

ENGINEERING @

Northeastern

SPRING 2020

Addressing Global Challenges

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DEAN'S MESSAGE

AS WE LIVE THE FIGHT AGAINST COVID-19, it is appropriate that this edition of the Engineering @ Northeastern magazine highlights a variety of research being conducted by our faculty to find solutions to a wide range of global safety and security challenges such as health, cyber, environmental, and explosives.

With the unprecedented pandemic, our researchers quickly shifted gears to apply their knowledge and research to address the global health crisis. View just a few highlights of the many efforts taking place across the college, from transforming the machine shop to produce parts to build protective personal equipment, to using modeling to optimize planning for patient care.

The internet is a critical infrastructure to people's everyday lives. Our cybersecurity researchers are finding solutions to make our connected world safer, from protecting personal data and smart devices to national security.

Hazardous materials seeping into the earth and water supply can harm people's health. Read about the efforts of our Puerto Rico Testsite for Exploring Contamination Threats (PROTECT) research center, which recently received a \$10.7 million five-year renewal grant from the National Institutes of Health.

Explosives come in many sizes and forms. Our Awareness and Localization of Explosives-Related Threats (ALERT) research center, which is a Department of Homeland Security Center of Excellence, conducts research and development for effective responses to explosives-related threats. In addition to receiving more than \$3 million annually in funding, over the past year the center has been awarded nearly \$5 million in Task Order funding to make airport travel safer.

Diversity, inclusion, and equity are core values at Northeastern and in our college. We stand against racism and are committed to doing our part to create a world with equal opportunity and justice for all. While there is much more to do, I am pleased to announce our new partnership with the National Action Council for Minorities

in Engineering (NACME) that will provide scholarship opportunities for highly talented undergraduate engineering students from historically underrepresented populations (see page 2).

Experience-powered learning is the heart of a Northeastern education and we are one of only a few universities that offer graduate students co-op and other opportunities for real-world experience. Learn about the innovative ways we have been taking graduate experiential learning to a new level.

We are so appreciative to our alumni and friends for their ongoing philanthropy in support of our students and faculty. Your contributions are truly making a difference in education, activities, and experiences, and most recently for personal unexpected student expenses caused by the pandemic and for our faculty conducting research to fight the COVID-19 virus.

With our very best wishes to you and your families,



Jacqueline Isaacs
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ENGINEERING @ Northeastern

Spring 2020

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YOU ARE ESSENTIAL.

WE ARE GRATEFUL.

NORTHEAST

FEATURES



photo by Ruby Wallau

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Combating COVID-19

With the onset of COVID-19, our faculty, staff, and alumni applied their expertise and resources to address challenges such as producing medical masks, developing planning models, and innovating novel solutions to combat the virus.

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Northeastern Spearheading Advances in Travel Safety

CAMPUS BEAT

Many exciting accomplishments, initiatives, and experiences are happening across the College of Engineering. Here are some highlights over the past year.

New Partnership with the National Action Council for Minorities in Engineering

A NEW PARTNERSHIP BETWEEN NORTHEASTERN UNIVERSITY and the National Action Council for Minorities in Engineering (NACME) has created scholarship opportunities for highly talented undergraduate engineering students from historically underrepresented populations, including Black/African Americans, Latinx/Hispanic American, and Native/American Indian. NACME is the largest provider of college scholarships for underrepresented minorities pursuing degrees at schools of engineering. Northeastern is the only university partner in Massachusetts out of 38 university members nationwide.

“I am pleased that NACME has recognized our accomplishments in increasing student diversity in STEM fields by awarding us through our university partnership the Block Fund grant. The program provides scholarship funding and so much more,” said Assistant Dean Richard Harris, director of Northeastern University Programs in Multicultural Engineering (NUPRIME). “Through its criteria for an institution to receive Block Grant funding, NACME establishes an infrastructure across universities to help recruit and retain high-achieving underrepresented students. It also helps pave the way for students to be hired after graduation by giving member companies access to this talent pool.”

Northeastern had in place several programs exceeding the criteria set by NACME for Block Grant funding and even served as a model for others. Some highlights include:

- Summer Bridge program, where to date 500 students have participated and achieved an average GPA above a 3.0 as part of the retention program.
- Cooperative Education program with a best-in-class infrastructure with employer partners that include many of NACME’s member companies.

- Institutional research for knowledge sharing in the area of tutoring, Summer Bridge, and more.
- Recruitment programs of underrepresented minorities such as the Women in Engineering Program, NUPRIME, and S-POWER which is a transfer program to Northeastern for students from Historically Black Colleges and Universities without engineering programs.
- FACT program (Faculty Advisor Communication Tool) which provides a holistic approach for academic advising and an early warning system and involves the Women in Engineering Program, the Center for STEM Education, and the NUPRIME organization—all working together to support student success.
- Diverse student groups such as the Society of Asian Scientists and Engineers, the Black Engineering Student Society, the Society of Women Engineers, the Society of Hispanic Professional Engineers, and oSTEM (out in STEM) for the LGBTQ community.

Northeastern has matched \$120K in scholarship funding received from NACME—making available \$240K in scholarship funding to students, over the next four years, with the first cohort of students participating in the College’s Summer Bridge program for fall 2020 enrollment. Additionally, the college plans for other diversity scholarship funds to be redirected to increase NACME scholarship opportunities.

In speaking on the significance of the NACME university partnership, Harris said, “Long-term I see our relationship with NACME as helping Northeastern engineering raise the bar even farther above national averages on how we recruit, retain, and graduate underrepresented students...and to be seen by employers as the go-to academic institution to hire diverse highly skilled talent.”

Her Engineering Degree Was the Launchpad for a Wide-Ranging Career

THERE IS AN UNDENIABLE SYMMETRY to Michele Lezama's career, but it's the breadth of that career that's most impressive.

Lezama, E'88, arrived at Northeastern on a scholarship for Black engineering students and now is President and CEO of the organization that made her education possible. During the 35 years between, Lezama worked as an IBM engineer, a media executive for CBS and HBO, and the top executive for three nonprofits.

"There was certainly nothing planned or designed about my path," says Lezama, who has completed the circle as president of the National Action Council for Minorities in Engineering (NACME). "It was the product of having the skills I needed to take advantage of the opportunities that came my way."

She credits Northeastern with providing the launchpad for her long and varied career.

