

INDUSTRIAL AND SYSTEMS ENGINEERING



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CHAIR'S MESSAGE



Greetings and welcome to our spring 2019 newsletter!

We are entering the final stretch of another busy academic year. We're excited to have a record number of senior design projects in our department (16 this semester alone!). By working with industry clients through the course, our

students put classroom lessons to the test and compete against their peers for prestigious department awards.

Many students have taken advantage of our one-year accelerated master's programs, either in systems engineering and analytics or human factors and health systems engineering. Both of these programs allow our students to enhance their professional qualifications and obtain a master's degree in as little as two semesters.

In addition, we are extremely happy to welcome Amanda Smith as our new associate chair of undergraduate affairs and Charlene Yauch as the executive director of the Center for Quick Response Manufacturing. Both Amanda and Charlene are alumni of the department, and we know that their presence here will greatly enhance our students' experiences.

Throughout this year, our faculty's hard work and dedication have earned new grants (such as Pascale Carayon and Doug Wiegmann), distinguished awards (Laura Albert, Jingshan Li and Kaibo Liu) and recognition for outstanding lifetime achievement by nationally recognized professional associations (Vicki Bier). These are only a few of the highlights from our faculty in the past few months. Be sure to read the full stories, along with much more, on our Facebook and Twitter pages.

I would also like to recognize our advisory board chair, Ed Kopetsky, for receiving the Healthcare CIO of the Year Award from two leading organizations. Ed has helped our department for many years and we can't thank him enough for the excellent leadership he brings to our advisory board!

As the end of the academic year approaches, I want to stop and take a moment to thank you for everything you do to support our faculty, staff and, of course, students through philanthropy and mentorship. Your support is essential to the success of our department. I look forward to connecting with you soon. Please feel free to drop me an email, give me a call, or stop by 3270 Mechanical Engineering if you are back on campus.

ON, WISCONSIN!

Jeffrey Linderth, Professor and Chair

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Familiar face in a fresh place



Three-time alumnus Amanda Smith (BS '13, MS '16, PhD '18) has enjoyed her time in ISyE so much, she's decided to stick around.

Smith started as the department's associate chair for undergraduate affairs in January 2019, shortly after

she finished up her PhD under Associate Professor James Luedtke. In the newly created position, Smith will teach, develop and design courses, meet with students, and help lead the department's upcoming undergraduate curriculum review.

It's an optimal fit for someone who enjoys working within the full breadth of ISyE—compared to having to choose one specific area as a graduate student.

"I wanted to do everything," she says.

Smith eventually settled on optimization, applying mixed-integer programming to questions in open-pit mining and metabolic engineering.

"I love taking a really hard problem that people have looked at in a variety of different ways," she says, "and being able to take new tools and throw stuff at it, basically, until something finally sticks. That satisfaction that you get from finally solving the hard problem and seeing your results work—I think that's probably the best part."

During her graduate studies, Smith served as graduate coordinator for teaching assistant training in the College of Engineering. She also taught a few courses and worked as a teaching assistant. She says teaching was the most fulfilling and enjoyable part of graduate school.

"When I'm teaching, I really feel like that's when I'm making a difference in the world," she says. "I love to get undergraduates excited about industrial engineering—showing them this new world that they either didn't know about or they didn't understand fully."

Smith, who grew up just southwest of Madison in Fitchburg, spent a year working for the federal government in Washington, D.C., after earning her bachelor's degree. She's thrilled to stay in Madison after graduation this time.

"To be able to stay here long term, it makes me really happy," she says. "It's a dream come true, honestly."

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VISUALIZE SUCCESS

Students learn to view data in graphic detail

Show most people a spreadsheet full of numbers and their eyes are apt to glaze over. Turn that data into a graphic, though, and suddenly it makes sense.

Just ask the student in Emerson Electric Quality and Productivity Professor John Lee's data visualization class who had previously muddled through a course on health policy—only to have a classmate's visual representation of healthcare investments and outcomes around the world belatedly deliver some key lessons.

"I finally understand what they taught us last semester!" she blurted out.

In *Interactive Data Visualization*, a special topics course, a mixture of undergraduate and graduate students learn to combine, organize and present data. They learn the ins and outs of the statistical programming language R and its open-source software RStudio, how to plot data in the visualization package ggplot2, and how to create interactive web applications in R Shiny.

Each student chooses a topic that's both personally interesting and meaningful to society, gathers and manipulates datasets, and builds out a visualization.

