lewer, to work out the details. And BCP covered the entire shipping cost.

“It was literally a delivery where we didn’t have to worry about the fuss of traveling with a trailer,” says Wang. “It just showed up and it was there. Without Nancy’s help, we couldn’t have made it out there.”

The pod reached SpaceX headquarters in Hawthorne, California, safely and intact a whole week before the competition was set to begin, allowing the team to immediately begin work. While there wasn’t time for the pod to test on the 1-mile track underneath SpaceX,

the team won an innovation award for the second straight year, this time for its propulsion system.

“It was a great learning experience, eye-opening experience, because after all we were interacting with some of the best engineers in the industry,” says Wang, who completed a co-op with Tesla in fall 2017 and graduated with his master’s degree in May 2018. “Seeing their thought processes and how procedural everything was, all the checklists and all the precise documentation, that is something that is definitely learning on the job. I think that’s valuable training for engineers.”

Badgerloop is set to return for Competition III in June 2018, with a goal of entering the Hyperloop to finally test its pod. And the team will do so with the help of Spelsberg and BCP once again.

“It was really a godsend,” Wang says.



The Badgerloop team poses with its pod in June 2017.



Elon Musk in Pod I.



Pod II.



Pod I reveal event.

GETTING TO THE ROOT OF MEDICAL ERRORS



Douglas Wiegmann

Medical error is the third-leading cause of death in the United States: Each day, almost 1,000 patients die, while another 1,800 additional patients are harmed in some way.

These numbers are stunning, though also controversial, says Associate Professor Douglas Wiegmann.

"We don't yet have a way to systematically track these events, and it's not always straightforward to pinpoint the primary cause of a patient's death," he explains. "But there's no doubt that we have a major problem."

To tackle that problem, Wiegmann is now leading a pilot study for analyzing and correcting the root causes of patient harm events in the UW Health system.

The study, rolled out in January 2018, builds upon his extensive experience with root cause analysis in other industries and is funded with \$150,000 from the UW Institute for Clinical and Translational Research. Wiegmann and his UW Health colleagues will develop a toolkit—consisting of guidelines, interview questions, checklists and causal factor diagrams—that helps stakeholders decide which corrective steps they should take to reduce the frequency of patient harm events.

In doing so, Wiegmann will draw on his research on equipment failures and human error in the aviation industry. He and a colleague studied hundreds of accident reports containing thousands of causal factors to improve the industry's safety protocols. They developed the human factors analysis and classification system, a toolkit that can be modified for use in other industries, including healthcare.

With data from the completed pilot study, Wiegmann and his colleagues plan to submit a larger proposal to federal funding agencies in order to measure how effective the new tools are in reducing patient harm events.

"We first need to know what works and what doesn't," he says. "Given my experience with other industries, I believe a continued investment in root cause analysis is our best bet for improving patient safety in hospitals around the country."

MORE: www.engr.wisc.edu/lessons-learned-plane-crashes-can-improve-patient-safety/



MANUFACTURING GETS SMART



Leyuan Shi

"Although smartphones and tablets are ubiquitous, many of the companies that make our everyday consumer products still rely on paper

trails and manually updated spreadsheets to keep track of their production processes and delivery schedules," says Professor Leyuan Shi.

That's what she hopes to change with a research idea she first published almost two decades ago.

During the past 16 years, Shi has visited more than 400 manufacturing companies in the United States, China, Europe and Japan to personally observe their production processes.

"And I have used that insight to develop tools that can make these processes run much more smoothly," she says.

These tools are based on the notion of a "digital twin," a computer representation of physical assets (machines and people) and processes. Managers can use that digital representation to visually track the global production progress in real time and adjust workflows as needed. The tool provides continuously updated start times for each assembly stage and constantly refined delivery times for customers.

"That's what we mean by smart manufacturing," Shi says.

At the heart of Shi's technology is a mathematical algorithm she originally published as a research paper in 2000.

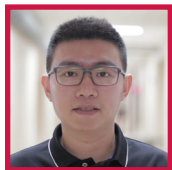
Although the methodology, known as nested partitioning, is not new, its implementation is only now becoming feasible. It relies on ultra-fast computers and wireless technology that connects machines, devices and people to the internet and to each other: the Internet of Things.

"It was a long time coming, but we're finally seeing a real paradigm shift in the industry," Shi says. "By giving manufacturing companies the ability to track the progress of their sales orders in real time and manage their shop floors proactively, they can deliver high-quality products to their customers much faster than before."

MORE: www.engr.wisc.edu/putting-smart-manufacturing/



Robert Ratner Professor **Raj Veeramani** received the Ragnar E. Onstad Service to Society Award from the college in recognition of his efforts to share his expertise with the broader community. Veeramani has built university-industry collaborations to catalyze innovation and economic growth.



Assistant Professor **Kaibo Liu** received a \$169,994 grant from the Air Force Office of Scientific Research as the principal investigator of a project using data-driven modeling, sampling and monitoring of data streams for real-time solar flare detection.



Procter & Gamble Bascom Professor in Total Quality **Pascale Carayon** took part in a January health information technology design webinar put on by the Agency for Healthcare Research and Quality, part of the Department of Health and Human Services.

STAFF NEWS



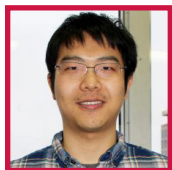
Peter Hoonakker, associate director of research in the Center for Quality and Productivity Improvement, received the Bollinger Academic Staff Distinguished Achievement Award for Research from the college. He has studied worker safety, patient safety, health information technologies and quality of care.

