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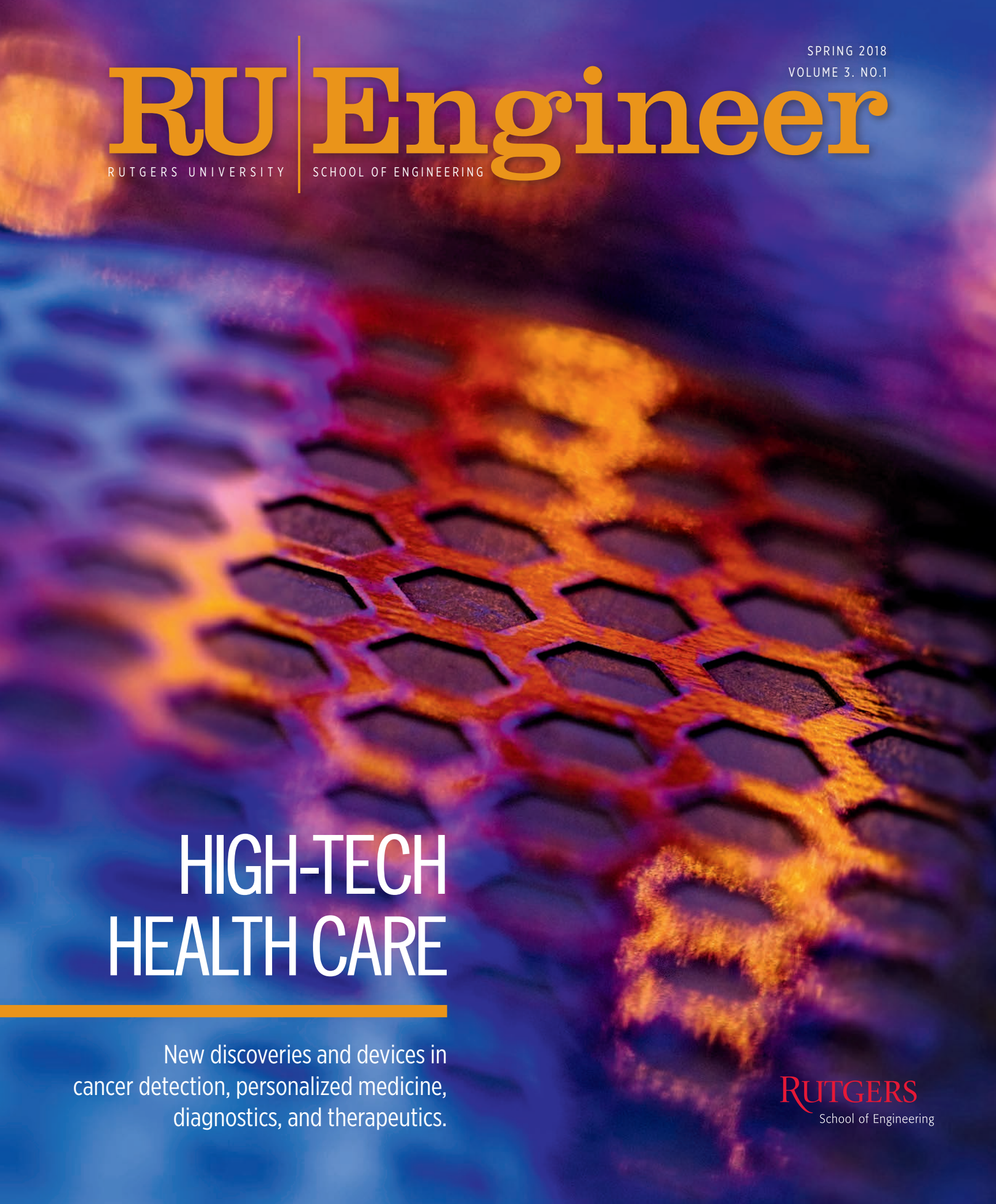
RU Engineer

RUTGERS UNIVERSITY | SCHOOL OF ENGINEERING



HIGH-TECH HEALTH CARE

New discoveries and devices in cancer detection, personalized medicine, diagnostics, and therapeutics.

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Rutgers University-New Brunswick
School of Engineering
98 Brett Road, B-211
Piscataway, NJ 08854
848-445-2214
soe.rutgers.edu

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From the Dean

Greatness Grows Here

BEAM SIGNING
Dean Tom Farris joins Dick Weeks as he signs the final beam before it's put in place, during Weeks Hall construction.

PHOTOGRAPH: NICK ROMANENKO

Being named the number one public university in the NJ/NY metropolitan region for undergraduate engineering education and among the top 50 programs nationwide (*U.S. News and World Report*) puts Rutgers engineering in a great position among our peers. It's a good feeling to have a rising reputation to uphold!

One way we are ensuring our continued growth and excellence is by providing the best facilities we can to educate our students and conduct world-class research. Richard Weeks Hall of Engineering is the latest in a planned effort by Rutgers University-New Brunswick and the School of Engineering to provide outstanding facilities.

Thanks to a generous donation from Richard N. Weeks (ENG'50), Weeks Hall—with dynamic labs, classrooms, and lecture halls—is nearing completion. We are now preparing for the next phase in an ambitious plan that envisions a modern learning environment on the Busch campus for engineering students. To learn more, visit soe.rutgers.edu/21century.

Weeks Hall will be formally dedicated on November 15, 2018, at an event open to all SoE alumni and friends. I hope to see you there!

Thomas N. Farris

THOMAS N. FARRIS
DEAN, SCHOOL OF ENGINEERING

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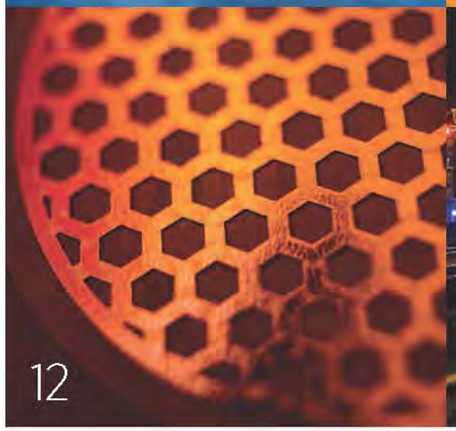

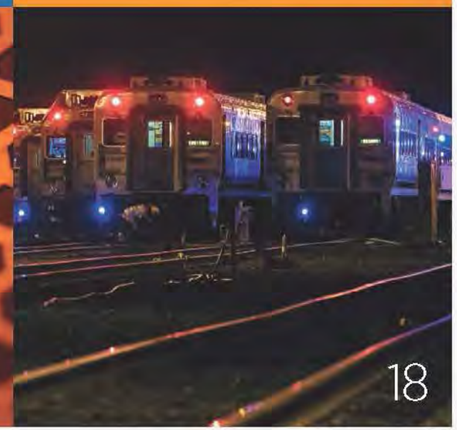

Features

Sections

ON THE COVER
Professor Aaron Mazzeo and his research team introduced a paper-based sanitizer with an array of potential microbe-killing uses. Photograph: Don Hamerman

Good Vibrations

VIBWRITE—A SMART ACCESS system that senses finger vibrations to verify users—is a low-cost security system that could eventually allow users to gain access to their homes, apartment buildings, cars, appliances—anything with a solid surface.

"Everyone's finger bone structure is unique, and their fingers apply different pressures on surfaces, so sensors that detect subtle physiological and behavioral differences can identify and authenticate a person," says **Yingying (Jennifer) Chen**, a professor of electrical and computer engineering and the senior author of a peer-reviewed paper on VibWrite.

By integrating passcode, behavioral, and physiological characteristics, VibWrite, it's hoped, will be able to verify a person's identity whenever a user's fingers touch a solid surface.

By integrating passcode, behavioral, and physiological characteristics, VibWrite, it's hoped, will be able to verify a person's identity whenever a user's fingers touch a solid surface. The technology builds on a touch-sensing technique that uses vibration signals yet differs from two widely applied methods. Traditional password-based approaches validate passwords but not legitimate users, and behavioral biometrics-based solutions typically rely on touch screens, fingerprint readers, or other costly hardware, leading to concerns about privacy breeches and "smudge attacks," which trace oily residue on fingertips.

"Smart access systems that use fingerprinting and iris-recognition are very secure, but they're probably more than 10 times as expensive, especially when you want to widely deploy them," says Chen, who is also a member of the Wireless Information Network Laboratory (WINLAB) at Rutgers.

Besides its low cost, VibWrite uses minimal power and includes an inexpensive vibration motor and receiver, turning any solid surface into an authentication surface. Both hardware installation and maintenance are easy, and "VibWrite probably could be commercialized in a couple of years," Chen says.

Media

BIOMETRICS: THE NEW PASSWORD

Vishal Patel, an assistant professor of electrical and computer engineering, was featured on *CBS This Morning* for his research into active authentication—using smartphone sensors to monitor users. Thanks

to biometrics, phones can be trained to recognize users based on the unique way they scroll, type, click, even walk. Researchers believe that biometric data could begin replacing passwords within the next few years.

ILLUSTRATIONS: *TOP*, ELLEN WEINSTEIN; *BELOW*, DANNY SCHWARTZ

Unraveling the Mystery of the Arctic

THE REMOTE ARCTIC REGION REMAINS LARGELY A MYSTERY TO SCIENTISTS due to its sheer magnitude. ICEBERG—Imagery Cyberinfrastructure and Extensible Building-Blocks to Enhance Research in the Geosciences—is a collaborative project funded by the National Science Foundation (NSF) determined to change that. ■ "ICEBERG represents a major investment by the NSF to develop algorithms and software systems at the interface of high-performance computing and data science to transform the way we study the polar regions and thus better understand our climate," says **Shantenu Jha**, a professor of electrical and computer engineering and one of the project's principal investigators. "ICEBERG will have major impact in both polar science as well as the technological capabilities available for polar science, thanks to the integration of high-performance computing and high-resolution satellite imagery." ■ The ultimate goal is to provide scientists with a new imagery-computing superhighway that will allow them to study processes at much larger spatial scales than has been previously possible.

$1.85M

NSF FUNDED RESEARCH: To study the effect of climate change on glaciers, sea levels, and Arctic wildlife, as well as the classification of geological characteristics of snow, mineral deposits, and water via algorithms.

