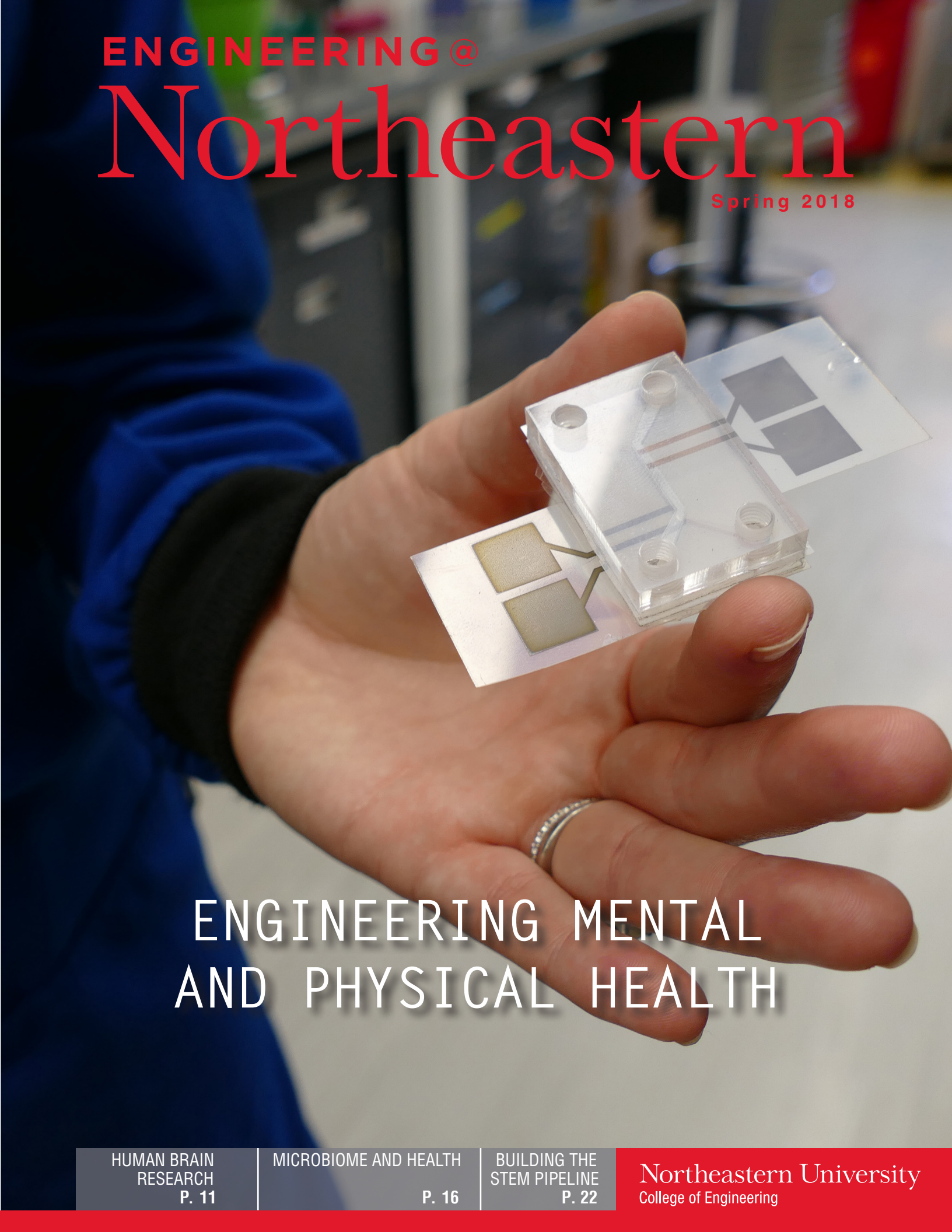
ENGINEERING @

Northeastern

Spring 2018



ENGINEERING MENTAL AND PHYSICAL HEALTH

Northeastern University
College of Engineering

Dean's Message

"Our distinctive approach to education and research has made us one of the top engineering schools in the world."

Dear Friends,

Engineering mental and physical health is a complex area of research with many challenges and even more opportunities to significantly impact the quality of people's lives. The human brain is an ever-unraveling mystery where multidisciplinary researchers are uncovering groundbreaking discoveries connected to overall health—those that could lead to a treatment for epilepsy, a cure for Alzheimer's, the healing of spinal cord injuries, and the availability of cognitive and neurological assistive devices for Parkinson's patients, among others (see page 11).

Microbiome in the human body is another area of high interest to scientists. Our faculty are on the cutting-edge conducting novel research to further understanding of the relationships in the areas of gut inflammation and mental health, the gut and neural health, and the measurement and control of microbes in the body—ultimately leading to the prevention and treatment of diseases and conditions such as depression, anxiety, and autism (see page 16).

In addition to our research strengths, the College continues to be committed to offering a diverse and inclusive environment by having programs and support systems in place to create opportunity for all talented students to pursue an engineering education. From kindergarten through the PhD level, learn about how we are "Engineering the Next Generation" on page 22.

Our students never cease to impress me. In this edition, we highlight several of their amazing accomplishments and experiences. From cooperative education and research, to national and global competitions, and student club initiatives, they are extending the definition of experiential learning and becoming multifaceted, global engineers capable of advancing society.

My sincere appreciation goes out to our supportive community of alumni and friends for your ongoing commitment to the College and all you do for our students and faculty. As our greatest ambassadors and through your generosity, you are helping to fuel a distinctive approach to education and research that has made us one of the top engineering schools in the world.

With kind regards and well wishes,

Nadine Aubry
Dean of the
College of Engineering
dean@coe.neu.edu

inside

Photo by Laura Shrago

COVER IMAGE

Abigail and Ryan Koppes, assistant professors of chemical engineering, show a benchtop model or platform called "body on a chip" they are developing to mimic certain aspects of the brain and gut, focusing on the enteric nervous system. The research will address the as-yet unproven theory that it may be possible to harness the nervous system to reduce inflammation present in diseases such as Irritable Bowel Syndrome.

» Learn more about this and other microbiome research on page **16**.

» Learn more about research on the brain on page **11**.

Questions and Comments

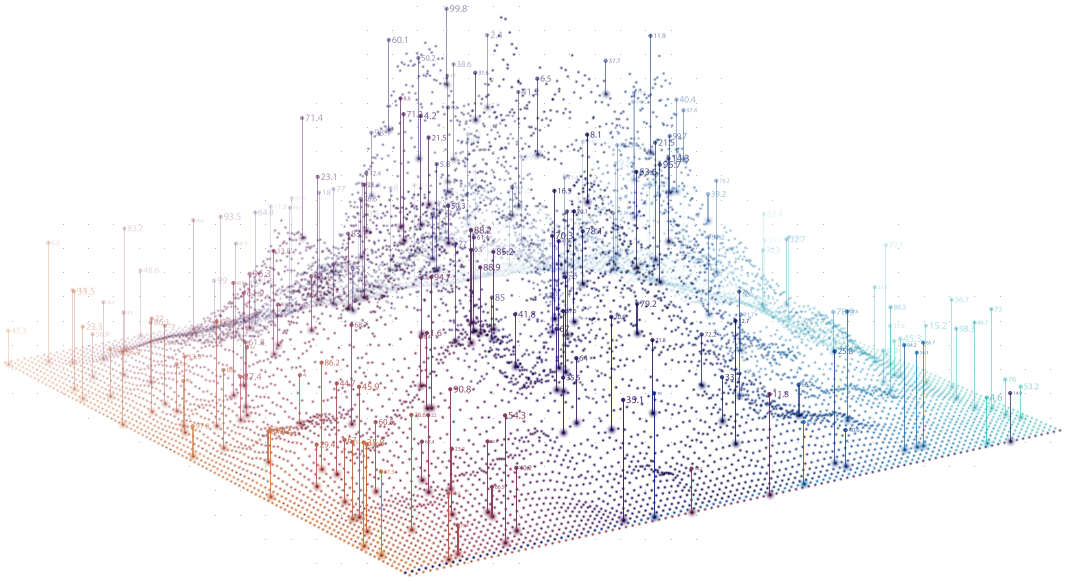
dean@coe.neu.edu
College of Engineering
230 Snell Engineering Center
Northeastern University
360 Huntington Avenue
Boston, MA 02115
617.373.6300

Editorial
Cindy Fusco
Janet LeClair
Kathrin Havrilla
Joyce Melikian
Charles Wolfston

Editorial Credits
News@Northeastern

Design
Alexandra Berleus

Photography Credits
Heratch Ekmekjian
Adam Glanzman
Matthew Modoono
Laura Shrago



BIG DATA, BIG CHALLENGES

The unprecedented growth of the Internet and social media have created enormous volumes of data—about consumers, their browsing habits, their shopping preferences, and other online behaviors. This information holds significant strategic and financial value for manufacturers, retailers, and other businesses. But the question is, how can this information be effectively mined for valuable insights? How can the critical data be distinguished from the trivial?

According to Stratis Ioannidis, an assistant professor in the Department of Electrical and Computer Engineering (ECE) at Northeastern, data management experts have two options. "We can apply traditional methods of data analysis and computer processing, and wait months or even years to arrive at meaningful answers," he explains. "Or we can develop more innovative methods of managing Big Data—including new processing schemes and mathematical algorithms—that accelerate results."

Since he joined the College of Engineering in 2015, Ioannidis has been leading a team of researchers focused on Big Data innovations. In his Data, Networks, and Algorithms Lab, he is working to automate and accelerate the process of sifting through billions of data points to discover those pieces of information that truly matter.

Recently Ioannidis won a prestigious CAREER Award from the National Science Foundation (NSF) to fund this research. "One of the key concepts in managing Big Data is parallel processing," Ioannidis notes. "By spreading complex calculations across thousands of computer processing units, or CPUs, we can rapidly identify trends, patterns, and critical insights in even the largest databases. The problem is that many mathematical algorithms don't lend themselves to parallel implementations across multiple computers."

To address this challenge, Ioannidis is investigating new algorithms and computing platforms that enable parallel solutions for common Big Data problems. He and his team are leveraging the Massachusetts Green High Performance Computing Center (MGHPCC) to test new algorithms and processing methods across hundreds of machines and thousands of CPUs. The MGHPCC is a joint venture between Northeastern and four other universities—Boston University, Harvard, MIT, and the University of Massachusetts.

Stratis Ioannidis, assistant professor of electrical and computer engineering

While understanding consumers' online behaviors and preferences is one application of this research, Ioannidis emphasizes that his work has broad implications for industry, academia, and government agencies. "Whenever there is a huge volume of information that must be sorted and mined, new algorithms and processing schemes can add tremendous value," he says.

Ioannidis, who left Yahoo Labs to join Northeastern, has always enjoyed problem solving—and he believes Northeastern is the perfect environment for his research on massive parallelization.

"From resources like the MPGHPCC to the interdisciplinary collaborators that I can call upon across the university, Northeastern is an ideal place to tackle big, sophisticated challenges," Ioannidis states. "Solving multifaceted problems requires a varied skill set and a diversity of perspectives. Northeastern has assembled all the leading expertise I need to support my research, and I don't even have to leave the campus."

ON THE FRONT LINES OF **GROUND-BREAKING** RESEARCH

At Northeastern University's College of Engineering, a second-year student can be at the forefront of groundbreaking medical research. That's exactly where Erica Wagner, a bioengineering major, finds herself right now. Working in the lab of Assistant Professor Ambika Bajpayee, Wagner has been on the front lines of the creation of a new method of treatment for intervertebral disc issues. She recently received an Early Research and Creative Endeavor Award from Northeastern for this work.

"We're trying to develop a drug carrier that can increase the retention and localization of the drug in the intervertebral disc," Wagner said. "Current treatments don't work that well."

Current treatments can leave patients needing additional injections to their back as early as a week later, she said. The pain reliever injected could also spread to the spinal cord and cause damage to it, necessitating further debilitating treatment.

Wagner has long been interested in medical research. "I've always wanted to get into this," she said. "My freshman year, I was looking for professors and trying to find something I found interesting. Dr. Bajpayee had some very interesting academic research, so I asked if I could join her lab."

Bajpayee and Wagner are working on a drug carrier that could deliver treatment to the intervertebral disc more efficiently and effectively than the injections currently used. After they achieve this, Wagner said, they plan to begin work with live tissue.

"We're going to begin working on a live culture model for the disc," Wagner said. "Currently, we extract the discs from a bovine tail where we focus on the connective tissues rather than the viability of the cells. After we develop a carrier using this ex vivo tissue model, we'll start working with live disc tissue."

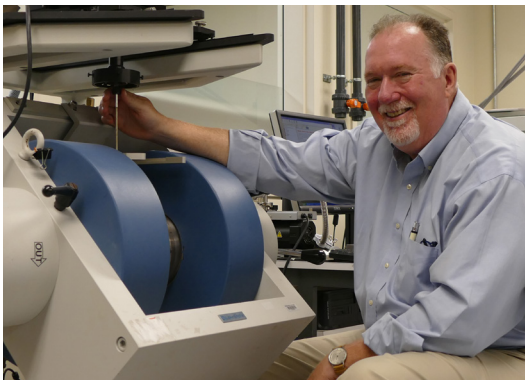
Erica Wagner, BS bioengineering student

One test they plan on doing will assess load-bearing capabilities of the discs injected with the drug carriers, because spinal discs have to bear weight. After she graduates, Wagner said she's interested in going into this type of research as a career.

Making a Quantum Leap in RF Materials Science

Under an $8 million, 30-month grant awarded by the Defense Advanced Research Projects Agency (DARPA), Vincent Harris, University Distinguished Professor and William Lincoln Smith Chair Professor, electrical and computer engineering, will lead a Northeastern team to reinvent the transmit/receive module (TRM)—a key component of every radar system. The work will be carried out in collaboration with Metamagnetics, Inc., a spinout from Harris' lab at Northeastern, and industry partner, Qorvo, Inc.

The Northeastern team will serve as materials integrator, bringing together TRMs with gallium nitride (GaN), a high-efficiency semiconductor material considered the "gold standard" of next-generation RF materials. The project will focus on three areas: reducing TRM size (miniaturization), achieving higher frequencies, and performing at high power, thus increasing heat, which can become a significant challenge.



Vincent Harris, University Distinguished Professor and William Lincoln Smith Chair Professor, electrical and computer engineering

Harris notes that while most communication and sensing platforms use TRMs—for example, radar and mobile cell phone base stations—the technology has not changed significantly in more than 30 years. "Our work will allow us to break through the existing design paradigm—that is, discrete component TRM systems—and move to something that has never been done before: the TRM system on a GaN wafer," he says.

"The TRM is at the heart of the radar as it interfaces with the antenna and [power amplification and] signal processing components," says Harris. "Incorporation of GaN allows us to put more power through the radar system. That means the radar can reach deeper into space, define threats earlier and allow for countermeasures. It will be able to identify threats more effectively, ultimately saving the lives of our troops."

Environmental **IMPACT**

Madeline DuBois, BS environmental engineering student

To third-year College of Engineering student Madeline DuBois, Northeastern's new environmental engineering major made perfect sense when she decided to declare it during the fall of her sophomore year. Her upbringing—in an outdoorsy area of upstate New York where there were more people living in her freshman dorm than in her childhood town of Poolville—instilled an affection for the environment, and the burgeoning new program gave her an outlet to make it her life's work.

"I spent a lot of time outside growing up," DuBois said. "I love hiking and outdoors stuff. So I've always cared about the environment."

Though she was undeclared during her first year at Northeastern, a talk with an environmental engineering professor, Loretta Fernandez, sold her.

"I thought about doing chemistry, graphic design, communications or environmental science," she said. My dad is an engineer, so I was kind of determined not to do engineering. But that talk changed my mind. [Environmental engineering] combines my interest in being outside and actually making solutions through engineering."

There are many angles to take in the subject and many areas to focus on; renewable energy sources, clean water infrastructure, and clean manufacturing technology are a few. DuBois has taken a special interest in using science to help people who don't have the skills or knowledge to help themselves.

In her involvement with Engineers Without Borders—an organization of volunteer engineers tasked with creating solutions for water, shelter, and energy for impoverished people worldwide—she's contributed to the Northeastern chapter's drinking water distribution systems for developing countries.

"I think it would be really cool to implement solutions to meet people's needs for water or energy, solutions that are sustainable and environmentally friendly," she said. "It's important that they meet all three of those criteria, and that's a big challenge."

DuBois also works in a research lab with Associate Teaching Professor Annalisa Onnis-Hayden, where work is being done on a tidal wetland wastewater treatment system—a system that treats water for reuse using just bacteria and plants.

A class that DuBois is particularly excited about, "Climate Science, Engineering Adaptation and Policy," could lend a window into another important aspect of the environmental engineering field: Policy could take on a crucial role in the field in the coming years. In these days of political turmoil and environmental uncertainty, informed scientists are sure to play a vital role in informing the public and shaping policy. "I'm also interested in the policy side," DuBois said. "I don't know as much about it, but I'd definitely like to learn more."

Interest is growing in the new major, which was only available as a concentration and not a formal degree before. She said, "It seems to be creating a legion of young engineers eager to make a difference."

Northeastern's College of Engineering Hosts the 54th Annual Technical Meeting of the **Society of Engineering Science**

SES Co-Chair, Donald W. Smith Professor, and Chair of the Department of Mechanical and Industrial Engineering Hanchen Huang gives opening remarks.