First-year graduate student Ankur Aggarwal is drawing on his decade of work experience in the energy sector to develop graphics that detail the energy sources of American power plants.

"I hope to create awareness about optimal consumption of energy in U.S. households, cutting back on usage of fossil fuels and focusing on renewable energy sources,"

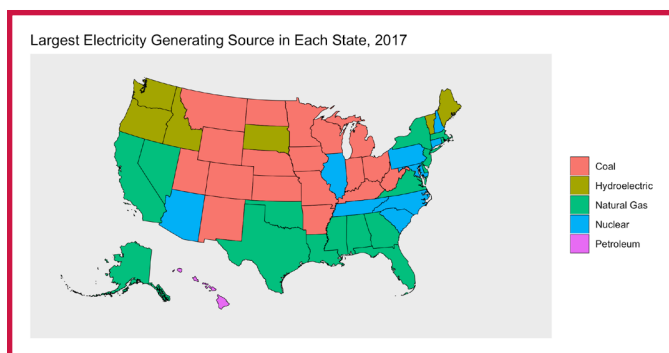
says Aggarwal, who's studying manufacturing and production systems. "Also, I intend to highlight the growth of power plants running on various renewable energy sources like solar, wind, biomass and geothermal."

Other students have taken on complex issues such as the prevalence of cancer across the state of Wisconsin as a function of arsenic levels in groundwater.

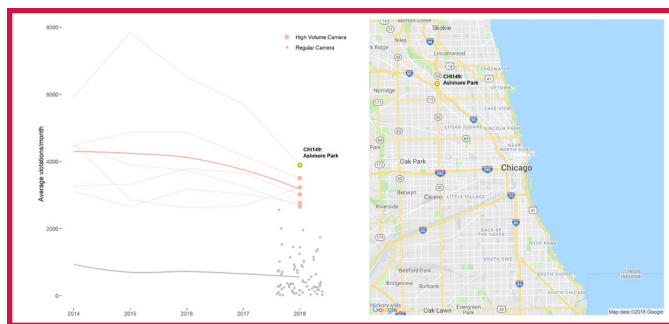
While Lee has taught the course three times in the past five years, in 2018 he added a twist by borrowing a format for feedback from a friend teaching a creative writing course at the University of Iowa.

The workshop method provides students—working in small groups—with a framework for thoughtfully delivering constructive critiques and asking for feedback to ultimately improve their projects.

"It can be challenging to present constructive feedback," Lee says. "There's a temptation to say, 'Oh, it's ugly. It doesn't work. It's wrong.' You have to learn how to present the feedback, but then you also have to learn to accept the feedback. It's hard."



Engineering physics PhD student Katie Mummah's data visualization shows the largest power source for electricity in each state.



Industrial engineering master's student Cole Soffa created visualizations using data from speed cameras in park and school zones in Chicago. This tool shows the average number of monthly speeding violations from cameras in park zones. Users can click on each point to see the camera's location on a map of the metro area.



Professor John Lee consults with students on their visualization projects.
Photo: Tom Ziemer.

So is presenting a visualization, which is why Lee invited Meriko Borogove, a former senior director of engineering at Apple who led development on the iPhone, to speak to the class. She shared firsthand lessons from presenting to Apple executives, like figuring out their individual quirks and preferences.

"Know your audience. Know what they like," she told the students.

When Borogove offered to stay after class to critique the students' in-progress visualizations, Katie Mummah, a PhD student in the Department of Engineering Physics, seized the opportunity to get feedback from a seasoned professional.

"Data and numbers are such a fundamental part of engineering," says Mummah. "This class has given me the tools to visualize data faster, easier and better than I ever have before. I'm learning to think from a design standpoint to think critically about how I present data."

PROJECT PLOTS SAFE PASSAGE FOR PATIENTS



A team tends to a fake patient in the emergency department at UW Hospital. Photo: John Maniaci, UW Health.



A fall sends an elderly woman to the emergency room. After a short hospital stay, she returns to her nursing home, where she avoids walking for

fear of another slip. In the meantime, though, she develops a blood clot that prompts another trip to the emergency room.

When it comes to the issue of patient safety, older adults—those age 65 and older—are among the most vulnerable populations. Studies have shown they're at a greater risk than their younger counterparts for a host of potential unwanted complications of hospital visits: infections, medication errors, subsequent falls and more. They're also more likely to stay at the hospital longer and return soon after.

