Industrial & Systems Engineering
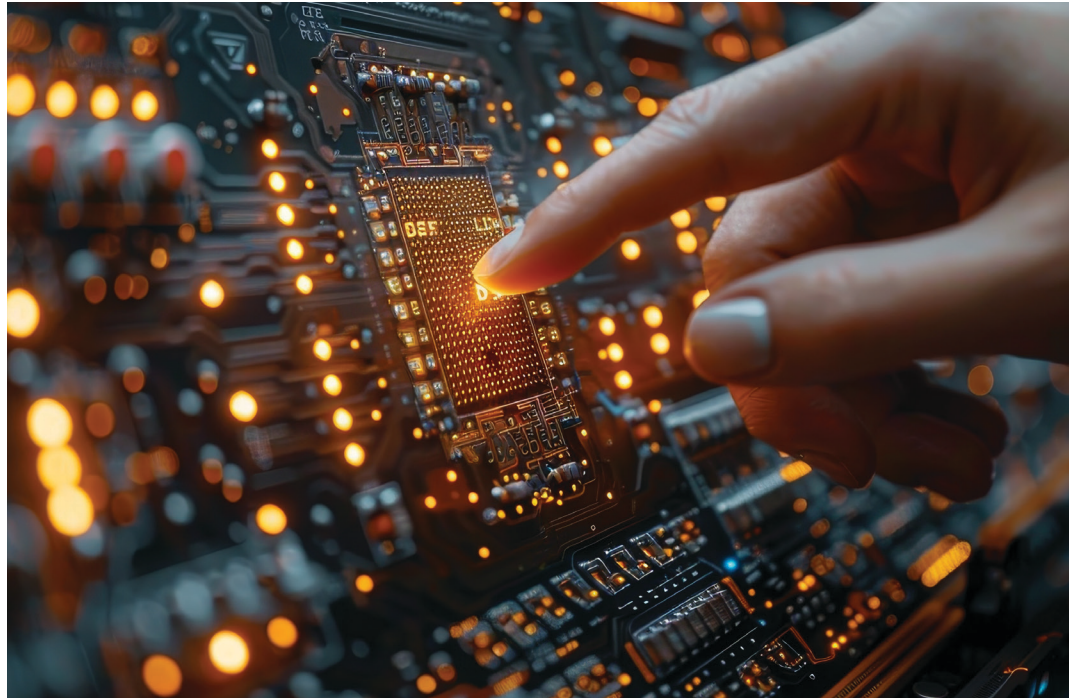## at Rutgers

ise
news

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–NEW BRUNSWICK
School of Engineering
Department of Industrial and Systems Engineering

Designing Solutions that Embrace Uncertainty in Autonomous Navigation

Associate professor Zhimin Xi is currently wrapping up "Collision-free Dynamic Window Approach for Moving Obstacles," a year-long project funded by Rutgers TechAdvance.

While dynamic window approach (DWA) enables autonomous vehicles such as wheelchairs and robots to move safely in their surroundings, is imperfect. "The complexity of real-world environments often introduces challenges that the standard DWA isn't equipped to handle flawlessly, particularly when it comes to unpredictable obstacles that move and change course," says Xi. "Here's where our innovative approach stands out. Unlike conventional DWA methods that take a somewhat static view of the world, our solution is designed to embrace uncertainty."

With this project, he is integrating a nuanced understanding of uncertainties into a navigation algorithm in order to anticipate and plan for potential errors. The result?

"Safer, more reliable collision avoidance, especially in dynamic settings where obstacles aren't just sitting still," says Xi.

This project aligns fully with many of Xi's broader research goals involving autonomous wheelchairs. By reducing the risk of accidents, it will provide the wheelchair-bound with enhanced mobility and independence, as

Industrial engineers discover solutions to problems that impact our daily lives, whether by employing AI to predict wind for offshore turbines or collaborating on a $3million interdisciplinary project to advance manufacturing for tomorrow's smart factories.

ISE undergraduate and graduate students receive a world-class education that fuels their drive to discover and innovate solutions that are at once reliable, cost-efficient, and environmentally sustainable.