700 researchers gather at Northeastern.

PhD students from around the world present their research during the conference's poster competition.

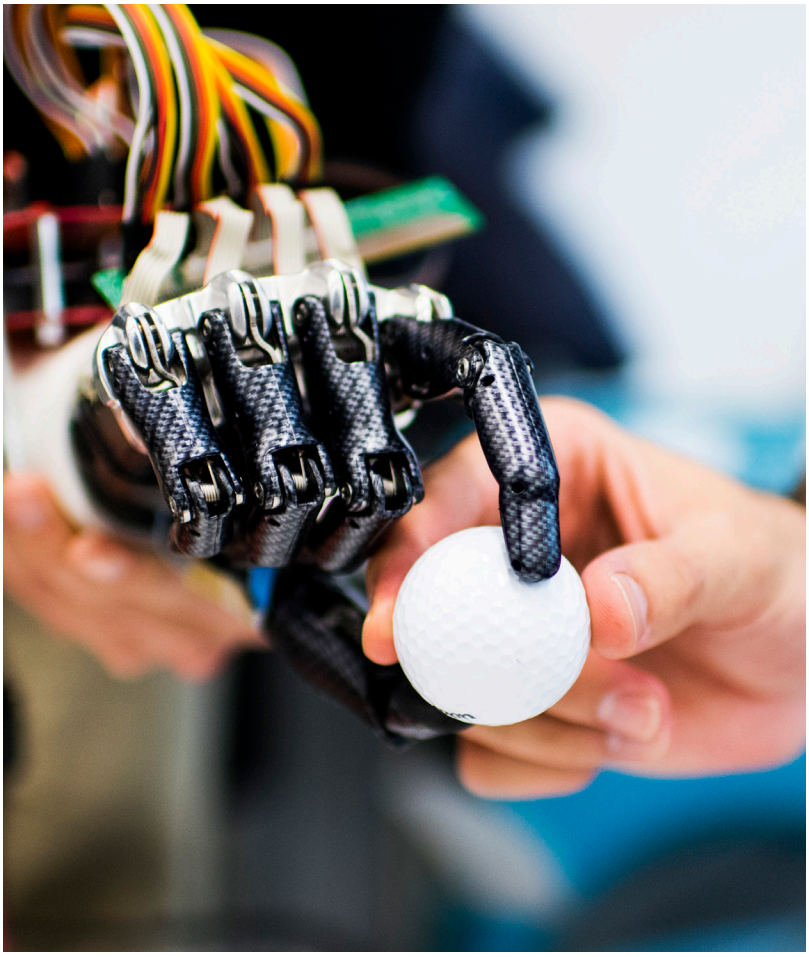
Dean Nadine Aubry accepts the Society of Engineering Science G.I. Taylor Medal, awarded for outstanding contributions in fluid mechanics.

On July 25-28, 2017, nearly 700 engineering researchers and scientists from around the globe attended the Society of Engineering Science (SES) Annual Technical Meeting, held jointly with the Applied Mechanics Division of the American Society of Mechanical Engineers and hosted by Northeastern at its Boston campus. A comprehensive program, with numerous symposiums led by acknowledged experts at leading institutions and universities, was designed to spur innovation through interdisciplinary research, collaboration, and knowledge sharing. Nadine Aubry, dean of the College of Engineering at Northeastern, who gave a plenary talk, was presented the G.I. Taylor Medal at the conference. A symposium was organized to honor Professor Aubry's contributions to the various areas of fluid mechanics. Also, 35 PhD students from around the world presented their research at the conference's first poster competition.

The SES Technical Meeting is held annually to foster and promote the exchange of ideas and information among the various disciplines of engineering and the fields of physics, chemistry, mathematics, bioengineering, and related scientific and engineering fields.

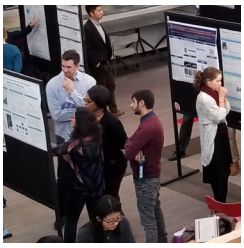
View Northeastern's College of Engineering 2018 **highlight video** from our celebration of National Engineers Week **http://bit.ly/2oXcrPL**

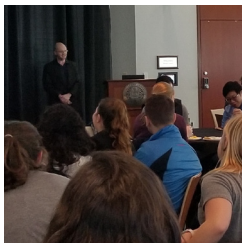
National Engineers Week 2018



From the College of Engineering's inaugural PhD Research Expo and a Robotics Showcase to distinguished guest speakers, a Women in Engineering Day, K-12 STEM fair, 3D printing demonstrations, and hands-on fun for students and prospective students, National Engineers Week inspired the wonder of engineering at Northeastern.

- Distinguished Speaker Series
- Engineering for Everyone Expo
- Interactive Engineering Open House
- New ISEC Footbridge Presentation
- PhD Research Expo
- Robotics Showcase





Connect with #NUeweek2018

Marvin Onabajo, assistant professor of electrical and computer engineering

Chipping Away at Vulnerabilities

Is your electronic device infected with a malicious hardware Trojan? Assistant Professor Marvin Onabajo of the Department of Electrical and Computer Engineering is addressing this difficult-to-detect risk. As a recent recipient of a Young Investigator Award from the Army Research Office, Onabajo is developing an on-chip thermal sensing technique that detects hardware hacking attempts.

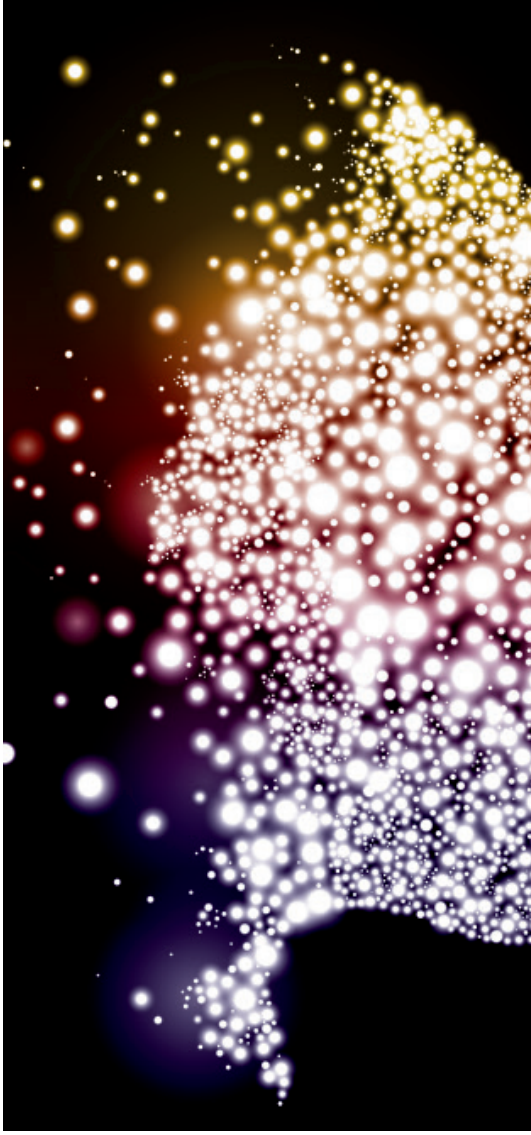
"There is an increasing risk of harmful modifications that can be made when third parties alter chip designs that are manufactured offshore," Onabajo states. "This means you might purchase a device with built-in vulnerabilities and, at some point, hackers can remotely activate the Trojan component and begin to steal data from your device. Alternatively, a malicious integrated circuit that is inserted without consent of the designer can also degrade functionality or deactivate a chip after a certain time or event."

With a main concern of compromised chips being used in critical operations such as those in airplanes, medical devices, and national defense, Onabajo is exploring a unique solution: Designing thermal sensors that can be placed within chips to detect an increase in heat within the device when a Trojan circuit is activated. The sensor circuits will provide a security alert that can potentially be used to notify users of the malicious hacking attempt before data is compromised, or automatically stop the execution of critical tasks.

This research is part of Onabajo's ongoing focus on addressing a pressing question facing chip manufacturers: How can we make chips smaller and less expensive, while still maintaining the highest standards of performance and reliability? "As consumers demand better integration of voice, video, and internet connectivity—into smaller and smaller mobile devices and medical implants—this is an urgent challenge."

Onabajo notes, "One solution is to design chips that measure their own performance, and then self-calibrate to correct any issues." In 2015, Onabajo received a CAREER Award from the National Science Foundation to support the design of more reliable chips for wireless communication in medical applications with the goals of ensuring signal integrity and resisting interference, while reducing power consumption.

"Every chip application is important, but obviously it's critical to maintain the signal integrity of medical implants and other devices that transmit life-saving information," says Onabajo. "My research team at Northeastern is addressing this problem by designing tunable integrated circuits to improve performance in the presence of manufacturing variations and interference from unwanted wireless signals in the environment."



TRANSFORMING WIRELESS COMMUNICATION AND COMPUTATION FOR A CONNECTED WORLD

AI Startup Acquired by Global Cosmetics Company

Associate Professor Raymond Fu, with a joint appointment in the Department of Electrical and Computer Engineering and in the College of Computer and Information Science, founded a spinout in 2016, called Giaran Inc., from the research being conducted in his Synergetic Media Learning Laboratory. The SMILE Lab, as it is known, focuses research in the areas of computer vision, Big Data, and augmented reality in order to create novel algorithms for data mining and predictive modeling.

This research led to the founding of Giaran, which uses advanced artificial intelligence technology with the goal of providing an interactive virtual experience for consumers to find and try on cosmetics products. Recently, Shiseido Americas Corporation—a subsidiary of the leading global cosmetics company Shiseido Company, Limited—acquired Giaran.

In the SMILE Lab, Fu and his team focus primarily on research with security and defense applications. Beauty, on the other hand, was hardly on his team's radar initially. "In the early stages of this research, we didn't know much about fashion, makeup, and beauty," Fu explained. But this potential application took shape as they were researching how to digitally remove someone's makeup to improve facial recognition. "It was then when we thought, 'If we can remove someone's makeup, maybe we can apply this to other domains.'"

To explore this idea further, Fu applied for and received a National Science Foundation I-Corps grant in spring 2016 to conduct market research with beauty industry professionals as well as consumers. Fu said they found a strong interest in the market for an efficient web tool that allows users to virtually try-on cosmetics and find products that best match their individual face shape, skin tone, and texture.

Fu then founded Giaran the same year, and credits Northeastern's Center for Research Innovation as well as the deans, department chairs, and colleagues in the College of Engineering and College of Computer and Information Science for supporting his efforts to advance this research and launch the company.

The Defense Advanced Research Projects Agency (DARPA) awarded a $10 million, four-year research project to Raytheon BBN, Northeastern's College of Engineering, and the Massachusetts Institute of Technology as part of the Dispersed Computing Program to advance wireless communication technology. Professor Edmund Yeh, of the Department of Electrical and Computer Engineering, is leading the effort at Northeastern.

As part of this multi-university and industry collaborative award, Northeastern and MIT engineering researchers will develop a set of optimized communication and computation algorithms and protocols to support multiple-sender multiple-receiver applications with highly demanding latency constraints over heterogeneous, congested, and error-prone network environments. BBN will use the algorithms and protocols in software to develop new wireless communication technology solutions to create a new system architecture from the ground up.

Yeh explains, "Wireless communication networks today have limitations. The goal is to develop a new intellectual design framework that determines how to design the signal, route and code traffic, handle user mobility, and relieve network congestion to guarantee that transmissions are error-resilient and efficient. The technology will enable seamless wireless communication and computation in the field, regardless of channel conditions and computing platforms, thus enabling real-time intelligence for critical decision making."

Edmund Yeh, professor of electrical and computer engineering

GLOBAL IMPACT

Discover the many COE student stories
coe.neu.edu/blog

Aspasie Song, Bioengineering

Aspasie Song recenty completed her second co-op in Berlin, Germany, at SOPAT GmbH in photo-optical imaging.

"This global co-op experience not only has opened up my mind to a lifestyle so different from the ones in Cambodia or the US, and allowed me to make some lifelong connections, but has also impacted my career path."

Engineers Without Borders

Maria Franko, Civil Engineering

"I was beyond thrilled to travel to Uganda, see the project that I had spent a year working on, and meet the community members of Bbanda...I was able to experience a culture very different from my own, gain new technical skills, and improve my soft engineering skills."

Boldly Innovating to Revolutionize Transportation

Hyperloop team, SpaceX Hyperloop Pod Competition

Picture being able to travel from San Francisco to Los Angeles in under 30 minutes at upwards of 700 mph through a tube infrastructure connecting major cities and with pods carrying people and cargo. This is the vision of Elon Musk, founder of rocket and spacecraft manufacturing company SpaceX, and a challenge the Paradigm Hyperloop team set out to bring closer to reality.

Made up of an interdisciplinary undergraduate team from Northeastern University and Memorial University of Newfoundland & Labrador, Paradigm Hyperloop was selected as one of only 25 invited teams globally to participate in the second SpaceX Hyperloop Pod Competition out of a pool of 1,200 designs. They were also one of only five teams globally over the last two years that the competition existed that qualified as a finalist. The team ultimately took **second place** in the global competition.

Luke Merkl, a fifth-year electrical engineering student at Northeastern who was part of the Paradigm Hyperloop team, explained that Paradigm's big innovation—and what set the team apart from every other team—was air levitation. Their system created a cushion of air for the pod to float on, "like an upside down air hockey table," Merkl said. This drastically reduced friction and required less energy than magnetic levitation, a method several teams employed.

"I am so very proud of our students and the Paradigm Hyperloop team for their tremendous accomplishments. Through dedication, innovation, and global collaboration, they are boldly inventing a revolutionary next-generation transportation system that could have a profound impact on people's lives," said Nadine Aubry, dean of the College of Engineering at Northeastern.

Dialogue of Civilizations

Left to right: Nour Naja, Anna Foxs, Rachel Jankowski, and Sofia Catalina

Sofia Catalina,
Chemical Engineering

Sofia Catalina recently traveled to Tarragona, Spain, with Professor Ronald Willey and 22 other students on a Chemical Engineering Dialogue of Civilizations to study Thermodynamics and Process Safety.

"My dialogue was incredibly rewarding with knowledge, experiences, connections, and friendships I would not have found otherwise. I would strongly recommend to any student to take the opportunity to go on dialogue."

Instagram

#GlobalEngineer

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SENIOR STUDENT SPOTLIGHT

Passion for Learning, Teaching

After being accepted into Northeastern's prestigious University Scholars Program for his outstanding high school performance, Delaware native Thurston Brevett, E'18, intended to take full advantage of the College of Engineering's top academics and well-known experiential learning programs to make the most of his degree.

A fan of tinkering with remote-controlled vehicles in his backyard as a kid, Brevett took this hobby, and his adeptness with math and science, and selected electrical engineering as his major. During his first year, he began working as part of the Gordon Center for Subsurface Imaging and Sensing (CenSSIS) research center, led by College of Engineering Distinguished Professor Michael Silevitch, and working with College of Engineering Distinguished Professor Carey Rappaport, of the Department of Electrical and Computer Engineering. He participated in the development of a synthetic aperture radar scanning system, similar to body scanners found at airports, which can detect dielectrics, or electrical insulators that are often found in plastic explosives.

Brevett continued working with radars during his first co-op with MIT Lincoln Labs. He and colleagues processed and analyzed experimental data to determine the impact the creation of a wind turbine farm at Naval Air Station Patuxent River in Maryland would have on the radar systems used to detect the base's aircraft.

For his second co-op, Brevett—a Bermudian citizen by birth—created his own joint co-op in his mother's home country with consulting and construction company Onsite Engineering Services and Electronic Communications Ltd (ECL), a leading Bermuda radio provider for handheld radios, GPS, and dispatch and communications solutions.

Brevett completed his most recent co-op at NK Labs in Cambridge, Massachusetts, working with image processing algorithms for x-ray images to create a technological solution for the inspection of tiny, soldered circuit boards for electronics, instead of the manual inspection currently in place.

All of Brevett's hard work has also led to some pretty impressive accolades: He was a finalist for the prestigious Rhodes Scholarship to promote civic-minded leadership, as well as for the Knight-Hennessy Scholarship, a graduate fellowship program at Stanford University that seeks to support graduate students to solve large-scale global problems. He was also selected to receive a GEM Fellowship, which fully funds doctoral studies in science and engineering for outstanding students from underrepresented communities, as well as a National Science Foundation Graduate Research Fellowship.

Thurston Brevett, BS electrical engineering student

Looking toward the future, Brevett intends to pursue his PhD in digital signal processing with the eventual goal of becoming a professor himself one day. As the president of Eta Kappa Nu, which offers free tutoring service to all electrical and computer engineering students, and the founder of Bits & Bots, which teaches robotics to low-income middle school students, he is a natural teacher.

"By teaching, you begin to understand what you're doing even better," Brevett says. "I love connecting with people and discovering different ways to teach different learners. Part of what I've learned at Northeastern resonates with my teaching style: answering the question, 'Yes, we've solved this particular problem, but can we solve it better?'"

Smart and ELECTRIFYING

Free to propose any type of solution to energy-related challenges, energy systems master's students, Emilda Totozani and Keyur Jigyasu, entered into the Go Green in the City global competition sponsored by Schneider Electric, a major player in the energy management industry.