UW-Madison's Wisconsin Institute for Healthcare Systems Engineering (WIHSE) hopes to help safeguard older adults after trips to the emergency room through a four-year, \$2.5 million grant from the Agency for Healthcare Research and Quality in the U.S. Department of Health and Human Services.

Procter & Gamble Bascom Professor in Total Quality Pascale Carayon and School of Medicine and Public Health Professor Maureen Smith are leading a team of collaborators from the College of Engineering, the School of Medicine and Public Health, the School of Nursing, the School of Pharmacy

and UW Health. They're creating a patient safety learning laboratory and are working to develop, implement and evaluate what they call a patient safety passport.

Much like an international traveler's passport records movement across borders, the patient safety passport would collect key information from each stop on a patient's passage through the healthcare system after a trip to the emergency room. The aim is to improve coordination and share potential safety pitfalls and guidance among patients, caregivers and medical personnel, even after discharge to a home or nursing facility.

"One of the concepts that we're interested in with WIHSE is the idea of the patient journey. We want to look at what happens to patients, not just at one point in time, but when they travel through the healthcare system," says Carayon, the director of WIHSE. "And when they do that, they are very likely to encounter multiple groups, multiple healthcare organizations, multiple people, and so that means there are many different transitions. The transitions are what we're really interested in."

MORE: www.engr.wisc.edu/project-plots-safe-passage-patients/

Carayon offers expert analysis

Human factors and systems engineering hold unrealized potential to improve patient safety across the United States healthcare landscape.

That's the view Procter & Gamble Bascom Professor in Total Quality Pascale Carayon and a team of collaborators deliver in a paper published in a thematic issue of *Health Affairs* devoted to the topic of patient safety.

Through her work examining the use of human factors and systems engineering approaches in healthcare settings—with a particular focus on patient safety—Carayon has established herself as a leading voice in the field.

Among her group's set of proposals:

- Creating educational programs for clinicians around human factors and systems engineering tools and methods,
- Training more engineers in healthcare applications and increasing hiring of them within healthcare organizations,
- Establishing closer relationships between academic programs in engineering and the health sciences,
- Improving data infrastructures in health systems,
- Expanding the use of human-centered design among medical technology companies,
- Assisting rural and healthcare organizations in accessing human factors and systems engineering methods and tools,
- Creating a coordinated, national initiative to facilitate widespread adoption of human factors and systems engineering throughout the healthcare field.

MORE: www.engr.wisc.edu/expert-analysis-carayon-calls-expanded-engineering-role-patient-safety/

GET REAL

Students dive into industry in senior design projects

When undergraduate Andrew Ochoa left his group's senior design project kickoff meeting, his mind was swirling.

He and his four teammates had just listened to management from their assigned client, local trucking company BCP Transportation, detail gaps in the parts-tracking process in the enterprise's service shop. Now it was up to the students to home in on one specific issue and come up with a remedy that would recover lost revenue for the company.

"We just had tons and tons of information thrown at us," recalls Ochoa.

By the end of the fall 2018 semester, the group had sifted through all that information and delivered a solution that BCP embraced: hiring an additional, dedicated employee to manage all parts inventory using a reengineered business process.

Students uncover those kinds of answers—recommendations that impact companies' bottom lines and shape business processes—every semester in ISyE 450, *Senior Design Project*, the department's capstone undergraduate course. They work in teams to tackle significant problems, curated by course instructor and Robert Ratner Chair Professor Raj Veeramani, for local manufacturing companies, healthcare organizations, service businesses such as insurance providers, and more.

The students also compete in the long-running Ratner Senior Design Project Award competition, which rewards the best work with certificates and cash prizes to emphasize the late professor Robert Ratner's belief in giving students opportunities to work on industry problems.

Ochoa and groupmates Allen Dowe, Dhananjay Prahladka, Maximilian Shakal and Samantha Leblanc took first prize in the fall 2018 competition for their work with BCP Truck Services.

To arrive at their final recommendation, the student team employed the Six Sigma DMAIC problem-solving methodology, exploring and analyzing data from the company's inventory software, creating affinity diagrams, talking with mechanics, and leading brainstorming sessions. After that turned up a handful of possible solutions, they used a Pugh matrix to determine which one most effectively addressed BCP's pain points. Ultimately, the group's solution predicted savings of more than \$250,000 for the next year.