This newsletter shares how our talented faculty, students, and alumni are changing our world for the better.

Our students draw on their creative and engineering skills to address ISE challenges with innovative senior design projects.

We applaud our ISE alumni featured here who have applied their foundational skills and training to achieve career success.

Our faculty continue to receive funding for exciting research projects for everything from wind energy and advanced manufacturing to power system reliability and transportation system needs.

I'm certain you will share my excitement about this other recent department news featured here.

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.

Associate Professor Weihong (Grace) Guo is collaborating with Rutgers CAIT, Syracuse University, and consulting firm Steer on a New York Metropolitan Transportation Council (NYMTC) funded "NY Transit Service Coordination Needs Assessment." The project aims to identify challenges hindering coordination among New York metro area transit agencies and propose strategies to address them. "The assessment will benefit various stakeholders involved in regional transit planning and operation, including transit agencies, government authorities, policymakers, and ultimately the residents and travelers within the New York Metropolitan region," says Guo.

Assistant Professor Aziz Ezzat delivered a keynote speech, "Reflections on STEM Research in the Digital Era," at the New Jersey Junior Science and Humanities Symposium that was held at Rutgers in March. He reports that he emphasized the contributions undergraduates have made – particularly in the ISE department – to building data-driven solutions for improved operation and economic outlook of renewable energy.

Assistant Professor Robert Mieth reports a new affiliation with the Center for Urban Policy Research through which he will receive funding from the New Jersey Public Board of Utilities for research on power system reliability. This extends his existing affiliation with the Rutgers Climate and Energy Institute and the Offshore Wind Collaborative. In March Mieth chaired an invited session on "Advanced Optimization Methods for Modern Power Systems" at the 2024 INFORMS IOS conference, and he will chair a session on data valuation methods at the 2024 EURO conference. Mieth was also elected to be a Director on the Board of the Energy Systems Section of Institute of Industrial & Systems Engineers (IISE) for the 2024-2026 term.

new faculty

Robert Mieth joined the ISE faculty in fall 2023 as an assistant professor. His research focuses on the operation and planning of renewable-dominant power and energy systems in the context of climate change. Dr. Mieth's lab – the Reliability, Operation, and Planning of Power and Energy Systems (ROPES) lab – will collaborate with the ISE Department's existing efforts in Energy Systems and its Energy Lab.

As Dr. Mieth sees it, clean, reliable, and affordable access to electric energy benefits society as a whole. "Some of the specific problems my research addresses, will resonate with current challenges faced by power system operators, regulatory agencies, and electricity market stakeholders working on the renewable energy transition," he says.

Besides his two graduate students, he is currently supporting two master's degree students and one undergraduate student who are competing in the IEEE Hybrid Energy Forecasting and Trading Competition. This semester, he is also "hosting three talented engineering students through the Douglass Women in Science and Engineering (WiSE) Project SUPER who are working on questions related to 'Electrify Everything' for an economy-wide decarbonization."

Associate Professor Zhimini Xi is expanding dynamic window approach (DWA) research that is designed to embrace uncertainty.

well as safety and security, and enhanced opportunities for social interaction. Xi notes that ultimately it has the potential of "leading to breakthroughs in other sectors that can benefit from improved navigation systems."

Significant Project Milestones

To date, Xi reports that completed project milestones are bolstering a foundation for

> **"What excites me the most about this project,"** he says, **"is the profound impact it has on enhancing the autonomy and safety of individuals with mobility impairments"**
> —Zhimin Xi

autonomous wheelchair technology that can be viewed on You Tube at https://youtu.be/rbDUoUtivJQ.

According to Xi, these advances include conducting wheelchair motor analysis and safety tests and applying results to wheelchair motors; designing and 3D printing a custom fixture to install a magnetic encoder for precise motor control; modifying wheelchair control panel design; building a tailored Robot Operating System (ROS) to allow for future functional expansions; and creating a simulation platform for testing autonomous control and navigation in various indoor environments.

"What excites me the most about this project," he says, "is the profound impact it has on enhancing the autonomy and safety of individuals with mobility impairments."