PHOTOGRAPHS: *TOP*, REZUS/ISTOCK BY GETTY IMAGES; *ZONOUZ*, NICK ROMANENKO

Gifts & Grants

MARTIN YARMUSH (BME)
Transplantable human liver grafts; $1,600,000 National Institutes of Health

SHANTENU JHA (ECE)
Ensemble Toolkit for Earth Sciences; $1,250,000 National Science Foundation EarthCube

ASSIMINA PELEGRI (MAE)
Ultra-high molecular weight polyethylene films; $725,000 Office of Naval Research

SAMAN ZONOUZ (ECE)
Cybermanufacturing systems embedded controllers; $625,000 National Science Foundation

LALEH NAJAFIZADEH (ECE)
Quantitative framework to understand the brain; $360,000 National Science Foundation

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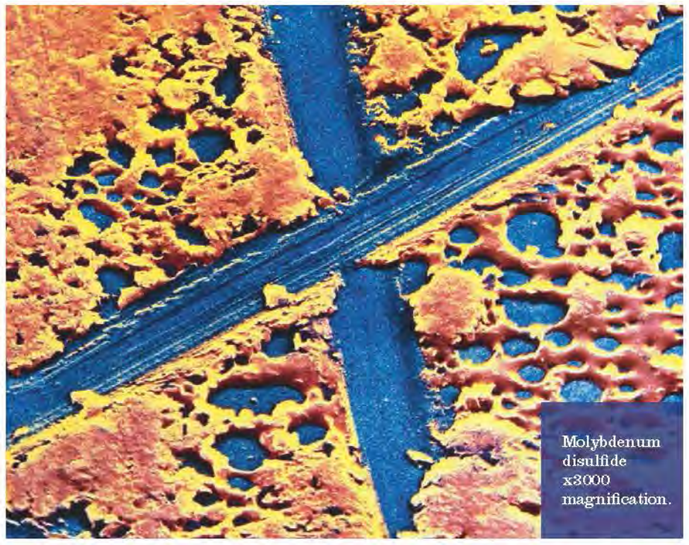


Molybdenum disulfide x3000 magnification.

Heavy Lifting

MOVE OVER SUPERMAN, THERE'S A NEW SUPER HERO IN town. Rutgers engineers have discovered a simple, economical way to make a nanosized device that weighs 1.6 milligrams (about as much as five poppy seeds) and can lift 265 milligrams (the weight of about 825 poppy seeds) hundreds of times in a row. ■ The Rutgers discovery is called an "inverted-series-connected biomorph actuation device" and it derives its strength from a process of inserting and removing ions between very thin sheets of molybdenum disulfide (MoS_2), an inorganic crystalline mineral compound. It's a new type of actuator—devices that work like muscles and convert electrical energy to mechanical energy. ■ "We found that by applying a small amount of voltage, the device can lift something that's far heavier than itself," said **Manish Chhowalla**, materials science and engineering professor. "This is an important finding in the field of electrochemical actuators. The simple restacking of atomically thin sheets of metallic MoS_2 leads to actuators that can withstand stresses and strains comparable to or greater than other actuator materials." ■ Actuators are used in a wide variety of electromechanical systems and in robotics, including steerable catheters, aircraft wings that adapt to changing conditions, and wind turbines that reduce drag.

MANISH CHHOWALLA
professor, materials science and engineering

Smartphones: the New Secretary

"Ideally, a smartphone notification-management system should be like an excellent human secretary who knows when you want to be interrupted or left alone," says **Janne Lindqvist**, an assistant professor of electrical and computer engineering. ■ A model developed by Lindqvist and his team can predict users' receptiveness to notifications and tolerance for interruption. The study, based on 5,000 smartphone records from 22 participants, found that participants' "interruptibility" varied according to mood, activity, and location: people might be highly interruptible at medical facilities waiting to see doctors, but less willing to be interrupted while studying or exercising. ■ Lindqvist says smartphone customization can match different preferences, such as always allowing certain people to interrupt the user. "A call from your kids or their daycare should always pass through, no matter the situation," he says, "while some people might want to ignore their relatives."

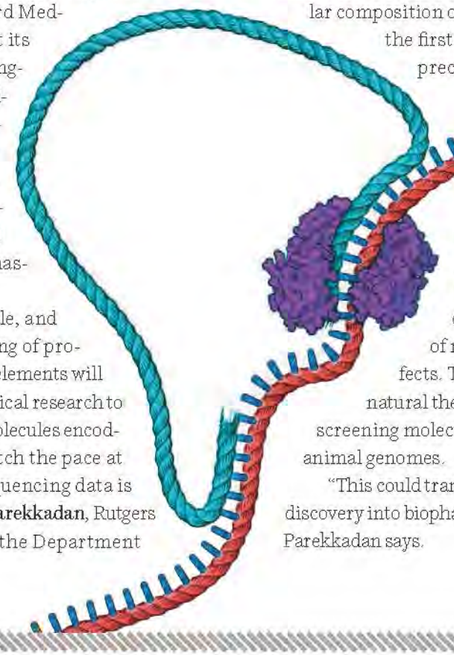
4D PRINTING
MAE professor **Howon Lee** has invented a hydrogel printing method that could lead to the development of "living" structures in human organs and tissues, soft robots, and targeted drug delivery.

Cloning the Future

SCIENTISTS AT RUTGERS AND OTHER universities have invented a technology that could lead to rapid discovery of medicines and biomarkers hidden in genomes. In a study published in the journal *Nature Biomedical Engineering*, a team comprising researchers from Rutgers, Johns Hopkins University, and Harvard Medical School showed that its technology—LASSO (long-adapter single-strand oligonucleotide) probes—can capture and clone thousands of long DNA fragments at once, creating, at unprecedented speed and precision, massive protein libraries.

"The rapid, affordable, and high-throughput cloning of proteins and other genetic elements will greatly accelerate biological research to discover functions of molecules encoded by genomes and match the pace at which new genome sequencing data is coming out," says **Biju Parekkadan**, Rutgers associate professor in the Department of Biomedical Engineering and co-author of the study. The researchers used the common model organism E. coli bacteria as a proof-of-concept, cloning more than 3,000 DNA fragments and capturing about 95 percent of their gene targets. The team also reported cloning the first protein library from a human microbiome sample. Understanding the molecular composition of the human microbiome is the first step in the effort to improve precision medicine that affect the microbial communities of the gastrointestinal tract, skin, and lungs, according to Parekkadan. The pharmaceutical industry currently screens large synthetic chemical libraries in search of molecules with medicinal effects. The team's goal is to discover natural therapeutic proteins by rapidly screening molecules of human, plant, and animal genomes.

"This could transform pharmaceutical drug discovery into biopharmaceutical drug discovery," Parekkadan says.



Next Up: The Naviator

REACHING NEW HEIGHTS The Rutgers-developed aerial aquatic drone—the Naviator—conducted historical aerial and underwater demonstrations last summer, successfully inspecting the Delaware Memorial Bridge in Delaware and a 100-passenger vessel at the Cape May Ferry Terminal in New Jersey. It showcased just a few of the drone's far-reaching applications, which range from bridge inspections to ocean mapping, search-and-rescue operations to naval warfare.

PHOTOGRAPH: *TOP LEFT,* JEREMY BURGESS/SCIENCE PHOTO LIBRARY
ILLUSTRATION: CHRISTOPH HITZ

PHOTOGRAPH: BILL CARDONI; LASSO ILLUSTRATION:
JENNIFER E. FAIRMAN/JOHNS HOPKINS UNIVERSITY

ALL IN THE FAMILY

By **AMY WAGNER**
Photography by **JOHN EMERSON**

For some legacy families, engineering is in their DNA

Engineering DNA

Kovacevich Family

PARENTS:
John Kovacevich ENG'89
Allyson Kovacevich RC'89
NEXT GEN:
Justin Kovacevich ENG'18
Dylan Kovacevich ENG'20

ALL IN THE FAMILY: From left, John, Justin, Allyson, and Dylan Kovacevich

Engineering DNA

DiStefano Family

PARENT:
Hala George DiStefano ENG'82
NEXT GEN:
Kristin DiStefano ENG'17
Nicole DiStefano ENG'13, GSNB'17
Jason DiStefano ENG'20

FOUNDATION FOR SUCCESS Justin Kovacevich will graduate in May with a degree in industrial and systems engineering—and a job in Campbell Soup Company's supply chain rotational program. As a junior, he was accepted into Rutgers' MBS 4+1 program. "I'll begin taking graduate courses in the spring," he says. "My concentration is engineering management, and I plan to continue working towards the degree after I graduate."

"I feel pride and relief that Justin found something so quickly," says father John Kovacevich ENG'89, an industrial systems engineering graduate who earned his MBA from Rutgers. As executive vice president for operations and supply chain at Bentley Laboratories, he oversees the company's manufacturing, production, and supply chain operations. "Everything—from the time we receive an order to the time that we ship it—falls under my direction," he says.

He's convinced that his Rutgers education provided a solid foundation for succeeding in his career and personally. "Besides meeting my wife, Allyson RC'89, I established lasting relationships with my college friends."

Justin's similar path is "almost scary," John says. "An MBA is always a good complement to a basic engineering education. It took me seven years; Justin's on a faster pace to get it done."

John's younger son, Dylan, is a mechanical engineering major in his second year who recently received his junior year status. He hasn't determined whether he will go to graduate school upon graduating or seek employment.

John believes that his (CONTINUED ON PAGE 39)

PROUD TRADITION When Hala George DiStefano ENG'82 graduated from the School of Engineering, she was ready to take on the world. "I walked out with my BS degree knowing that I could work in any environment as a female," she recalls. "Rutgers taught me what you needed to know." At the time, though, she hardly

WE ARE FAMILY: Clockwise from top right, Kristen, Jason, Nicole, and Hala George DiStefano

"You naturally wish the best for your kids and want them to succeed in life. But it's amazing that all three were savvy in math and science and got into engineering. I'm proud that they are all doing engineering and even prouder that they chose Rutgers."

-HALA GEORGE DISTEFANO

expected that she would have three children who would follow in her footsteps at the engineering school.

"You naturally wish the best for your kids and want them to succeed in life," she says. "But it's amazing that all three were savvy in math and science and got into engineering. I'm proud that they are all doing engineering and even prouder that they chose Rutgers."