"We had nothing in mind beforehand," Totozani said. "We just started booking rooms in the library and brainstorming. We decided on electric vehicles because they're trending nowadays, and we wanted to figure out why more people don't buy them and why they're not the primary driving vehicle in the world."

To vanquish the fear in many prospective electric drivers' minds of getting stranded on a deserted stretch of highway with no charging station in sight, Jigyasu and Totozani decided on proposing a 'smart' charging station that comes to the car.

Called "Druber"—derived from the words "Drone" and "Uber"—their system would allow drivers to use an app that summons a battery to be flown via drone to wherever it's needed.

"Like Uber, wherever you are, you would call Druber and this drone with a battery would come and plug into your electric vehicle so you can move on in your journey," Totozani said. Disruption is minimal, as Jigyasu said the battery can plug in and charge the car during travel, with little to no damage to aerodynamics.

Their entry earned them a second-place finish at the North American finals—held in Andover, Massachusetts—and was also one of only twelve teams for the final round in Paris out of a pool of more than 20,000.

The Trip of a Lifetime

Alek Razdan, PhD in computer engineering

Brutally windy. Unfathomably cold. Disturbingly isolated. Yet, Alek Razdan, PhD'21, computer engineering, says, "If I had another opportunity to go, I would jump on it in a second."

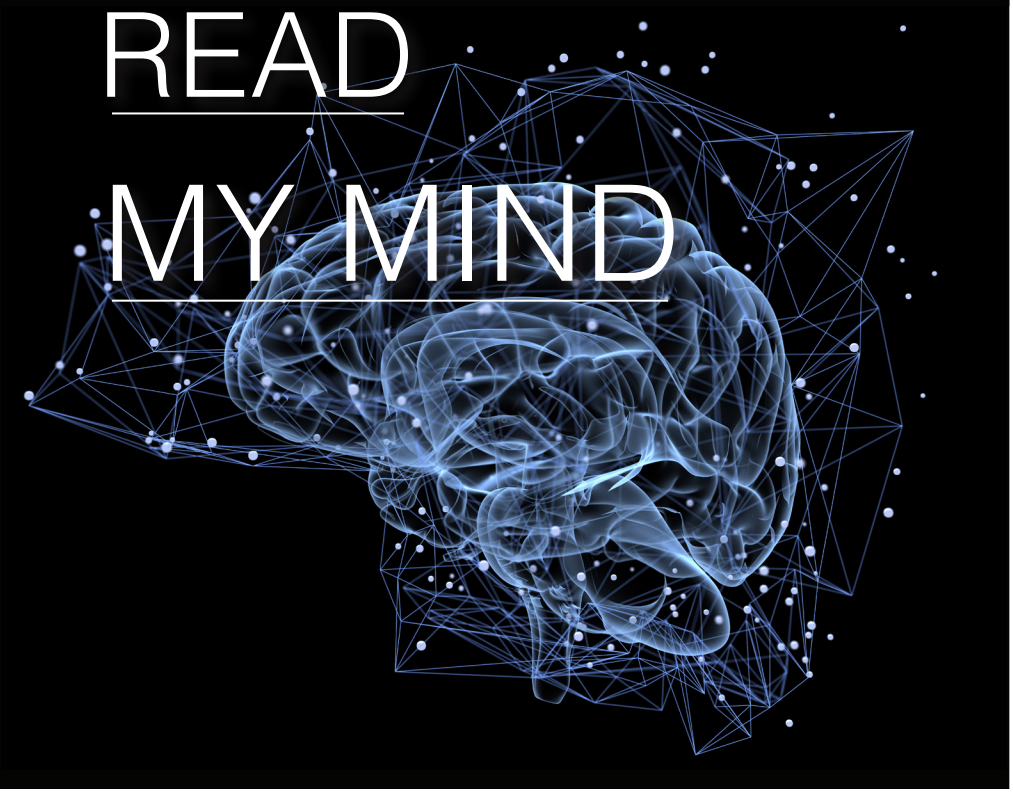
Razdan is speaking of a two-month research expedition he took in the winter to the Ross Sea off the coast of Antarctica, as part of an international crew of scientists. Razdan works with Electrical and Computer Engineering Professor Hanumant Singh, who designed and built another member of the crew—the Jaguar, an autonomous underwater vehicle. The expedition was the first ever to deploy an underwater robot into the Antarctic Ocean during winter.

The goal of the trip was to measure the underside of sea ice sheets to understand why sea ice appears to be expanding in the Antarctic and shrinking in most other places on Earth. Huge sheets of ice help cool the Earth by reflecting away the sun's rays. When the ice forms, it produces dense waters that sink deep into the ocean and drive underwater currents that move heat around the globe, controlling temperatures and climates.

To measure the sea ice, the crew took a new approach using the Jaguar. Rather than drilling a hole in the ice and dropping in a weighted cord to take measurements, the robotic vehicle plunged into some of the coldest waters on Earth, during the most treacherous time of the year. Razdan was responsible for helping to assemble, deploy, and recover the vehicle. He also generated 3-D maps from sonar data collected by the Jaguar.

The research findings, published in *Science Robotics*, indicated that sea ice is thicker than previously thought. There is also much more regional variability than anyone knew—with some sea ice in the Antarctic expanding, and in other regions, shrinking. Why? That is the next mystery Singh is looking to solve.

YOU READ MY MIND



Faculty and researchers from the College of Engineering collaborate here at Northeastern and all over the world to tackle one of the most complex topics imaginable—the human brain.

Inherently multidisciplinary, research on the brain has relevance to nearly every scientific field—engineering, psychology, chemistry, medicine, pharmacology, neuroscience, and more. The brain can be studied from individual molecules at the nanoscale level, to its entirety as a complex organ that influences every aspect of our daily lives, including memory, physical function, mental well-being, and even overall health, leading to prolific, trans-disciplinary collaborations right here at Northeastern.

"If we just thought about the brain from a purely engineering point of view, the models and tools we create would not capture the critical aspects of how brains and minds actually work," says Professor Dana Brooks of the Department of Electrical and Computer Engineering (ECE). "With a system as complex as the brain, we have to be actively working and struggling creatively and synergistically to solve problems together."

Dana Brooks: Brain-related modeling and signal processing research

Using computational modeling, Brooks and his collaborators are enabling other researchers in industry and medicine to make better use of brain stimulation technology to modulate neural activity, using electrodes on the scalp and, via surgical procedures, directly on the cortical surface, as well as magnetic coils held above the head.

Dana Brooks, professor of electrical and computer engineering

Working with colleagues, Brooks builds individualized models of brain anatomies from MRI or CAT scan images, constructs computational models that respect internal structures inside the head, and then suggests the best way to transmit electrical currents to each part of the brain doctors want to stimulate for the desired outcome, while also optimizing patient safety.

The results encouraged Brooks' collaborators at Electrical Geodesics Inc. (now part of Royal Philips) to develop hardware and software enabling their customers to use electroencephalography (EEG) electrodes for targeted brain stimulation. Brooks' group is working closely with researchers at the Berenson-Allen Center for Noninvasive Brain Stimulation at Beth Israel Deaconess Medical Center and at the University of Washington in Seattle to better target their stimulation treatments.

"At the University of Washington," says Brooks, "they use cortical surface electrode arrays to help treat children and adolescents with epilepsy when drugs aren't enough to control their seizures. By using the electric stimulation to discover which areas of the brain are responsible for which sensory and motor functions, doctors hope to better patient outcomes when surgically removing the tissue causing the problem without effecting any other areas or functions."

Say Goodbye to Stitches and Staples

Nasim Annabi, assistant professor of chemical engineering, is inventing a new type of surgical glue that could replace the need for staples and sutures. Annabi is leading the research, which she and her colleagues from the University of Sydney and Harvard Medical School described in a paper published in *Science Translational Medicine*.

Nasim Annabi, assistant professor of chemical engineering

The gel-like glue, called MeTro, is made from a human protein that has been modified to react to ultraviolet light. Researchers apply the glue to a wound, place it under UV light for a few seconds, and voilà—the wound is sealed.

MeTro is unlike anything currently available, Annabi said. It is highly adhesive, acting as a patch on lungs, hearts, or other organs. The gel's elastic quality makes it ideal for tissue that requires flexibility, like an expanding lung. It can be fine-tuned to degrade at a pace specific to the amount of time an organ needs to heal. And because it's made from a human protein, the glue has another valuable trait.

"We observed that this isn't just a sealant, it actually helps with tissue regeneration," Annabi said. For example, after a heart attack, the glue could be applied on damaged heart muscle to assist in regrowth.

Annabi's previous research has shown that the glue could be sprayed on skin to form a barrier over wounds and promote healing. She has recently received two R01 grants of $3.1 million and $2 million from the National Institutes of Health to continue research efforts. Annabi estimates that the glue will be available in hospitals within three to five years.

Additionally, Annabi received a $2.1 million grant from the U.S. Department of Defense, U.S. Army Medical Research and Material Command (2018-2021) to develop a transparent, non-toxic, and highly adhesive biomaterial that is retained for long periods in the cornea and takes the contour shape of the native cornea. The adhesive firmly adheres to the corneal tissue and seals the defects without the need for stitches, and regenerates the damaged corneal tissue.

More broadly, Brooks and several College of Engineering collaborators are working closely with the Institute for Affective Science in Northeastern's Department of Psychology, along with faculty in the computer science and physical therapy departments, in an ambitious research effort to integrate engineering, neuroscience, and psychology perspectives to address fundamental questions about how the brain creates the mind. The brain stimulation work plays a key role in this effort because it offers a unique means to directly but safely alter specific aspects of brain function and then observe the consequent mental affects.

Heather Clark: Nanosensors with diverse applications

Using nanosensors capable of measuring chemical activity in the brain in real time, Bioengineering Professor Heather Clark is working to help round out the toolbox that neuroscience researchers can access to answer their questions about memory, function, disease states, and more.

"For many researchers, it is a scramble to find a tool to answer specific questions about the brain, such as what chemical is being used or transmitted and when," says Clark. "A further issue is that many of the existing tools can only be implemented after the fact. Our nanosensors are not only designed to answer specific questions, but they are also capable of collecting this crucial data as it happens."

Clark's nanosensor is a modular system that selectively binds to the molecule being measured and communicates when that process has occurred. By varying the elements of the sensor, it can be tuned to measure different molecules, or to be compatible with a variety of imaging instruments.

Clark has received funding from the National Institutes of Health (NIH) for her research, including a Research Project Grant (R01) and money from the Stimulating Peripheral Activity to Relieve Conditions (SPARC) program.

Working with the Northeastern engineering students in her lab—undergraduate through post-doctorate—is one of the favorite parts of Clark's job. While examining brain tissue samples in mice and rats, Clark and her team look not for trends, but for the precise analytical information the researchers they partner with need to measure to see how robust the tool they've created is.

The nanosensors that Clark creates have wide-reaching applications, such as measuring the level of specific

Heather Clark, professor of bioengineering

Samuel Chung, assistant professor of bioengineering

neurotransmitters like acetylcholine in certain disease stages or during different emotional states. For her, working with the brain is a fascinating area that offers boundless opportunities for exploration.

"The chemical processes that happen in the brain lead to memories and thoughts that cannot be recreated in a beaker. Why? And what are the spatial or temporal things going on that we can't see or experience yet? Finding answers to these questions is what excites me."

Samuel Chung: Nerve regeneration

Samuel Chung, assistant professor in the Department of Bioengineering, is working on a model for central nervous system regeneration with a rather unusual animal: an invertebrate worm that's 1mm in length.

Chung's research started from his background in physics and optics, where he learned about surgical technology using a laser that emits very short pulses as the scalpel, which is highly effective in very precise surgeries on the human eye. Chung has adapted this technology to cut individual axons—short extensions of nerve cells—from each of his worm's brain cells and then watch them regenerate after surgery.

Thanks to funding from the Morton Cure Paralysis Fund and Northeastern's Department of Bioengineering Start-Up Fund, Chung's lab is working to very quickly screen for genetic mutations that affect regeneration in the worm. Using these invertebrates is vastly faster than conducting the process with other animals—regeneration requires hours to days for worms, compared to weeks or even months for mammals.

Chung's main goal is to be able to find the genes responsible for regenerating the worm's central nervous system. Through collaboration with other scientists and engineers working with mammals, he eventually hopes to apply these genetic findings to human spinal injuries and neurodegenerative diseases like Amyotrophic Lateral Sclerosis, commonly referred to as ALS or Lou Gehrig's disease.

"Scientists have known for 30 years that the human spinal cord can regenerate under the right conditions," explains Chung. "We want to better understand these conditions and the genes responsible for them so we can help improve human quality of life in the future."

Lee Makowski: Alzheimer's disease studies

Lee Makowski, professor and chair of the Department of Bioengineering, is working to slow the march of Alzheimer's disease.

Alzheimer's is a slow-moving disease that can take years, even decades to reach its hallmark point of neural degradation, during which time the victim suffers from progressive memory loss and dementia.

"I feel that researchers and clinicians are beginning to connect the dots, and I think there's real potential for future solutions."

— Lee Makowski, professor and chair of bioengineering

Because of the singular challenges of carrying out experiments on human brain tissue, scientists have found it exceedingly difficult to understand the processes behind the disease.

Neuronal degradation in Alzheimer's is linked to the presence of amyloid fibrils composed of Abeta proteins and neurofibrillary tangles made of the protein called "tau." However, there isn't a clear correlation between the amount of these aggregates and the state of disease progression: People with advanced Alzheimer's can have low levels of these proteins, just as those who have only begun to show symptoms can have relatively high levels.

Over the past four years, Makowski has been working with neuropathologists at Massachusetts General Hospital to analyze brain tissue samples collected from Alzheimer's patients during autopsy using scanning x-ray microdiffraction. Makowski and his team then interpret the data to map the molecular structure of what they find, particularly in the case of the amyloid fibrils.

"We're trying to understand how different strains of amyloid proteins might end up

Lee Makowski, professor and chair of bioengineering

expressing different levels of toxicity," explains Makowski. "By looking at different parts of the brain in subjects with different clinical presentations of Alzheimer's, we hope to correlate the molecular differences we see in our data with what they see in the clinic."

By using this data to understand the mechanism of disease progression, Makowski and his collaborators hope it could help researchers design a therapy to further slow Alzheimer's, or even halt it in its tracks.

"I'm very upbeat about our chances for making progress," says Makowski. "I feel that researchers and clinicians are beginning to connect the dots, and I think there's real potential for future solutions."

Sarah Ostadabbas: Computer vision and human-computer interaction

Sarah Ostadabbas, director of the Augmented Cognition Lab and assistant professor in the Department of Electrical and Computer Engineering, primarily researches digital prosthetics. These cognitive and neurological assistive devices can be used for rehabilitation, Parkinson's patients, diabetics, and individuals on the autism spectrum.

The emerging field of digital prosthetics requires two important elements: real-time understanding of the cognitive/neurological state of the user, and real-time understanding of the state of the world around him/her. To help accomplish these technological hurdles—which Ostadabbas calls "pose of the user" and "pose of the world," respectively—her lab uses deep learning, physics-based generative models, and subspace modeling/factorization to develop solutions.

In addition, Ostadabbas collaborates closely with members of the psychology, neuroscience, and rehabilitation departments on another key technological aspect of her research: augmented/virtual reality (AR/VR).

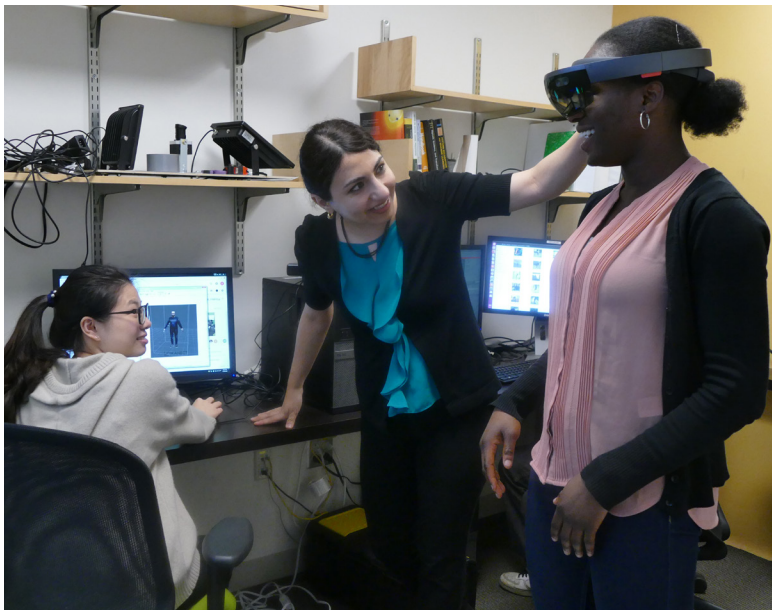
"Using AR and VR technology can help us produce digital prosthetics that impact a variety of human situations, including a VR system in which a patient's low-functioning leg seems to mirror the actions of the functioning leg to jump-start movement, and using AR to draw short-range walking targets to prevent gait freezing in Parkinson's patients," says Ostadabbas. "These new technologies offer patients more freedom than the lower-tech assistive devices currently in use, such as using physical mirrors and objects to accomplish the same task."