Aziz Ezzat Receives Grant to Develop Offshore Wind Energy Forecasting Tool

Assistant professor Aziz Ezzat has received a $361,000 National Offshore Wind Research and Development Consortium (NOWRDC) grant to develop an AI-powered, physics-based tool for offshore wind forecasting and grid integration. NOWRDC is a federally funded consortium, with support from the Department of Energy (DOE), to advance the science and practice of offshore wind energy in the United States.

"The project is special because it is use-inspired," Ezzat says. "Not only would we

like to formulate innovative solutions, but importantly, we would like to make sure those solutions are extensively tested and validated at key offshore wind energy areas off of the East Coast."

His three-year project aims to create an AI-powered forecasting technology that will significantly enhance our ability to forecast offshore wind resource and generation, and thus make real-world impacts that can eventually be put into use.

According to Ezzat, ultimately this tool will help both offshore energy producers and developers, grid operators, and other offshore wind stakeholders run offshore turbines at low cost and high efficiency and that can reliably meet demands for clean energy production.

"This is why the project has a cross-disciplinary industry advisory board comprised of private, state, and federal experts and stakeholders,"

he explains. "Rutgers Office of Innovation Ventures is also involved with helping our project team – which includes ISE graduate students, an undergraduate research fellow

> **"Without them, operating an offshore wind turbine – the largest rotating machine on earth – is like shooting in the dark"**
> —Aziz Ezzat

and a Rutgers computer science student – envision market pathways for our research products."

Accurate forecasts are crucial to the successful operation of offshore wind farms. "Without them, operating an offshore wind turbine – the largest rotating machine on earth – is like shooting in the dark," explains Ezzat.
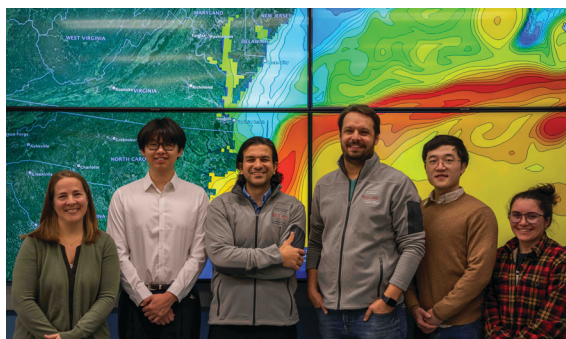
Assistant Professor Aziz Ezzat, pictured third from left with his students, is developing an AI-powered, physics-based tool for offshore wind forecasting and grid integration.

Transforming Latency-critical Manufacturing for Future Smart Factories

Associate Professor Weihong (Grace) Guo is a co-PI on a four-year, nearly $3 million National Science Foundation (NSF) project to develop "NextG-Enabled Manufacturing (NextGEM) of the Future – one of five "Future Manufacturing" grants awarded in 2023.

She is part of a collaborative School of Engineering team led by PI mechanical and aerospace engineering (MAE) professor Yuebin Guo that also includes electrical and computer engineering (ECE) faculty Yingying Chen and Narayan Mandayam, MAE's Jingang Yi, and Ivan Seskar of WINLAB.

For latency-critical manufacturing processes, operation efficiency, quality control, and safety depend on timing. "The goal of the project is to reshape latency-critical manufacturing processes with 5G and future 6G wireless communication technologies to achieve high flexibility, ultra-low latency, high speed, and high reliability – and improve real-time control," explains Guo.

Ultimately, according to her, the project will transform various manufacturing sectors by offering improved operation efficiencies, fewer defects, and emerging new business models to drive growth.

As a co-PI, she says she shares responsibility for the project's success with her fellow co-PIs. "Specifically, I will lead two major tasks: cyberinfrastructure and education and workforce development, or EWD."

She will be leading the development of a sustainable cyberinfrastructure providing "testbed, data, and software services for end-users to access, interoperate, and reuse."

In leading EWD, Guo plans to "nurture and grow the next generation of talent to strengthen the global U.S. leadership in Industry 4.0," she says. "The 5G revolution will create 4.6 million 5G-related new jobs through 2034. Yet, a diverse 5G-savvy workforce is scarce. We hope to fill in the gap by creating the next generation of the digital manufacturing workforce."