"Engineering is a background for so many fields," she says. "You can apply the analytical skills to any task. You learn how to think through a process. My engineering degree taught me to become a problem solver."

Engineering = opportunity

As a girl growing up in The Bronx, Lezama excelled at math. So naturally, she wanted to become a math teacher—it was the only option she knew.

"My mother looked up the salaries for math teachers and said, 'That's never going to get you out of The Bronx.' Then she saw the salary for engineers and said 'This is your ticket.'"

But there was still one problem: The price of that ticket was out of reach.

That's when NACME came to the rescue with a scholarship that, combined with student loans, made it possible for Lezama to attend Northeastern. While earning a degree in industrial engineering, she landed a co-op at IBM and the company offered her a full-time job after graduation.

She was on her way.

"Northeastern gave me the skills and experience I needed to gain access to an industry I would never have had access to growing up in The Bronx," she says.

Dream job

After five years at IBM, she earned two master's degrees at Columbia University—one in engineering and the other in finance. With these additional skills in hand, she decided to shift gears and

begin a media career, first with CBS and then with HBO.

At CBS, she handled on-air signaling for national programming, including the logistically complex March Madness basketball tournament and was part of the financial team that handled David Letterman's transition from NBC to CBS.

The exposure she received from the Letterman deal led to a lucrative job offer from HBO, where she was in charge of the company's satellite connections during the birth of television's Golden Age.

"It was the era when Sex in the City and Chris Rock were the rage," recalls Lezama. "I grew up in an under-resourced community in New York City, and now I was working for a company that was high profile in that neighborhood. I was like a kid with her hand in the jelly bean jar."

Lezama thought she would be at HBO forever. But after four years, she received a call from the National Society of Black Engineers (NSBE), an organization she had volunteered for as a student at Northeastern.

The organization was looking for a new executive director who had both engineering and financial skills.

"I thought I'd take two years and help NSBE become more financially stable, then go back to my media career," she says.

That was twenty years ago—and she has never gone back.

Instead, Lezama served as the executive director of three nonprofits and found what she refers to as her

life's work—building social, financial, and educational pathways for minority engineers.

Looking back, she says her success all started at Northeastern. While earning her engineering degree, she served as president of the campus chapter of NSBE and ran the national organization's annual conference in Boston, which featured presidential candidate Jesse Jackson as the keynote speaker.

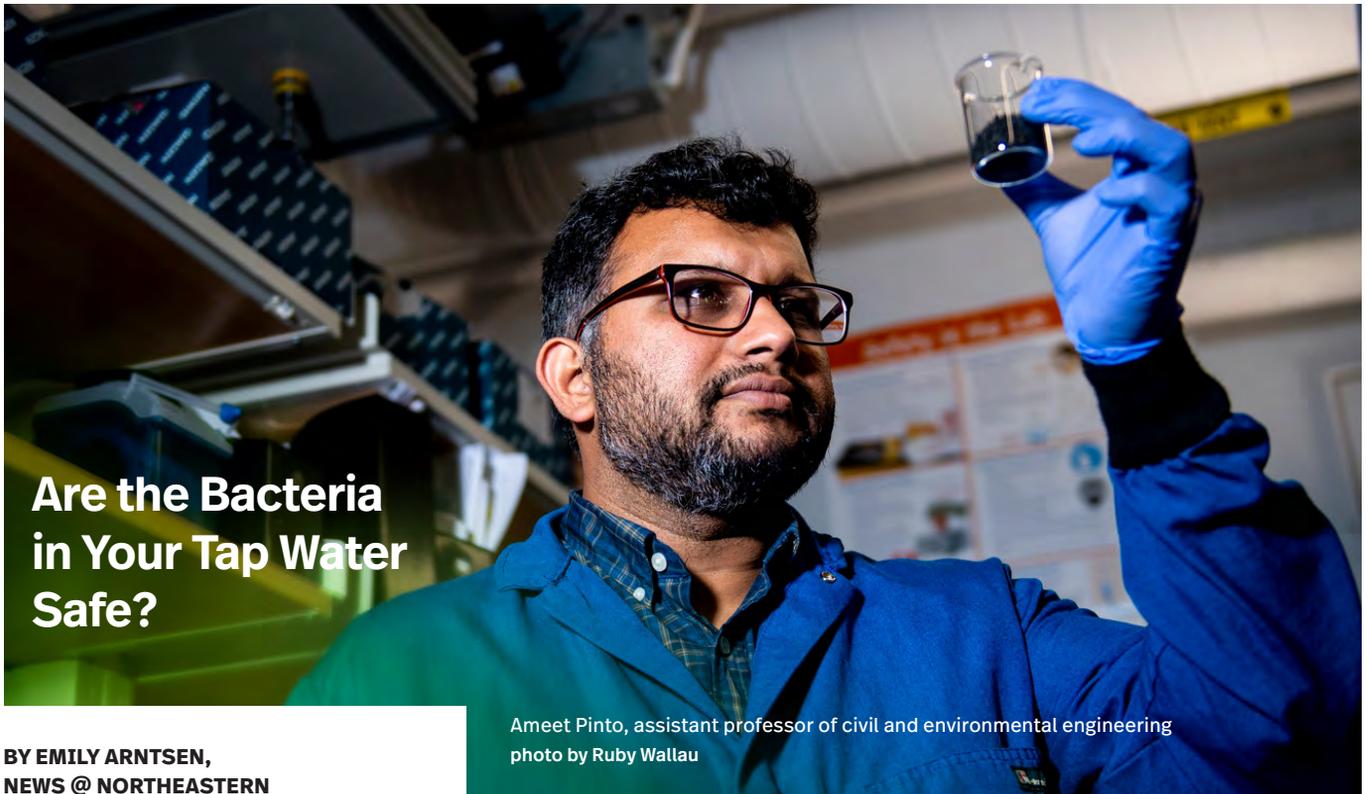
"Who would have thought that being active in a student organization would lead to the executive director 30 years later?" she says, noting this led directly to her current position as president and CEO of NACME.

For Lezama, there is a lesson for others in her journey:

"Be actively engaged in every experience along the way," she says. "For me, each experience was a tool—a foundation and skill developer—for a position I would hold later in life."



photo courtesy of Michele Lezama



Are the Bacteria in Your Tap Water Safe?