Collaborating with experts in other fields to solve difficult problems is an important element of Professor Ostadabbas's worldview.

"We've entered the 21st century surrounded by massive amounts of data and some incredible technological tools, which can be used to ease human suffering and solve some of our most long-standing problems. The key to tackling these grand challenges in a humane way is a nuanced and cross-domain collaborative approach, and I look forward to working with colleagues around the world to address these issues."

"We've entered the 21st century surrounded by massive amounts of data and some incredible technological tools, which can be used to ease human suffering and solve some of our most long-standing problems."

— Sarah Ostadabbas, assistant professor of electrical and computer engineering



Sarah Ostadabbas (center), assistant professor of electrical and computer engineering, with Yu Yin, MS student, and Adaeze Adigwe, BS student, in the Augmented Cognition Lab

Members of the Augmented Cognition Lab collaborate, including PhD students Shuangjun Liu (right), and Amirreza Farnoosh (second from left)

COMBATTING THE OPIOID CRISIS WITH SYSTEMS ENGINEERING

"By noon every day in Massachusetts, we've lost another person to the opioid crisis, three to four per day. One opioid-associated preventable death nationally every 15 minutes, every single day, every week, every month. It's unacceptable," said Professor of Mechanical and Industrial Engineering James Benneyan, founding director of the Healthcare Systems Engineering (HSyE) Institute at Northeastern.

Over the past 20 years, the HSyE Institute has developed systems engineering strategies to solve any number of healthcare challenges. Focusing now on the opioid crisis specifically, Benneyan's team has followed a classic engineering lifecycle to decompose the problem and recompose integrated solutions, from prevention through recovery.

Supported by grants from the National Science Foundation, National Institutes of Health, Agency for Healthcare Research and Quality, and Massachusetts Health Policy Commission, they have worked on safe prescribing, the spread of the epidemic itself, jail-to-community transitions, and recovery of at-risk patients—including large-scale, quantitative models showing how the epidemic spreads geographically over time. These models accurately predict abuse and mortality over two decades, mapping the spread of overdose mortality by individual county and zip code.

James Benneyan, professor of mechanical and industrial engineering

"We're now starting to replicate our work in Maine, Florida, California, Texas, and New Mexico to inform policy," said Benneyan.

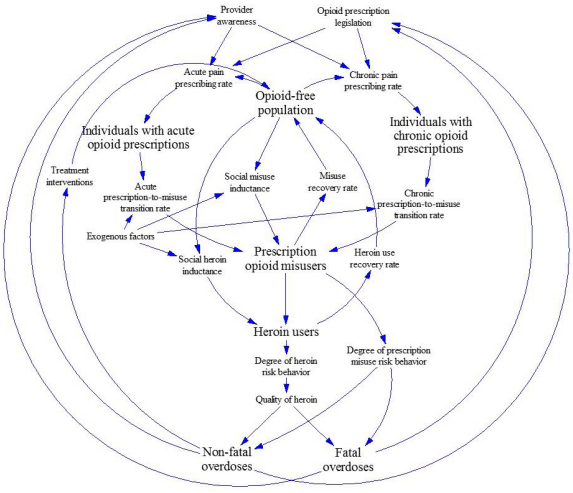
Engineering Model-Based Interventions

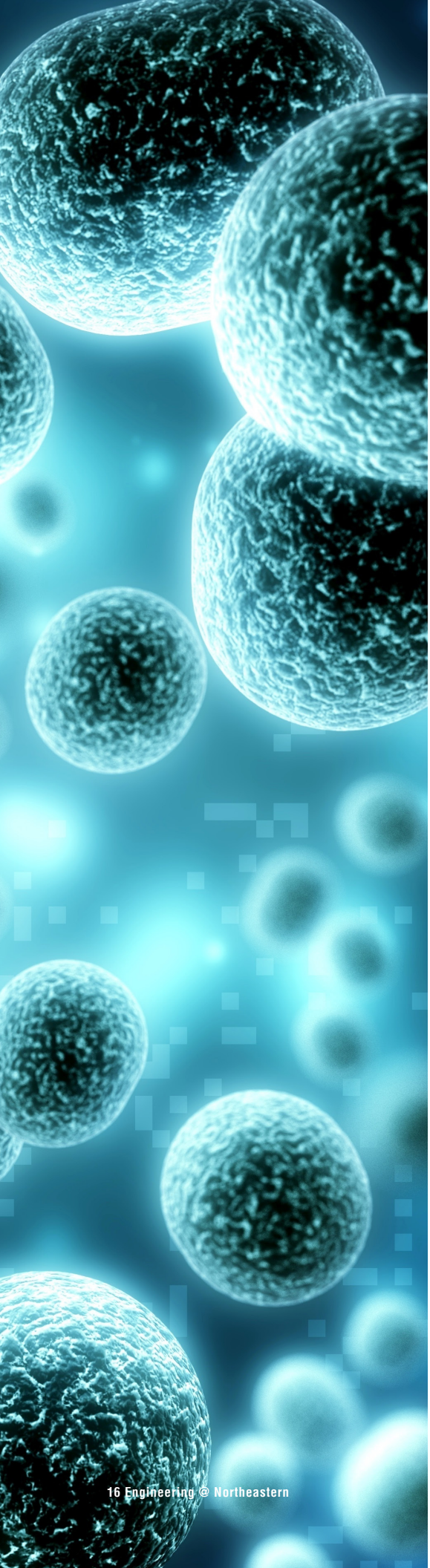
The opioid crisis is dauntingly complex. There is no simple solution to the problem, and no single intervention that's guaranteed to be effective. That's where the systems engineering approach comes in. "What we've learned through our work is that one intervention alone isn't going to make much difference and probably is just going to cause a problem elsewhere," said Benneyan. "There really needs to be an orchestrated intertwined set of interventions that constantly adapts." Engineering models can help do this.

In both prevention and recovery, furthermore, healthcare clinics are strapped for resources. They don't have the means to screen everyone seeking painkillers or capacity to serve everyone seeking treatment. Benneyan's Institute has built predictive models that healthcare clinics can use to identify patients at high risk so clinics can focus care efforts where they're most needed.

To further improve availability of treatment, Benneyan has developed mathematical computer models to help states optimize capacity planning and locations for short-term and long-term treatment facilities. "There is a tragic percentage of people who want to get into care but can't, which is heartbreaking," Benneyan said. His team has found that—without spending any additional money—significantly more treatment can be provided and lives saved.

Within front-line clinics themselves, finally, the HSyE Institute has deployed student teams to help address staffing, flow, operations, and logistics challenges to help them run more efficiently. Where next? Says Benneyan, "We need to do more and talk less. We are just getting started, committing Institute reserve resources, and seeking matching funds."





Research that Takes Guts

The community of microbes that comprise the microbiome in the human digestive system are a source of endless fascination and research at Northeastern's College of Engineering, sparking innovations from faster wound healing to autism therapy to the obesity epidemic.

Collaborative scientific projects to further technology and understanding to solve the world's grand challenges are no new occurrence. The largest to date is the successful Human Genome Project (HGP)—an international effort begun in the 1990s to identify and map all of the genes in the human body.

On the heels of HGP's success came the Human Microbiome Project (HMP) in 2008. This National Institutes of Health (NIH) initiative was intended to span just five years, with the goal of identifying and characterizing all the microorganisms found in both healthy and ailing humans. But HMP has continued at NIH and beyond, with scientists tackling current initiatives such as the role of the microbiome in conditions like preterm birth, irritable bowel disease, and the onset of Type 2 diabetes.

"The explosion of interest in gut health has come about since the realization that the condition of the microbiome has a direct relationship to a variety of health conditions," says

Rebecca Carrier, professor and associate chair of research for the Department of Chemical Engineering. "At Northeastern, we have a large focus on use-inspired research and practical applications, so this is a perfect opportunity to help explore what we can do to positively affect the health of future generations."

The field of human microbiome research has grown exponentially in the last decade, with researchers, engineers, and scientists from Northeastern tackling the thousands of microbes in the human body that outmeasure our own genetic material, and discovering just what effect they have on our current and future health.

Rebecca Carrier: In vitro study of gut inflammation and mental health

As part of a collaborative project between Northeastern, MIT, and Boston Children's Hospital, Professor Carrier is leading a $5 million NIH Bioengineering Research Partnership grant to develop an in vitro human model of the interactions between microbes and immune cells in the gut and other organ systems.

"Interactions between the epithelium (the tissues that line the intestine and other organs in the body), the microbiome, and immune cells have been observed, but aren't well understood," says Carrier. "Seventy percent of the body's immune cells are found in the gut, so by learning more about the relationships between the gut and the rest of the human body—particularly those associated with inflammation—we can potentially prevent or develop therapies to treat a host of diseases."

Rebecca Carrier, professor of chemical engineering

Carrier and her collaborators have been largely focused on the gut side of the interaction, having already published studies on the gut-liver connection. Fellow microbiome researcher and NIH grant recipient Abigail Koppes, assistant professor of chemical engineering, is working with Carrier and her colleagues on the integration of nerves crucial in the gut-brain connection, creating a simulation of this interaction in a dish by culturing nerve cells adjacent to epithelium, mimicking the anatomical location of nerve cells in gut tissue in the body. The nerve cells can thus sense signals sent from the epithelium and microbiome, and vice versa.

Ultimately, the plan is to incorporate multiple nerve cell types that are responsible for forming neural pathways that act as physical connections between the gut and the brain.

"Right now, there is no other in vitro way to study the real-time impact of the microbiome on human health like you can with 'guts-on-a-chip' models. Most of the work in the field is done in rodents, and any human studies usually involve analysis of the microbes present in feces, which only tells part of the story."

The challenge Carrier and her team struggle with is to maintain the perfect conditions to keep both the gut microbes and the mammalian cells happy—something that happens constantly inside the human body, but is very difficult to attain inside a lab.

"Trying to mimic the actual environment in the intestine—including the digestive enzymes and low oxygen levels required for some microbes to survive, which can actually kill the other cells you're trying to work with—is very challenging. But, by perfecting our culture systems to allow analysis of crosstalk between the microbiome and the mammalian cells in the gut, we'll ultimately have a model gut system that can allow study of the interactions between the gut and the brain. Such a tool would be highly useful in development of strategies to prevent or treat disease states that have been linked to gut inflammation, including autism, Alzheimer's, and depression."

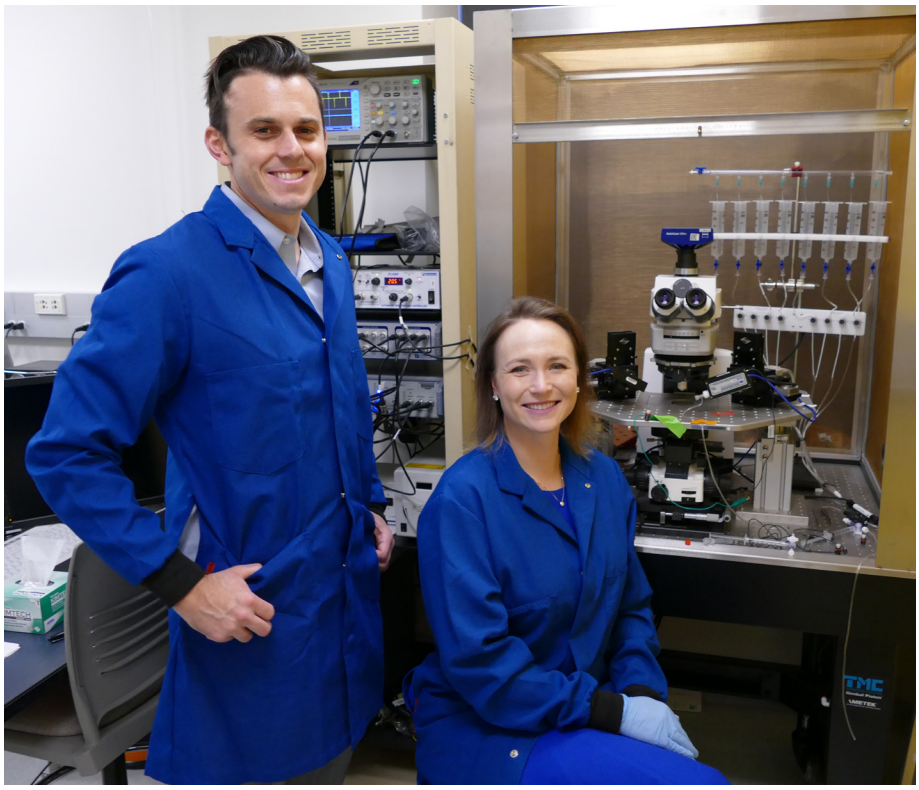
"Seventy percent of the body's immune cells are found in the gut, so by learning more about the relationships between the gut and the rest of the human body…we can potentially prevent or develop therapies to treat a host of diseases."

— Rebecca Carrier, professor of chemical engineering

Abigail and Ryan Koppes: The connection between gut and neural health

Assistant Professor Abigail Koppes completed her post-doctoral study with Professor Carrier as an NSF ADVANCE Future Faculty Fellow and is closely linked to her human gut epithelial-microbiome-immune axis study. Now, Koppes and Chemical Engineering Assistant Professor Ryan Koppes are undertaking their own study on gut-brain communication, having recently been awarded a three-year, $632,000 Trailblazer New/Early Career Investigator R21 Award from the NIH National Institute of Biomedical Imaging and Bioengineering.

The Koppes' teams are working on a "body on a chip" model to mimic certain aspects of the brain and gut that leverage the whole nervous system—the central nervous system (CNS), which includes the brain, spinal cord, and peripheral nerves that run to our extremities, and the



Ryan Koppes, assistant professor of chemical engineering, and Abigail Koppes, assistant professor of chemical engineering

autonomic nervous system (ANS), which regulates involuntary vital functions like breathing, blood flow, and the "fight or flight" response.

Working with researchers at Boston Children's Hospital and Harvard Medical School, the team is trying to understand more about the enteric nervous system—a part of the ANS that controls gut function—and how it communicates with and regulates the digestive system.

"There are more neurons in your gut than in your spinal cord," says Abigail, "but the area is vastly understudied. We're developing new technologies to create bigger and more complex model systems that incorporate key aspects of the enteric nervous system and cells from the intestines."

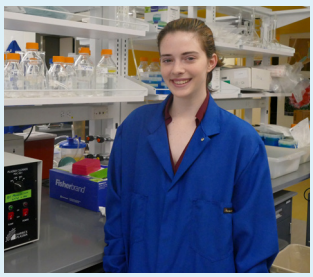
Much like Carrier's research, one of the hardest parts of the study is trying to replicate the conditions that allow for the specific neural pathways that connect the brain and the gut to communicate outside of the human body.

Inspired to Research

As a first year student, Caroline Ghio, chemical engineering, volunteered in Assistant Professor Abigail Koppes' Advanced Biomaterials for Neuroengineering Laboratory (ABNEL) and worked with PhD student Marissa Puzan on her research studying the connection between the small intestine (or gut) and the brain, and the development of neurogastrointestinal conditions. This inspired her to apply for Northeastern's Undergraduate Research and Creative Endeavor Award as a sophomore, which she was recently awarded.

Ghio credits Koppes and Puzan for nurturing her interest in their projects even while Ghio was still learning basic cell culture technique. "Marissa and Dr. Koppes didn't stop with just teaching me technical skills, they included me in lab meetings, shared articles with me, and helped me begin to develop an understanding of the small intestine and its relationship to conditions such as irritable bowel syndrome, depression and autism, and this gave me the confidence to pursue a project of my own."

As Ghio learned more about the goal of the lab to build an in vitro tissue engineered model of the small intestine, her excitement grew and she started trying to develop an original idea that would contribute in some way to understanding the small intestine. Part of Ghio's inspiration for her UGRCE submission came from her father, a physician scientist. Ghio explained, "My dad is a pulmonologist and studies iron in the lung in relation to lung disease. Discussions at the intersection of these two fields of study yielded the idea of studying iron in the intestine."



Caroline Ghio, BS chemical engineering student

In Ghio's research, she is studying the impact of metabolites on iron absorption in Caco-2 cells (a line of cells developed from colon cancer cells) that model the regulation and absorption of nutrients in the intestine. By undertaking this research, Ghio hopes to learn more about iron absorption in the gut, specifically ways to enhance that absorption. Ghio hopes data will prove useful to the ABNEL goal of making an in vitro model of the small intestine, and she also believes that research in this area will help shed light on conditions such as anemia and lactic acidosis; improved understanding will hopefully allow doctors and other researchers to better treat and diagnose these illnesses.

"Working with these models is a bit like taking a computer, smashing it to pieces, putting it in a dish, and trying to get it to run and connect to Facebook," jokes Ryan. "But, by simplifying the nervous system on a chip, we hope to better understand and mimic the complexity of the human body and how nerves impact organ function." The long-term goal of the Koppes' project is to use these platforms to identify certain types of nutrients and metabolites that can reestablish normal function, such as a probiotic that can help ease depression and/or anxiety symptoms or minimize the inflammation caused by irritable bowel syndrome (IBS).

