Industrial & Systems Engineering
at Rutgers

ise news

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inside

Industrial & Systems Engineering at Rutgers

Industrial and systems engineers devise ways to make products and services better, safer, easier to use, less expensive, and more energy efficient–dramatically transforming industry and society with advances in computing, communication, and automation sciences in the process. Rutgers' leading-edge ISE program emphasizes core competencies in reliability engineering, advanced manufacturing, smart systems, and energy systems, giving the next generation of engineers and technology leaders a richly relevant educational experience.

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RUTGERS School of Engineering

SoE Hosts Inaugural Forum on Hydrogen Energy Technologies

Expert attendees envision a transformational role for clean hydrogen in energy delivery

More than 175 experts from academia, industry, and government joined in an inaugural forum on hydrogen energy technologies and policy at Rutgers School of Engineering this past fall just as an infusion of federal money has jump-started initiatives to harness the chemical element for clean-energy production.

Hydrogen will play a role, particularly in industrial and heavy-duty transportation sectors, as the United States strives for net-zero carbon emissions by 2050. More than $9.5 billion in federal infrastructure and jobs development money was allocated this year for research and development of clean hydrogen. The inflation reduction act also allowed for significant tax credits for hydrogen implementation for clean energy.

"These are exciting times for hydrogen," said Mohsen A. Jafari, chair and professor of industrial and systems engineering at Rutgers. He noted the creation of regional clean hydrogen hubs (H2Hubs) across the country that will create networks designed to produce, process, deliver, and store hydrogen. New Jersey has joined in a hub with other northeast states. "We're hoping this workshop will help us move toward a collaborative future," said Jafari, who moderated the workshop.

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Message from the chair

Industrial engineers are a curious bunch. As we wonder how things work—we also look for new ways to make products and services safer, easier to use, more energy efficient, and less costly. Our innovative solutions touch nearly every aspect of our lives—from energy to healthcare, from data collection to manufacturing, and so much more.

ISE undergraduate and graduate students are ensured a world-class education that whets their curiosity and instills them with a drive to seek answers to their questions. This newsletter shares how our talented faculty, students, and alumni are satisfying their curiosity.

In this newsletter, you'll learn how some of our students are devising new solutions to some of today's critical ISE problems with their capstone projects.

This fall, we helped to lead an inaugural forum on hydrogen energy and policies that was attended by more than 175 experts from academia, government, and industry, further burnishing our school's reputation as a trailblazer in clean energy solutions.

ISE alumni, too, are succeeding in industry early in their careers—**Kevin Stern BS'21** at Rolls-Royce and **Kate Lechner BS'05, MS'07**.

In the spring we'll be offering two new courses designed by **Randy Reagan**, one of our new faculty members, to boost our students' successful entry into the workplace. The courses focus on competency and and understanding of project management and human factors—invaluable skills in any industry.

I'm delighted to share this and other exciting department news with you in this latest issue of our newsletter.

Sincerely,

Mohsen A. Jafari, Ph.D.
Chair, Department of Industrial and Systems Engineering

department news

ISE faculty and students have distinguished themselves with funded research projects, keynote presentations, publications, and industry awards.

Fellowship

Professor **David Coit** is the recipient of the prestigious Jean D'Alembert Fellowship from the Université Paris-Saclay to support his research and academic studies in France in 2023 and 2024.

The fellowship, which is named for 18th-century French mathematician, philosopher, and writer Jean Le Rond d'Alembert, brings top researchers from around the world together to collaborate with professors, researchers, and students at the Université Paris-Saclay.

During his fellowship, Coit will be focusing on advanced research topics in risk and reliability at CentraleSupélec Laboratoire Génie Industriel (LGI).

Publication

The third edition of ISE distinguished professor **Elsayed A. Elsayed**'s book, *Reliability Engineering*, has been selected as one of BookAuthority's "23 Best Industrial Management eBooks of All Time."

BookAuthority—which has been featured on CNN and in *Forbes* and *Inc.*—ranks the world's best books based on recommendations by thought leaders and experts.

Reliability Engineering, explains Elsayed, has been adopted by many universities including Rutgers as a text for reliability engineering courses geared towards ISE senior undergraduates or graduate students. "It covers the fundamentals of reliability engineering. Every theoretical development is followed by an engineering example to illustrate its application, while many problems are included at the end of each chapter."