Both graduate and undergraduate students will be involved in the project, including a PhD graduate research assistant Guo hired in Fall 2024, who will conduct project research.

Associate Professor Guo and students attend the INFORMS annual meetings in Phoenix, AZ, in October 2023. From left to right: Mengfei Chen (ISE PhD candidate, graduating in May 2024 and joining New York New Paltz as a faculty member), Samar Saleh (fourth year ISE PhD student), W. Grace Guo, Vidita Gawade (ISE PhD alumna, graduated in May 2023 and now a faculty member at NYIT).

Additional students will be involved throughout the project's duration.

Guo notes that the "project aligns with my research interests and represents an opportunity to contribute to the advancement of manufacturing technology and to address critical challenges facing industry in the era of Industry 4.0."

She adds, "I'm thrilled to be part of an interdisciplinary team working together on this major NSF project. My involvement serves as an acknowledgment of my past contributions and dedication to advancing research in manufacturing."

Guo along with Yuebin Guo, Henry Rutgers Professor of Advanced Manufacturing, served as co-chairs of the 2023 International Manufacturing Conference held at the School of Engineering along with 800 participants.

Strong Teams Deliver Better Senior Design Projects

In March, junior ISE majors prepared for senior design by attending "Habits of High Performing Teams," a joint presentation by George Huang, a leadership coach and vice president and general counsel of Flatlands Solutions, and Kerry Kittles, a noted life coach and former NBA basketball player.

Working with their teams, the students learned to establish positive team norms such as trust and decision-making, identify bad habits, and give and receive constructive feedback to avoid challenges in successfully completing their senior design projects.

Huang and Kittles also emphasized the value of strong teams in the workplace and in personal relationships. Prof. Jafari hopes to continue team building workshops for students and faculty.

Succeeding by Design

Senior design projects are a rite of passage for SoE students, who identify and tackle complex engineering challenges. William Schaub and Amit Upadhye are among the ISE seniors whose ambitious projects were designed for success.

Students William Schaub, Nick Vagott, Christian Sawicki, and Ian Sullivan presenting to a team of judges during ISE Senior Design event.

Schaub and team members Nick Vagott, Ian Sullivan, Christian Sawicki devised Liftlogic, a sensor suite and machine learning model that makes weightlifting safer by providing real-time form metrics and follow-up machine learning analysis for weightlifters practicing unsafe lifts.

Using a K-Nearest Neighbors (KNN) machine learning model, the team was able to identify specific lift errors captured by sensors at each end of a barbell with 92% accuracy in less than a second.

Iyengard, Amit Upadhye, and Girish Sankrithi.

Schaub recalls that he most enjoyed the project's "'Eureka!' moments with the team after working on an issue for a couple of days and suddenly reaching a workable result. This happened quite a few times throughout the project because we'd chosen to start from scratch. But by the end of the project, we'd worked our way through so many problems that it truly felt like nothing could stop us."

Upadhye and fellow team members Girish Sankrithi and Vishnu Iyengar addressed the issue of quality assurance and defect detection in small-scale 3D printing with "GANufacturing."

This project used machine learning techniques such as Generative Adversarial Networks (GAN) and YOLOv5 to advance real time defect detection in 3D printers and create a balanced, comprehensive dataset.

While Upadhye reports that the team's main challenge was a tight timeline, his favorite part of the project was learning all about GANs – currently one of the hottest topics in machine learning.

"I'm super interested in seeing its application in the future," he says.

Both Upadhye and Schaub are facing bright post-graduate futures.

Schaub will be returning to active duty as a U.S. Air Force officer and civil engineering project engineer, while Upadhye will be working in Nordstrom's Seattle headquarters as an industrial engineer.

William Schaub demonstrates his team's design project to event attendees.

Industry Turns Out For Student Meet and Greet Event

More than 200 engineering students who attended a March Meet & Greet event hosted by Rutgers Institute of Industrial & Systems Engineers (IISE) chapter and sponsored by the ISE department were able to meet with representatives from ten companies, including Axtria, Creston, JP Morgan Chase, L3 Harris, Nestlé, Panasonic, Picatinny, Proctor & Gamble, Schneider Electric, and Tesla.