"We're an engineering family," says Nicole ENG'13, GSNB'17, the oldest of the three DiStefano children with an undergraduate degree in mechanical and aerospace engineering and a master's degree in biomedical engineering. Her mother, Hala, is Microsoft's director of delivery management in the New York metropolitan area, and her father, Michael, a SUNY Stony Brook graduate in electrical engineering, is an engineering consultant. "I think he feels left out at times because he didn't go to Rutgers," she says.

A self-described go-getter, Nicole loves working as a senior engineer at Stryker, where she has an impact on people's health by designing instruments for hip surgery, such as implants for hip joints. "Stryker is a Type A personality kind of company," she says. "I fit in right away because of my School of Engineering experience."

Nicole was not only the first of her siblings to attend SoE, but also the first to major in biomedical engineering. Her sister, Kristin, a student in the department's five-year BS/MS program, will graduate in May 2018 with her master's degree. (CONTINUED ON PAGE 39)

SARA RIOS is one of four siblings to attend Rutgers engineering.

A SECOND HOME Growing up in Peru, Delia Rios ENG'09 developed an interest in math, fostered by her father who was an engineer. "During the summers, he would always get us together to do math problems," she says. "It was fun and really got us into math—and engineering."

The Rios family moved to New Jersey when Delia was 13, and she struggled in school because of her unfamiliarity with English. But there was one language she knew: "Math is such a universal language," she says. "We did well; our dad instilled that in me and my siblings."

Delia, unfamiliar with the American college application process, credits a counselor at her high school in Paterson, New Jersey, with helping her to chart her course to Rutgers. "She came from heaven, helped me take the right tests, and helped me with my applications," she says.

Rutgers was the ideal choice for Delia, an industrial and systems engineering major whose college experience included serving as the president of the SoE chapter of the Society of Hispanic Engineers. "I made lasting friends there, and the experience showed me how to work with different personalities—a valuable lesson for the workplace," she says.

FAMILY MATTERS: There was no pressure to attend and study engineering at Rutgers, but it was a good fit for Delia, Joseph, and Maria Rios, above left to right.

Delia, who is a quality assurance supervisor for FOODMatch, an importer and producer of Mediterranean foods, was the first of her three siblings to attend SoE. Her sister Sara Rios ENG'10 is a Verizon Wireless network operations manager who resides in Dallas. Delia encouraged her to apply to Rutgers. "I helped her with her application; eventually Sara said, 'I'm going to Rutgers, too.'" The sisters were close on campus, with Sara serving as a vice president of the Society of Hispanic Engineers while Delia was president. "Despite our different majors, we took one class together. We were even roommates my fifth and last year," says Delia.

"Delia and I have been roommates since I can remember," Sara says, who studied mechanical engineering, "and it was great to have her as a roommate again. We became really close friends, aside from being sisters."

Their brother, Joseph, who graduated in 2012 with a degree in electrical and computer engineering, is a Verizon Wireless vendor manager in New Jersey. He is pursuing an MBA at William Paterson University and recently became a part-time (CONTINUED ON PAGE 39)

Engineering DNA

Rios Family

NEXT GEN:
Delia Rios ENG'09
Sara Rios ENG'10
Joseph J. Rios ENG'12
Maria Rios ENG'21

PHOTOGRAPH: ROSALYNN FUERTE PHOTOGRAPHY

High-Tech Health Care

Pending breakthroughs, borne of faculty and student research, could dramatically improve health care outcomes.

By **TODD BATES AND MANYA GOLDSTEIN**

Photographs by **DON HAMERMAN**

Professors and students at the School of Engineering are developing novel health care advances by using innovative techniques and applications, including biosensors, nanotechnology, and imaging. Their discoveries are catapulting Rutgers engineers to the forefront in finding the next generation of health care solutions.

THE NEXT STEP
Mehdi Javanmard, assistant professor, Department of Electrical and Computer Engineering.

Among the advances in development are wearable devices that can analyze biomarkers to predict asthma attacks; nanoparticles and imaging technology that diagnose cancer and defuse viruses; and a paper-based device that uses a simple blood drop to distinguish viral and bacterial infections, a development that will help curb the over prescription of antibiotics worldwide.

Paradigm Shift

Mehdi Javanmard is developing a device that uses biomarkers to predict an asthma attack.

Representing a big step forward in the field of personalized medicine, Rutgers researchers have invented a graphene-based sensor that can detect asthma attacks and improve the treatment of respiratory diseases.

"Our vision is to develop a device that someone with asthma or another respiratory disease can wear around their neck or on their wrist and blow into it periodically to predict the onset of an asthma attack or other problems," says Mehdi Javanmard, an assistant professor in the Department of Electrical and Computer Engineering.

The miniaturized electrochemical sensor works by measuring nitrate in exhaled breath condensate—the tiny liquid droplets discharged during breathing. "Nitrite levels in breath condensate is a promising biomarker for inflammation in the respiratory tract," says Clifford Weisel, coauthor of the study and professor at Rutgers' Environmental and Occupational Health Sciences Institute. "Having a rapid, easy method to measure it can help an asthmatic determine if air pollutants are affecting them so they can better manage use of medication and physical activity. It could also be used in a physician's office and emergency departments to monitor the effectivness of various anti-inflammatory drugs to optimize treatment."

ON THE FRONTLINE
BME students Sudeepti Vedula, Charles Rabolli, Neel Nirgudkar, and Sarah Salter (at left); Laura Fabris, associate professor, materials science and engineering (below).

The sensor utilizes reduced graphene oxide, which boasts excellent electrical properties and the ability to accurately detect biomarkers. Javanmard says the idea of continuously monitoring biomarkers could become a paradigm shift in the field, which is now limited by costly, bulky equipment and poor diagnostic accuracy. The next step is to develop a wearable system, which, he says, could be commercially available within five years.

Disarming Viruses

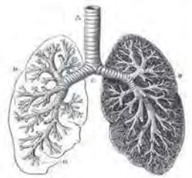
Laura Fabris attacks the flu by hijacking infected cells using imaging tools with gold nanoparticles.

Laura Fabris is playing a key role in a federal project to fight influenza virus by using TIPS—therapeutic interfering particles—to defuse not just the flu, but also, potentially, HIV, Ebola, and other deadly viruses. For the first time in virology, Fabris and her team are using imaging tools with gold nanoparticles to monitor, with unprecedented sensitivity, mutations in the influenza virus as it enters cells.

"Before we can understand how to make these therapeutic particles, we need to understand how viral mutation works," says Fabris, associate professor in the Department of Materials Science and Engineering. Her work is supported as part of a four-year, $5.2 million program funded by the Defense Advanced Research Projects Agency (DARPA).

DARPA says it wants to harness TIPs, which are tiny virus-like entities, with engineered genetic material that encodes defective viral proteins. TIPs, like viruses, can enter cells, but they don't replicate unless the cells are also infected with the virus.

SoE Advances



BREATHING EASY
Rutgers University researchers have invented a graphene-based sensor that can detect asthma attacks and improve the treatment of respiratory diseases. "Nitrite level in breath condensate is a promising biomarker for inflammation in the respiratory tract. Having a rapid, easy method to measure it can help an asthmatic determine if air pollutants are affecting them so they can better manage use of medication and physical activity," said **Clifford Weisel**, study co-author and professor at Rutgers' Environmental and Occupational Health Sciences Institute (EOHSI).

In a cell infected with both a flu virus and a TIP, the cell makes copies of the TIP genome, which competes with the flu virus for viral proteins. The goal is for harmless TIPs to outnumber flu virus genetic elements so that infected cells would generate relatively few infectious viruses and a bumper crop of "dud viruses" containing TIP genes, thus rapidly diluting the harmful viruses and halting the infection, according to DARPA.

"Ideally, the TIPs will be introduced into influenza virus populations and compete for protein so that the virus will starve and not be able to reproduce," says Fabris. She believes the research will have global health repercussions because, to cite one example, inexpensive machines could be used in clinics available to underserved populations around the world.

Resistance Fighters

A student-designed diagnostic innovation addresses the risk of antibiotic-resistant bacteria.

As part of its senior design project, a biomedical engineering team took second place in the MGH-APF 9th Annual Student Technology Prize in Primary Healthcare competition for creating a diagnostic tool that will mitigate the rise of antibiotic-resistant bacteria.

The team of Charles Rabolli, Neel Nirgudkar, Sarah Salter, and Sudeepti Vedula, advised by biomedical engineering assistant professor Adam Gormley, was awarded $50,000 to continue developing a point-of-care, paper-based microfluidic device that can differentiate between bacterial and viral infections. Rabolli says the goal of the project is to address the global nemesis of over-prescribed antibiotics.

"This mentality of over-prescription has led to a serious crisis with the rise of antibiotic-resistant bacteria," Rabolli says. "The paper-based microfluidic device will test a small blood sample, like that of a finger-prick used to check blood glucose levels by diabetics. The blood will then be wicked forward onto the device by the paper. We will incorporate biological markers that are specific for only bacterial infections and others that are specific for only viral infections."

Massachusetts General Hospital's Ambulatory Practice of the Future (APF) hosted the national competition, which is sponsored by the Gelfand Family Charitable Trust.

> "Research has implications for brain-computer interfaces that bridge gaps between machines and humans, as well as with commercial development of portable immunoassays and scalable processing of renewable paper products."
>
> AARON MAZZEO

Zapping Disease with Paper Sanitizers

Could a material as simple as paper have a new high-tech application?

A Rutgers-led team of researchers has introduced a paper-based sanitizer that offers an array of potential uses, ranging from self-sterilizing clothing to smart bandages that can heal wounds. The results of the team's study were published in *Proceedings of the National Academy of Sciences*.

NEW LIFE
Aaron Mazzeo, assistant professor, mechanical and aerospace engineering (left); a sample of the metallized paper, the first of its kind to be used to generate plasma (below left).

"We found that by applying high voltage to stacked sheets of metallized paper, we were able to generate plasma, which is a combination of heat, ultraviolet radiation, and ozone that kills microbes," says Aaron Mazzeo, assistant professor in the Department of Mechanical and Aerospace Engineering.