These features, according to Elsayed, are also designed to increase the usefulness of the 900-page book as a comprehensive reference for practitioners and professionals in the field of quality and reliability engineering.

Awards and Grants

Distinguished professor **Elsayed A. Elsayed** was inducted as an INFORMS (Institute for Operations Research and the Management Science) Fellow in recognition of his "innovative contributions to theory and applications in reliability engineering, distinguished contributions in education, and leadership to industrial engineering and INFORMS professional societies."

Assistant professor **Aziz Ezzat** received the Institute of Industrial and Systems Engineers' (IISE) Data Analytics Teaching Award from the IISE Division of Data Analytics and Information Systems. The award recognizes individual faculty's excellence in teaching courses related to data analytics in industrial engineering.

Assistant professor **Farzad Yousefian** has received a $400,000, two-year Department of Energy (DOE) grant for his randomized federated learning project.

Partnerships will be needed since delivery of clean hydrogen presents several logistical challenges. Existing infrastructure can be used in some cases; hydrogen blending is already underway in some natural gas pipelines, including those in areas of New Jersey. But in other realms, such as refueling heavy-duty vehicles, new delivery infrastructure will be needed.

"It is quite clear that we have significant challenges ahead in this domain, so we need academia, industry, and government working together to advance sustainable and also long-term solutions," said Alberto Cuitiño, Rutgers Engineering interim dean. "We will meet energy sustainability and environmental justice goals through public-private partnerships. Rutgers is fully committed to a clean energy future," he said citing the university's "broad expertise in energy, science, and public policy."

The day-long workshop was co-sponsored by Rutgers' Center for Advanced Infrastructure and Transportation (CAIT), Fuel Cell and Hydrogen Energy Association, NJ Fuel Cell Coalition, and New Jersey Clean Cities.

Academic, industry, and government attendees explore the bright future for hydrogen energy and technologies. The workshop featured panelists and keynote speakers from the U.S. Department of Energy, Toyota North America, and GE Grid Solutions, among others.

"Incredible Challenge"

Plenary speaker Tomas Green, fellow with the U.S. Department of Energy, said the development of clean hydrogen technologies will be a "critical case study about how we can build an industry that does not exist today," since clean hydrogen is nearly non-existent.

The Paris Agreement treaty on climate change calls for the U.S. to cut carbon emissions by 50% by 2030 and reach net-zero by 2050. "It is expected that ten percent of emissions reduction will be achieved through clean hydrogen deployment with the other 90 percent from other technologies," he said.

> **"These are exciting times for hydrogen. We're hoping this workshop will help us move toward a collaborative future."**
> **—ISE Professor and Chair Mohsen Jafari**

Part of that "incredible challenge" is to transform our energy production system with environmental justice in mind since legacy industries placed undue burdens on poor communities, he said, "We have a responsibility to get this right."

Other panelists emphasized that the public's concerns about safety and workforce development also need to be addressed.

Speakers said hydrogen had been eclipsed by solar, wind, and electrification in most public discourse on clean energy. The H2Hubs will be designed with public education and participation in mind and feature training, economic development, and apprenticeship programs.

"We need to engage the workforce of the future," said Catherine Klinger Kutcher, senior policy advisor with NJ Governor Murphy's Office of Climate Action and the Green Economy. "What we need to do as a state is to be ready and really harness that opportunity."

Transforming energy delivery

Refineries and ammonia production, where hydrogen is now used, will be an initial focus of the transformation to clean production, Scott said. Then it is envisioned clean hydrogen will play a role in industries and uses that are difficult to electrify, such as aviation and maritime transportation, long-haul trucking, public transit, and steelmaking.

Speakers described the new federal money for hydrogen as a game-changer. Elliott Flick, vice president of commercial projects for the Pennsylvania-based energy company Constellation, said the federal incentives are already in play. "When it comes to the hydrogen production tax credit, frankly, we can't go fast enough," said Flick. "There are a number of projects we are working on."

Dave Edwards of Air Liquids, the French company specializing in industrial gasses, said hydrogen will enable "transition in three of our most critical energy infrastructure areas—the electric grid, natural gas distribution systems, and our transportation infrastructure."