Undergraduate student Allen Dowe consults with workers from BCP Truck Services, the service entity of BCP Transportation. Photos courtesy: Andrew Ochoa.

"In classrooms, you get a lot of data given to you. You get a problem, you have all the numbers and then you just plug it into a software and you solve your problem," says Ochoa. "But in the real world, it's not like that. It's messy. Data's not there or the data's messy and you have to do a lot of cleaning, and you have to problem-solve. It was nice that we were able to transfer our skills to a real-world problem and then also, in the process, create a job for somebody."

Students Caleb Michiels, Dorian Staeven, Edward Lei, Matthew Munts and Nicholas Schueller took second prize in the Ratner competition for their work improving the food delivery system at Madison's UnityPoint Health-Meriter hospital. Jack Pulito, Jennifer Murray, Morgan Adkins, Nathaniel Buswell and Sai Yarlagadda placed third for helping Hoffman Manufacturing with the layout design for an upcoming facility expansion.

When selecting and helping craft the projects, Veeramani looks for opportunities that can leave meaningful marks on the sponsoring companies while empowering students to apply theoretical knowledge. He hopes the experience builds confidence in the soon-to-be graduates and prepares them for whatever comes next.

"The real-world project experience that students gain in this course will support them for their entire professional career," he says, "because they can use the systematic approaches to system design and process improvement that they learn in this course to tackle any project that they are asked to lead in the future."



The winning team in the fall 2018 Ratner Senior Design Project Award competition (from left to right): Maximilian Shakal, Allen Dowe, Dhananjay Prahladka, Samantha Leblanc and Andrew Ochoa.

ALUMNUS ENGINEERS A DIFFERENT KIND OF DISTILLERY

The craft of distilling marries art and science, relying on the former for creative inspiration and the latter for consistent execution.

To alumnus Nick Hanson (BS '02), the scientific process behind producing spirits is too often lost to images of back-country moonshiners making concoctions in old copper stills.

Hanson and mechanical engineering graduate Dave Farnia (BS '02, MS '04)—along with their wives, fellow UW-Madison graduates Stephanie Farnia (BA '02) and Amy Hanson (BS '01)—started Two Tall Distilling in 2016 with a distinct approach: using modern equipment and an engineering mindset to produce consistent tastes, reduce waste and ensure process efficiency.

That way of thinking stems straight from Hanson and Farnia's engineering backgrounds. Outside of running the distillery in the town of Burke, just northeast of Madison, Hanson manages American Family Insurance's continuous improvement department, while Farnia is the director of research and development for Arnold Magnetic Technologies.

The duo met as sophomores in a computer science course in spring 1999, when they were randomly assigned to be lab partners. But they didn't become friends until that summer, when both had taken part-time jobs helping convert that same course to an online format. Their similar driven, yet laid-back personalities meshed while they repackaged existing course materials and filmed videos to explain important concepts.

"We tried to have a good time with it," says Hanson, who recalls the pair filming campy skits about topics such as stochastic modeling. "That's really when we started hanging out a lot."

The friendship persisted beyond graduation, and the two started hosting Scotch whisky tasting parties while living in the Twin Cities. Soon, they were touring distilleries and—like any curious engineers would—asking questions about the science and details of the distillation process.

"We were always kind of disappointed with the answers. There was a lot of tribal knowledge," says Hanson. "That didn't sit well. So we wanted to learn more about it."



Nick Hanson and partners launched Two Tall Distilling in 2016 in the town of Burke, just northeast of Madison. Photos: Sarah Page.

They contemplated creating their own line of automated stills before discovering a Dutch company that already sold precisely that. After moving back to Madison within six months of each other in 2014, they ordered two iStills—at the time, the first ones in the United States. In September 2017, their distillery and tasting room publicly opened with a name that pays homage to their two families' physical statures.

Two Tall's set of iStills features programmable settings and electric-fired heat, giving Hanson and Farnia the type of well-controlled, repeatable production process they say leads to less waste and more consistent-tasting spirits. And they're able to monitor everything remotely from their phones during the day.

In addition to producing Two Tall's standard lineup of barrel-aged gin, coffee liqueur,

whisky, vodka and London dry gin, Hanson and Farnia like to experiment to create unique offerings such as a whisky derived from a coffee chocolate porter beer. They're also taking on contract projects from breweries and other companies that are interested in having their own lines of spirits but lack the distilling knowledge and equipment.