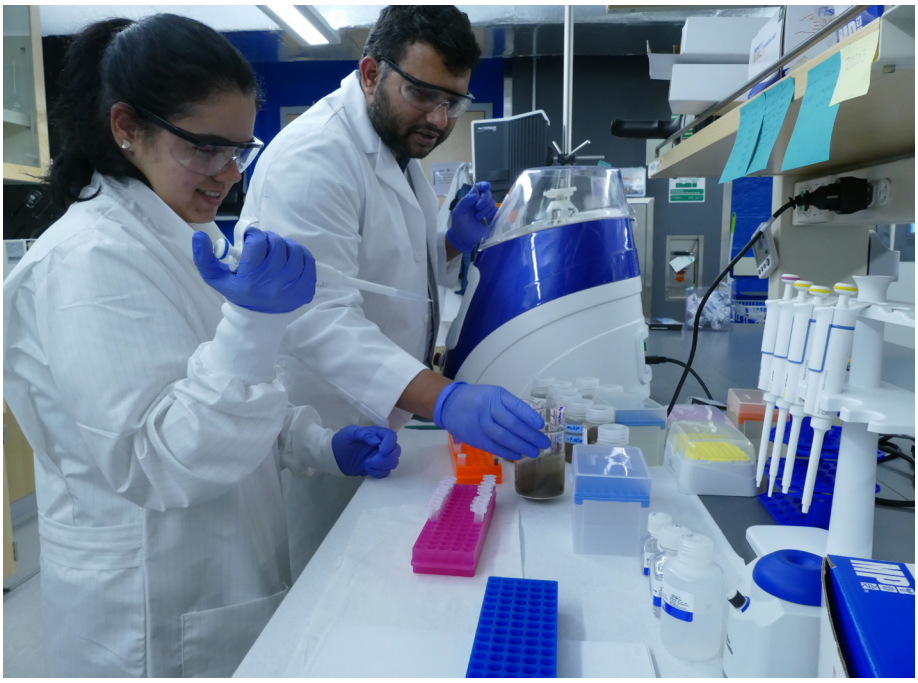
Ameet Pinto: Microbes found in water and their impact on health

For his part, Ameet Pinto, assistant professor in the Department of Civil and Environmental Engineering, is looking at microbes that begin outside of the human body: Pinto's research is focused on microbial communities in drinking water.

With support from the National Science Foundation (NSF) and the Water Research Foundation (WRF), Pinto uses genomics and DNA sequencing to help identify unknown microbes in water in minutes to hours, not days. He and his team focus on microbes that are unregulated, some of which can cause health issues in those with compromised immune systems, from gastrointestinal to respiratory infections.

"When I started my post-doctoral work in drinking water engineering in 2009, we could spend days trying to characterize DNA sequences for 100 microbes," says Pinto. "The technology has become so much more advanced that we can characterize millions in the same amount of time. It's these advancements that make the microbiome much more accessible to researchers like myself and my colleagues."

While water utility companies treat water to the height of federal and state regulations, the challenge is trying to predict what will come out of your tap at home after it has traveled through hundreds to thousands of miles of pipeline. Utility companies try to control for these unknowns by sampling at locations throughout their pipeline system,



Ameet Pinto, assistant professor of civil and environmental engineering, and PhD student Maria Sevillano-Rivera in the Pinto Lab

"The hope is to be able to predict what kind of infection a person could develop to be able to intervene at an earlier stage."

— Ed Goluch, associate professor of chemical engineering

but it takes two to three days to test these samples, and by then, the population has already consumed the water.

That's where handheld DNA sequencers come in. Perfected in the lab, being tested in the field, and perhaps available for home use soon, this portable technology allows for real-time testing of water samples for continuous monitoring.

"We want to get to the point where we can predict a water contamination event instead of waiting until the problem has been recognized because it is already effecting people," says Pinto.

Ed Goluch: The measurement and control of microbes within the body

Chemical Engineering Associate Professor Edgar Goluch is the self-described "device guy." His main area of expertise lies in creating the hardware and diagnostic tools that other researchers need to find the answers they seek.

Able to create sensing devices as small as a single bacteria cell, Goluch and his team focus much of their efforts on developing tiny sensors capable of measuring chemicals in real-time.

From what happens when someone eats turkey and its amino acid tryptophan comes into contact with bacteria in the gut, to what exact chemicals from bacterial processes prevent chronic bed sores from healing, Goluch has been working with microbiome researchers for nearly

a decade, including Carrier, the Koppes, and Pinto.

"Right now, we're working with the Center for Vascular, Wound Healing & Hyperbaric Medicine at Tufts Medical Center to help them measure the molecules that bacteria produce. The hope is to be able to predict what kind of infection a person could develop to be able to intervene at an earlier stage," says Goluch.

Working with the Barabasi Group at Northeastern, which received a grant from One Brave Idea, Goluch is developing swallow-able technology to help assess whether the chemicals in the food a person eats can affect their chances at developing heart disease.

"With these chemical sensors on a pill, we can measure any chemical a researcher is interested in, from antioxidants to lipids, to see how the food people eat affects their disease state long-term. Not only that, but we're looking into how many different chemicals we could measure with just one pill. One hundred? One thousand? Time will tell as both the technology and our understanding continues to grow, and that's the exciting part of our research."

Amy Mueller (right), assistant professor of civil and environmental engineering, and the Marine Science Center in Nahant, Mass., housing her Environmental Sensors Lab.

Re-inventing Wastewater Treatment

Anammox technology, as daunting as it sounds, is a scientific approach for reducing the cost and energy required to treat wastewater using nitrite rather than oxygen to remove ammonia and break down waste. While used by some wastewater operations, the technology can currently only be applied to warm ammonium-rich side streams, limiting the number of treatment plants where it can realistically be implemented.

As part of a collaborative grant with the University of Washington and California Institute of Technology, Assistant Professor Amy Mueller of the Department of Civil and Environmental Engineering, jointly appointed in Marine and Environmental Sciences (CEE/MES), will work on a $2.7M DARPA team grant to increase the robustness of Anammox technology for municipal scale-applications in the main processing stream. Mueller will work on development of the sensing and control systems at Northeastern.

Mueller remarked, "Water reclamation facilities consume approximately two percent of the annual U.S. energy budget, and this strategy has the potential to cut that energy demand in half, while eliminating greenhouse gas emissions. This project is an exciting example of the power of collaborative research and sharing of tools—especially data analysis strategies—across disciplinary lines."

At Mueller's lab at Northeastern, researchers will develop new sensing strategies to achieve the needed online measurements for stabilizing the Anammox bio-granular process at the target conditions, including low ammonium, low oxygen, and cool temperatures, which are representative of the main processing stream in most wastewater treatment plants. Researchers will work specifically on biologically-informed machine learning algorithms for accurate measurement at low levels, which will be used to drive real-time feedback control strategies that ensure that reactor conditions remain stable across fluctuating environmental conditions to promote the targeted microbial communities.

Aerial Drone System Leads to Discovery of Penguin Super-Colony

Adélie penguins jumping off iceberg, Danger Islands, Antarctica. © Stony Brook University, Louisiana State University, Courtesy Rachael Herman.

Researchers have made the exciting discovery of a colony of more than 1,500,000 Adélie Penguins on the remote Danger Islands—more than the rest of the entire Antarctic Peninsula region combined. An autonomous aerial drone with an imaging and navigation system developed by Northeastern Professor Hanumant Singh, jointly appointed in electrical and computer engineering, and mechanical and industrial engineering, led to the findings, recently published in the journal, *Scientific Reports*.

"It's unbelievable. We knew the colony existed, but we didn't know how big it was," said Singh. Earlier reports using satellite data suggested the colonies may exist, but heavy ice pack is common around these islands—even in summer months—making it difficult to access the area to conduct a comprehensive survey. That's where the drone system came in. The drone flew about 30 meters over the surface of the islands—close enough for a machine-learning algorithm Singh developed to rapidly count each individual penguin.

The drone flew in a "mowing the lawn" pattern, Singh said, creating images the researchers compiled into a detailed mosaic map of the island. "As soon as we did the first run, it became very obvious that counting penguins this way was more efficient than anything else we've ever thought of," Singh said.

The super-colony—which is comprised of 751,527 penguin pairs—includes the third and fourth largest Adélie penguin colonies in the world. Researchers believe the Danger Islands will be an important breeding location for penguins under projected climate change, and that they deserve special consideration in the negotiation and design of Marine Protected Areas in the region.

The number of penguins in the Danger Islands could provide insight not just on penguin population dynamics, but also on the effects of changing temperature and sea ice on the region's ecology, according to the Woods Hole Oceanographic Institution, which collaborated on the study with researchers from Northeastern, Stony Brook University, Oxford University, Louisiana State University, and Southampton University.

Quadcopter aerial imagery of an Adélie penguin breeding colony on Heroina Island, Danger Islands, Antarctica © WHOI, Northeastern University, Courtesy Thomas Sayre McChord, Hanumant Singh.

Thomas Sayre-McCord (WHOI/MIT) and Philip McDowall (Stonybrook University) pilot a Quadcopter at an Adélie penguin breeding colony on Brash Island, Danger Islands, Antarctica. © Stony Brook University, Courtesy Casey Youngflesh.

ENGINEERING THE NEXT GENERATION

To support future innovation, the College of Engineering has developed a number of outreach efforts aimed at introducing diverse young people and college students to careers in science, technology, engineering, and math (STEM), and fostering their development throughout the college experience.

Ask Claire Duggan what she loves about her job as director of Northeastern's Center for STEM Education within the College of Engineering and the answer is clear: It's all about securing the future. Duggan is passionate about the Center's mission to reach out to young scientists and engineers. "The field of engineering continues to be challenged to educate an adequate number of engineers," says Duggan. "Young people aren't pursuing engineering at a rate that will meet our long-tern needs for science and engineering skills in the U.S. And women and minorities continue to be underrepresented." See related article, "Breaking the Stereotype."

Given the challenges involved in creating a strong pipeline of future engineers, Nadine Aubry, dean of the College of Engineering, has made STEM outreach a strategic priority.

"As a leading engineering school, our college has a responsibility to proactively create awareness of STEM topics and share our enthusiasm for the profession," Aubry points out. "We need to engage students early and throughout the college experience, as well as create opportunities for the next generation of engineers of all ages, and from every background. That's the only way we can ensure that engineering will remain vital, and that engineers will continue to arrive at truly innovative solutions to our most pressing problems as a society."

Bridging the Gap: The Center for STEM Education

Northeastern's Center for STEM Education is critical to this mission. The Center brings aspiring scientists and engineers in grades K-12 together with students, faculty, and researchers in the College of Engineering who can provide them with exposure to STEM topics—along with hands-on learning opportunities that bring those topics to life.

"The more young people we can reach, and the more moments of discovery we can create, the greater the chances that a future STEM professional will find his or her place in the world," says Duggan.

Each year, the Center hosts approximately 1,500 elementary and middle school students for one-day STEM field trips to the campus, while also sponsoring a variety of summer program offerings for middle and high school students. Through the Young Scholars Program, local high school students can benefit from a six-week paid research internship in the College of Engineering. The Center partners with faculty to create targeted outreach programs, as well as with local corporations like General Electric that are committed to increasing the STEM pipeline.

A key factor in the Center's success is the active involvement of students from across the College of Engineering. In fall 2017, more than 90 engineering undergraduates volunteered at the Center, making visits to local schools and hosting young visitors to the campus. Colin Bergmann, E'21, environmental engineering, began working with younger students as a work-study employee at the Center in 2016 and has remained involved ever since.

"I decided to become an engineer because I was exposed to hands-on learning opportunities in high school. That's how I realized I enjoyed solving problems," recalls Bergmann. "When I began to work for the Center, I realized not everyone has those same opportunities. I love watching kids struggle with a problem, work on it, then solve it. For many of them, it's a new and exciting experience. They're using their critical-thinking skills and pushing themselves, maybe for the first time."

Bergmann has enjoyed his work at the Center so much that he worked with other students to create a student organization called the STEM Outreach Club, or STEMout. With over 350 undergrad volunteers in its database, the club gives members greater flexibility to volunteer. "We can bring Northeastern engineering students together with younger kids on weekends, or during one-time events like science expos," notes Bergmann, now the club's president. "There's a huge demand for volunteer opportunities in STEM outreach, because I think a lot of us remember that 'aha' moment when we decided to be engineers—and we want to share that with others."

Service learning: Face to face with the future

Another avenue for STEM outreach is the first-year service learning curriculum designed by Susan Freeman, director of First Year Engineering and a faculty member in mechanical and industrial engineering. In her two sections of Cornerstone of Engineering—a required course for all first-year students—Freeman has incorporated an outreach component that has made her classes extremely popular.

"When I first announced that I was adding a hands-on service learning component to my Cornerstone classes, about 280 students expressed interest—many more than I could accommodate," says Freeman. "Today we have about 75 first-year students each year enrolled in the service learning option. They visit 14 local after-school programs in the neighborhoods of Roxbury and Dorchester each week, teaching robotics to middle school students."

Why has the opportunity to mentor young scientists proven so popular? Former Cornerstone student Chris Scianna, E'19, electrical and computer engineering, believes many Northeastern students are excited about introducing students to topics in engineering that they themselves were never exposed to in high school, "I was always good at math and science, but I wasn't sure what engineering entailed," he states.

Scianna notes that the hands-on robotics projects led by service-learning students encompass many engineering disciplines, giving middle school students broad exposure to the field. "They're coding software, they're wiring boards, they're learning structural mechanics—you can see the kids going from overwhelmed the first day to quickly becoming excited and showing off their working robots. It's really gratifying to know you were a part of that," he says.

Scianna enjoyed his first-year service learning experience so much that he became a teaching assistant to Susan Freeman, mentoring the mentors as they traveled out to local schools. To reach even more middle school students, in fall 2017 Scianna launched a student club called "Roxbury Robotics," focused on extracurricular outreach activities.

Susan Freeman (front row fourth from right), director and teaching professor of First Year Engineering Program

With about 100 student members, the club is actively coaching 150 middle school students, in addition to those who participate through Freeman's Cornerstone service learning courses.

"We need to expose all kinds of young people to the field, to show them that they have a place and they are welcome. We need to show them the real work that engineers do—and, believe me, they just light up the first time their robot works. It's that moment of discovery and accomplishment that I'm trying to foster in all my service learning work," says Freeman.

Breaking new ground: Nontraditional paths to engineering

"While it's important to increase awareness among K through 12 students, we also need to support those college students who want to pursue an engineering degree, but may have lacked the right information or opportunities when they chose a college and a major," explains Richard Harris, assistant dean and director of the Northeastern University Program in Multicultural Engineering (NUPRIME).

Harris is a co-principal investigator, along with Marilyn Minus, Brad Lehman, and Claire Duggan, for a $5 million National Science Foundation (NSF) program called S-POWER (Student Pathways Opening World Energy Resources). S-POWER provides transfer scholarships at Northeastern for underrepresented minority students at colleges that do not offer a traditional engineering degree—including historically black colleges Clark Atlanta University and Hampton University, as well as MassBay, Middlesex, and Northern Essex Community Colleges in Massachusetts. Northeastern welcomed the first cohort of students as part of this program in fall 2017.

2017 S-POWER cohort

Latonya Beverly, E'19, industrial engineering and math, is one of those students. "When representatives from Northeastern visited Clark Atlanta University to talk about the S-POWER program, at first I was skeptical about coming to a school that was completely unfamiliar to me," she admits. "They promised that they were creating a diverse, supportive community, and that has absolutely been true. Teachers and students alike have welcomed me. Moving to Northeastern was the best decision I ever made."

The College of Engineering is also supporting undergraduate and graduate students in pursuing STEM fields through the Louis Stokes Alliances for Minority Participation (LSAMP) program. Seven engineering rising sophomores had the eye-opening experience of traveling to China in summer 2017 to conduct research at Shanghai Jiao Tong University as part of LSAMP's International Research Experiences for Undergraduates program funded by a $3.5 million NSF grant, co-led by Harris and Hameed Metghalchi, professor of mechanical and industrial engineering, and in collaboration with five other U.S. universities.

In addition, Northeastern will be a host site for LSAMP's 2018-2020 Bridge to the Doctorate program, under a $1 million NSF grant led by Provost James Bean (PI), Metghalchi (co-PI), other co-PI's across the university, and collaborators Harris and Vice Provost of the PhD Network and Professor of Civil and Environmental Engineering Sara Wadia-Fascetti. This is the first post-baccalaureate program at Northeastern, which will include a student cohort of 12 underrepresented minority STEM graduate students from LSAMP campuses across the nation.

Talent pipeline: Partnering with community colleges

Another initiative to attract nontraditional college-age students is TRANSFORM, an NSF-funded collaboration between Northeastern and MassBay Community

College aimed at training unemployed recent liberal arts graduates for STEM careers. "Unemployment rates for college graduates with non-technical degrees are relatively high—about 9.4 percent for liberal arts majors," reports Ibrahim Zeid, professor of mechanical and industrial engineering at Northeastern and a principal investigator for the TRANSFORM grant. Via a modular, 12-month fast-track curriculum, which includes courses and internships, TRANSFORM helps these nontraditional students gain the skills they need to capitalize on the national growth in STEM jobs.

College of Engineering Distinguished Professor David Kaeli, electrical and computer engineering, is also a strong advocate of partnering with local community colleges to introduce their students to opportunities in STEM. Among his many efforts is an NSF-supported summer program called "NSF Research Experience for Undergraduates: Data-Driven Discovery," or more simply REU-D3.This initiative brings rising sophomores from local community colleges to the Northeastern campus each summer, where they work on data-driven research problems, gaining and applying skills in machine learning, data analytics, and computational technologies.