What's more, the concept appears to be the first of its kind. "To our knowledge, we're the first to use paper as a base to generate plasma," says Jingjin Xie, the study's lead author and a doctoral candidate at the School of Engineering.

In experiments, the paper-based sanitizers killed more than 99 percent of Saccharomyces cerevisiae (a type of yeast) and more than 99.9 percent of E. coli bacteria cells. The sanitizers were also able to kill spores from bacteria—which conventional sterilization methods struggle to do.

"Our next phase is to vigorously test how effective our sanitizer system is in killing spores," says James F. White Jr., coauthor of the study and professor in the Department of Plant Biology.

Mazzeo says one of the goals of their continued research is to invent paper-based sensors that can protect against external microbes while registering environmental input. Modeled after human and animal skin, the sensors could potentially cover parts of prosthetics, buildings, or vehicles and sterilize them upon entering or leaving contaminated areas. SoE

SoE Innovation

AN INSIDE TIP

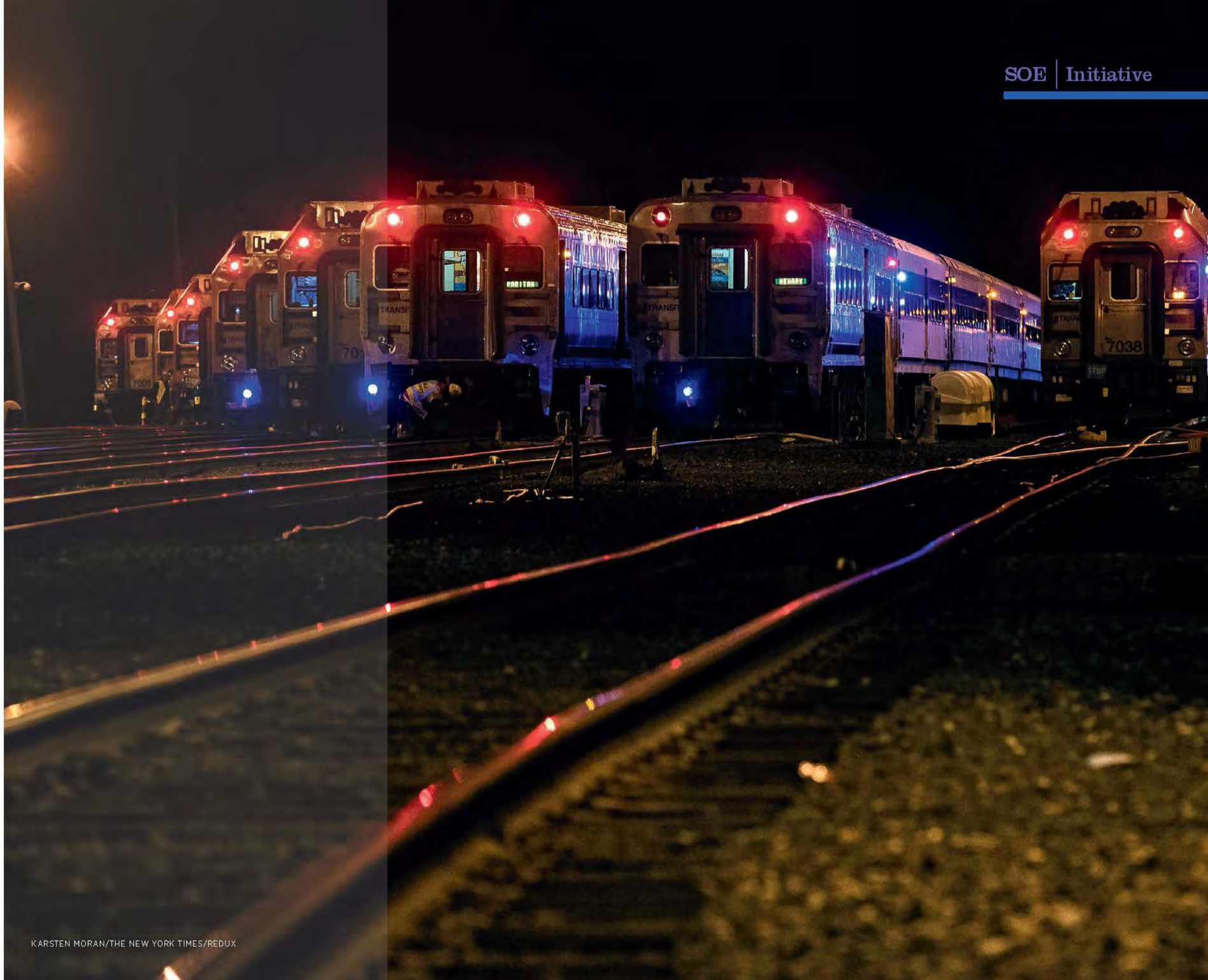
They're called TIPs and their task would be to infiltrate and outcompete influenza, HIV, Ebola, and other viruses. For the first time in virology, **Laura Fabris** and her team will use imaging tools with gold nanoparticles to monitor mutations in the influenza virus, with unprecedented sensitivity, when it enters cells. Fabris received an $820,000 grant from the Defense Advanced Research Projects Agency (DARPA), part of a four-year, $5.2 million INTERfering and Co-Evolving Prevention and Therapy (INTERCEPT) program.

ILLUSTRATION: MPHILLIPS007/ISTOCK BY GETTY IMAGES

LIGHT AT THE END OF THE TUNNEL

By **CARL BLESCH**

The North American railroad industry was left for dead in the 1970s as passengers and freight abandoned the rails and took to the airways and highways. A decade later, the industry came roaring back, benefitting from business deregulation and technical innovation. It is once again a robust part of the American economy.



KARSTEN MORAN/THE NEW YORK TIMES/REDUX

But the industry is facing a new challenge that could stop trains in their tracks. By some estimates, half of all railroad employees will be eligible to retire in the next five to 10 years. To help the industry meet the challenge, Rutgers has established a railroad engineering program that, in addition to attracting engineers to the field, will introduce technology that will advance the nearly 200-year-old industry in exciting ways.

"The railroad industry needs a sustainable pipeline of talent," says Xiang Liu, assistant professor of civil and environmental engineering, who in 2015 established the first railroad engineering course in Rutgers' history, a course he calls "railroad engineering 101." This year, he is adding a second course, which emphasizes track engineering and technology.

Liu conducts research into railway engineering, operations, safety, and risk management. His investigations include digital railway technologies, big-data analytics, safe transport of hazardous materials, and next-generation train control and operations. Other faculty members in the School of Engineering and other academic units also conduct industry-related studies, he says.

"The railroad industry is capital and labor intensive, spending more than $26 billion on infrastructure and rolling stock per year," he says. "But railroads have typically trained their technical people in-house and haven't funded basic research. There is a huge potential for universities to contribute knowledge and talent to the industry."

Liu joined Rutgers in 2014 after earning a doctorate in civil engineering from one of the few American universities to focus on railroad engineering: the University of Illinois at Urbana-Champaign. Liu says that his program has a way to go to match UIUC's 14 courses in the specialty, but he believes Rutgers has a leg up on other schools.

"Our home turf has a greater variety of rail settings," he says. "Along with transporting freight, we have transit, commuter, high-speed corridor, and long-haul passenger traffic."

Although the Rutgers program is still in its early years, it is the only such program in the New York metropolitan area now and the foreseeable future. Liu is exploring collaborations with industry professionals who can benefit from research and recruiting. One of these is Steven Santoro, former executive director of New Jersey Transit, the nation's third largest provider of bus, rail, and light rail transit.

"Railroads are going to be around for a very long time," says Santoro ENG'75. "They are a significant driver for the success of our economic development in New Jersey and the region."

Santoro (see his profile, p. 40), who earned his degree in civil engineering, jokingly calls himself "one of the old ones," but he is serious about the demographic reality. "The retirement situation has become a challenge to us, and it is going to continue for several more years," he says. Few of his peers grew up with the technology that the industry is implementing, such as advanced signaling, positive train control, and data-driven maintenance. He welcomes Liu's focus on railroads.

"It's a curriculum that at the core is civil engineering, but it gets to the specifics of how railroads and civil engineers interface," he said. "It's still vectors and stresses, but the clearances of railroads, the loads of trains, and many other factors are pretty specific to railroad infrastructure."

Rutgers Legacy Leader

RAILWAY BUSINESSMAN AND INNOVATOR

Rutgers engineer **Leonor F. Loree**, class of 1877, was the president of the Baltimore & Ohio Railroad, and a director of more than 50 other rail companies. He developed the standard railway semaphore, earning a patent for it in 1903. This 'traffic light' for trains was used nationally for the next 50 years. His flamboyant style and ability to turn a phrase made him an oft-quoted business baron, best known for the phrase, "This is a helluva way to run a railroad."

ILLUSTRATION: DANNY SCHWARTZ

KARSTEN MORAN/THE NEW YORK TIMES/REDUX

another is Joy Chiu of the New York City Transportation Authority, the largest public transportation agency in North America with daily subway ridership of more than five million people. "As a civil engineering student, I was never exposed to railroads as an option; I kind of fell into it," says Chiu, assistant chief officer for subway action plan in the division of station environment and operations at New York City's MTA. "As I talk to more engineers, they had the same experience. There's nothing wrong with learning on a project, but it's not as productive. Together, in collaboration with Rutgers, we can develop a pool of students who proactively seek out our industry."

David Becker, who is chief engineer of design and construction for the Norfolk Southern Railway, one of North America's seven major railroads and one of the two that primarily serves the eastern United States, is looking to boost engineering talent by promoting student chapters of the rail industry's professional organization. Becker is the immediate past-president of AREMA, the American Railway Engineering and Maintenance-of-Way Association; Rutgers established its student chapter last year. "Traditionally, the railroad industry was developed and driven by people who had engineering backgrounds," says Becker. "Basic engineering tasks, like surveying, bridge construction, telegraphy, and electrification, were embedded in engineering curriculums."

That fell away as the industry entered a period of stagnation in the middle of the last century. "With the rebirth of the industry, there's a desire to reintroduce the idea of railroad engineering and design into curriculums," he continues. "That has been a big focus of AREMA's efforts: to provide that intellectual spark."

ON TRACK FOR THE FUTURE
Rutgers professor Xiang Liu, pictured with his students, is introducing railway engineering courses to the Rutgers curriculum.