"The intimate setting made it very easy to break the ice with industry representatives," reports Assistant Teaching Professor Randy Reagan. "At this time of year, there are still full-time positions and internships available, and this was a great opportunity to match students with the openings these companies had to offer."

Alumnus John Sharkey Receives 2023 SoE Medal of Excellence Award

Pictured left to right; School of Engineering Dean Alberto Cuitiño, Medal of Excellence honoree John Sharkey, and School of Engineering alumnus Brian Reilly.

Industrial and systems engineering alumnus John Sharkey is the 2023 recipient of the School of Engineering's (SoE) Medal of Excellence Award, which was presented at a gala event on campus last September. The award, which recognizes lifetime professional and civic achievements, is SoE's highest honor for an alumnus.

Sharkey's long and distinguished career at Corning Incorporated, along with his community engagement activities and his support of the School of Engineering, were celebrated during the event that was attended by alumni and friends, faculty members, students, and industry representatives and sponsors including Johnson & Johnson, Corning, PSEG, Colgate-Palmolive, and Verizon, among others.

He began his 36-year career with Corning as a senior project engineer. For much of his career, he led strategy, mergers and acquisitions, intellectual property protection, business analytics, and corporate development in Corning's optical fiber business. At the time of his retirement in 2018, he was vice president-chief of staff to the company's CEO.

Sharkey, who earned his bachelor's and master's degrees in industrial and systems engineering in 1979 and 1990 respectively, has characterized his Rutgers education as a "true growth and

learning experience. I learned it was okay to question things and challenge the status quo. I was able to enjoy an unbelievable career because of my experience at Rutgers, which taught me a structured way to approach problem solving."

ISE master's students Patrick Rudawski (left) and Michael Mesham (right) along with Spot the robotic dog, conduct research related to crop management.

A self-described "pay it forward kind of guy," Sharkey and his wife Chris honored ISE distinguished professor Elsayed A. Elsayed by establishing an endowed scholarship in his name. The scholarship supports underrepresented minority students studying industrial engineering with demonstrated financial need. It has been their hope that the scholarship will help to put deserving students on a path that will enable them to achieve their dreams.

Sharkey has also supported students in other ways, including serving as a senior design judge in 2023 that subsequently led to him hosting ISE master's degree students Patrick Rudawski and Michael Mesham on his farm in upstate New York, where they conducted research to help small farmers better manage their crop yields.

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"I was able to enjoy an unbelievable career because of my experience at Rutgers, which taught me a structured way to approach problem solving."
—John Sharkey

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Mesham says, "One of the greatest lessons I've learned from John is his pay it forward approach to life. He took an interest in our senior design project and offered his farm to expand our research. He wasn't just interested in supporting our research, he also saw how it could benefit the farmers in his community – and we were able to see the research make an impact."

A lifelong volunteer, Sharkey has served on boards such as the American Red Cross's Greater Steuben Chapter, Family Service Society, Inc., and Southern Tier Network, a public/private partnership enabling universal and affordable broadband services and promoting economic growth throughout the Southern Tier and Finger Lakes region of New York.

To watch a video of John Sharkey's Medal of Excellence Award presentation, visit https://go.rutgers.edu/kw4d4vba

ISE Degree Launches Alumna Tracie Parker's Sales and Marketing Career

ISE alumna Tracie Parker.

"My degree in industrial systems engineering has been the perfect foundation for my career, from my start in production planning to my current leadership role," says Tracie Parker ENG'94, who is based in California as a sales and marketing director for a Tier 1 automotive manufacturer.

"I'm in the aftermarket, which means I have to understand dynamic customer needs, present compelling technical solutions and quickly translate opportunities into business cases for future product launches. It's more of a strategic sales job," she says. "My ISE degree provided a good background in production, which is critical in dealing with our plants in terms of capacity planning, production forecasting, and understanding how customer inventory can impact our tactical sales plans."