"One goal of the REU-D3 program is to introduce students—especially women and underrepresented minorities—to undergraduate research opportunities in the field of engineering," Kaeli states. "Data analytics and machine learning represent two of the fastest-growing and most critical aspects of engineering today, mainly because our world is generating huge volumes of data every day. The challenge of data-driven discovery is easy for students to understand and relate to. The REU-D3 program is a great starting point for an exciting career in engineering."

Mike McMahon, BS mechanical engineering student

Mike McMahon, E'18, has benefited from Northeastern's collaboration with community colleges. After retiring from combat as a First Lieutenant, Ranger and Platoon Leader in the U.S. Army, and spending eight years as a project manager for the U.S. Special Operations Command, McMahon made a bold decision. He wanted to fulfill his burgeoning desire to become a professional engineer and work on technical projects, so he enrolled at MassBay Community College to study mechanical engineering. Then, after meeting representatives from Northeastern's College of Engineering when they visited MassBay, he transferred to the university to finish his degree. "It's a hard decision to give up a secure job and pursue a college degree, especially when you're an older student," McMahon says. "I was worried about how I'd be received at Northeastern, surrounded by brilliant 20-year-olds. These students are an elite group."

A Summer Camp Launches a Career

When she was entering seventh grade, Needham, Massachusetts native Mary Beth Rockett, E'21, bioengineering, attended a two-week summer camp at Northeastern sponsored by the Center for STEM Education. That experience proved life-changing.

"I'd always loved math and science, but I felt like I had no outlet for that passion—and no support beyond my own family. Worse, I was embarrassed because girls weren't 'supposed' to like those subjects," Rockett recalls. "But at the camp, I met girls from all over Massachusetts who were just like me. We stayed up late at night building bridges. I knew then that I wanted to be an engineer."

Rockett continued to keep in touch with Northeastern's Center for STEM Education for the next five years, visiting the campus during "Engineering Wednesdays"—when prospective undergraduates are invited for engineering-specific information sessions and tours.

Then, as a rising high school senior, she was accepted into the Young Scholars Program sponsored by the Center. This competitive program matches promising high school students with hands-on research internships led by College of Engineering faculty. For six weeks, Rockett worked with Assistant Professor Matthew Eckelman, civil and environmental engineering, also an alumnus of the Young Scholars Program. "I was studying life-cycle assessment for pharmaceutical drugs and their impact as they break down in the environment," she says. "At the end of my internship, I presented my findings to faculty, postdoctoral researchers, and students. It was a thrilling experience for an 18-year-old."

When it was time to choose an engineering school, Rockett found Northeastern an obvious choice. "A huge factor was the connection I'd already made with the College of Engineering," she notes. "I felt welcomed. I felt like the professors cared about me. I felt at home."

Adds Rockett, "One of my goals is to work as a mentor at a summer camp sponsored by the Center for STEM Education. That would bring me full circle, and give me a chance to give something back by inspiring a new generation of young people to explore engineering."

Mary Beth Rockett (center), BS in bioengineering, Matthew Eckelman (left), assistant professor of civil and environmental engineering, and Louis Sokolow (right), Young Scholars student

"But I've felt welcomed by my peers," he continues. "The faculty take an interest in students and help them overcome their unique challenges. When the volume of students and course-load become heavy, there are a lot of other resources available on campus. And, by joining informal study groups and organizations like the ASME student chapter, I've felt the excitement of connecting with other students who are passionate about science and engineering, just like me. Everyone here shares the dream of being an engineer, and in the end we have more similarities than differences."

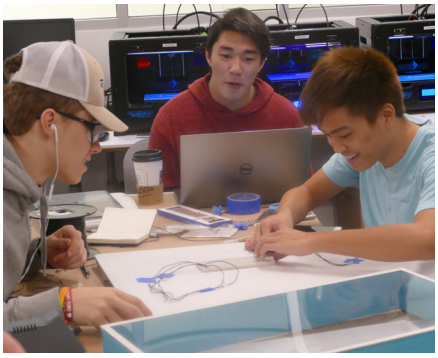
Harris emphasizes, "Our goal is to institutionalize the philosophy of diversity and inclusion at Northeastern over the longer term. "By opening new pathways to welcome nontraditional students, we're creating an engineering workforce of the future that is more innovative and more creative—because it brings together a diversity of cultural backgrounds, perspectives, and problem-solving approaches. That benefits our university, our field, and society as a whole."

MAKING SPACE FOR HANDS-ON LEARNING

How do you make engineering interesting—and relevant—to first-year college students who aren't really sure what exactly engineering is? For Susan Freeman, director of First Year Engineering at Northeastern, the answer is simple: create hands-on learning opportunities. She has been instrumental in establishing and expanding the College of Engineering's makerspace, as part of the First Year Learning and Innovation Center.

This hands-on learning environment has recently been enlarged from 700 square feet to more than 1,700 square feet, providing even more room for first-year students to tackle design-and-build projects for the mandatory year-long Cornerstone of Engineering course. The newly redesigned space includes high-tech 3D printers and CNC machines, along with more traditional tools like band saws and soldering equipment.

From robotics and software design to security and biotech, students can leverage the makerspace to complete a wide range of coursework. Since the goal of the class is to introduce students to engineering and help them choose a major, Freeman notes that it's critical to actively engage students, while also increasing awareness of Northeastern's diverse engineering strengths.



"Over time, we've tried to make the first-year experience more practical and hands-on, and less theoretical," explains Freeman. "We want our students to begin their journey at Northeastern by being enthusiastic about engineering and feeling a real sense of accomplishment from the start. We've complemented a new project-based Cornerstone curriculum with a physical space to complete those projects. The makerspace has been enthusiastically received as a place to solve complex problems while also having fun."

Breaking the Stereotype

"While there is more to do, each year our enrollment of female students is increasing and the success they are having while enrolled and after graduation is so very impressive," says Rachelle Reisberg, assistant dean in the College of Engineering and director of the Women in Engineering Program—a network of resources and formal and informal support for female engineering students.

In fall 2017, 34% of freshman students in the College of Engineering were female, up from only 21% five years earlier. "We are also involved in and have an active chapter of the Society of Women Engineers, which furthers our ability to provide a supportive environment where female students can find mentors, learn about career opportunities, build a professional network and be part of a vital community," says Reisberg.

"I recently read that women represent only 11 percent of professionals in electrical and computer engineering, and I'm proud to be one of the next generation of women engineers that is increasing that percentage," says Caroline Binns, E'21, computer engineering, who recently was a recipient of the 2017 Women Forward in Technology Scholarship, one of only 16 awardees nationwide. The scholarship's goal is to promote diversity within the science, technology, engineering, and math (STEM) workforce. "I think there's a lot of stereotypes surrounding STEM majors and women in STEM, and it's important for girls to know that they don't have to fit those stereotypes to be successful in this field."

Sarada Symonds, BS computer engineering student

Elizabeth Wig, BS in electrical engineering, at her co-op at NASA

At Northeastern, Binns is active in the Society of Women Engineers (SWE), where she serves as coordinator for an annual event called "Cool Women, Hot Careers"—aimed at encouraging female high school sophomores and juniors to consider STEM careers.

Sarada Symonds, E'19, computer engineering and computer science, is also a recipient of the Women Forward in Technology Scholarship, and was awarded the Ada I. Pressman Memorial Scholarship for the 2017-2018 academic year by SWE. Recently she also was awarded the finalist prize from the Box Diversity Scholarship program.

As part of the SWE, Symonds has attended national conferences where she was able to network with female engineering students from across the U.S. "Through the Society of Women Engineers, I've met a lot of great role models. One of the most important has been the SWE advisor Rachelle Reisberg. She and my professors at Northeastern have always been very encouraging to me as a female engineering student, and I know there are many resources on campus, such as SWE, where I can go for advice and support."

Symonds completed a semester abroad at Trinity College in Dublin, an experience she says was not only "awesome" but also gave her skills and a new viewpoint that will be valuable in an increasingly global field. She also completed her second co-op at MIT Lincoln Laboratory, a Department of Defense research and development lab. Her first co-op was in web and mobile app development at a small San Francisco area software design firm. "Being exposed to a variety of work experiences and cultures during my co-ops is so important in helping me decide what kind of work I want to do in the future," she says.

Elizabeth Wig, E'20, electrical engineering, received the 2017 GE Women's Network Scholarship from the SWE, and was awarded the prestigious Goldwater Scholarship established by Congress. "When I was three years old, the career I imagined for myself was a ballerina princess mathematician, combining the three jobs I found coolest at the time," she recalls. "Engineering is a way for me to harness the math and science that I have always loved to improve the world."

Following her first co-op at Draper Laboratories in Cambridge, Massachusetts, Wig is currently on co-op at NASA Armstrong Flight Research Center in California. Here she is working on integrating ADS-B into supersonic aircraft, which can pave the way for commercial supersonic flight and installation on spacecraft for safer and better-tracked flights. "I'm learning a ton about what I want to do," she says of her co-op

"Engineering is a way for me to harness the math and science that I have always loved to improve the world."

— Elizabeth Wig, BS in electrical engineering

experience. "It's really helped to define my direction in engineering."

Wig expresses a great deal of pride in being a woman in engineering at Northeastern. "Whenever you encounter another woman engineer, you can count on her being extraordinary," she says. "Whether they're working on solar panels in Tanzania, designing applications for Microsoft, leading STEM education workshops for kids, doing groundbreaking biomedical work at Harvard Medical, or founding organizations to include LGBT people in STEM, women engineers are phenomenal. And I've met women engineers at Northeastern who are doing all these things."

Binns agrees, "Here at Northeastern, we have a community that's very welcoming to female students, and I'm happy to support that spirit of diversity, as well as demonstrate it to potential new students." She reflects, "I've always felt inspired and supported by the faculty here; they value and encourage all of their students. Although women engineering students are still in the minority, I feel that Northeastern is at the forefront of minimizing the gender gap."

Carolina Binns (at podium), BS computer engineering student

Welcome New Faculty

The College of Engineering has hired nearly **71** faculty since 2012, and **10** in 2017.

Qin Jim Chen
PhD Old Dominion University

Professor of Civil and Environmental Engineering

Samuel Chung
PhD Harvard University

Assistant Professor of Bioengineering

Heather Clark
PhD University of Michigan

Professor of Bioengineering

Joshua Gallaway
PhD Columbia University

DiPietro Assistant Professor of Chemical Engineering

Safa Jamali
PhD Case Western Reserve University

Assistant Professor of Mechanical and Industrial Engineering

Yang (Emily) Liu
PhD Columbia University

Assistant Professor of Mechanical and Insutrial Engineering

Samuel Muñoz
PhD University of Wisconsin-Madison

Assistant Professor of Civil and Environmental Engineering

Eduardo Sontag
PhD University of Florida

University Distinguished Professor of Electrical and Computer Engineering

Aron Stubbins
PhD Newcastle University

Associate Professor of Civil and Environmental Engineering

Srinivas Tadigadapa
PhD Cambridge University

Professor and Chair of Electrical and Computer Engineering

PROMOTIONS

» TO PROFESSOR

Rebecca Carrier (CHE)

Deniz Erdogmus (ECE)

Yunsi Fei (ECE)

Auroop Ganguly (CEE)

Yung Joon Jung (MIE)

Sagar Kamarthi (MIE)

Emanuel Melachrinoudis (MIE)

Hossein Mosallaei (ECE)

» TO ASSOCIATE PROFESSOR

Andrew Myers (CEE)

Matteo Rinaldi (ECE)

Young Investigator Recognitions

*These faculty recognitions bring the total young investigator awards in the college to **83**, including **43** NSF CAREER and **18** DOD Young Investigator awards.*

Assistant Professor **Stratis Ioannidis**, electrical and computer engineering, was awarded a National Science Foundation CAREER grant for "Leveraging Sparsity in Massively Distributed Optimization." See page 2.

Assistant Professors **Abigail Koppes** and **Ryan Koppes**, chemical engineering, were awarded a $632K NIH grant to develop a microfluidic model of the "brain-in-the-gut." The grant is a three-year Trailblazer New/Early Career Investigator R21 award with the National Institutes of Health National Institute of Biomedical Imaging and Bioengineering. See page 17.

Assistant Professor **Ameet Pinto**, civil and environmental engineering, was awarded a National Science Foundation CAREER award for "Developing a Spatial-Temporal Predictive Framework for the Drinking Water Microbiome." His work will advance the safety of drinking water by integrating microbial ecology into drinking water microbiome research through establishing a long-term observatory to monitor high-resolution drinking water microbiome dynamics in Boston's water distribution system, and developing models to forecast the abundance and composition of the drinking water microbiome.

Assistant Professor **Richard West**, chemical engineering, was awarded a National Science Foundation CAREER Award for "Predictive Kinetic Modeling of Halogenated Hydrocarbon Combustion." HHCs are important flame suppressants and refrigerants, but the chemical kinetic models for describing their combustion are highly complex. To effectively build these models, the project will use machine learning to predict the properties of HHC molecules and their reactions. This breakthrough will enable the development of an automated reaction mechanism generation tool to create detailed kinetic models for combustion of novel HHCs.

Assistant Professor **Marvin Onabajo**, electrical and computer engineering, has received a Young Investigator Award from the Army Research Office. The grant supports Onabajo's efforts to develop security solutions for the global semiconductor industry—specifically, an on-chip thermal sensing system that detects hardware hacking attempts. See page 6.

Chemical Engineering Assistant Professor **Adam Ekenseair** received the American Chemistry Society's Polymer Science and Engineering Young Investigator Award.

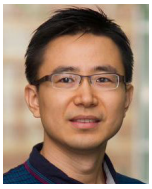
Recent Fellows

Selected engineering faculty who have been elected as Fellows of national professional societies.

Associate Professor **Tommaso Melodia**, electrical and computer engineering, was selected as an IEEE fellow for his contributions to underwater acoustic and multimedia networks.

Chair and Professor **Hanchen Huang**, mechanical and industrial engineering, has been named a fellow of the American Association for the Advancement of Science (AAAS).

Chair and Professor **Lee Makowski**, bioengineering, has been selected as a fellow of the American Institute for Medical and Biological Engineering.

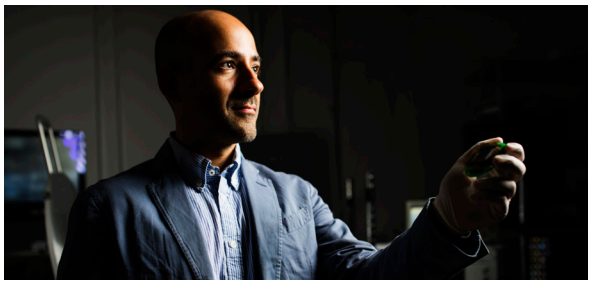


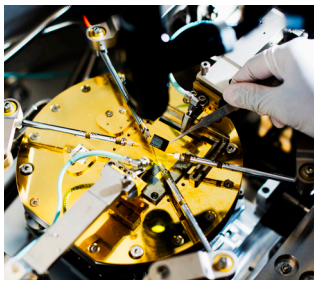
Associate Professor **Raymond Fu**, electrical and computer engineering, jointly appointed in the College of Computer and Information Science, was selected as a fellow of SPIE, the international society for optics and photonics.

Chair and Professor **Thomas Webster**, chemical engineering, was named a fellow of the National Academy of Inventors. Being elected as an NAI fellow is regarded as the highest professional distinction for academic inventors whose work has made contributions to tangibly impacting society.

Professor **Yiannis Levendis**, mechanical and industrial engineering, was selected as a fellow of The Combustion Institute, for excellent research in the combustion of fossil and alternative fuels, including the evolution and control of pollutants.

GROUNDBREAKING SLEEPING SENSORS





Matteo Rinaldi, associate professor of electrical and computer engineering

Connected devices are expected to grow from 15 billion today to 50-200 billion by 2020 due to the Internet of Things revolution. These devices need power to operate and they have to be maintained. With such growth, current technology and methods can't keep pace.

Associate Professor Matteo Rinaldi, electrical and computer engineering, explained, "To power and maintain connected devices, state-of-the-art sensors consume power continuously to monitor the environment, even when no relevant information is present. Constant power consumption is problematic; it limits the sensor's lifetime and causes high maintenance costs, particularly for networks of "unattended sensors" that detect infrequent, but time-critical events such as perimeter intrusions, wildfires, earthquakes or chemical warfare threats."

To address this issue, Rinaldi and his research team, recently unveiled groundbreaking findings published in the journal *Nature Nanotechnology*. The solution: a zero-power infrared digitizer prototype that allows sensors to, in effect, remain "asleep"—with zero-power consumption—until awakened when useful information is available or a critical event occurs. With such capability, unattended sensors can operate with a nearly unlimited lifetime.

Enhancing the quality of life

"To break the paradigm of wasting energy in standby, we really need to think out-of-the-box and devise new kinds of completely passive digitizing sensor microsystems that can detect and discriminate events of interest by exploiting only the energy contained in their specific physical signatures," says Rinaldi.