Hydrogen will allow for increased fuel storage on the electrical grid, said Jack Brouwer, professor and director of the National Fuel Cell Research Center and Advanced Power and Energy Program, University of California, Irvine. "If you want resilience and reliability...we need hydrogen for a carbon-free future," he said.

ISE Welcomes New Faculty

This fall, the department welcomed two new faculty members.

Farzad Yousefian, *Assistant Professor*

Assistant professor Farzad Yousefian approaches teaching with enthusiasm. "It's a rewarding experience to mentor a diverse group of students in conducting cutting-edge research in the interdisciplinary area of optimization—and contribute to their success in building careers and pursuing their passions in industry and academia," he says.

While the 2020 National Science Foundation (NSF) Faculty Early Career Development (CAREER) Award recipient's research interests encompass everything from distributed optimization in multi-agent networks to computational game theory, he is currently working on three research projects.


Farzad Yousefian

The first, with its focus on advancing mathematical models and algorithms of distributed optimization in multi-agent networks has the potential to help measure transportation system efficiency.

The second project designs and analyzes computational methods to solve large-scale optimization problems that might occur in applications such as those in defense and machine learning.

Emerging health care and Big Tech applications needing learning predictive models from numerous datasets are motivating Yousefian's design and analysis of new computational methods for federated scientific machine learning.

"In each of my projects, what most excites me is how applied mathematics can be beautifully employed to address research questions that greatly impact our society," says Yousefian.

Randy Reagan, *Assistant Teaching Professor*

Randy Reagan brings more than 30 years of industry experience as a senior leader in small, medium, and large, start-up, and non-profit companies to his role as an assistant teaching professor.

"What I am enjoying most is the daily interactions with students inside and outside of class," he says. "I look forward to sharing practical examples of my years working in a wide variety of industries, companies, and positions."


Randy Reagan

While Reagan most recently managed the development of heavy equipment and tools for oil and gas, power generation, and mining industries, he is also experienced in developing tools and components for transportation and structural industries, as well as in designing and developing telecommunications and optical fiber communications systems. He has led teams that developed and launched more than 500 new products, many of which have set new industry standards.

His 90 patents, he says, "cover a range of inventions in optical fiber communication, including fiber optic network management and fiber to the home network connectivity."

ISE, for Reagan, is an exciting and engaging field. "Its broad range of topics allows me to learn something new every day. There's never a dull moment," he insists.

Innovative New Courses

Nowadays, an understanding of project management and the human factors behind product or system design success is often a requirement in today's complex workplace.

Two new courses taught by new faculty **Randy Reagan**– ***Human Factors in Engineering*** and ***Engineering Project Management***–that are open to all Rutgers graduate students will help train engineers to meet the expectations of today's employers, according to SoE Interim Dean Alberto Cuitiño.

Human Factors in Engineering offers an introduction to human factors engineering and information processing, including human/computer interface, visual displays, software design, and automated system monitoring, with an emphasis on human performance and end-user needs.

Engineering Project Management "prepares engineers to conduct and lead projects by providing them with essential technical and leadership project management skills, tools, and best practices," says Reagan. It also provides a pathway to industry certification

Designing Seniors

Student teams draw on all they have learned to develop culminating Senior Design Projects.

Robot dog "Spot's" ground images help Masser Ghannam and team create an AI model for identifying plant growth anomalies.

ISE majors start working on their Senior Design Projects during the spring of their junior year. "These projects give our students an opportunity to bring all that they have learned to bear on a culminating team project," says Mohsen Jafari, professor and ISE department chair. "This year's projects really capture the inherent flexibility of the field."

A team that has developed an app to help deaf and hearing people communicate and a team that is working with AI and machine learning to detect agricultural anomalies embody the creativity and innovation of ISE seniors.

Can You Hear Me?

Tyler Croker and team members **Victor Ramon, Austin Preiss**, and **Omuezue Erechuku** embarked on a coding project using Python to create an app to help deaf and hard-of-hearing people communicate with hearing people.

"We're using gesture recognition and machine learning to train models to essentially translate American Sign Language into English," explains Croker.