BY EMILY ARNTSEN,
NEWS @ NORTHEASTERN

Ameet Pinto, assistant professor of civil and environmental engineering
photo by Ruby Wallau

WITH EVERY GLASS of crystal-clear tap water, it's perfectly normal to consume thousands of microorganisms.

"If drinking water doesn't have bacteria in it, there's something wrong," says Ameet Pinto, a Northeastern assistant professor of civil and environmental engineering.

So when it comes to filtering water, the question isn't whether bacteria are present, but rather how much and what kind. Right now, deciphering the type and amount of bacteria in filtered water is extremely expensive and complex.

To simplify that process, Pinto's lab is developing a low-cost microscope and easy-to-follow procedures that will help regulate how water quality is monitored. One of those procedures involves sequencing the DNA of microbes in a water source.

The lab uses a portable DNA sequencer that can be used on-site to test what kind of bacteria are in the water with immediate results. This is an upgrade to the current system, which usually involves bringing samples back to a lab to test them, a process that can take days and doesn't always represent the full microbial ecosystem of the water.

That sequencing technology is already widely used, but "the way we collect that sample, extract that DNA, and treat it before putting it onto the sequencer can be wildly different," Pinto says.

To standardize that process, Pinto is defining protocols on how to use the DNA sequencer so that operators at water utility sites can monitor bacteria levels themselves. "Right now these sequencers are really only used in academic or commercial laboratories," Pinto says. But the sequencer only solves half the problem. "The DNA shows you who's there, but it won't tell you how many of them are there," he says. "That's what the microscope is for."

To quantify the bacteria, Pinto's lab, which recently received the Water Research Foundation's Paul L. Busch award of \$100K, is developing a microscope that costs about \$250 to make and can be assembled using generic parts that anyone could buy online. The point is to create a tool that's easy to use and cheap to produce so that anyone can have access to it, whether that person is operating a water utility site or drinking tap water at home.

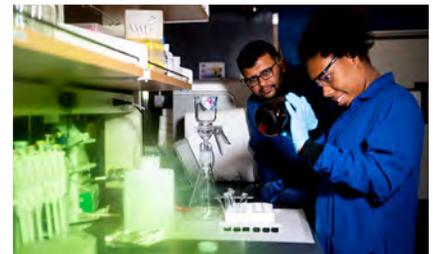
"It could be in your house, for example,

so that you can decide how long to flush the tap after you've been away for a month before deciding when the water is safe to drink," he says.

"As long as the tap water is clean, as long as the toilets flush, a lot of people don't care what's going on to make that happen," he says. "If more people can engage with their water quality, they will have much more awareness of what goes into bringing them clean water and taking wastewater away."

Looking ahead, Pinto imagines that this microbial monitoring platform has the potential to extend to other areas of the engineered water system, such as wastewater and resource recovery systems.

"Microorganisms are everywhere," he says, "They play an important role across the entire water system."





Ambika Bajpayee, assistant professor of bioengineering

photo by Ruby Wallau

Trailblazing Research to Treat Osteoarthritis

FOR MANY PEOPLE suffering from osteoarthritis—a debilitating disease that gradually destroys the cartilage that provides a “cushion” between our bones—the only available remedies are pain control and, eventually, joint replacement. Drugs designed to treat osteoarthritis often fail because of challenges inherent in delivering them to the cartilage and keeping them there long enough to be effective.

Imagine if doctors could treat osteoarthritis early on—repair cartilage and prevent additional tissue destruction—with an effective, targeted drug delivery mechanism. That’s the goal Ambika Bajpayee, assistant professor of bioengineering, and her team are pursuing as part of a three-year, \$628K NIH Trailblazer Award from the National Institute of Biomedical Imaging and Bioengineering.

Because cartilage lacks blood vessels and is the most negatively charged tissue in the body, it is difficult to penetrate. The potential solution may lie in harnessing the body’s internal electrical fields.

“In our lab, we design electrically charged biomaterials for delivering drugs and contrast agents to tissues that are hard to penetrate,” says Bajpayee. “It’s important that drugs reach their cell targets. By using the electrostatic interactions—engineering drugs at molecular level to make them positively charged—we can enhance their uptake into the tissue by 200-400 times.”

A groundbreaking application

Bajpayee and her team are also proposing to use a new class of cell-like materials known as exosomes to aid in drug transport. Once viewed as cell debris, exosomes are now considered to be important structures in the body. “They can travel, from one cell to another, one tissue to another, and they carry the basic cell signature, whether healthy or diseased,” says Bajpayee.

Exosomes, however, are negatively charged. In a groundbreaking application, Bajpayee and her team are making the exosomes cationic or positively charged, enabling them to penetrate into the negatively charged cartilage.

Bajpayee envisions using her proposed technology for other negatively charged tissues in the body, for example, in oral drug delivery to penetrate the mucosal barrier lining of the gastrointestinal tract. “There are multiple applications,” she says. “This is a platform technology so we can use it to deliver a wide range of drugs to a wide range of tissues. I’m very excited about that.”

Distinctive Excellence

Kritika Singh, E'20, has achieved a rare distinction by being named a Rhodes Scholar, a Truman Scholar, and a Goldwater Scholar.



photo by Adam Glanzman

MOST CANDIDATES FOR THE RHODES SCHOLARSHIP, widely viewed as the most prestigious academic honor for U.S. college students, are likely overwhelmed by the process of writing a personal essay, submitting the application, undergoing an interview, and awaiting the results. But for bioengineering major and healthcare advocate Kritika Singh, E'20, it was a process that had become routine.

When Singh was announced as one of 32 Rhodes Scholars for 2020, she achieved the rare distinction of being named a Rhodes Scholar, Truman Scholar, and Goldwater Scholar (see “Three Honors, One Outstanding COE Student.”)

Singh, a member of the University Scholars and Honors Programs at Northeastern, will leverage full financial support from the Rhodes Scholarship to pursue a doctorate in biomedical sciences at Oxford University. Following her studies in the UK, Singh hopes to return to the U.S. and attend medical school. Her ultimate goal is to become a true “triple threat” by addressing critical emerging diseases as a physician, scientist, and advocate.

“In order to conquer the world’s most pressing health challenges, we need to bring together biomedical research, clinical practice, and health policy. By being at the intersection of those fields, I hope to assume a leadership role and encourage professionals to collaborate more freely, across disciplines and national boundaries,” she explains.

