

ise news

FALL 2021

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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.

ise.rutgers.edu



New Labs Set the Stage for Discovery

For researchers, cutting-edge facilities are a must. The Department of Industrial and Systems Engineering (ISE) has recognized this by establishing two new state-of-the-art laboratories: the **Energy Lab** and the **Human-AI Systems Lab** are designed to promote discovery in renewable energy and collective intelligence.

Human-AI Systems Lab

As professor and ISE chair Mohsen Jafari points out, industrial revolutions spurred human and machine collaborations, while leaving decision-making and specialized tasks in human hands. For over two decades, the internet and renewable energy industrial revolution has been characterized by the abundance of IoT, wide-scale automation, and machine-to-machine communication, and has planted the seeds for the next industrial revolution.

"It's widely believed that AI—which is already good at many human jobs—will fuel the

next industrial revolution, which is poised to fundamentally change how complex manufacturing, transportation, and other systems will operate," says Jafari. "Its greatest impact will be complementing and augmenting human capabilities, rather than replacing them. It is collective intelligence that many companies are seeking today."

According to Jafari, the new Human-AI Systems Lab includes robots, eye trackers, augmented reality, autonomous devices, smart data collection and control devices, and more,

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Message from the chair

We often take for granted the many innovative solutions in everything from manufacturing and energy to finance and healthcare devised by industrial and systems engineers. But it is their vision and dedication that makes the products and services we depend on safer, easier to use, less costly, and more energy efficient.

While we have happily returned to campus in force, not even a global pandemic and a pivot to remote learning could diminish the achievements of our talented faculty, students, and staff. Our commitment, as a department, to deliver a top quality education to our undergraduate and graduate students has never been stronger.

ISE students are succeeding on a national level. In this issue, you'll learn how a senior design team's paper won first place in the prestigious **Institute of Industrial and Systems Engineers IISE technical paper competition**.

You'll also meet doctoral students who are taking part in a year-long **AmEx fellowship/internship program** established by alumnus Di Xu, vice president and head of information management decision science and big data labs at American Express.

Students and faculty alike are benefiting from our **Energy Lab** and the **Human-AI Systems Lab**—two new cutting-edge facilities fostering discovery in renewable energy and collective intelligence.

ISE alumni are writing their own success stories. **Joel Reiss ENG'92**, executive vice president of TransDigm Group, was the 2021 recipient of the SoE Medal of Excellence for Distinguished Achievement in Industry. And **Ali Tosityali**, who earned his doctoral degree in 2019, is sharing his expertise in data-driven research to students at Rochester Institute's Saunders Business College, where he is an assistant professor.

Our faculty are conducting groundbreaking research. Assistant professor **Aziz Ezzat** is applying federal funding to determine offshore wind farm profitability as the nation moves to transition to clean energy.

I am pleased and proud to share the news of their achievements and success with you in the pages of this 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.

Grants

Professor and PI **Aziz Ezzat** has received a three-year, \$450,000 collaborative NSF-funded GOALI grant for a project that aims to strike the optimal balance for wind farm profitability. As co-PI he's also received an NSF award to study ductile metal fracture.

Professor and department chair **Mohsen Jafari** received a three-year, \$176,000 research grant from Qatar National Research Foundation for his project, "Zero Carbon Communities." A joint \$605,000, two-year award from New Jersey Transit with Princeton University Andlinger Center for Energy and Environment supports the railway decarbonization pathways project.

Keynote Addresses and Presentations

Professor **David Coit** presented a keynote speech at the online IEEE 8th International Conference on Industrial Engineering and Applications (ICIEA 2021).

"Manufacturing Automation—Digital Thread of Metal Additive Manufacturing" was the topic of Assistant Professor **Weihong "Grace" Guo's** keynote speech at the spring 2021 IEEE International Conference on Robotics and Automation

Professor **Tuğrul Özel** presented a keynote paper as the lead author at the CIRP (Collège International pour la Recherche en Productique) General Assembly in Munich, Germany in August 2021. In November, he was a keynote speaker at the 3rd International Conference on Industry 4.0 and Smart Manufacturing, in Austria.

Professor **Elsayed Elsayed** spoke at the Distinguished Research Seminar Series—Frontiers in Reliability Engineering at The Hong Kong Polytechnic University's Department of Industrial and Systems Engineering in October 2021.