> "... there's a desire to reintroduce the idea of railroad engineering and design into curriculums. That has been a big focus of AREMA's efforts: to provide that intellectual spark."
>
> DAVID BECKER

One of professor Liu's doctoral students, Zhipeng Zhang, leads the Rutgers student chapter of AREMA. He agrees with Becker's assessment that railroad engineering fell out of academic favor. "Engineering students flocked to the 'cool' majors during the past decades," he says, citing fields involving semiconductors and software. By rejuvenating a collaborative relationship, Zhang expects railroads to benefit from the knowledge and skills associated with these fields.

"One of my research areas uses data sciences, or 'big data'; those are very popular words these days," he says of his studies in accident frequency and severity. "A clear understanding of contributing factors in train accidents, like train speeds, loading conditions, and seasonal effects, can assist with data-driven safety decisions."

When Liu reflects on what lies ahead for the railroad industry, he doesn't have to look further than one of America's top business investors, Warren Buffett. In 2009, Buffett's Berkshire Hathaway Inc. acquired Burlington Northern Santa Fe Corp., which operates North America's second largest railway.

"Warren Buffett bought into the industry, and he's a shrewd investor," says Liu. "Decades ago, the question was how do we keep railroads from dying. Now, it's how do we make railroads thrive." SOE

SOE Paves the Way

Carson Hess

A niche industry with a lot of opportunity.

Immediately following graduation in 2017 with my degree in mechanical engineering, I began working as a train control engineer for the rail division of Balfour Beatty Infrastructure on a light rail expansion project in Denver before being transitioned to the Green Line Extension project in Boston. I work specifically on the construction side. Some of my responsibilities include developing installation drawings and plans for the various train control equipment (switch machines, signals, track circuits, etc.) and procuring all necessary material to complete the installation. I've also had tremendous exposure to areas outside of train control such as track, traction power, and overhead catenary power systems in just the few months I've been with the company. ■ At Rutgers I learned how to look at the details of any project. As a Rutgers engineer I was trained to go through things line by line to make sure everything is squared away. I also had the opportunity to build things with my own hands which helps you really get to know how all the components of a system function together. ■ It's been a fun ride to say the least!

Real-World Experience

STUDENTS GET ON BOARD FOR UNION PACIFIC PROJECT

Using massive amounts of data and historical train schedules, SoE students took on a complex project for the Union Pacific Railroad to investigate the problem of scheduling trains along bi-directional tracks, where conflicts among trains passing track segments are a recurrent problem. "The student team designed a simulation model that could be used to test rules to recover from delays and conflicts and made recommendations for traffic control based on their analysis," said industrial and systems engineering professor and advisor W. Grace Guo.

PHOTOGRAPHS: *LEFT,* HALBERGMAN/ISTOCK BY GETTY IMAGES; *TOP AND BELOW RIGHT,* KARSTEN MORAN/THE NEW YORK TIMES/REDUX; *CENTER,* DON HAMERMAN

GETTING NOTICED

Rutgers and the School of Engineering collaborate to offer courses and programs designed to leverage student innovations while exposing graduates to rewarding careers ■ *By* DIANE REED AND AMY WAGNER

Like a menu option for those looking to "have it all," the best offering in engineering education is often the combination platter—academic learning coupled with real-world experience and opportunity beyond the classroom. At Rutgers University–New Brunswick, graduate engineering students have a unique set of programs and courses from which to choose, allowing them to advance innovation, develop as tech entrepreneurs, and explore non-academic science careers in the engineering field.

ILLUSTRATION: ROBERT PIZZO

These programs, named CTEC, I-Corps, and iJOBS are examples of a national educational effort endorsed through funding by the National Institutes of Health (NIH), the National Science Foundation, and the Department of Energy.

CTEC = Collaborative for Technology Entrepreneurship and Commercialization

The CTEC course is a two-semester course that takes MBA and STEM discipline graduate students through the process of identifying and commercializing a technology product. Students participating in the course, which is offered jointly by the School of Engineering and the Rutgers Business School, work in teams of four to six. During the first semester, students build portfolios of up to three intellectual property (IP) assets—selected from discoveries made in university labs or from government agencies such as NASA or the U.S. Navy. After evaluating the commercial potential for the capabilities of their IP, students begin to devise product ideas.

By the second semester, each team has chosen a single technology that it believes has the best potential for commercialization. "At this point, their focus is on developing a viable, investment-grade business plan for a start-up company," says Roger Debo, the director of CTEC and a professor of management and global business.

Jubilee Prasad Rao

Roger Debo

David Talarico

To date, Debo and Stephen Tse, a professor of mechanical and aerospace engineering, have challenged two cohorts of students to translate innovative IPs into potentially viable business opportunities.

The collaboration between business and engineering students is especially fruitful, Tse believes. "Business students without science backgrounds bring a different perspective to the process," he says. "They can often come up with things that those who are too focused on technology may not have considered."

For Jubilee Prasad Rao, a mechanical and aerospace engineering doctoral student, the CTEC course was a positive experience. "It brings engineering and business together in an all-round picture of starting and maintaining a start-up business," he says. "For an engineer, it gives a new perspective of products and their markets, and gives insight into business processes and decision-making."

I-Corps = National Science Foundation (NSF) Innovation Corps

Discovery is happening throughout Rutgers—in labs, research centers, libraries, and facilities. As a result, Rutgers receives more than $650 million in research funding each year, generating more than 150 invention disclosures and more than $15 million in licensing income annually. Yet finding an innovation pathway beyond the university is not always ensured. Rutgers has launched a program to bridge the gap between lab and marketplace, bringing research outcomes to the commercialization stage.

Dunbar Birnie, a professor of materials science and engineering, led the team that recently received a $500,000 grant to support Rutgers' inventions for the next five years through the NSF's I-Corps program. According to the foundation, the I-Corps program facilitates bringing research projects to the marketplace, thereby fostering a national ecosystem of innovation.

Birnie is collaborating with the Rutgers Office of Research Commercialization, Business School, and Graduate School of Biomedical Sciences to nurture university IP through the

Prize-winning Innovation

HARVESTING WIND ENERGY

Based on an IP that **David Talarico** brought to the course, he and teammate **Ryan Annibali** developed a sail-based wind harvester. It consists of a sail that moves back and forth on a track while transmitting power to an electric generator. "It will outperform existing rotary turbines with higher efficiency, higher power density, lower noise, and less potential harm to wildlife," says Talarico. Since winning the coveted $50,000 Department of Energy prize, they have legally structured their start-up, VelXEnergy.

PHOTOGRAPHS: *DEBO*, ROY GROETHING; *PRASAD RAO AND TALARICO*, DON HAMERMAN

"Our program is aimed very broadly to help Rutgers faculty, staff, and students take their innovations and help them move more rapidly toward commercialization."

DUNBAR BIRNIE

Dunbar Bimie

Tracy Scott and Evangelia Chnari

new NSF I-Corps site. The initiative aims to offer training to 30 research teams a year working on STEM-based projects that align with NSF research areas. They include biological sciences, computer science, engineering, environmental research, math, physical sciences, and social and behavioral sciences. The training will help teams understand how their work can be turned into a product that fits a customer need and could become the basis for a technology startup.

Birnie said the goal of the program is to help good ideas get developed and increase the economic impact of research developed at Rutgers. "We want to help our students and faculty become a powerful economic force, which is something that benefits not only Rutgers, but also the entire state," Birnie says.

iJOBS = Interdisciplinary Job Opportunities for Biomedical Scientists

According to the National Institutes of Health (NIH), the biomedical research field relies on the creativity, innovation, and dedication of a highly trained scientific workforce. The agency has become increasingly concerned, however, that doctoral degree programs that are largely oriented toward academic-style research training are falling out of step with the range of non-academic careers that more and more students pursue. In response, the NIH launched a grant program for "Broadening Experiences in Scientific Training," or BEST.

In 2014, Rutgers–New Brunswick became one of only 17 schools in the country to be awarded an NIH BEST grant to create the iJOBS program that would expose life science doctoral students and postdocs to a range of non-academic careers.

"iJOBS is preparing students for the innovation workforce as entrepreneurs, researchers, and industry leaders," says Janet Alder, professor of neuroscience and cell biology. As an executive director of iJOBS, she is responsible for programming career panels, site visits to partnering companies, case studies, and workshops covering topics such as communication, leadership, finance, and project management.

In a subsequent phase of the program, trainees may apply to shadow a professional in their area of interest as part of an externship. Tracy Scott is a returning alumna who is taking advantage of the opportunities that iJOBS offers. After completing her doctoral studies in 2003, she pursued an alternate career path in education and took time out to raise her children. Now, as she prepares to plunge back into the world of research and engineering, the iJOBS program is helping her with that transition.

Scott says the seminars, workshops, panel discussions, and site visits with people in the industry expose her to all the options available to those with advanced engineering degrees. She has also learned that many of the skills that she acquired during her studies can be included in her resume.

"You realize that what you've done in research is similar to what is being done in industry," she says. "I now have a lot more confidence saying 'I have this skill set.'"

During the shadowing phase of the program, Scott is partnered with biomedical engineering alumna Evangelia Chnari, who is the associate director of product development for MTF Biologics, which houses the largest tissue bank in the world. Remembering her own transition before landing a job, Chnari is eager to smooth the pathway for others.

"You don't know what you don't know," says Chnari. "iJOBS provides a link to the various facets of industry, from regulatory and design compliance, to project and financial management, to licensing and commercialization. That exposure helps you understand where you fit best."

As she nears the end of the program, the experience has provided Scott with a leg up in her job hunt, helping her widen her career opportunities, sharpen her presentation, and build a network. "iJOBS connects you with industry in a way that you usually don't get until you're in that first or even second job," she says. SOE

Seed Money

$2,500

CORPORATE STRUCTURE MATTERS

Participants in the Rutgers I-Corps site program will receive up to $2,500 for their market research and be required to conduct dozens of interviews with potential customers to identify whether there is a market for their idea and to refine their business model. Each team will include the researcher or inventor who serves as an academic lead; an entrepreneurial lead who would fulfill the role of CEO for the team (and can be a graduate student or post-doctoral student); and an industry mentor whose experience and connections can guide the team.