"Among different physical signals, the intensity and spectral content of light emitted by targets of interest, such as a vehicle or a human body, can be one of the most effective and specific triggering signatures," explains Zhenyun Qian, the lead author on the paper, "so we came up with the idea of building micromechanical relays that are selectively triggered by specific wavelengths of infrared light without the need of any electrical power."

"Our findings can ultimately enhance quality of life," concludes Rinaldi. "The capability to consume power only when useful information is present has a groundbreaking impact on the proliferation of the Internet of Things where physical and virtual objects in different environments are connected through the exploitation of sensing and wireless communication capabilities with the intent of making the everyday life safer, simpler and more efficient."

Research team members: Matteo Rinaldi, Zhenyun Qian, Sungho Kang, Vageeswar Rajaram, Cristian Cassella and Nicol E. McGruer

FACULTY NEWS

Selected Highlights

Laura Lewis, Cabot Professor, chemical engineering and mechanical and industrial engineering, has received a Fulbright U.S. Scholar Program grant for a research project in Spain where she will conduct research at the Instituto de Ciencia de Materiales de Madrid as part of a project to tailor magnetic microwires for advanced applications. Lewis has also been recently appointed to the rank of University Distinguished Professor, the highest honor the university can bestow upon a faculty member.

Professor **Edmund Yeh**, electrical and computer engineering (ECE), received a $1 million, two-year National Science Foundation award, entitled "CC* Integration: Software Defined Network-Assisted Named Data Network for Data Intensive Experiments (SANDIE)." Northeastern is the lead on this multi-university initiative, working with the California Institute of Technology and Colorado State University. It will use data-centric networking architecture to redesign the world-renowned Large Hadron Collider (LHC) network.

Assistant Professor **Stratis Ioannidis**, electrical and computer engineering, received a $2 million BIGDATA grant from the National Science Foundation and a donation from Google to lead a collaborative research effort for the "Design and Computation of Scalable Graph Distances in Metric Spaces: A Unified Multiscale Interpretable Perspective."

Professors Agnes Chan of the College of Computer and Information Science (CCIS) and **David Kaeli**, electrical and computer engineering, were awarded a $4.6 million National Science Foundation grant to continue and expand its participation in the CyberCorps® Scholarship for Service program.



Professor **Auroop Ganguly** civil and environmental engineering (CEE), ECE Professor **Edmund Yeh**, and affiliated CEE Professor **Stephen Flynn**, along with Kathryn Coronges of CCIS are part of an interdisciplinary Northeastern team led by Professor Albert-Laszlo Barabasi (PI), College of Science (COS), which was awarded a $2.5 million National Science Foundation CRISP grant for "Interdependent Network-based Quantification of Infrastructure Resilience (INQUIRE)."

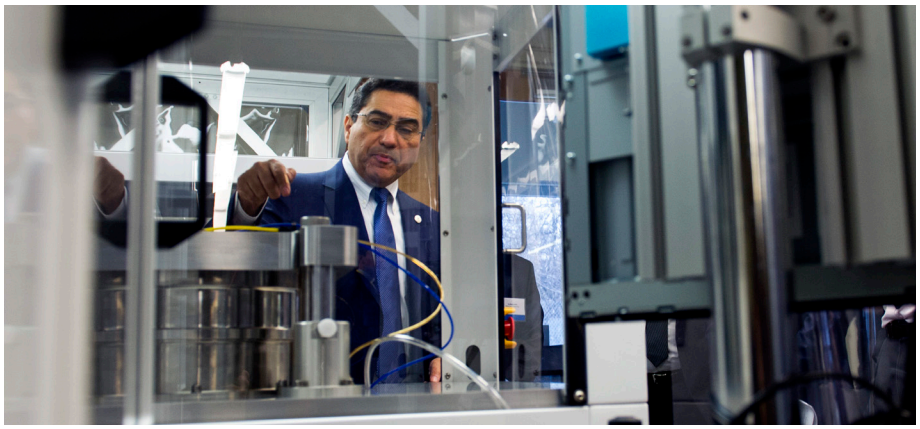
Associate Professor **Tommaso Melodia**, electrical and computer engineering, will lead a three-year $1.57 million National Science Foundation grant with Associate Professors Stefano Basagni, Matteo Rinaldi, and Professor Milica Stojanovic for the "Development of a Software-Defined Networking Testbed for the Internet of Underwater Things."

Associate Professor **Carol Livermore**, mechanical and industrial engineering (MIE), recently launched a spinout company, ApreX Biotech, which is using origami techniques to mimic tissues in the human body to test drug interactions.

MIE Professor **Yung Joon Jung**, COS Associate Professor Swastik Kar, and ME Alumnus Dan Esposito, E'08, were awarded the $50K gold medal at the 2017 MassChallenge, for their start-up company, Guardion, which uses nanotechnology to create highly sensitive, low-cost, networked detectors of radioactivity and nuclear radiation.

Associate Professor **Marilyn Minus**, mechanical and industrial engineering, was awarded a five-year $1.25 million Air Force Office of Scientific Research Grant for "Forming True Blends: Developing New Processing Routes for Polymer-Based Nano-Composites."

Second Generation Nanoscale Offset Printing System Unveiled



Ahmed Busnaina, University Distinguished Professor and William Lincoln Smith Chair of mechanical and industrial engineering

Recently unveiled, NanoOPS Gen 2, a second-generation-nanoscale offset printing system, is a pioneering manufacturing technology designed to drive innovation in fields such as sensors, electronics, display, medical and energy harvesting and storage applications.

According to Ahmed Busnaina, University Distinguished Professor and William Lincoln Smith Chair Professor in the Department of Mechanical and Industrial Engineering, the technology can print 1,000 times faster and 1,000 times smaller circuits—down to a 20 nanometer—than inkjet-based printing systems on the market today.

The second-generation system is modular and can print multiple layers at a time and on larger substrates than the first NanoOPS. It also has the ability to use a wider variety of organic and inorganic materials and has much more precise control of the manufacturing process. Busnaina said researchers are using NanoOPS to develop a variety of sensors and wearable electronics for industry partners, from biosensors or chemical sensors, to medical implantable devices, to electronics.

NanoOPS Gen 2 was developed in collaboration with Milara Inc. and through Northeastern's Advanced Nanomanufacturing Cluster for Smart Sensors and Materials, directed by Busnaina and funded by the Massachusetts Technology Collaborative. CSSM is led by Northeastern, and partners with Tufts University and UMass Boston.

Professor **Heather Clark** and Associate Professor **Mark Niedre**, bioengineering, were awarded a $1.4 million, four-year grant from the National Institutes of Health to develop circulating red blood cell based nanosensors for non-invasive optical drug monitoring.

Professor **Miriam Leeser**, electrical and computer engineering, was selected for a prestigious Fulbright Award to study wireless and networking technology with applications to the Internet of Things, wireless networking, cognitive radio, software-defined radio, and software-defined networking at Maynooth University and the CONNECT Centre, Trinity College Dublin, Ireland.

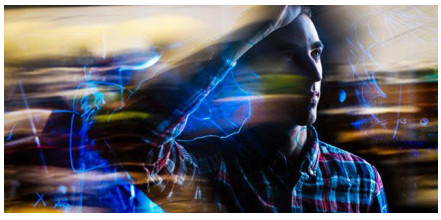
STUDENT NEWS

Selected Highlights

Bioengineering student **Kritika Singh**, E'21, won a $10,000 Thermo Fisher Scientific Antibody Scholarship. This top-level award is given to only two students nationwide annually for their research and academic accomplishments.

PhD candidate **Brian Lejeune**, chemical engineering (ChE), has been awarded a Science Graduate Research Fellowship award through the Department of Energy. Lejeune is advised by ChE Cabot Professor Laura Lewis. The Fellowship will enable him to continue his research on crystal growth of magnetic materials for six months at the AMES National Laboratory in Iowa.

The student-run Energy Systems Society's annual Energy Conference took place fall 2017 on the Boston campus, drawing over 300 attendees, including industry, faculty, and students from across the country. Keynote speakers included Emily Reichert, CEO of Greentown Labs, and Robert Armstrong, director of MIT Ei.



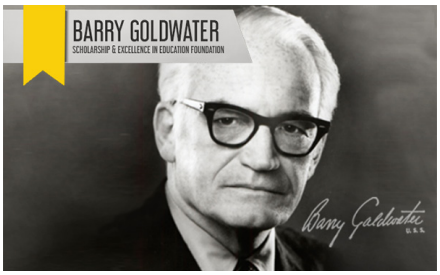
Brett Daley, E'18, electrical and computer engineering, has been named a Schwarzman Scholar, a prestigious honor given to only 142 students out of more than 4,000 applicants, enabling him to enroll in a yearlong, fully funded master's program at Schwarzman College on the Tsinghua University campus in Beijing, China.

PhD student **Maria Sevillano**, civil and environmental engineering, won the "Best Student Presentation" award at the Association of Science Engineering & Science Professors (AEESP) research and education conference in Michigan for her presentation, titled "Incidence of Antimicrobial Resistance Genes in Municipal Drinking Water Samples from the United Kingdom." She was one of four winners chosen from more than 200 student presenters.

A Northeastern University team, advised by Associate Professor **Taskin Padir**, electrical and computer engineering, was selected as one of ten finalists in the International Atomic Energy Agency Robotics Challenge for their entry "Small-UGV for Conducting In-Field Inspections (SCIFI) in Nuclear Environments." The competition is aimed at improving the working conditions of IAEA inspectors with robot-enabled inspections. The team designed and programmed a small mobile robot platform with a custom design lift mechanism to autonomously perform several tasks.

The Northeastern University Student Chapter of the International Society for Pharmaceutical Engineering (ISPE) was selected by the ISPE Boston Area Chapter as the Student Chapter of the Year.

Associate Professor **Ningfang Mi**, electrical and computer engineering, and two PhD students, **Zhengyu Yang** and **Janki Bhimani**, won the best paper award at the 36th IEEE International Performance Computing and Communications Conference in San Diego, California.



Four students from the College of Engineering, including **Minhal Ahmed**, E'19, **Kritika Singh**, E'20, **Isaac Kresse,** S/E'19 and **Elizabeth Wig**, E'20 have earned the 2018 Barry Goldwater Scholarship, the United States' premier award for outstanding young researchers in STEM fields.

STAYING HYDRATED ON MARS

ALUMNI SPOTLIGHT

Onward to an MD and PhD

Jordan Harris', E'17, goal was simple: Take advantage of Northeastern's College of Engineering education and experience to gain access to a graduate program to render his opportunities in science and engineering virtually limitless. Graduating with a 4.0 GPA and being accepted into many dual MD/PhD programs, Harris is on target for achieving his bold ambition.

He started at Northeastern in chemical engineering working early on in research in the Advanced Drug Delivery Lab under Professor Rebecca Carrier, chemical engineering. At the time, he thought he'd like to wind up in a PhD program related to tissue engineering or molecular biology. His three co-ops, though, helped him realize a tremendous interest in medical research and immunology. As a result, he's now at the University of Pennsylvania earning a dual MD/PhD degree, hoping to run his own lab where he can do research and practice medicine simultaneously as a physician-scientist.

At Selecta Biosciences in Watertown, Massachusetts, his co-op was related to immunology and applying nanomedicine to manipulate the immune system to increase immunogenicity in response to pathologic antigens or tolerance to prevent the formation of anti-drug antibodies. "This first co-op was the catalyst to changing my career goals to medicine," he said.

His second and third co-ops confirmed his interest sparked by the first. At a program called CanCURE, in which students are placed with cancer nanomedicine labs in the Boston area to do research and work with a mentor, he took on an independent project working with nanoparticles for mitochondrial drug delivery in prostate cancer. With this work, he was recognized as a finalist in the national AIChE Intern Student Competition.

Then he joined Moderna Therapeutics in Cambridge, Massachusetts. "Basically, they use nanomedicine to encapsulate messenger RNA for a wide variety of purposes, including vaccine development, personalized cancer treatment, and treatment of protein deficiencies." He found their research platform so interesting that he stayed on for an extra two months after his six-month co-op term concluded. "They helped me take the research experience to a new level and dig deep into the minutiae of science to fuel new technology and help build medicines," he said.

Upon completion of his program at UPenn, Harris will have both a PhD and an MD, allowing him to run a lab and see patients in clinic at the same time. "I hope to use the research in my lab to fuel my work with patients, and vice versa," he said. "My work with patients can guide my decisions in the lab." Most interested in cancer immunology, Harris hopes to be able to make world-changing progress in that area.

Taskin Padir, associate professor of electrical and computer engineering, and Daniel McGann E/CIS'20

Scientists believe that there is water on Mars, lending to the possibility of NASA having manned-missions to Mars in the 2030s. Most of the water, however, is stored as ice deep beneath the planet's dusty surface, and accessing it requires drilling through a thick layer of dirt and melting the ice. To tackle this challenge, NASA established the 2018 NASA RASC-AL Mars Ice Challenge, where student groups compete to build the best robotic water-extraction device.

The Northeastern undergraduate engineering team's proposal, led by Daniel McGann, E/CIS'20, and advised by Associate Professor of Electrical and Computer Engineering Taskin Padir, was one of ten chosen from a pool of 50 submissions from universities all over the country.

The fully autonomous robotics system that the students proposed and are now building is shaped like a large 3-D printer that includes a drill and an extractor. Both are attached to a positioning system within a metal frame. The drill will make a hole for the extractor, which is outfitted with a heating element, to glide down through a layer of dirt and into the ice. Once it has penetrated the ice, the extractor moves around, melting as it goes and pumping water back to the surface.

As finalists, the student team must construct the prototype, produce a technical paper, and give a poster presentation. In June 2018, the team will travel to the NASA Langley Research Center in Hampton, Virginia, to compete. NASA awarded them $10,000 to build the device.

ALUMNI SPOTLIGHT

"My ambition is to carry this to higher levels of autonomy where cars can drive in all weather conditions and all driving scenarios."

— Antonio Rufo's, E'14, ME'17

'Autonomous' Choices

Antonio Rufo, E'14, ME'17

Antonio Rufo's, E'14 and ME'17, College of Engineering journey at Northeastern began when he was in high school as part of Northeastern's FIRST Robotics team, and carried him to where he is today: in a top position in Silicon Valley working on one of the high-tech industry's most cutting-edge developments: autonomous cars.

While pursuing his bachelor's degree in computer engineering, each of his three co-op positions guided his career journey. At his first co-op, at iRobot, Rufo said, "I worked on robot vacuum cleaners. That's where I got super into robotics, and perception and navigation. The cool part about iRobot is that their stuff is in consumers' hands, so you can say, 'I worked on that thing you have in your house right now.'"

For his second co-op, Rufo joined QinetiQ, a company that makes bomb disarming robots for several U.S. government agencies. Then, he thought, "Why don't I do something that's a little more research-y, a little more out there and different?" So, for his third co-op, Rufo took a position in the active optics group at MIT Lincoln Labs. Here he got experience with all kinds of imaging, including laser radar. He enjoyed this position so much that he stayed for almost four years after graduation, working mostly on LIDAR (light detection and ranging), which is a type of radar that utilizes lasers.

While at Lincoln Labs, Rufo returned to Northeastern to earn his Master of Science in electrical and computer engineering under the guidance of Professor Hanumant Singh, who he says, "pushed me to think outside of an individual sensor or system, to think about the big picture, and consider autonomy as a whole." Rufo combined his experiences with both LIDAR and robotics into his thesis, entitled, "Progress Towards LIDAR Based Bicycle Detection in Urban Environments." He hopes to further autonomy research by sharing the data sets he collected throughout his thesis with the general public. The project opened his eyes to just how much work remains before autonomous vehicles become a reality, and Rufo intends to contribute to the solutions.

With significant expertise in LIDAR, Rufo was a top pick for a senior LIDAR engineer position at NIO USA Inc. "My job today is to help the company in integrating laser radar into their autonomous vehicles," he said. I'm working on inventing technology that'll be out in next generation vehicles."

As the team's "LIDAR expert," as he termed it, he's at the forefront of research and development into using laser radar systems to allow cars to navigate and steer themselves. "My ambition is to carry this to higher levels of autonomy where cars can drive in all weather conditions and all driving scenarios," he said. "I want to push this technology to its limit, and also make it available to consumers."

Dear Alumni and Friends,

This year marks a period of significant growth and achievement within Northeastern's College of Engineering (COE). A co-op program that has long been the gold standard among our peer institutions, cutting-edge research, and a curriculum designed to address 21st century challenges all come together in the college.

For helping to plant the seed for these accomplishments and more, we have you, our donors, to thank.

COE alumni and friends have been leaders in philanthropy, volunteering, and ambassadorship. You have funded undergraduate scholarships, graduate fellowships, new educational and research programs, and supported our commitment to recruit and retain the finest faculty from around the world. You have provided professional guidance to our faculty, shared industry best practices and trends, and served as connectors with the broader community. You have helped build COE into the premier college it is today, motivating us all with your accomplishments, commitment, and generosity.

In the following pages, we share just a few of the ways your support has helped advance our mission. Whether by empowering our faculty, enabling our graduate programs to thrive, providing resources that attract the best and brightest undergraduates, or spurring innovation and entrepreneurship, you embody the community spirit of Northeastern both here on campus and in the world.

We hope these stories inspire you as much as they do us. From all of us in COE, thank you for your support!