“We’re incredibly proud of Kritika for winning these three major awards in three years—but even more proud of the person she is,” says Jacqueline Isaacs, interim dean of Northeastern’s College of Engineering. “With an infectious passion to make a difference in people’s lives, Kritika has continuously forged ahead, embracing all that Northeastern has to offer to reach her bold and admirable ambitions. She embodies our mission of developing the next generation of engineering leaders to solve global challenges, and we are so excited to see where her career path will take her.”

Making an early impact

Although just 22 years old, Singh has already made an extraordinary impact. After becoming aware of the continuing prevalence of malaria in India—despite the availability of affordable prevention—Singh started a nonprofit organization called Malaria Free World as a high school sophomore in Virginia. She traveled to India to speak with students and faculty in regions affected by malaria, and met with researchers and scientists at the National Institute of Malaria Research. This organization is still actively raising awareness and funds today.

With support from the Office of Undergraduate Research and Fellowships and the cooperative education program, Singh has continued to focus on the science behind malaria while expanding her scope to conduct research at the intersection of chemical biology and bioengineering at Massachusetts General Hospital, under the direction of Ralph Mazitschek. Singh’s research there has focused on studying patients’ resistance to antimalarial drugs in order to develop new pharmaceuticals, as well as investigating the role of genetics in determining malaria outcomes.

At Northeastern, Singh has founded the NU Global Health Initiative (NUGHI), which fosters interdisciplinary collaboration among students, medical practitioners, and public policy experts. Leveraging a Service/Research Project Award from the University, Singh organized the Northeastern Global Health Initiative Conference in October 2018. The largest student-led undergraduate global health conference in the nation, this event focused on wide-ranging topics such as tropical disease prevention, innovative surgical procedures, HIV prevention, the environment’s effects on human health and the role of robots in tracking epidemics. An overarching theme was the role of government and public policy in fostering better health care.

“Kritika is a unique individual because she innately understands that public health issues cannot be addressed via science alone,” notes Lee Makowski, professor and chair of the Department of Bioengineering at Northeastern. “Her skills in public policy, advocacy, and leadership have distinguished her from a young age. She truly embodies the multidisciplinary mindset of the College of Engineering at Northeastern.”

A process of discovery

According to Singh, the process of applying to three award programs, in three consecutive years, had a surprising benefit. “As I wrote the personal essays for these awards, my vision of my future began to get clearer and clearer,” she notes. “I had to

articulate who I am as a human being, what I plan to accomplish, and how I can personally contribute to society. It was an incredibly helpful exercise, and my mentors in bioengineering and across Northeastern supported me in defining a clear path for myself post-graduation.”

“The COE and University communities have been like family to me for the past four years, and have helped me find my place in the world,” she adds. “When I received the news about the Rhodes Scholarship, I called Dr. Makowski and others at Northeastern immediately. I yelled, ‘We won the Rhodes!’—because it really took a team effort to bring me to this place.”



In order to conquer the world’s most pressing health challenges, we need to bring together biomedical research, clinical practice, and health policy. By being at the intersection of those fields, I hope to assume a leadership role and encourage professionals to collaborate more freely, across disciplines and national boundaries.”



KRITIKA SINGH, E'20, BIOENGINEERING

THREE HONORS, ONE OUTSTANDING COE STUDENT

The Goldwater Scholarship. In 2018, Singh won this competitive award for sophomores and juniors studying the natural sciences, mathematics, and engineering. She was one of 211 scholars selected based on academic merit from a field of 1,280 students nominated from over 2,000 U.S. colleges and universities.

The Truman Scholarship. Singh was one of 62 Truman Scholars honored in 2019, chosen from 840 candidates nominated by 346 colleges and universities. This premier scholarship, typically awarded to college juniors, supports graduate education for aspiring public service leaders in the U.S.

The Rhodes Scholarship. Singh was one of only 32 Rhodes honorees for 2020, selected from 963 students endorsed by 298 American colleges and universities. The Rhodes criteria include scholarly achievements, character, commitment to the common good, and leadership potential.



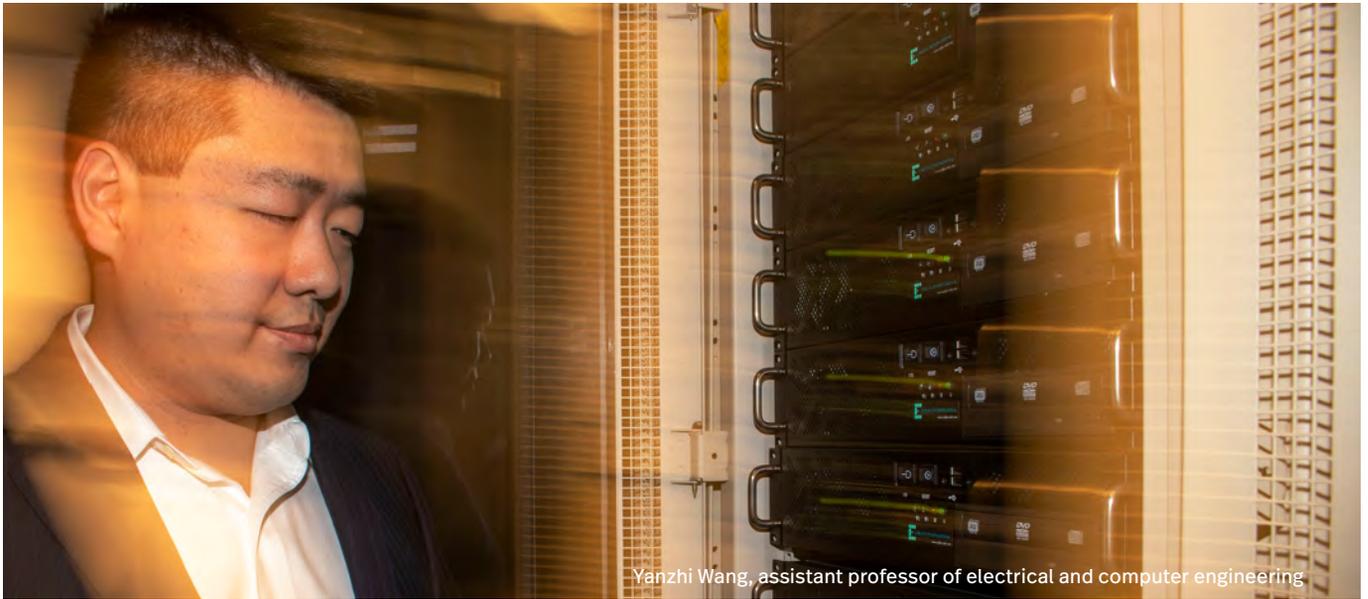
Recognized for Diversity

The College of Engineering has been selected as a recipient of the 2019 ASEE Diversity Recognition Program – Bronze Level by the American Society of Engineering Education. The Bronze level recognition means that Northeastern University is among the nation’s leaders in inclusive excellence.