Publications

Statistical Reliability Engineering by Professor **Hoang Pham** (Springer, 2021) presents the state-of-

the-art methodology and analytical models used to assess the reliability of complex systems. He is a co-editor of *Safety and Reliability Modeling and Its Applications* (Elsevier, 2021), which addresses recent developments and new theoretical issues related to safety and reliability.

Professor **Zhimin Xi** has been appointed an associate editor for the IEEE Robotics and Automation Letter.

Awards

The Rutgers University Student Chapter of the INFORMS (Institute for Operations Research and the Management Science) was selected as a 2021 *cum laude* student chapter winner. The chapter's student leaders are: **Ayca Altay**, **Vidita Gawade**, and **Petros Papadopoulos**.

Professor **Zhimin Xi** received the 2021 ASME (American Society of Mechanical Engineers) Design Automation Young Investigator Award recognizing noteworthy contributions in design automation.



providing students with hands-on experience in configuring smart systems and optimizing decision-making through collective intelligence.

“Having the technology on campus gives many more people the opportunity to use it,” says ISE assistant teaching professor and undergraduate director Elin Wicks. “Undergraduate students will be able to dabble with the newest technology and seniors and graduate students will be able to experiment with it. The technology will be introduced to sophomores so that they might use it in undergraduate projects such as Senior Design.”

The big benefit for students, according to assistant professor and faculty advisor Grace Guo is the “seamless integration of textbook knowledge and theory and the ability to see how theory is applied to new technologies will prepare students well for future careers.”

“For researchers,” she adds, “the lab provides testbeds for Human-AI systems that integrate research and educational activities in collective intelligence, smart systems, and optimized decision-making.”

Energy Lab

Assistant professor Zhimin Xi is using the Energy Lab’s lithium ion battery lab for ongoing study of battery performance reliability and its integration with renewable energy to serve as energy storage systems in electric vehicles.

Assistant professor Aziz Ezzat conducts research on renewable energy analytics in the lab. “As part of the Energy Lab, our Renewables and Industrial Analytics (RIA) research group continuously collects weather and generation data for forecasting and opti-

“ [The] seamless integration of textbook knowledge and theory and the ability to see how theory is applied to new technologies... will prepare students well for future careers. ”



Professor Zhimin Xi in the Energy Lab with a senior design team making a small-scale electric car with a battery monitoring system to provide an accurate drive range prediction. The result will be scaled to the actual size of an EV based on a physics model with validation study. Students can thus recommend better driving behaviors to extend the driving range of a real EV.

mization models to enhance the predictability, productivity, and reliability of wind and solar energy assets,” he explains.

To do this, Ezzat’s group operates an off-grid solar array system with high-resolution generation and asset health sensors, a visual/thermal drone for AI-based autonomous inspection of

solar energy assets, a research-grade meteorological monitoring station, as well as an all-sky imager that collects high-resolution sky images for real-time cloud detection and solar forecasting.

The Energy Lab’s energy simulation platform of buildings and solar and wind farms also collects and analyzes energy usage data from

some of Rutgers campuses’ 1000+ buildings.

“The lab also supports undergraduate senior design and graduate courses in energy systems and risk analysis,” reports Xi.

Graduates and undergraduates take part in Ezzat’s research and data collection work. “The data collected is also integrated into undergraduate ISE courses as in-class data challenges, to help teach how data science and analytics can solve critical energy-related problems,” he says.

As Ezzat sees it, “the large-scale integration of renewable energy sources into present-day electricity systems hinges on innovative solutions that mitigate such barriers as the predictability of renewable energy and the reliability of renewable energy assets. This is, in fact, one of the main research thrusts of the Energy Lab.”

Doctoral Students Take Part in AmEx Internship

In 2019, Di Xu, who earned a doctoral degree in industrial engineering from Rutgers and is now vice president and head of information management decision science and big data labs at American Express, helped create a lasting fellowship/internship program between his company and Rutgers that is spearheaded by ISE.

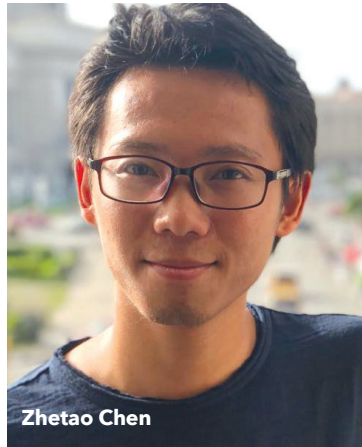
Altay, who hopes to work in research after earning her doctoral degree in May 2022, appreciates the fact that the nature of the program lies between academia and industry. "Being at the near intersection of the two worlds is a unique opportunity. I'm looking forward to climbing the learning curve, being resourceful, and making tangible contributions."