PHOTOGRAPH: BILL CARDONI

PHOTOGRAPH: DON HAMERMAN

Marco Gruteser

Will self-driving cars transform road travel? Professor Gruteser is a driving force behind the efforts to ensure that new technologies will improve the safety, comfort, and efficiency of automated driving.

Marco Gruteser is a professor of electrical and computer engineering and a member of the school's Wireless Information Network Laboratory, or WINLAB. Gruteser's WINLAB team wants to make road travel safer. To meet this goal, they are developing technologies that use communications to give cars the ability to see around corners.

Q: What kind of technologies are you working on?
A: For the past decade, we've been working on different prongs of technologies that use communications to give self-driving cars foresight into road environments. This includes collecting information about near-accidents and corner incidents to enhance the development of self-driving algorithms. We're also working with connected vehicles and sensor-sharing technologies that let cars see around corners—or even through trucks—to learn about and avoid potential traffic hazards.

Q: How would these technologies work?
A: The cloud, cellular technology within cars, and dedicated short-range communications (DSRC) let vehicles exchange information. These networks can also be used to collect information about challenging road situations. The communication between cars lets them learn from each other's mistakes—and see beyond their own lines of sight. Imagine, for instance, that cars equipped with cameras will be able to look through each other's cameras to share information about what's happening up ahead or around the next corner.

Q: Is your work funded?
A: We have funding from the National Science Foundation, Toyota, and General Motors and are working with them on designing and evaluating reliable direct communications protocols that will enable wireless sharing of data among nearby vehicles.

Q: When will self-driving cars be available?
A: Full self-driving systems will gradually appear in the market. Initially, they are likely to be limited to specific roadways as on a corporate campus, where no other cars can drive. Gradually, use will expand to more roads such as certain highway segments. In the longer term, we'll likely see cars drive more safely than people on many roadways and there may no longer be steering wheels at the driver's seat.

Q: What do you most hope your work on self-driving cars will accomplish?
A: The big goal is to make driving safer, more efficient, and more comfortable for everyone. SOE

PHOTOGRAPH: BILL CARDONI

New Degrees Offer Industry Focus

Professional programs enhance career opportunities.

Career advancement master's degrees and certificate programs offer curriculums in emergent fields, including energy systems engineering, packaging engineering, industrial and systems engineering, and medical device development. Programs are designed for professionals looking to enhance their existing practice in a focused area of concentration. School of Engineering faculty members **Mohsen Jafari** (ISE), **Hae Chang Gea** (PE), and **Martin Yarmush** (BME) initiated these new career-directed programs that provide training across a wide spectrum of specialization, recognizing both the demands of industry and employer need. Find out more **@soe.rutgers.edu/graduate-student-applicants.**

ILLUSTRATION: MICHAEL MORGENSTERN

Faculty Awards

Young Faculty Achievement

National Science Foundation Early CAREER Awards recognize research and teaching leadership.

Meenakshi Dutt, Associate Professor, Chemical and Biochemical Engineering
RESEARCH: Hybrid Soft Materials-based Nanoparticle Design
VISION: Applying computational methods for designing soft materials with specific structure-function relations to potentially facilitate innovations in medicine, energy, and environmental sustainability.

Aaron Mazzeo, Assistant Professor, Mechanical and Aerospace Engineering
RESEARCH: Papertronic Sensors for Concurrent Bioelectrical and Sweat-based Diagnostics
VISION: In developing disposable, paper-based electronics with wearable sensors to monitor sweat and bioelectrical signals to monitor human alertness and stress there is the potential to improve the safety of individuals and their surrounding environments.

SoE Developments

New Faculty

Rutgers School of Engineering welcomes new faculty members:

Alex Bertuccio
Assistant Teaching Professor
Chemical and Biochemical Engineering

Onur Bilgen
Assistant Professor
Mechanical and Aerospace Engineering

Yingying (Jennifer) Chen
Professor
Electrical and Computer Engineering

Salim El Rouayheb
Assistant Professor
Electrical and Computer Engineering

Rajiv Malhotra
Assistant Professor
Mechanical and Aerospace Engineering

Chung-Tse (Michael) Wu
Assistant Professor
Electrical and Computer Engineering

Zhimin Xi
Assistant Professor
Industrial and Systems Engineering

Awards & Distinctions

MARTIN YARMUSH Paul and Mary Monroe chair and distinguished professor of biomedical engineering, was elected to the prestigious National Academy of Engineering for his pioneering work in cellular, tissue, and organ engineering and his leadership in applying metabolic engineering to human health.

RICHARD RIMAN distinguished professor of materials science and engineering, was inducted into the National Academy of Inventors for the development of a low-temperature solidification process that can reduce the carbon footprint of cement and concrete products by up to 70 percent.

Professors **MARIANTHI IERAPETRITOU** (chemical and biochemical engineering) and **ATHINA PETROPULU** (electrical and computer engineering) advanced to the ranks of distinguished professor—a title reserved for faculty who have achieved scholarly eminence in their field.

ASHUTOSH GOEL assistant professor of materials science and engineering, received the International Commission on Glass Vittorio Gottardi Prize for outstanding young achievement.

DIPANAKAR RAYCHAUDHURI distinguished professor of electrical and computer engineering and WINLAB director, was named the school's Faculty of the Year.

LAURA FABRIS associate professor of materials science and engineering, was named the school's Outstanding Engineering Faculty.

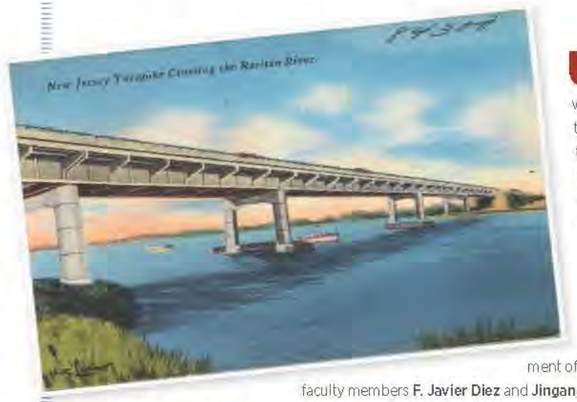
RAJIV MALHOTRA mechanical and aerospace engineering assistant professor, was named Society of Manufacturing Engineers Outstanding Young Manufacturing Engineer.

Faculty Honors

Biomedical engineering associate professor **Mark Pierce**, electrical and computer engineering associate professor **Waheed Bajwa**, and Ph.D. students **J. P. Dumas** and **Asad Lodhi** received the 2017 Gallo Award for Scientific Excellence from the Cancer Institute of New Jersey for their work combining signal processing and biomedical optics for early cancer detection.

SOE Robots to Monitor Raritan Water Quality

River serves as a unique laboratory in Rutgers' backyard.



Using the Raritan River—which has been polluted with industrial toxic waste for over 100 years—as their field testing site, a School of Engineering team will design a cyber physical system that will allow drones and autonomous underwater robots to monitor water quality in real time and right in Rutgers' backyard. ■ With a National Science Foundation grant of nearly $1 million, Department of Electrical and Computer Engineering associate professor **Dario Pompili** and Department of Mechanical and Aerospace Engineering faculty members **F. Javier Diez** and **Jingang Yi** plan to design a system that will allow networked robots to identify regions of interest, take measurements, collect biosamples if needed, and transform the measurements into water quality information onsite. Real-time water quality monitoring in rivers, lakes, and water reservoirs is critical to prevent contaminated water from reaching civilian populations.

POSTCARD: BOSTON PUBLIC LIBRARY/TICHNOR BROTHERS COLLECTION

Engineering a Better World

SOE students are combining technical know-how with compassion to bring about important change in places near and far from home.

As if poverty, homelessness, and crime weren't enough, Camden residents also find themselves trapped in a food desert—with only one supermarket available to feed its 80,000 citizens. The Rutgers Engineers without Borders Camden Project is working to counteract this problem by partnering with local farmers to grow fresh produce on abandoned city lots. ■ "They often build on lots that do not have a water source nearby, so our job is to create a structure that will capture rainwater, store it into a tank, and distribute it," said **Chris Sacaleris**, Camden Project co-lead and mechanical engineering junior.

■ Distribution methods range from fully automated drip irrigation systems to manual hoses, depending on the needs of the farmer. Each system requires a pump, which is powered by a solar panel to make it sustainable for years to come. ■ Further from home, Rutgers Bridges to Prosperity (B2P) members completed their first solo bridge-building mission in Bolivia, during the summer of 2017. B2P is an international non-profit organization that works to connect crucial infrastructure—such as schools, hospitals, and jobs—to isolated communities in developing countries. ■ The diverse team of undergraduate and graduate students, two professional engineers, and the residents of a small start-up community in central Bolivia, had eight weeks to construct a 165-foot bridge connecting the residents' homes to their farms, which were inaccessible during the rainy season. ■ Rutgers B2P spent the entire school year planning for the trip. From selecting the site to designing the bridge, chapter members guided the process from beginning to end. Once on site, the team spent 10 hours a day, six days a week building the professional foot bridge with materials ranging from rocks and wood to steel cables and beams. ■ "These bridge builds definitely empower students when they see how much their actions can change the world," said **Sharon Xiao**, a civil engineering sophomore. "It was an amazing feeling to see what started out as a 2D AutoCAD design, become a 50.4 meter bridge that will help almost a thousand people and many more generations to come."

FROM BOLIVIA TO CAMDEN Rutgers students are using their engineering skills to make a difference through groups like Engineers without Borders and Bridges to Prosperity.

PHOTOGRAPHS: *TOP LEFT*, CHRIS SACALERIS; *TOP RIGHT*, CYNTHIA ARELLANO

Society of Women Engineers

ON THE ROAD **Liz O'Neill Ruetsch** ENG'94 (top row, second from left) met up with students from the School of Engineering at the Society of Women Engineers (SWE) national conference in Austin, last October. Ruetsch, who is director of sales, services, and support for Keysight Technologies, was at the conference to receive SWE's Global Leadership Award.

2,181

Pounds of Generosity

Electrical and computer engineering sophomore **Sheza Asghar** found a way to "engineer" support for the Rutgers Student Food Pantry—make it a competition for pizza across engineering departments. Launched in 2017, the food pantry is the first to specifically serve Rutgers-New Brunswick students. While the CBE department scored the winning pizza party, the real winner was the food pantry, taking in 2,181 pounds of food and personal care donations thanks to the school's collective generosity.