It demonstrates that the unit is committed to the following outcomes:

1. Establishing baseline support for groups underrepresented in engineering.
2. Quantifiably analyzing and assessing unit composition, policies, culture, and climate related to all groups underrepresented in engineering.
3. Implementing programs and initiatives that strengthen the K-12 or community college pipeline thereby reducing significant barriers related to long-term growth.
4. Developing an action plan focused on continuous improvement.

“As a college, we continue to meet the needs of society by helping to develop diverse engineering talent through our engineering program. We are pleased that our efforts have been recognized by the ASEE—a highly credible organization in education,” says Richard Harris, assistant dean and director of Northeastern’s Multicultural Program in Engineering.



Yanzhi Wang, assistant professor of electrical and computer engineering

Bringing Deep Neural Network Machine Learning to Mobile Devices

A DEEP NEURAL NETWORK (DNN) teaches a computer how to think like a human mind, both flexible and complex. The machine learning of DNNs has previously been thought to require computations and memory storage capacity too large for mobile delivery. To address this, Assistant Professor Yanzhi Wang, electrical and computer engineering, has been awarded a prestigious Young Investigator Program Award from the Army Research Office (ARO) on ultra-efficient, real-time DNN acceleration on mobile platforms. The ARO YIP is awarded to outstanding scientists beginning their independent careers to attract them to pursue fundamental research in areas relevant to the Army, to support their research in these areas, and to encourage their teaching and research careers.

“Previously the coding and compilations required of DNN performance and accuracy were too much for mobile,” says Wang. “Our work enables the machine learning to automate the coding and reduce DNN storage by up to 6,645x on the mobile platform, saving manpower and processing power, and sacrificing no speed or accuracy.”

Wang’s work achieves end-to-end mobile DNN connectivity previously only thought possible within the computational and storage capabilities of desktop devices. Using a unique methodology of model compression, compilation, and design, the research offers a flexible model for DNN machine learning on the mobile platform.

Wang and his team focused first on pruning and quantization of Neural Networks based on the ADMM (Alternating Direction Methods of Multipliers) framework. Pruning requires researchers to train dense algorithmic networks, trim out the less important connections, then retrain the compressed neural networks. Wang’s work combines a depth of pruning and quantization that makes DNN-level mobile storage viable.

The compiler, based on the ADMM solution framework, acts as a bridge from the data set compression to hardware application, allowing for acceleration of the DNN process. At theory, algorithm, compiler, and hardware levels, the research demonstrates the potential of accurate end-to-end data transfer in real-time.

Wang’s research opens up unprecedented possibilities for mobile devices. “Extremely high-resolution object detection and recognition will be achievable,” he notes. “I can envision real-time translations and question-answering, automated license plate detection, and immediate access augmented reality and virtual reality applications.”

With just a phone or tablet, individual soldiers in the field will be able to more accurately recognize friendly or non-friendly objects, day or night, and give drones and helicopters more fidelity in target mapping. “In some cases, the processing speed can be up to 50x faster with the same accuracy,” Wang notes. “For populations without reliable internet, if we can provide high performance processing power on hundreds of billions of devices we can make access more equitable and have a big impact.”

Wang came to Northeastern from Syracuse University in the fall of 2018 with the vision of bringing this level of connectivity to the world. Now he plans to expand on scientific application, perhaps applications to better protect and guide soldiers in the field.

“I’m happy and grateful to receive the award, the work for which was only possible with the help of the department chair and the strong support of Northeastern. This new funding will allow us to expand on what we’ve achieved, enabling DNN to be more widespread, and making new things possible for all of us.”

ARO is an element of the U.S. Army Combat Capabilities Development Command’s Army Research Laboratory.

Solutions to Global Energy Problems May Exist in the World's Smallest Materials



Yi Zheng, associate professor of mechanical and industrial engineering

ASSOCIATE PROFESSOR YI ZHENG, mechanical and industrial engineering, is examining some of the world's biggest problems—such as climate change and dependency on fossil fuels—and finding solutions in the world's smallest materials. His research focuses on nanomaterials, which generally range in size from 1 to 100 nanometers (a nanometer is one billionth of a meter).

Recently, Zheng has been awarded a \$500K prestigious CAREER Award from the National Science Foundation to create new fundamental knowledge about nanoscale

radiative heat transfer, which is needed to solve pressing problems in energy harnessing, conversion, and cooling. The project aims

to design nanomaterials that can be integrated into solar cells to increase their effectiveness and make solar energy a more appealing and viable prospect against other forms of power. In addition, it will explore radiative cooling, a process by which energy from the sun is harnessed to lower temperatures.

While the general public is aware of the sun's ability to generate heat, it's not yet a mainstream idea that it can also be used to cool things down. "When people talk about cooling, all they know is water-based cooling, where you have water circulating to reduce temperatures," says Zheng. "But this radiative cooling material I'm working on could replace traditional air conditioning units."

Traditional ACs use an immense amount of electricity to provide their users with cooler temperatures—and using electricity causes greenhouse gases to enter the atmosphere. By contrast, the radiative cooling technology Zheng is working on cools things down without using nearly as much energy, reducing the carbon footprint of temperature regulation.

Zheng knows that solving global energy difficulties needs to be a collaborative effort. "What I'm doing is just a small piece of the puzzle," he says. To that end, his project also intends to foster young people's interest in the potential of nanomaterials, paving the way for future engineers to work toward solving these problems. "I want to show the public how cool nanomaterials are, especially high school students," Zheng says. "I want to bring them into nanoengineering, where they can come up with their own solutions to these problems."

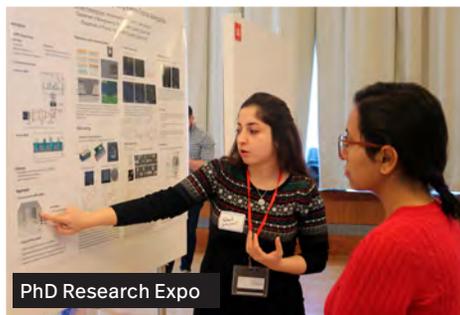
National Engineers Week 2020

From the College of Engineering's PhD Research Expo 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.