An iPhone voice assistant such as Siri would then read the translation so that a hearing person could respond orally. For an ongoing two-way conversation, the deaf person could read the response on the app and sign a response.

For the team, according to Croker, the most exciting part of their project has been to create something that could help so many people. "While we might not solve the problem of seamless communication between hearing people and the hard of hearing, we're happy to show that this level of communication is possible and to demonstrate one potential way of achieving this goal," Croker says.

Tyler Croker and his team's senior design project app translates American Sign Language into English.

Down on the Farm

Masser Ghannam and **Michael Mesham** led the five-member design project team that also included, **Rene Rivadeneira, Edwuin Jiminez**, and **Jules Gouton**. "Everyone brings an incredible value to our project. We're all learning so much," Ghannam says.

They're working to create an image processing model to detect anomalies in blueberry farming. "Through taking aerial multispectral images with drones and using the Boston dynamics robot dog "Spot" to take ground images, we're creating a machine learning AI model to identify discrepancies in plant growth," Ghannam explains.

> **"It's been exciting to look at emerging possibilities in this field. …Everyone brings an incredible value to our project and we're all learning so much."**
>
> —Masser Ghannam

"Our motive is to optimize industrial farming, by helping farmers improve crop growth indexes, lower the use of pesticides, and the overall cost of production."

The team settled on their project by discussing ideas with Jafari, who Ghannam says gave them the confidence to move forward. "It's been exciting to look at the emerging possibilities in this field," she says. "Analytical image analysis in agriculture is such a rapidly growing sector. I can't wait to contribute to this area of agricultural technology."

Kevin Stern ENG'21

Data Engineer | Rolls-Royce

Kevin Stern began his tenure at Rolls-Royce as a strategy development team member under their manufacturing, assembly, and test organization. He subsequently served as a project manager in a warehouse consolidation initiative before assuming his current role as a data engineer, where he functions as an internal consultant for the company's defense business.

What do you most enjoy about working for Rolls-Royce?

Rolls-Royce has been open to hearing my career aspirations and allowing me to act on them, and has supported me throughout my early career. I'm grateful for the opportunities they've provided me.

Why did you choose Rutgers and ISE?

Rutgers hit all the marks in academic quality, affordability, and social activities. Personally, I was looking for a big school, with a good engineering program, that wouldn't require me taking out a great deal of student loans. This all made Rutgers the stand-out option. Coming into college, I was unsure of where I wanted my career to go. When I heard about ISE, I found it gave me the flexibility to choose my own path.

What do you value most about your SoE education?

Regardless of the engineering specialization you choose, graduating from SoE sets each student up for post-graduate success by teaching you how to solve complex problems.

Do you have any advice for the SoE's new ISE students?

I challenge students just beginning in ISE to avoid thinking about your dream job title, and focus on determining what you enjoy and also what you dislike about work. This will save you a lot of headaches down the road when you are deciding where you want to go next after ISE. Also, be sure to utilize the school's resources—the professors, labs, free CAD software, and more—while you have access to it.

Kate Lechner, ENG'05, MS'07

Service Delivery Integration Lead | Meta

Kate Lechner kicked off her career in systems engineering and program management, but it wasn't until she worked at Apple in new product introduction that she was able to fully leverage both her technical skills and the management training she gained when earning her MBA at Duke University. Today, Kate is the Service Integration Lead at Meta.

How have you successfully applied your engineering training and business know-how in the working world?

Despite working in several industries and functions, all my jobs since my time at Apple have been operations-focused roles that require pulling from both sets of strengths. I love getting to apply analytical skills, but also, especially since operations is highly cross-functional, I must be able to think strategically and make business tradeoffs. At Meta, I lead a team in People Operations that works to ensure the right systems and tools are in place to support Meta's internal workforce. My team develops multifaceted solutions to complex challenges; evaluating business implications is an important part of this process.

Do you work out of California?

Yes, I live in San Francisco with my partner and two young children. As East Coast transplants, we long for the unmatched NYC pizza and bagels we can't get in the Bay Area, but we love taking advantage of all the West Coast has to offer. Luckily, we get back to the Northeast regularly for family visits.

Why did you choose Rutgers for your undergraduate and graduate degrees?