Ayca Altay



Yufei Huang



Zhetao Chen

Like Altay, **Yufei Huang** is working with the NLP group at AmEx to improve chatbot accuracy and understanding of customers' intentions. "The internship helps me understand the gap between academics and industry and also helps me practice implementing an algorithm and solving a real-world problem. Getting access to real data to solve problems is very exciting."

Huang, who expects to receive his doctoral degree in 2023, says he plans to continue to work in the field of human-AI interaction. "I want to study how humans and AI negotiate when making a decision

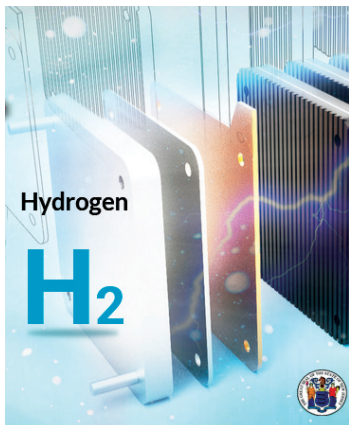
This year, three doctoral candidates in ISE are taking part in the yearlong program. They began working remotely in September, and will continue to do so at least until January.

Ayca Altay has been assigned to the AmEx Natural Language Processing (NLP) team that designs chatbots. "When a customer enters needs via text, the chatbot must understand and respond accordingly," she explains. "It is more than a simple linguistic response—the chatbot is also responsible for initiating the processes mentioned in the response, such as sending a replacement card or correcting a double transaction. I'm working towards making this process more accurate and satisfying for customers."

and enhance each other's complementary strengths through collaborative intelligence."

At AmEx, **Zhetao Chen** is working as a data scientist, which he expects will prove helpful to his goal of becoming a data scientist in industry once he receives his degree within the next year. "This is a great step for me for my future," he says. "I can get experience and learn related skills through this program."

In particular, he is looking forward to gaining access to a large number of datasets, which he describes as "the most important thing for data science."



Mohsen Jafari Appointed to New Jersey Fuel Cell Task Force

In January, New Jersey Governor Phil Murphy appointed Department of Industrial and Systems Engineering professor and chair **Mohsen A. Jafari** as a member of the recently established New Jersey Fuel Cell Task Force.

"This appointment is a real honor for me as it aligns both my research interests in clean energy advancement

and my desire to help the state explore opportunities associated with fuel cell initiatives," says Jafari who also leads the Laboratory for Energy Smart Systems (LESS) at Rutgers. "I've worked for the state on a number of related projects, and now being a member of this task force will enable me to continue to help New Jersey reach its goal of 100% clean energy by 2050."

Optimizing Wind Farm Profitability



By 2030, more than 10 million homes will be powered by offshore wind turbines, according to a Biden administration plan designed to stall climate change and accelerate a transition to clean energy.

Yet the transition to wind energy presents an immense challenge in terms of cost-effectiveness: a balance must be achieved between revenue-producing electricity generation and the long-term expense of asset maintenance.

With help from a recent three-year, \$450,000 Grant Opportunities for Academic Liaison with Industry (GOALI) grant funded by the Electrical, Communications and Cyber Systems division of the National Science Foundation (NSF), Aziz Ezzat, industrial and systems engineering (ISE) assistant professor and director of Rutgers' Renewables and Industrial Analytics (RIA) research group, will address this challenge.

"I can't stress how fortunate I am to have joined Rutgers in 2019 as offshore wind energy was about to take off in the north Atlantic region," he recalls. "One of the strategic thrusts of RIA is to look at the needs of this emerging sector and establish strong industry partner-

ships. This award comes at the right time to pursue challenging—and impactful—research avenues that bridge data and wind energy sciences through an ISE lens."

As principal investigator (PI), Aziz is collaborating with co-PI Joseph Brodie, the director of Atmospheric Research in Rutgers' Center for Ocean Observing Leadership; PI Murat Yildirim of Wayne State University; co-PI Feng Qiu of Argonne National Lab; and co-PI Mina Mousa, a senior analytics engineer at Cognite Inc. on "Generation Versus Degradation: Striking the Optimal Balance for Wind Farm Profitability via Digitization, Predictive and Prescriptive Analytics."