Photos by Thomas Spierto

Watch recap online
<https://bit.ly/3aeP5LS>

Connect with **#NUweek2020**



PhD Research Expo



Gerald E. Buckwalter, CEO and Strategy Officer, American Society of Civil Engineers



Mechanical and Industrial Engineering Industry Panel



Engineering for Everyone Expo STEM Activities



Dr. Tayyaba Hasan, Professor, Harvard Medical School Health Sciences & Technology



Northeastern's Chapter of the Society of Women Engineers Wins Gold Mission Award

WHEN SOFIA CATALINA, E'20, chemical engineering, first came to Northeastern she had no idea what she wanted to do. Like many undergraduates, she picked her major almost at random. "I honestly kind of did it because most of the smart girls I was graduating with did engineering," she says, laughing, "and I thought 'I'm a smart girl.'"

It was only when she attended meetings with the Northeastern student chapter of the Society of Women Engineers (SWE) that she began to narrow her field of vision on a specific professional path. She says the support and guidance of the women in the group was integral to her success during her formative first year at the university. Through attending SWE meetings and engaging in co-op experiences at Nuvera Fuel Cells in Billerica, Massachusetts; Form Energy in Somerville, Massachusetts; and Tesla in Palo Alto, California, she found her academic, research, and career focus in energy storage for renewable energy. Now, as president of the SWE student chapter, she's working to pass that kind of critical support and guidance on to other young women who join engineering programs at Northeastern.

Membership in the student chapter of SWE doesn't just provide general guidance on how to navigate the ins and outs of being a Northeastern student, of course. As the name implies, it's a student organization with a mission very much geared toward the experience of being a woman in a field that continues to lag behind in gender equality.

Recently, the student group received the Gold Mission Award from the national SWE organization. This honor is given to SWE groups that embody the organization's core values of integrity, inclusivity, mutual support, professional excellence, and trust, and demonstrate continuous improvement in their efforts. Sixteen members of the student organization accepted the award at the WE19 conference in Anaheim, California.

Catalina credits the cooperation, skills, and solidarity of all the women in the organization for being recognized with the Gold Mission Award. She says there's still a long way to go toward increasing the diversity of students in SWE and STEM education in general, so she's made that one of the key goals of her presidency. "We want this to be a group that's supportive of all women, no matter your background."



Taking Research to the NSF I-Corps 'Shark Tank'

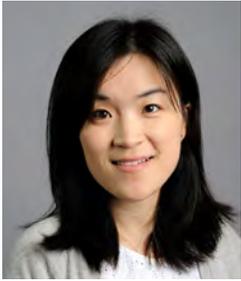
CELL CULTURE RESEARCH—defined as the process by which cells are grown in conditions like those in the body—is one of the most useful tools at scientists' disposal. In several research areas, it is desirable to grow cells in low oxygen conditions or hypoxia. However, the cost of hypoxic cell culture is far too high, discouraging scientists from implementing this valuable research technique to potentially gain more understanding of diseases such as cancer. To address this problem, Zach Rogers, a chemical engineering PhD student in Assistant Professor Sidi A. Bencherif's lab, developed a novel proposal and was selected to join the Northeastern node of the National Science Foundation's I-Corps program for his work.

Working on a solution to make hypoxic cell culture research more affordable, Rogers and his team in the Bencherif Lab have developed hypoxia-inducing cryogels (HICs), polymer-based tablets that can be added directly to cell cultures to create hypoxia. "We have developed a tablet that scientists can add directly to their cell culture plate," Rogers says. "We have attached unique oxygen-depleting biomolecules to a biomaterial scaffold. As oxygen enters the liquid that cells are cultured in from the surrounding air, these biomolecules deplete that oxygen rapidly. The result is a hypoxic environment within minutes that is maintained over the span of a cell culture experiment."

Originally from California, Rogers has become enamored with the city of Boston since moving here to study at Northeastern—and he says he plans to stay and use the knowledge he's gained through the university to make a difference in the pharmaceutical industry. And now that he's part of I-Corps, he'll have a significant advantage forging down this path. His induction into the program shows a level of confidence in his proposal and his future as a chemical engineer on the part of the NSF, which operates I-Corps out of various "nodes" across the country that support regional educational institutions, including Northeastern. According to the NSF website, the program "prepares scientists and engineers to extend their focus beyond the university laboratory and accelerates the economic and societal benefits of NSF-funded, basic research projects that are ready to move toward commercialization."

As a member of the program, Rogers has earned access to the mentorship of engineers and entrepreneurs from a wide variety of industries. "It's like a less aggressive Shark Tank," he says of the support from the I-Corps mentors. "They're very supportive, but if they're interested, they're willing to push you to see what you can or can't do."

Using AI in Advanced Manufacturing Processes



Xiaoning "Sarah" Jin, assistant professor of mechanical and industrial engineering

TODAY'S ADVANCED MANUFACTURING TECHNOLOGY demands greater efficiency, reliability, and precision. That's where Mechanical and Industrial Engineering Assistant Professor Xiaoning "Sarah" Jin believes her research can play a critical role. A recent recipient of a five-year, \$500K National Science Foundation (NSF) CAREER Award for "Unifying Sensing, Machine Perception and Control for High-Precision Micromanufacturing," Jin's goal is to develop an artificial intelligence and

machine learning-assisted technology framework for high precision, advanced manufacturing processes.

With a focus on emerging products—biosensors, micro/nano-scale electronics, batteries and flexible electronics, for example—Jin's solution is to leverage data to understand process dynamic behavior and performance in real time. This information, in turn, will improve the precision and effectiveness of process controls to meet product quality targets and make products faster, with higher throughput and minimal defects.

"Our goal is to use the abundant sensor data from complex manufacturing equipment and processes to make reasonable inferences and reveal what's going on," she explains. "We are trying to reveal the hidden behavior existing in high throughput, high

speed processes of micro-scale device fabrication to maintain high reliability and mitigate defect rates. If there are tiny defects or errors at the beginning of a process, and you don't have enough visibility into the process to make a timely correction, you will see a higher defect rate, which can generate significant waste in materials and energy. If we can use all available information to infer what's happening, we can then provide proactive, adaptive action."