ALUMNI NEWS



Zainab Ghadiyali (MS'12) was one of the Wisconsin Alumni Association's 2018 Forward under 40 Award recipients. Ghadiyali, a product manager at Airbnb, is the co-founder of Wogrammer, a nonprofit that highlights the stories of women in STEM fields.

STUDENT NEWS



PhD student **Chao Wang** earned a UW-Madison teaching assistant award for early excellence in teaching, presented by the Graduate School. Wang, a third-year PhD student from Changzhou, China, is the teaching assistant for the lab sessions of ISyE 605, *Computer Integrated Manufacturing*.



Graduate student **Merve Ozen** took second place in the Global Stewards Sustainability Prize as part of the Wisconsin Energy & Sustainability Challenge in February. Ozen helped develop a low-cost and renewable way to produce a chemical used to make everyday paints and plastics.

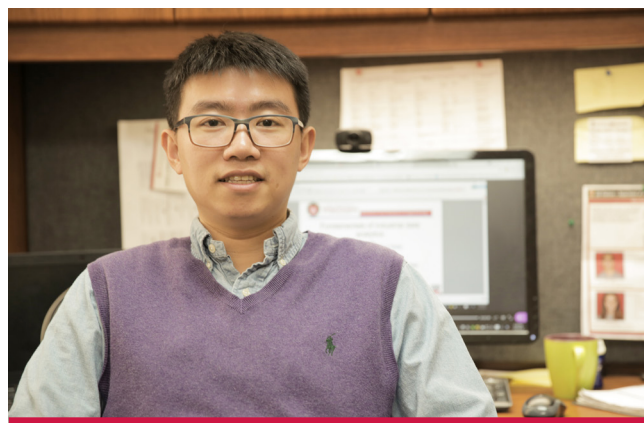


Photo: Renee Meiller

ONLINE COURSE BRINGS ANALYTICS SKILLS TO WORKING ENGINEERS

The ability to make data-driven decisions has become an essential skill for engineers and many other professionals. To extract meaning from large datasets, data analytics techniques rely on specialized computer software to organize and model the data, identify patterns and draw conclusions.

Working engineers can now catch up on these important skills, which may not have been offered as part of their original training, in an online class called *Fundamentals of Industrial Data Analytics* developed by Assistant Professor Kaibo Liu. The course debuted in the spring semester through the Department of Engineering Professional Development.

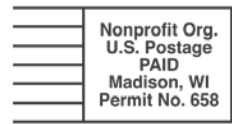
The inaugural class (ISyE 412) has attracted 32 working engineers, ranging in age from late-20s to mid-50s and living in 16 different states as well as Canada, Nigeria and the United Arab Emirates. They work for the likes of 3M, Harley-Davidson, Intel, Siemens, Boeing and John Deere.

"The students are self-motivated and eager to learn because they already know how useful data analytics skills will be for their companies," Liu says. "But they aren't the only learners here. Many of the questions and problems they bring to the class will be new to me and some may even kick off long-term academic-industry collaborations for our department."

The class meets in live 60-minute web conferences twice a week, with the students watching video lectures beforehand to inform their live sessions. Students ask questions about the video material or their homework assignments, and Liu can share his computer screen with his virtual audience to explain the material in more depth.

"I'm really excited to teach this class because it's the first time that the course material I have developed is having an immediate impact well beyond the physical boundaries of the campus," Liu says.

MORE: www.engr.wisc.edu/teaching-data-analytics-beyond-campus-boundaries/



FAST AND FOCUSED: STUDENTS SPECIALIZE WITH NEW MASTER'S OPTIONS

Madeline Ford (BS '17) felt confident in her education and skills as an industrial engineer as she perused job listings heading into her senior year. The only problem?

"All the jobs that I knew I wanted, that I felt like I had the skills for, I didn't have the qualifications for in the education department," Ford says.

The health systems engineering and hospital process improvement positions she had her eye on required either master's degrees or nearly a decade of work experience. Luckily for Ford, the ISyE department had just launched a new one-year master's program that was an ideal fit for her.

This spring, she is among the first batch of graduates of the department's two new specialized master's options in human factors and health systems engineering, and systems engineering and analytics.

"These programs build on our current areas of strength and what we are really known for, both in the state of Wisconsin and nationwide," says Professor Jeffrey Linderoth, ISyE department chair. "We also identified a significant need for training students with a deeper technical background and knowledge in those areas."



The programs also offer considerable flexibility: Among the 30 required credits, students work with their advisors to find the right blend of classes to suit their career interests—whether that's working in human-centered design for Apple, for example, or in analytics for a manufacturer.

For Ford, the program has allowed her to dive deeper into healthcare-related coursework and learn from the likes of Procter & Gamble Bascom Professor in Total Quality Pascale Carayon, a nationally recognized expert in patient safety and her advisor.

"I was a good industrial engineer from undergrad; we have a great program for that. I was just going deeper," says Ford, who will join the Johns Hopkins University Applied Physics Lab as a health systems engineer after graduation.

"It just really showed me how I can use all this knowledge that I've learned in a practical way while still picking up a deeper understanding and more advanced skills along the way."

Learn more: advanceyourcareer.wisc.edu/engineering