The mother of three, who admits to a love of complex problems, also holds a master's degree in technology management from Stevens Institute of Technology.

Parker, who grew up in small-town Vernon, New Jersey, has traveled and worked with people all over the world. She enjoys the "pretty amazing" diversity of nationalities and cultures that she encounters through her work. "You have to be prepared to reorient yourself in a variety of situations to be able to best deal with someone from a different background."

Looking back, she especially appreciates her ISE degree for the opportunities it offered. "I really believe it's been a doorway for me to what all the possibilities could be," she explains. "With our background you can pursue work as an IP attorney, production or quality

"Never be shy to ask anyone in industry for advice... you can use their experience to help guide your own path to success."
—Tracie Parker

management, sales and marketing (as I do), or go into consulting. It really gave me a broad outlook to the different paths you can take."

She offers advice for students hoping to expand their own sense of the possible.

"Never be shy to ask anyone in industry for advice or even to be your mentor–whether it's a friend's parent, or someone you briefly met on an airplane. When you strike up conversations about someone's career journey you can use their experience to help guide your own path to success."

Parker has followed an unexpected path in tandem to her corporate career. She and her husband own The Wine Crush, a Long Beach, California boutique wine shop that works with distributors to offer weekly diverse wine flights from around the world.

Aziz Ezzat Receives IISE Excellence in Teaching Award

Assistant Professor Aziz Ezzat is a recipient of an Institute of Industrial & Systems Engineers (IISE) Excellence in Teaching of Operations Research Award. The award recognizes transformative innovations he has made in the core ISE course Probabilistic Models in Operations Research (OR).

"Aziz's redesign of a core ISE course for juniors and sophomores epitomizes our commitment to preparing the next generation of engineers with the tools and skills they need to become leaders," says department chair Mohsen Jafari.

"Our brains aren't wired to process uncertainty – let alone model it – and the central aim of the course's new design is to alleviate students' intimidation by OR/stochastics and replace it with curiosity, appreciation, and ultimately passion," explains Ezzat.

Ezzat's redesign of a course focused on decision-making under uncertainty, replaces traditional classroom instruction with an interactive, student-centered approach, that he says, "merges teaching pedagogies, including project-based, collaborative, and blended learning, with gamification."

For Ezzat, the IISE award is doubly meaningful. "First, I have come to the conclusion that inspiring students is indeed the best part of being an academic. It is through teaching that you get the fulfilling sense of creating a positive impact on young minds by seeing them grasp complex concepts," he says. "Second, IISE is our home as industrial and systems engineers, so recognition especially from its OR division is really rewarding."

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student spotlight Q&A

William Schaub ENG'24

William Schaub, who completed his studies in January, served as an enlisted member of the US Air Force (USAF) from 2012-2018, joining the New Jersey Air National Guard from 2019 to 2024 to remain in the military and use his GI bill while pursuing his degree. The married father of two has returned to active duty as a civil engineering project engineer and is attending Officer Training School at Maxwell AFB in Montgomery, Alabama.

Why Rutgers?

My family has a history with Rutgers, with three of my four grandparents having graduated. Rutgers Engineering is well respected, and the GI Bill covered my tuition costs.

Why ISE?

I appreciate that ISE is about understanding a variety of engineering disciplines but is largely focused on control and management as well as sound engineering principles. Given my age and prior experience, an engineering degree with more of a management perspective seemed like the best fit.

What do you most value about your SoE education?

I have a strong personal belief in public service, and I believe the skills and knowledge I gained will help me make a positive impact in people's lives – whether it's my fellow airmen or helping with humanitarian crises in which civil engineering is a crucial element.

How does this meet your career goals?

This is a great move for my career that will allow me to use my engineering skills and knowledge while gaining experience in engineering management, which – along with pursuing a master's in engineering management in the near future – will be highly valued by the civilian job market after I retire from the Air Force.

Where are you attending Officer Training School?

It's at Maxwell Air Force Base in Montgomery, Alabama. I'll be a Second Lieutenant once I complete the four-month course.

Where might you be stationed?

I recently learned I will be stationed at Joint Base Elmendorf-Richardson in Anchorage, Alaska.