The power of Big Data

Jin's innovative approach goes beyond traditional model-based control and design using the power of sensing technologies and advanced data analytics to enable real-time decision-making for meaningful action. "Using a more data-driven approach with engineering knowledge provides us an avenue of mass production for more precise, more reliable products with more complexity and less waste, and a significant improvement in efficiency," she says.

Under the NSF award, Jin will experimentally demonstrate and validate the framework and methods on two micromanufacturing processes—ion mill etching and roll-to-roll printing—to show the real-world impact of her research. "I want to develop a general methodology and algorithms to apply to a broader range of manufacturing processes," she says.

Jin's research is also coupled with STEM education and outreach activities aimed at building interest in next-generation "smart manufacturing" technologies among students at all levels and broadening the diversity of the STEM workforce. "My goal is to grow the program," she says. "I want to help the current workforce adapt to new technology and support the education and training of future manufacturing scientists and engineers to better prepare them."

GLOBAL EXPERIENCES

COOPERATIVE EDUCATION



Elise Papazian is a fourth-year BS student in Environmental Engineering from Rhode Island. She completed her first co-op at a civil engineering firm called The Morin Cameron Group in Danvers, Mass., and went on co-op in Armenia at Optimum Energy working on the design and construction of solar plants.

RESEARCH ABROAD



Michael Fitzgerald, E'20, or Fitz as he is known, is from San Diego, Calif., and is pursuing a BS in Bioengineering with a concentration in cell and tissue engineering and a minor in ethics. He went on co-op at the University of Oxford in England, conducting neurodegenerative disease research.

DIALOGUE OF CIVILIZATIONS



Twenty-one second-year chemical engineering students joined Professor Ronald J. Willey and Program Assistant Alexis Dubs (ChE'20) for a five-week study abroad experience in July and August 2019. The Dialogue of Civilizations featured process safety as practiced abroad and included visits to Dow Chemical, BASF, and Clariant, chemical facilities located near Tarragona Spain.



Continuing a Bold Mission for Environmental Health

PUERTO RICO IS AN ISLAND COMMUNITY with a poverty rate quadruple that of the overall U.S. The island faces severe environmental pollution and is home to 18 Superfund sites—areas identified by the U.S. government as contaminated with hazardous chemicals that require clean up. These sites, along with hundreds of other non-Superfund contaminated sites, have resulted in extensive contamination of drinking water resources. Rates of preterm births and infant mortality in Puerto Rico are among the highest of all U.S. states and territories, and there is evidence that this contamination is a contributing factor. Moreover, frequent natural disasters, such as Hurricane Maria in 2017 and a 6.4 magnitude earthquake in 2020, may result in elevated exposures to Superfund chemicals, further compounding the adverse health outcomes.

Since 2010, the PROTECT multidisciplinary and multi-institutional research center has provided much-needed understanding of the relationship between several suspect chemicals and adverse pregnancy outcomes, including the exact mechanisms by which these chemicals act on the body. PROTECT (short for Puerto Rico Testsite to Explore Contamination Threats) is led by Northeastern University under the direction of Akram Alshawabkeh, University Distinguished Professor, Snell Professor

of Engineering, and Senior Associate Dean for Research and Graduate Education, in collaboration with colleagues from three colleges at Northeastern, the University of Puerto Rico, University of Georgia, and University of Michigan.

Since PROTECT's inception, the research center has built detailed and extensive data sets on environmental and prenatal conditions of over 1,500 pregnant mothers—close to 3,000 data points per participate in areas such as exposure, socioeconomic, and health data. The data shows a compelling link between suspect chemical classes (chlorinated volatile organic compounds and phthalates) and adverse pregnancy outcomes. Analysis of tap water collected by PROTECT after Hurricane Maria showed significantly elevated detection frequency and levels of many contaminants compared to pre-hurricane data.

“Extreme weather conditions are an unfortunate part of life for the people of Puerto Rico with the devastation left behind beyond what can be seen with the human eye,” says Alshawabkeh. “Our research findings indicate that not only do chemicals from Superfund sites contaminate drinking water, but natural disasters such as hurricanes are causing heightened toxic environmental conditions by exposing people to dangerous chemicals.”



In order to conquer the world’s most pressing environmental health challenges, we must seamlessly unite biomedical research, environmental science and engineering, clinical practice, and health policy. With our work at the intersection of those fields, I can lead by example, encouraging professionals to collaborate freely across scientific boundaries.”

**AKRAM ALSHAWABKEH,
DIRECTOR OF PROTECT**

In March 2020, PROTECT was awarded a five-year \$10.7 million grant from the National Institutes of Health to continue and expand its work. This next phase of PROTECT research will include the study of an additional 1,000 pregnant women and look at a mixture of chemicals beyond the initial two suspect chemical classes. The impacts of natural hazards on contaminant transport and exposure will be studied further, as will the underlying biological mechanisms by which contaminant exposure can lead to adverse pregnancy outcomes. Additionally, new water treatment technologies will be developed for portable water treatment systems. New statistical methods and data mining, machine learning, and visualization tools will be developed to allow PROTECT researchers to analyze data sets. PROTECT will also employ innovative approaches to engage and educate the community, and a broad suite of training, and professional and tailored activities will be provided to trainees to meet their needs and goals.

Alshawabkeh says, “Through improved understanding of the link between adverse pregnancy outcomes and contamination, together with sustainable technologies to reduce risk, our goal is to help improve health outcomes in Puerto Rico and beyond.”

Northeastern University PROTECT Center Faculty



AKRAM ALSHAWABKEH
Director of PROTECT, University Distinguished Professor, Snell Professor of Engineering and Senior Associate Dean for Research and Graduate Education in the College of Engineering



TOM SHEAHAN
Sr. Vice Provost for Curriculum and Programs, and Professor of Civil and Environmental Engineering



DAVID Kaeli
College of Engineering Distinguished Professor of Electrical and Computer Engineering



PHIL BROWN
University Distinguished Professor of Sociology and Health Sciences



JUSTIN MANJOURIDES
Associate Professor of Biostatistics



JENNIFER DY
Professor of Electrical and Computer Engineering, and Education Director, Experiential AI Postdoctoral Program, Roux Institute



PHIL LARESE-CASANOVA
Associate Professor of Civil and Environmental Engineering



ALISA LINCOLN
Professor of Health Sciences and Sociology, and Associate Dean of Research for the College of Social Sciences and Humanities



Northeastern gives us the option to explore this venture even if we come from different disciplines. Having a pharmacy student and engineering student coming together and creating value out of an idea is amazing.”