E-Week Energy

National Engineers Week celebrates how engineers make a difference in the world.

Students kicked National Engineers Week into high gear with activities that celebrate the exciting world of engineering and technology. From Rube Goldberg creations to a demo showcase that included **Forest Song**'s ping pong playing invention, the week's activities involved Rutgers students and faculty, local K-12 schools, alumni, and area STEM teachers. ■ More than 30 high school science teachers were invited to campus by their former students for Bring Your Teacher to School Day, offering a chance to reconnect with a teacher who had a significant impact on their decision to pursue engineering. ■ Students also competed for prizes, presenting their internship experiences before a panel of Lockheed Martin and alumni judges. The week ended with the crowd favorite Cardboard Canoe competition—30 teams building vessels with cardboard, duct tape, and garbage bags and then setting sail to see who crossed the finish line (or capsized) first.

Rutgers Students Shine in Hult Prize Competition

Two teams advance energy innovations and social enterprise.

Two teams—both comprised of School of Engineering students—made Rutgers history by winning the Hult Prize Regionals Competition in March for their groundbreaking energy innovations. The Hult Prize is the world's largest engine for innovative startups emerging from college campuses. This year's challenge was to build a scalable, sustainable social enterprise that harnesses the power of energy to transform the lives of 10 million people by 2025. ■ Students on the SULIS team developed energy-efficient water sanitation devices that function under a range of weather conditions, harnessing energy directly from the sun to sanitize water without relying on existing infrastructure. ■ The LivingWaters team created a zero-energy method for capturing fresh rain water and maintaining the water's quality until use. ■ Both SULIS and LivingWaters will participate in an intensive eight-week summer business accelerator in England, where they will receive training to launch their new social businesses. In September, finalists will pitch their projects at the United Nations for a chance to win $1 million in funding. Last year, a Rutgers team won the top prize for Roshni Rides, a transportation network solution for urbanized refugees.

WINNING TEAMS: Living-Waters: (above, left to right) **Shrey Ghate** and **Jane Peterken** (both civil and environmental engineering seniors), **Joshua Kao**, and **Thomas Irving**; SULIS: (below, left to right) **Anurag Modak**, **Yuki Osumi**, **Sarah Pomeranz**, and **Ari Mendelow** (industrial and systems engineering senior).

Good at Math

Prestigious math competition no sweat for ECE student

Electrical and computer engineering sophomore **Ernest Chiu** ranked number 28 out of the 4,638 participants in the prestigious Mathematical Association of America's William Lowell Putnam Competition. His outstanding performance placed him in the 99.4 percentile of all undergraduate students who participated in the December 2017 competition. The challenging six-hour mathematics exam has 120 available points. The highest score was an 89, with only 20 percent of participants scoring above a 13.

Rise Up

29% Women are on the rise at Rutgers Engineering. The Class of 2021 includes more women students than previous years, outranking the national average of 22%.

2017 Medal of Excellence

Rutgers School of Engineering established the Medal of Excellence in 2006 to honor alumni who have distinguished themselves professionally in industry, academia, government, research, and business, or through continued involvement in the School of Engineering or social responsibility. In October, the school celebrated five new honorees.

ACHIEVEMENT IN INDUSTRY

Roman P. Pacewicz BS'87 (Electrical and Computer Engineering)

As chief product officer for AT&T Business, Pacewicz is leading product development that supports nearly 3.5 million business customers and an annual revenue stream of nearly $70 billion. Since joining AT&T in 1988, he has held an array of leadership positions in product management, systems development, marketing, engineering, and operations, most recently serving as senior vice president of offer management and service integration, advancing the development of industry-leading networking based offers.

DISTINGUISHED YOUNG ALUMNUS

Emeka O. Oguh BS'05 (Electrical and Computer Engineering)

Oguh is founder and CEO of PeopleJoy, a benefits platform company that provides employee retention solutions focused on financial wellness. He founded a mobile app publishing company, acquired in 2015, worked as director of product at a venture-backed financial technology startup, and as a Wall Street analyst at Merrill Lynch. He is a Huffington Post contributor on articles related to financial wellness and managing student debt, and volunteers with MLT Ascend, a mentoring program for first-generation, low-income college students.

MEDAL OF EXCELLENCE

Andrew L. Intrater BS'85 (Chemical and Biochemical Engineering)

Intrater is chief executive officer of Columbus Nova, a multi-strategy investment firm he founded in 2000, managing director for Columbus Nova Technology Partners, and partner of Columbus Nova MB, a real estate investment platform. With over 30 years of technology and asset management experience, he began his career as founder of ATI, the predecessor of Oryx Technology, and led a $51 million equity/debt investment for controlling stake in Moscow Cablecom, known today as AKADO, for which he subsequently served as chairman.

DISTINGUISHED ENGINEER

John P. Cipolletti BS'78 MS'80 (Agricultural Engineering)

Cipolletti made critical contributions to America's space flight programs, participating in 114 space shuttle launch campaigns and new vehicle design efforts. His career began at Lockheed Martin, followed by United Space Alliance. Cipolletti was awarded the NASA Public Service Medal for his efforts during the Orbiter Columbia recovery and the Distinguished Public Service Medal, NASA's highest award for contractor employees. He joined Boeing in 2013 and serves as senior engineering manager and Florida site lead for their Space Launch System Program.

ACHIEVEMENT IN RESEARCH

Reates K. Curry PhD'94 (Biomedical Engineering)

Curry is a technical expert in the area of human-machine interaction at Ford's VIRtual Test Track Experiment Laboratory, which houses one of the most advanced, full-motion driving simulators in the world. She has coauthored numerous technical reports, conference papers, and journal articles, participates in National Society of Black Engineers conferences, and represents Ford as a recruiter at Society of Women Engineers (SWE) conventions. Curry was listed fourth among 43 women on Business Insider's 2017 list of most power ful female engineers and is the recipient of two Henry Ford Technology Awards.

PHOTOGRAPH: KEITH MUCCILLI

Bringing Healing Waters to Haiti

Alumni volunteers install sustainable water systems to the people of Haiti.

School of Engineering involvement in Haiti Water Partners first began at an American Water Works Association meeting in 2015, when **Shivangi Ganatra** ENG'15, who was then president of the school's student chapter of Engineers without Borders USA, met Albert J. Capuzzi, an engineer who had volunteered to help build a Haitian hospital for underserved people. ■ Ganatra—who now works for Capuzzi at Jacobs Engineering—is part of a team that includes environmental engineer **Jessica Kretch Koop** ENG'11, materials science engineer **Nimah Ahmed** ENG'15, civil engineer **Nicole Del Monaco** ENG'15 and GSNB'17, **Francesca Chery** ENG'16, a Haitian-American biomedical engineer, and bioenvironmental engineering student **Evan Lutz** ENG'19. ■ Currently a water engineer at international consulting firm CDM Smith, Koop serves with Capuzzi as a Haiti Water Partners co-director, working to install sustainable water and wastewater systems. "The short-term goal is ensuring that we have adequate funds to install the systems necessary to protect public health. Long term," she adds, "I hope we can utilize local contacts, international support, and our strong Haiti Water Partners team to successfully change the lives of thousands living far below the poverty line in Haiti." To learn more about Haiti Water Partners, visit **www.haitiwaterpartners.org.**

PHOTOGRAPH: *ABOVE*, EVAN LUTZ

SoE Spotlight: Erin McIntyre

RECORD SETTING

School of Engineering alumna **Erin McIntyre** was inducted into the 2017 Rutgers University Division of Intercollegiate Athletics Hall of Fame for her achievements as an exceptional swimmer and scholar during her undergraduate career. McIntyre was the first Rutgers athlete to qualify for the NCAA Women's Swimming Championships, setting records that stand to this day. She graduated summa cum laude with a bachelor's in mechanical engineering in 2003 before continuing her engineering education at the University of Michigan. McIntyre now works as a physician's assistant in the Division of Surgical Oncology at the University of Colorado-Denver.

RU Big Number

$2.5M+

Thank you for your support!

On Rutgers Giving Day, School of Engineering alumni came together to support all things scarlet! Your gift, combined with gifts from the university community, will have a powerful and enduring impact at Rutgers and beyond.

Helping the Next Generation

Avinash Prabhakar '93 Engineering Endowed Scholarship

Everyone has their own personal reasons for choosing education as a philanthropic motivation, but nearly all those who give reference their hopes for the next generation. **Avinash (Avi) Prabhakar** ENG'93 is no different. He recently established a $50,000 endowed scholarship to support full-time undergraduates based on their academic merit and need. ■ Prabhakar, who earned his undergraduate degree at Rutgers in chemical and biochemical engineering along with a medical degree in 1997 from New Jersey Medical School, is a product director in oncology marketing for Janssen Pharmaceutical Companies of Johnson & Johnson. He also earned an MBA from Yale. ■ "I believe in the power of education to propel people on a path to personal and professional success," says Prabhakar.

> "I feel grateful to Rutgers for helping me get started with my career and as I celebrate my 25 year college reunion I am honored to finally be in a position to pay it forward."
>
> AVI PRABHAKAR ENG'93
> SCHOLARSHIP DONOR

Alumnus in Conversation

A UNIQUE MIX: As part of National Engineers Week festivities **Dev Ittycheria** ENG'89 returned to campus to speak to students about his career as a software developer and venture capitalist. His unique mix of entrepreneurial, operational, and investing experience offered a platform for students to pepper him with questions from everything from his leadership style as president and CEO of MongoDB to how his engineering degree informs his various areas of expertise.

Welcome Aboard

SoE's Industry Advisory Board adds new members, supporting Dean Tom Farris and school efforts.