According to Ezzat, waters a few miles off the New Jersey coast will be hosting ultra-scale wind turbine designs for the first time ever to help achieve state and federal offshore wind goals. "These gigantic structures—the largest rotating machines on earth—will be almost twice the height of the Great Giza pyramid, with rotor diameters twice as long as a soccer field," he says.

"Such exciting promise, however, breeds technical challenges," he adds. "The predictability, productivity, and reliability of wind energy are challenges hindering its large-scale integration into current electricity systems."

Innovative solutions are needed to reduce the levelized cost of energy, which for wind energy includes high operations and maintenance expenditures. The revenue generated by harvesting wind is offset by exorbitant maintenance costs. "It is this unique trade-off that largely determines wind's economic viability as a clean, cost-efficient source of energy—and is the overarching theme of our project."

Ezzat aims to create an interactive digital twin of a wind farm, leveraging Cognite's tools and capabilities that can bind to the Rutgers and Wayne State teams' prediction and decision models within an end-to-end digitization platform. "It will enable operators to make cost-effective operational decisions on the fly."



ISE students will benefit from the award as well, through summer internships hosted at Cognite, and funding to train and support doctoral students working at the interface of data and wind energy sciences.

Ultimately, Ezzat says, the team "is looking forward to contributing to the realization of the promise of wind energy through this project."

Ali Tosalı, Ph.D.

Assistant Professor of Management
Information Systems (MIS)
Saunders College of Business,
Rochester Institute of Technology

In 2013, after receiving his B.S. degree from the Turkish Military Academy in Ankara, Turkey, Ali Tosalı enrolled in the School of Engineering where he received his M.S. and Ph.D. degrees in industrial engineering. While a doctoral candidate, he was a lecturer in the Rutgers Business School. He recently joined the faculty of Rochester Institute of Technology's Saunders College of Business as an assistant professor.

Why did you choose Rutgers for your graduate work?

Rutgers attracted me for its well-known world-class faculty and education and for its proximity to metropolitan areas such as New York City, Washington, D.C., and Philadelphia.

What attracted you to ISE?

I've always been fascinated about its position as a hub, where you have the opportunity to



analyze and improve various types of systems from other fields.

What do you most value about your SoE education?

I had the chance to work with brilliant students and learn from top-of-the-class professors. My advisor Myong Jeong had a big impact on my personal and professional life. His ability to break things down into larger pieces and then

build connections between different concepts amazed me and taught me useful life lessons.

What do you most enjoy about teaching?

I see my students as young professionals. Being able to build long-lasting relationships is what I most enjoy. You need to spend time and show your interest in your students' successes.

Are you involved in any research projects?

I'm working on several projects right now. My research focuses on the development of new methodologies for various data-driven problems. One is about detecting face reviews on e-commerce platforms such as Yelp and Amazon. In another, I'm proposing a new framework to identify top persuaders in digital social networks.

Do you have any advice for new ISE students at Rutgers?

My advice would be to work smart—including building lasting peer and faculty relationships—rather than too hard. In the end, we industrial engineers are very good at optimizing, right?

Joel Reiss ENG'92 Receives MoE for Distinguished Achievement in Industry



In 1992, Joel Reiss earned his bachelor's degree in industrial engineering from the School of Engineering. In October, at the school's Medal of Excellence Dinner, following introductions by Mohsen Jafari, ISE department chair and professor and sophomore ISE major Upashna Purohit, he was presented with the award for Distinguished Achievement in Industry.

"I'm truly honored to receive this award," says Reiss, who is the executive vice president of TransDigm Group, a leading global producer, designer, and supplier of engineered aerospace components, systems, and subsystems for nearly all commercial and military aircraft in service today. "To be recognized by my alma mater for achievement in industry is very humbling."

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"I've worked for nearly 30 years in various engineering and leadership positions in a variety of industries. During that time, I've been a part of many exciting and challenging opportunities that were solved by great people coming together to make the seemingly impossible possible," he adds. "I've never celebrated my own success in those efforts—it's always been the team's celebration. This award is a rare opportunity for me to look back and take in the role I've played in that success."

I've been a part of many exciting and challenging opportunities that were solved by great people coming together to make the seemingly impossible possible.

According to Jafari, Reiss is a terrific ambassador for the university, the school, and the department. "I greatly appreciate his enthusiastic willingness to support our department whenever possible," he says.

Jafari notes that as an ISE Industry Advisory Board member, Reiss has helped the department forge productive bonds with industry and corporate partners that benefit students, faculty, and businesses alike. He has also offered internship opportunities that give ISE students invaluable real-world experience.