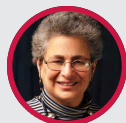
Through those partnerships and distilling classes they host—from three-hour primers on making gin to weeklong sessions on opening a distillery—Hanson and Farnia are eager to show others the science behind spirits.

"We love helping others learn about distilling," says Hanson.

FACULTY NEWS



The Institute for Operations Research and the Management Sciences awarded Associate Professor **Laura Albert** and collaborators the Impact Prize for their work in transportation security. The award is given once every two years to recognize widespread impact in the practice of operations research. Albert also received the Ragnar E. Onstad Service to Society Award as part of the College of Engineering's annual faculty and staff awards.



The Institute for Operations Research and the Management Sciences named Professor **Vicki Bier** a fellow for her contributions to *Decision Analysis*, a peer-reviewed journal.



Emerson Electric Quality & Productivity Professor **John Lee** is part of a new National Science Foundation-funded project exploring how people could use an automated vehicle as a workspace. Lee and Ja Young Lee (PhD '18) also published a paper in the *International Journal of Human-Computer Studies* that demonstrates a new model for simulating task-switching in drivers. Members of his research group presented a paper on existing vehicle-pedestrian interactions at the Transportation Research Board's 2019 annual meeting. Lee also received the college's Equity and Diversity Award.



The Institute of Electrical and Electronics Engineers Robots & Automation Society named Professor **Jingshan Li** a distinguished lecturer. Li is also leading a project funded by the healthcare company Baxter to better predict and address acute kidney injury and congestive heart failure.



Assistant Professor **Nicole Werner** and collaborators advanced to the second round of the Care Coordination for Children with Special Health Care Needs Challenge, a national competition to develop technology to benefit children with special healthcare needs and their families. Werner's team is creating a mobile app to connect and support family caregivers of children with enteral feeding tubes.



The American Society for Quality awarded its 2019 ASQ Feigenbaum Medal to Assistant Professor **Kaibo Liu**. The medal honors an individual who is 35 or younger and has demonstrated leadership, professionalism and potential in the field of quality.



Associate Professor **Douglas Wiegmann** is part of a group of UW-Madison researchers who received a five-year, \$2 million grant from the Department of Health and Human Services' Agency for Healthcare Research and Quality. The project will study different learning approaches to improve ventral hernia repairs.



Procter & Gamble Bascom Professor in Total Quality **Pascale Carayon** earned the Byron Bird Award for Excellence in a Research Publication as part of the college's annual faculty and staff awards.



Associate Professor **James Luedtke** is part of the organizing committee for a workshop called "Mathematical Optimization of Systems Impacted by Rare, High-Impact Random Events" in June 2019 at the Institute for Computational and Experimental Research in Mathematics. The event is part of a U.S. Department of Energy-funded project examining rare, high-impact events in complex energy and environment systems.

STUDENT NEWS



PhD student **Changyue Song** won an innovation in teaching award as part of UW-Madison's 2018 campus-wide teaching assistant awards. Song has taught *Fundamentals of Industrial Data Analytics*.



PhD student **David Azari** won the 2018 Chapanis Best Student Paper Award at the Human Factors and Ergonomics Society annual meeting. Azari works in the laboratory of Duane H. and Dorothy M. Bluemke Professor Robert Radwin.

ALUMNI NEWS



The College of Healthcare Information Management Executives and the Healthcare Information and Management Systems Society named **Ed Kopetsky** (BSIE '78, MSIE '81) their 2018 John E. Gall Jr. CIO of the Year. Kopetsky is chief information officer for Stanford Children's Health.



The answer to our quiz on the back cover: (d) Both (b) and (c)

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BACK TO SCHOOL

How sharp are your ISyE problem-solving skills?

Think you could still pass a final exam? Try your hand at this question, straight from Assistant Professor Xin Wang's fall 2018 final for ISyE 320, *Simulation and Probabilistic Modeling*.

|||||

Suppose customers at Aldo's Café follow an exponentially distributed interarrival time. In rush hours, there are five customers per minute. Otherwise, there is one customer per minute.

Suppose there is only one server and the service time is a fixed exponential distribution with x customers per minute. Customers line up to wait for the service in a first come, first served rule and no customer leaves the queue.

What is a possible value for x so that the queue is not exploded?

- (a) 3
- (b) 5
- (c) 7
- (d) Both (b) and (c)

See answer on page 7.



Photo: Bryce Richter / UW-Madison