With appreciation,

Dean Aubry and the COE Development Team

From left to right: Michael O'Brien, Matt Kirby, Sarah Batista-Pereira, Mike Booras, Kit McCarthy, Taylor Brown

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*Alma Bongarten**
*Harold Bongarten, E'47**
Duncan M., E'65, ME'67, and Constance W. Brown
Gerald D. Burstein, E'69
Alan B. Butler, E'67
Richard E. Butler, E'56
Vincent A. Carpano, E'40
Linda L. Carroll
Daniel J. Casaletto, E'72, ME'76
Alejandro Castro, E'14
Lynne S. Champion, E'69
Elisa Cheng, E'14, ME'14
David J. and Lorie P. Coulombe, PNT
Arthur Joseph and Mary Judith Coury
Kevin B. Deasy, E'64d
Ellen M., LA'70, MS'74, and John M. Essigmann, LA'70
Jeffrey A. Feldman, E'72
Michel, E'90, and Michele A. Fernandes, E'91, PNT
Ronald M. Fish, E'81
David U. Furrer
Thomas L. Gallerani, E'64, MBA'69
Hagai Gefen, E'79
Beth Ann and Andrew J. Ghio, PNT
Albert J. Glassman, E'57
Robert M., E'62, and Deanne Glorioso
Stephanos S., ME'62, and Katherine A. Hadjiyannis
Jerome F. Hajjar
Irene A. Hammer-McLaughlin, MA'94
John R. Hannon, E'97, ME'03
Allen A. Henry, II, DMSB'65
Edward J. Higgins, E'52
William H. Hover, E'77
Ronald Hunter, E'76
Jennifer E. Judge, E'14
Thomas W. Jurczyk, E'71
Robert E. Kearney, E'71
George F Kent, E'62, ME'64, MBA'79
Marilyn B. Kloss, E'82
Scott D. Krentzman, E'89
Alexander S. Lindenmeyer, DMSB'17
John M. Looney, ME'67
Qunkai Mao, ME'00, and Cuie Hu, ME'02
Robert C., E'54, H'97, and Anne Marini
Michael Morris and Hali Mansor
*Donald F., E'56, and Gladys A. Meade**
David C. Mores, E'72, ME'76
Edward F. Mosel, E'72
Ramesh K. Motwane, E'77
Ellen Nestervich, E'80, MBA'87
Robert A. Norbedo, E'66, ME'70
Karen G. O'Neill
Thomas O'Toole, Jr., E'62
Li Pan, ME'98
Eugene M. and Susan J. Pierce
Kathleen Michelle Pearson, E'96, ME'14
Matthew S. Pellegrino, E'13, ME'13
John G. and Felia I. Proakis
John E. Reardon, E'58
Steven A. Richardson
Thomas A. Rosse, E'60
Todd A. Ruderman, E'91
Daniel P. Saulnier, E'98
Marian K. Shapiro
David R. and Jennifer Smith, PNT
Allen Soyster
Fred C. Travaglini
Gulten and Ali R. Tural, PNT
William L. Vanderweil
Robert W. and Catherine M. Wardzala
Nadim Zameli, E'17
Anonymous (7)

Sparking an Entrepreneurial Spirit

"The makerspace is being developed to meet the immediate needs of the budding entrepreneurial community at Northeastern. When you're talking about technology, timing matters."

— Michael Sherman, E'68

You only have to speak with alumnus Michael Sherman, E'68, industrial engineering, for a few minutes to get a sense of his passion to instill an entrepreneurial mindset into the next generation of engineers.

Sherman and his wife, Ann, through their generosity and passion, enabled the creation of the Michael J. and Ann Sherman Center for Engineering Entrepreneurship Education at Northeastern's College of Engineering—with an initial multimillion-dollar investment in 2013—to prepare young entrepreneurs to develop and launch their own business ventures.

A successful entrepreneur himself, Sherman was drawn to Northeastern by its unique co-op program, which helped him pay for his education and get real-world experience. "Whatever I am today is because of co-op," he says. "It gave me the confidence to do anything and succeed at every level."

Early in his career, Sherman joined a small MIT startup where he learned how to run a business. "I learned to buy things, to negotiate, I did whatever needed to be done," he says. That experience sparked his desire to create his own business. It also made him realize that many of his fellow engineers were not well equipped for the business world. "Business people bring the product to market," he explains. "They don't have the technology knowhow; they must get that from an engineer. I wanted to bring business skills to engineers so they can better represent their ideas to business people and, if they do become entrepreneurs, be able to successfully run their companies."

Led by founding director Shashi Murthy, professor of chemical engineering, the Sherman Center is doing just that and making a real difference for students. The Center has grown to offer a host

Michael Sherman, E'68, and wife Ann Sherman, who through their generosity enabled the creation of the Sherman Center for Engineering Entrepreneurship Education

of programs and resources, including semester-long courses in product innovation and design, an entrepreneurial engineering minor, entrepreneurial mentors, a product development studio named Generate, and a co-op program for students to work on their own new ventures.

Recently, Sherman and his wife made an additional $1 million donation to establish a new makerspace for students at the Sherman Center. “The makerspace is being developed to meet the immediate needs of the budding entrepreneurial community at Northeastern,” he says. “When you’re talking about technology, timing matters. You have to come up with the right technology at the right time, and the clock is ticking.”

Murthy commented, “All of the Sherman Center’s programs and courses were started from scratch and today we’re impacting hundreds of students each year. The expansion enabled by the new gift will add a powerful new dimension via new capabilities in prototyping and co-working spaces. Michael and Ann are tireless advocates for our students and it has been a real pleasure to work with them to realize their vision.”

Ultimately, it comes back to co-op for Sherman. “I think entrepreneurship is just a natural extension of co-op,” he explains. “What you do in the Sherman Center is real business, real responsibility, real pressure. You’re applying the theory you learn in class.”

Thinking Like an Entrepreneur

Among the budding entrepreneurs benefitting from the Sherman Center’s innovative programs is Nader Yacaman Juha, E’18, industrial engineering, who completed the Sherman Center co-op in December 2017.

He successfully established IC Health, a medical distribution venture aimed at the Honduran and Central American markets. Yacaman focused on the growing diabetes crisis in Honduras, introducing a new glucose monitoring system that was more affordable, and easier to use and replace, than currently available devices.

Yacaman says he benefitted from Sherman Center mentors—assigned experts in areas where students need additional guidance. “In my case, this was in supply chain and medical products distribution,” he explains. “They gave me continuous feedback on what I was doing right and what I was doing wrong.”

So far, Yacaman has sold 300 devices to customers and plans to order 1,000 units from suppliers to meet anticipated demand. He is also introducing a new product line—diabetic socks. Comparing the intensity of his co-op experience to doing an MBA, he says, “It completely changed my mentality. You start breathing that air. After six months, I was thinking more like an entrepreneur, like a businessman. It opened my perspective to the possibilities of the business world.”

Thriving in an Innovative Community

Maddy Leger, E’18, computer engineering, sought out the Sherman Center’s Generate program—a student-led product development studio—to acquire more experience in program management.

At the suggestion of a friend, Leger joined as a project lead working with an all-volunteer student staff that helps students, alumni, and staff develop products and startup ventures. Supported by client and alumni mentors, Leger successfully led a team that developed “Trailtag,” a GPS tracking device for deep wilderness tracking that works without a cellphone. “The experience appealed to me because it was truly entrepreneurial. We started with creative ideas, and worked through the development process, while having an end goal of a nice, finished product,” she explains.

Leger then took the reins as Generate’s student executive director, making many contributions to the program while gaining valuable business and leadership skills. She will join Microsoft’s Cambridge, Massachusetts office as a program manager when she graduates. She believes the leadership and collaboration skills she gained through Generate will help her immeasurably. “All of this builds your confidence and skills,” she says. “And if I ever want to start a new business, the Sherman Center has prepared me well.”

Women ‘**STRONG**’ in Engineering

Valerie Perlowitz, E’86

A self-described “extreme supporter of STEM,” Valerie Perlowitz, Electrical and Computer Engineering ‘86, has a clear goal: continue to increase the number of women in Northeastern’s engineering programs. Women currently represent about a third of all engineering majors at Northeastern. Perlowitz wants to see that number grow to 50 percent or more.

Her desire to see more women in technology—ultimately more women in senior leadership positions and on corporate boards—fuels her passion for mentoring, and inspired Perlowitz and her husband to establish in 2001 the Valerie W. and William B. Perlowitz Women in Engineering Scholarship.

The Founding Partner of International Holding Company in Fairfax, Virginia, Perlowitz has had a long and impressive career as an engineer, systems consultant, corporate development expert and entrepreneur. “Northeastern made me what I am today,” she says. “It gave me opportunities to learn and apply that learning in the working environment, as well as to gain critical-thinking skills. Both my husband and I believe in the depth of training and education Northeastern provides to individuals to prepare them to be future leaders.”

A former university overseer, a Corporator since 2009, and a recipient of the Outstanding Engineering Alumnus Award in 2002, Perlowitz maintains a strong connection to the Northeastern community through her financial support and ongoing involvement with the Women in Engineering program and Society of Women Engineers.

A strong desire to help women succeed is a consistent thread that runs through Perlowitz’s life. Early in her career, she sought out opportunities to network with other women in technical fields. Recognizing that there were no organizations in the Washington, D.C. area that met her needs, Perlowitz founded Women in Technology, creating a place where women can meet each other, share their experiences, learn about new technologies and prepare themselves for career advancement.

> ***“Both my husband and I believe in the depth of training and education Northeastern provides to individuals to prepare them to be future leaders.”***
>
> — Valerie Perlowitz, E’86

Women in Technology honored Perlowitz with its Lifetime Membership Award for her leadership and vision. “I remember when we could fit into a couple of small rooms in an office building, and now we’re more than 2,000 strong,” she says. “I’m proud of the growth of the organization and its role as a force in the marketplace.”

For Perlowitz, nurturing young girls’ interest in science and technology is key to sparking a lifelong passion. “By high school, it’s too late,” she says. She works with girls at the middle school level “to get them and keep them interested” in math and science. “It’s important to let girls know that technology is good,” she says. Perlowitz often speaks to classes about her experiences and the opportunities that a career in technology can offer.

Hearing the stories of those students who have benefitted from the Women in Engineering Scholarship has been particularly gratifying for Perlowitz. She and her husband attended the graduation of the first scholarship recipient, an experience she describes as “very moving.” “The scholarship bridged a financial gap and allowed her to go to Northeastern,” says Perlowitz. “It made us understand how important it is to provide this support.”

LIFE-CHANGING OPPORTUNITIES

Frank Tempesta, E'62, ME'64, and wife Marilyn Tempesta

In many ways, Northeastern alumnus Frank Tempesta embodies the classic American success story. The child of Italian immigrants, Tempesta grew up poor in Boston's North End. In high school, he took a commercial course, putting him on track for a job in mechanics. Nearing graduation, he learned that he could have pursued an engineering career had he taken college coursework.

Tempesta decided he wanted to go to college, and reached out to Northeastern for guidance. He went to school for an extra year, completed the math and science courses he needed, and applied for admission to Northeastern's engineering program. "I chose Northeastern because I could live at home while attending school and because there was a co-op program, both of which made college affordable," says Tempesta who eventually earned bachelor's and master's degrees in mechanical engineering.

It was his co-op experience—two semesters at Avco Systems, a nationally renowned engineering company in Wilmington, Massachusetts, that ultimately determined the course of his professional life. Following two years in the U.S. Army, including service in Vietnam, Tempesta accepted a job at Avco. He rose through the company ranks—which was acquired by Textron Systems—to become president and CEO, growing Textron's business from $1.5 billion to $3 billion during his tenure.

"I was just a kid out of water," he says of his youthful self. "Northeastern guided me to get the credits I needed before I was accepted and facilitated a job that I stayed at through my entire career."

> *"Northeastern guided me to get the credits I needed before I was accepted and facilitated a job that I stayed at through my entire career."*
>
> — Frank Tempesta, E'62, ME'64

Reconnecting to Northeastern

More than 30 years after he left Northeastern, Tempesta received a call from Professor John Cipolla, the then Chair of the Department of Mechanical Engineering, who had a proposal: would Textron consider partnering with Northeastern to participate in the FIRST Robotics Program and jointly mentor local high school students? Tempesta agreed and the NU-TRONS team was born. Textron provided volunteers and financial support for the program that continues today.

The FIRST Robotics initiative brought Tempesta back to campus and he was "wowed" at the changes that had taken place in the years since he graduated. Eventually his "reconnection" to Northeastern—and appreciation for the university's impressive growth—led to his ongoing involvement, including his current participation on the College of Engineering's Mechanical & Industrial Engineering Industrial Advisory Board.

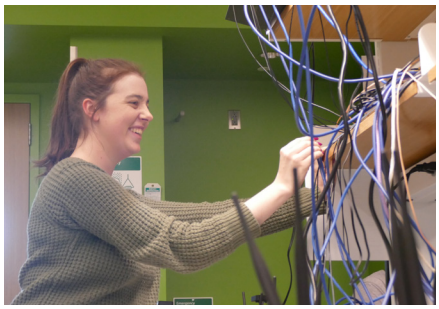
Following his successful business career, Tempesta and his wife, Marilyn, started to think about how best to give back to the university. Their decision to endow a scholarship for full-time undergraduate mechanical engineering majors grew out of their desire to help deserving young people who, like Tempesta himself, struggled to afford the cost of attending college.

"There was no question in my mind that Northeastern was a big factor in my life," he says. "It gave me an education and employment opportunities that led to much bigger things. I feel like I owe a lot of my success to Northeastern."

INVESTING IN THE FUTURE

The next-generation hold the face of the future in their hands. To foster their development and contribute to the United States remaining the world's preeminent leader in technology and innovation, a parent of a Northeastern engineering student has generously established the Sami Alsaif Doctoral Fellowship. Granted to exceptional doctoral students in the College of Engineering, Jennifer Rodowicz and Vikrant Shah are the first recipients of this award.

Jennifer Rodowicz



Jennifer Rodowicz, PhD student

While a lot of attention has been focused on how the Internet of Things (IoT) can impact our daily lives—including intelligent appliances, wearable electronics, and smart home security and comfort systems—far less attention has been paid to the huge potential of connected medical technologies. Jennifer Rodowicz was selected for the Sami Alsaif Doctoral Fellowship based on the potential of her research on smart medical implants.

After receiving a dual degree in electrical engineering and computer systems engineering in 2014 from Rensselaer Polytechnic Institute, Rodowicz worked in the defense industry for three years. She was drawn back to the world of academia by the chance to work with Associate Professor Tommaso Melodia of Northeastern's Department of Electrical and Computer Engineering (ECE).

A global thought leader in biomedical applications for the IoT, Melodia has won funding and recognition for his efforts to build reliable intrabody networks that increase the connectivity of devices to gather and exchange data—delivering real-time health benefits for patients.

"I've always been interested in signal processing and wireless communications," says Rodowicz. "Working with Professor Melodia, I've been able to see how I can impact a lot of people in a positive way by creating new applications for the IoT within the human body. Improving the connections between medical devices is an entirely new area of research for me, and I'm excited that I have the chance to break new ground."

Rodowicz's work focuses on optimizing the path of communication signals through human tissue. "Beam formation and signal direction are complex issues that have always challenged electrical engineers," notes Rodowicz. "We've solved many of these problems for in-air radio applications. My job is to solve these issues within the human body, at a miniaturized scale. The Sami Alsaif Doctoral Fellowship gives me the freedom to focus on this and potentially make a big difference in patients' lives."

Vikrant Shah

Vikrant Shah (left), PhD student, and Hanumant Singh, professor of electrical and computer engineering

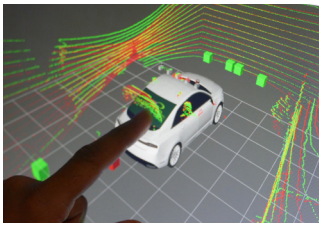
When he enrolled as a doctoral student at Northeastern, Vikrant Shah was already familiar with the pioneering robotic research of Professor Hanumant Singh. The two had previously worked together at the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, where Shah was mentored as a master's student by Singh.

When Singh joined Northeastern with a joint appointment in the Departments of Electrical and Computer Engineering (ECE) and Mechanical and Industrial Engineering (MIE) in 2016, Shah was eager to support this international robotics leader in his new home. Today, working under the guidance of Singh, Shah is focusing on building autonomous robots that can endure the most brutal Arctic conditions.

"We can learn so much about global warming, temperature change, and oceanic life forms by studying the Arctic environment," Shah points out. "But in the past, these studies could only be conducted during mild summer months—which paints an incomplete picture. Now we're creating autonomous robotic technologies that can withstand harsh winter conditions, which enables us to conduct this important research year-round."

Shah is using support provided by the Sami Alsaif Doctoral Fellowship to develop next-generation software, algorithms, cameras, sensors, and other robotic components built for both durability and efficiency. While he's currently focused on Arctic robots, Shah's work has broad implications for autonomous drones and self-driving cars, which also must endure tough environmental conditions.

"Autonomous robotics is one of the fastest-growing and most exciting fields in engineering today," Shah says. "I'm fortunate to be working under the direction of Professor Singh, an acknowledged leader, to address some of the most pressing problems today. I'm fortunate that the Sami Alsaif Doctoral Fellowship is enabling me to make a meaningful contribution in this industry."



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