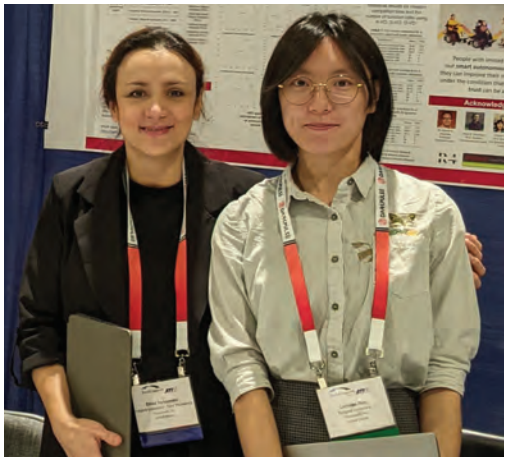
I started my college career at Rutgers for two reasons: It has a reputable engineering program, and I received a scholarship. By the time grad school rolled around, I could name hundreds of reasons to choose Rutgers—including the amazing, diverse student body, the devoted faculty, and the proximity to New York City and Philadelphia.

What drew you to ISE?

To me, ISE is about improving processes and designing systems that are more efficient. The possibilities are endless! When I was studying ISE, I didn't know exactly what I wanted to do post-graduation, but I was hopeful that ISE would enable me to explore my broad range of interests—and I was right.

ISE Team Receives NSF National I-Corps Award to Study the Market for Autonomous Wheelchairs

A team led by associate professor **Zhimin Xi** has been studying autonomous wheelchairs for five years. Their research has culminated with a $50,000 NSF National I-Corps Program grant to study and identify market opportunities for autonomous wheelchairs.



Elnaz Torkamani (left) and Lichuan Ren (right) attend the Defense TechConnect Innovation Summit Expo.

"Enhanced mobility can create an equitable and inclusive environment for wheelchair users in disadvantaged communities, by enabling them to navigate independently, safely, and worry-free in a crowd," predicts Xi.

Xi, and doctoral student **Elnaz Asghari Torkamani**, have demonstrated the feasibility of developing affordable and reliable autonomous wheelchairs through an innovative navigation method that can significantly reduce the cost for computing collision-free navigation without sacrificing travel time and ride comfort.

A Long and Winding Research Road

> **"We cannot afford to use autonomous cars' technologies for wheelchairs, and yet the wheelchair's operating conditions are more unpredictable than those of cars."**
> —Zhimin Xi

Xi recalls how they "studied the existing method; discussed improvements and new ideas; improved the method to be more generally applicable for different robots; filed a provisional patent and converted it to a patent cooperation treaty, or PCT filed through Rutgers for Research; published journal articles; attended the Rutgers I-Corps program; attended the NSF I-Corps Northeast Regional Program in August for wheelchair applications, where the team receive $3,000 in funding for market discovery," before receiving the National I-Corps Program award.

Through the NSF I-Corps Northeast Regional Program, Xi along with co-entrepreneur leaders (EL) Torkamani and Lichuan Ren interviewed more than 20 wheelchair users and companies to identify and match users' pain points with market opportunities.

In September, the team's autonomous navigation innovation, even at an early stage 3 technology readiness level (TRL), was selected as a 2022 Defense TechConnect Innovator at the Defense TechConnect Innovation Summit and Expo in Washington, DC.

The Path Forward

"The award will support any market study related expenses for Torkamani and additional co-EL Zhetao Chen," says Xi. "They'll conduct more than 100 interviews related to the wheelchair industry—including end users, manufacturers, and insurers—to pinpoint the match between technology and market opportunities. A Rutgers start-up will be formed, and the team will meet with venture capitalists."

Alumni Advancing in Academia

Many ISE alumni pursue academic careers at universities throughout the U.S. The department is proud to share some recent advancements in higher education.

Heidi A. Taboada, Ph.D.'07

recently became the first woman in the 85-year history of the Frank H. Dotterweich College of Engineering at Texas A&M University-Kingsville to assume the role of dean.

Houshang Darabi, Ph.D.'00

a professor in the Department of Mechanical and Industrial Engineering at the University of Illinois at Chicago was appointed department head in July 2022. The department offers degree programs in mechanical engineering, industrial engineering, and engineering management.

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