More recently, Jafari says, "his generous contribution has helped us develop our cutting-edge Human-AI Systems Lab, where students gain hands-on training in configuring smart systems and optimizing decision-making through collective intelligence." (See Cover Story.)

Reiss readily credits SoE as the foundation for his success. "Core classes like work design, manufacturing processes, and facilities planning provided me with the basics to help kickstart my early days as an engineer," he recalls. "But it was learning to build collaborative relationships and acquiring basic problem solving skills at Rutgers that really made the biggest difference for me in my career."

ISE student spotlights

Jingbo Guo, Ph.D. Student

I received my B.S. and M.S. degrees from Chongqing University back in China and a master's degree in statistics from Rutgers. I developed a huge interest in reliability assessment for vehicles after my internship in China working as a maintenance engineer. This is why I chose Rutgers for my Ph.D. The ISE department has top professors in the reliability field.



At Rutgers

My professors are very knowledgeable and helpful, and I love being able to choose classes from different departments. My research topic is on reliability estimation for complex systems, such as a multi-dimensional unmanned aerial vehicle (UAV) system. For these systems, maintaining balance while providing enough power is key. I also worked as a Rutgers-AmEx scholar in the AmEx machine learning lab from September 2019 until September 2020.

What's Next

I expect to receive my degree in January 2022 and will seek a career as a machine learning engineer after that.

Ali Saqib ENG'24

**Mechanical Field (Construction)
Engineer Intern
Bechtel Corporation**

How did you land your internship?

I attended a career fair at the 47th Annual National Society of Black Engineers (NSBE) Conference in May 2021 through the Rutgers School of Engineering organization MEET. A recruiter contacted me after seeing my resume for this position.

What was the best part of the internship?

It was having the opportunity to live on my own in a place I have never been [Augusta, Georgia]. Georgia in comparison to New Jersey is very different but having a unique environment was fun to adapt to. After having my first year of college completely remote, it was exciting to be able to meet new people in a new state in-person to develop myself professionally.

One thing you learned that surprised you?

The tasks of a mechanical field engineer. I thought while working on the nuclear plants at Bechtel, I would be doing tasks such as welding or putting parts together to help finish the project. I quickly learned that a field engineer is constantly doing field walk downs, completing work packages, as well as communicating with the craftspeople responsible for welding piping together for the plant. It was great seeing how a field engineer must be able to see the bigger picture to help complete the little steps that go into the final product.





ISE Students Place First in IISE Technical Paper Competition

As they started their capstone Senior Design project, **Kiran Aiyar**, **Harsh Patel**, and **Daniel Schechter** wanted to be a top team with a top project. Their positive mindset led to the creation of Tutor Vision—an intelligent system designed to help tutors diagnose student misconceptions using information generated by an eye tracker. It provides fixation boxes along with a predicted confusion score to inform tutors of possible areas of concern.

It's a project that the team believes can contribute to the fields of eye-tracking, intelligent tutoring systems, and human-computer interactions.

They recently won first place in the prestigious Institute of Industrial and Systems Engineers (IISE) technical paper competition. Their winning paper was published in ProQuest this fall.

"I see this win as recognition for hard work," says Schechter, who is now working in General Motors' supply chain department and

studying for his M.S. degree in engineering management at the University of Michigan.

"We sat on Zoom with each other countless nights until 4 a.m., and were told by too many people inside and outside of ISE that we were



straining ourselves too much on this project. Yet we were completely obsessed."

Realizing that a research paper was the next step, the team kept going. "I wanted to see this through and really contribute something to the machine learning space," Schechter adds. "This was the hardest thing I've ever done and getting international recognition

was unexpected—and perhaps my greatest achievement. I'm grateful I did it with my team members—who were two of my best friends."

Now working at Boeing as an industrial engineer Aiyar says the win was personally validating. "It was a complex project and required enormous effort from each of us," he says. "It was the culmination of an entire year-plus worth of work. We came up with a great idea, a great final project, and a great final paper."

This summer, Patel started at Johnson Controls in the BEST Fire Sales Engineering program. Looking back, he recalls that his team's biggest challenge was to "create a project that did justice to the existing research in fields such as eye-tracking, machine learning, and cognition."

Their success, to him, was satisfying not only as a senior design project, but also as a research paper "that showcases all we learned in the last four years and is an example of our best work."