Ramsey P. Homsany ENG'97
CO-FOUNDER, OCTANT BIO

Michelle E. O'Connor ENG'87
PRINCIPAL, LANGAN ENGINEERING AND ENVIRONMENTAL SERVICES

Vijay Swarup, Ph.D. GSNB'88, '90
VICE PRESIDENT, RESEARCH AND DEVELOPMENT, EXXONMOBIL

David Wade, ENG'89
PRINCIPAL, INCREMENTUM ENERGY

Richard S. Weeks
CEO AND PRESIDENT, WEEKS MARINE

Emmanuel Yamoah ENG'98
ASSOCIATE DIRECTOR, DURACELL INTERNATIONAL

PHOTOGRAPH: *ABOVE RIGHT,* MONGODB

All in the Family

CONTINUED FROM PAGES 08-11

Foundation for Success: The Kovacevich Family

FROM PAGE 08

wife and he influenced their boys' decisions to attend Rutgers. "It's one of the schools we suggested, and for different reasons, both sons decided to get their education there," he says. "My background and familiarity with the School of Engineering helped make it a comfortable decision for them."

Justin also played a role in Dylan's decision. "Dylan saw that Justin was there and enjoyed not just academics and coursework, but also sports, events, and activities," says John.

Justin enjoys seeing his younger brother on campus. "We mix friends and hang out together," he says.

The extended Kovacevich family also includes Rutgers alumni. John's sister-in-law and a nephew are, as he puts it, "people who have seen the light and the value of Rutgers."

"We didn't intend to become a big Rutgers family," says Justin, pointing out that everyone had his or her reason to attend and accrued a wealth of experience after choosing a path to follow. SOE

Proud Tradition: The DiStefano Family

FROM PAGE 10

Now an intern in supply chain technical operations at the Johnson & Johnson pharmaceutical company Janssen, she hopes to travel after graduation before starting a job.

"I chose Rutgers for its engineering program, which is one of the best," Kristin says. "But out of everything I've learned and done at Rutgers, what I value most is the people and the lifelong friendships I've made. At every step, they've made Rutgers a fun and memorable experience." Her brother, Jason, hopes that after he graduates in 2020, his biomedical engineering degree will land him in medical school and then a career as an orthopedic surgeon. His sisters gave him a leg up when he started at SoE. "They helped me navigate the systems, knowing what I should be doing and when I should be doing it," he says. "Most first-year students don't have that."

Although Nicole wasn't pressured to attend Rutgers, she does think she may have influenced her siblings' decisions to apply. "I love Rutgers and that showed, and it helped my siblings to decide to go there, too," she says. "It's a connection we share." SOE

A Second Home: The Rios Family

FROM PAGE 11

real estate agent. The youngest Rios sibling, Maria, expects to graduate in 2021. Like her brother, she is majoring in electrical and computer engineering. "I chose SoE because I saw that all my siblings enjoyed their time here and were able to accomplish so much because of their education," she says. "I also chose it because I remember visiting Rutgers all the time as a child and it feels like a second home."

Her older siblings made a big impression on her when she was growing up. "I don't think any one of them influenced me more than the others, but Delia's senior year project did have a profound impact on me," says Maria, recalling when as a 10-year-old she witnessed Delia's group presenting a project: the construction of a small robot that was programmed to paint walls. "I was impressed they could build such a complicated piece of machinery using just what they'd learned during their time at Rutgers," she says. "I thought it was really cool; I was set on becoming an engineer." SOE

Steve Santoro

While at Rutgers in the 1970s, working on the railroad didn't have much appeal to Santoro ENG'75. But a fast track job into construction management with a transportation company convinced him to jump aboard, leading him years later to head New Jersey Transit.

STEVE SANTORO'S FIRST JOB AFTER earning his bachelor's degree in civil engineering was with a company that had a storied history in the North American railroad industry. "I went to work for a large company, Gibbs and Hill," says Santoro. "It no longer exists, but it designed the first electrification into Penn Station (in New York City) on the Pennsylvania Railroad."

Santoro eventually rose to lead New Jersey Transit as executive director, overseeing a commuter agency that provides nearly one million passenger trips a day by train, light rail, bus, and paratransit.

He joined the state's commuter agency in 2000 as project manager when it was in the midst of completing the Hudson Bergen light rail system. He later assumed responsibility for all light-rail construction before advancing to the top post in 2016, a position he held until 2018.

Santoro's early experience at Gibbs and Hill, conducting cost estimates for San Francisco's electrified bus system, prepared him to oversee one of the biggest projects New Jersey Transit is undertaking: a "microgrid" to power trains in the event of a long-term outage in the commercial power grid, a hypothetical that became a reality during 2012's Superstorm Sandy.

"They call it a microgrid, but it happens to be a 200-megawatt microgrid," says Santoro, referring to the agency's proposed power plant and electrical distribution system.

Santoro is also keeping an eye on another challenge facing the railroad industry: maintaining a robust work force amid an aging population. "The retirement situation has become a challenge to us, and is going to continue for several more years," he says. He welcomes Rutgers' decision to build a program that introduces a railroading emphasis to the traditional civil engineering curriculum and also prepares new employees who embrace technologies such as positive train control and data-driven decision-making. The railroad industry, Santoro points out, offers millennials career opportunities that appeal to their desire to participate in public service and advance environmental sustainability.

"Railroads in any form—commuter, light rail, high-speed rail, and freight—are going to be around for a long time," Santoro says. "They are the core of New Jersey's economic vitality and a significant driver for economic development in this region."

PHOTOGRAPH: COURTESY OF NJ TRANSIT/GERVO KNOX

Did You Know?

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OF 200 RUTGERS MARCHING BAND MEMBERS ARE ENGINEERING MAJORS.

The Marching Scarlet Knights are a proud performing ensemble entertaining football fans at games both at home and on the road. Band members start preparing during the summer on weekends then in August they head to the Poconos for an intensive week, learning music and band formations. Once the season starts, members practice two hours three times a week. ■ Trumpet player and mechanical engineering senior Max Wackerman has been a member of the marching band for four years. In addition to sharpening time management skills, networking and friendships are the part of the experience he most values. "An engineer from the band set me up with an interview for a summer internship, so the connections are great."

PHOTOGRAPH: ELSA/GETTY IMAGES

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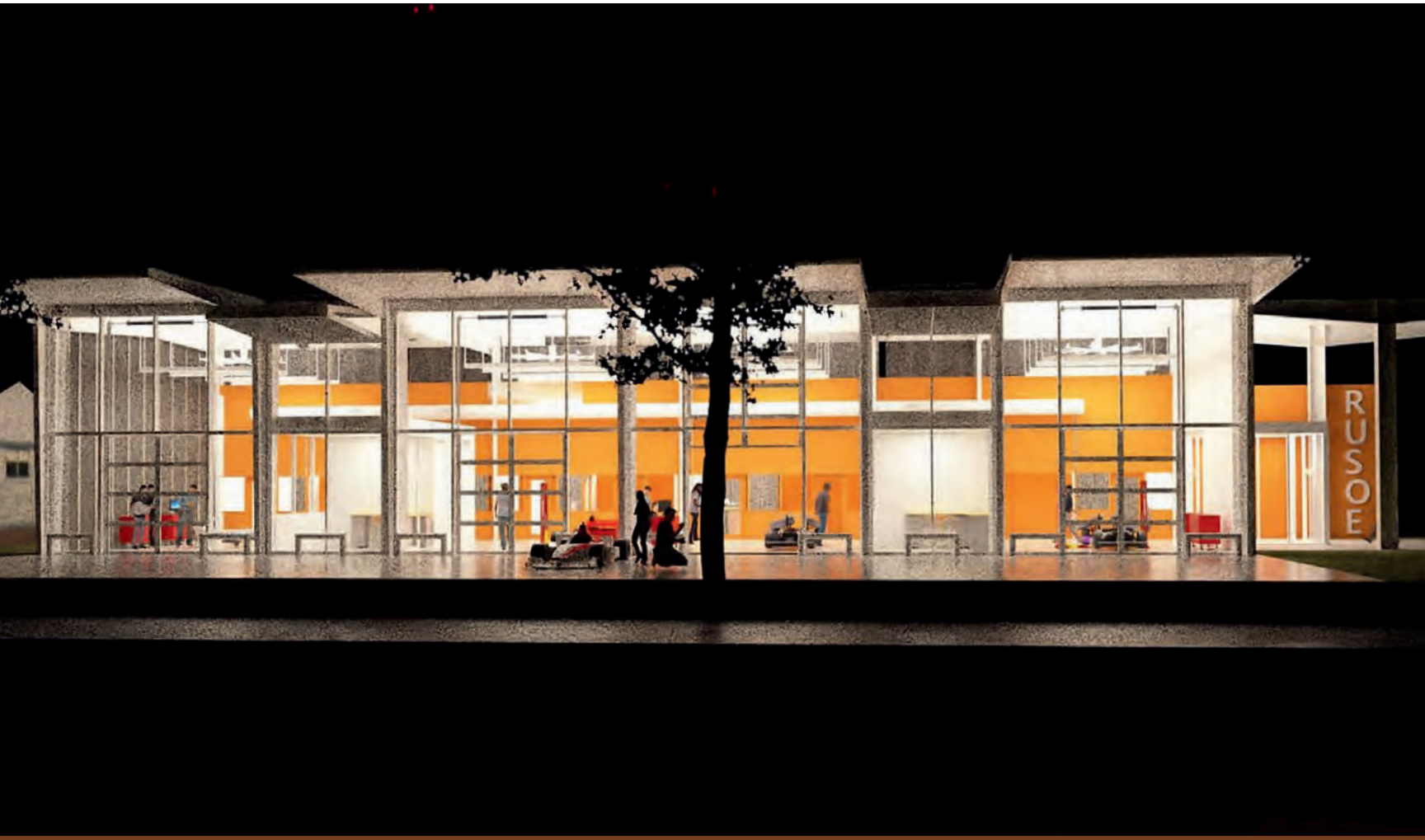
Rutgers University-New Brunswick
98 Brett Road
Piscataway, NJ 08854-8058



The School of Engineering Student Projects Garage

The engineering footprint continues to progress on the Busch campus with new facilities and significant renovations to existing buildings. The proposed Student Projects Garage puts learning directly into the hands of students, offering them a space for scale-sized project fabrications for hands-on learning, interdisciplinary collaboration, project and equipment management, and preparation for intercollegiate competitions. The Rutgers Formula Racing team will share space alongside other student groups working on solar vehicles, robotics, large-scale structural designs, and more. We are committed to providing the best for our students, helping them achieve their fullest potential and take on the world! For more information on the Garage, including ways you can support this project, contact Annie Nienaber, director of development, 848-445-2369, **annie.nienaber@rutgers.edu.**