VIDHAN BHAIIYA, E'21, CHEMICAL ENGINEERING

Improving Lives Through Entrepreneurship

START-UP COMPANY DR. BRINSLEY has come a long way in its short existence. The brainchild of chemical engineering student Vidhan Bhaiya, E'21, Dr. Brinsley is a footwear manufacturer catering to diabetics, combining medical performance with chic style. The company was honored at the Schulze Entrepreneurship Challenge, being selected among 25 finalists out of 100 entries across America and winning the Global Impact Award.

The idea first came to Bhaiya, company CEO, during a visit home. “I went to a wedding and my favorite uncle didn’t want to get up from his table or be in any photographs,” says Bhaiya. My father told me he had been diagnosed with diabetic neuropathy and hadn’t been the same since. He went from being flamboyant and stylish to unconfident and uncomfortable. Diabetic footwear currently is ineffective and expensive.”

While Bhaiya had a great idea for a product, it was his partnership with Jooyoung Kim, a pharmacy student, P'22, and vice president of business development for the company, as well as help from the university-wide entrepreneurship programs at Northeastern that helped elevate the company to the next level.

“I was going to become a traditional pharmacist, but I ended up hanging out with engineers and those who were

interested in business,” says Jooyoung Kim. “When Vidhan came back from India with this idea in his head, I thought these were important medical conditions we could learn about. Interdisciplinary projects like this require input from so many different fields.”

The two previously met during Welcome Weekend at Northeastern and hit it off immediately due to shared motivations and interests. Thanks to the Sherman Center for Engineering Entrepreneurship Education co-op program, Bhaiya was able to work on their project for his co-op while being paid. On top of the \$10,000 that was awarded to them due to their Global Impact Award, the company also received IDEA gap funding on two separate occasions. With all this momentum, they don’t plan on stopping anytime soon.

“We are focusing on ramping up the operation in India,” says Bhaiya. “We are working on a project right now with the largest hospital chain in India. We want to focus on markets like India where there is a high rate of diabetes and [shoes are] expensive.”

Dr. Brinsley is also sold in Singapore, South Africa, Bahrain, with plans for future expansion.

“Northeastern gives us the option to explore this venture even if we come from different disciplines. Having a pharmacy student and engineering student coming together and creating value out of an idea is amazing,” says Bhaiya. “We have so many opportunities that all we have to do is look around to be able to leverage these resources to work on projects.”

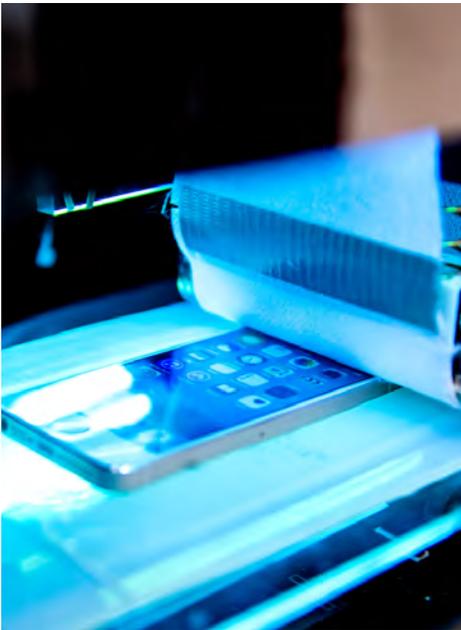
Capstone Projects to Advance Society

BY LAURA CASTAÑÓN,
NEWS @ NORTHEASTERN

photos by Ruby Wallau



Remotely operated robotic arm



Phone disinfection device

“HOW MUCH OF A DOCTOR’S SKILL or a surgeon’s skill relies on them being able to feel what’s wrong?” asked Orion Wilmerding, a fifth-year mechanical engineering student.

Wilmerding stood in front of a simplified robotic arm, with exposed motors and timing belts at the elbow and shoulder joints. Nearby, an interested student wore a series of motors and sensors strapped to his arm.

The two arms were part of an “avatar system” that allows a human to operate a robot remotely, designed by Wilmerding and four other Northeastern mechanical engineering students.

“It takes over 80 hours of training to get used to performing surgery remotely, without actually being able to sense what’s going on,” Wilmerding said. “When you put on an avatar system, which has haptic feedback, it’s like you’re actually there.”

When the wearer moves their arm, the robot arm moves in the same manner. And when the robotic arm touches an object, that feeling is translated back to the wearer. This kind of system could help doctors interact with patients remotely, improve the controls over robots sent into disaster areas, or assist in disabling explosive devices without putting human lives at risk.

“It adds that level of human touch back into a robotic system,” Wilmerding said.

The design was a mechanical engineering capstone project on display as part of an exhibit at the Interdisciplinary Science and Engineering Complex.

Other mechanical engineering projects included a battery-powered water purification system, a machine to speed up the processing of cocoa pods in Nigeria, and a scanner to help with surgery to remove skin cancer, among others.

Brandon Goldstein and his teammates have been working with a startup company to design a centrifuge that can extract additional oil from the waste products of oil and gas companies.

Currently, three to six percent of the oil extracted from underground wells doesn’t make it to refineries, Goldstein said. It’s mixed in with wastewater, salt, and sediments that the companies pay others to dispose. The students’ centrifuge spins this material rapidly and smoothly, allowing the oil to separate from the contaminants.

“It’s not only financially beneficial for the industry, but it’s also beneficial for the environment,” Goldstein said. “It’s making the best use of the resources we have.”

Another team was working on solving a problem that was closer at hand: the microbes growing on our cell phones.

“We use our phones every day,” said Gerardo Milano. “Phones are basically an extension of ourselves, and because of that, we believed there was an implication that mobile phones could be a reservoir of bacteria.”

The team members tested the bacterial colonies on their own phones and set to designing a method of removing them. They created a box which, in a 24-second cycle, wipes the phone’s surface with a microfiber cloth and exposes it to ultraviolet light.

“We did a lot of testing with E. coli in the biology lab,” Milano said. “After 10 seconds of exposure to UV-C [ultraviolet light] and wiping, we killed most of the bacteria.”

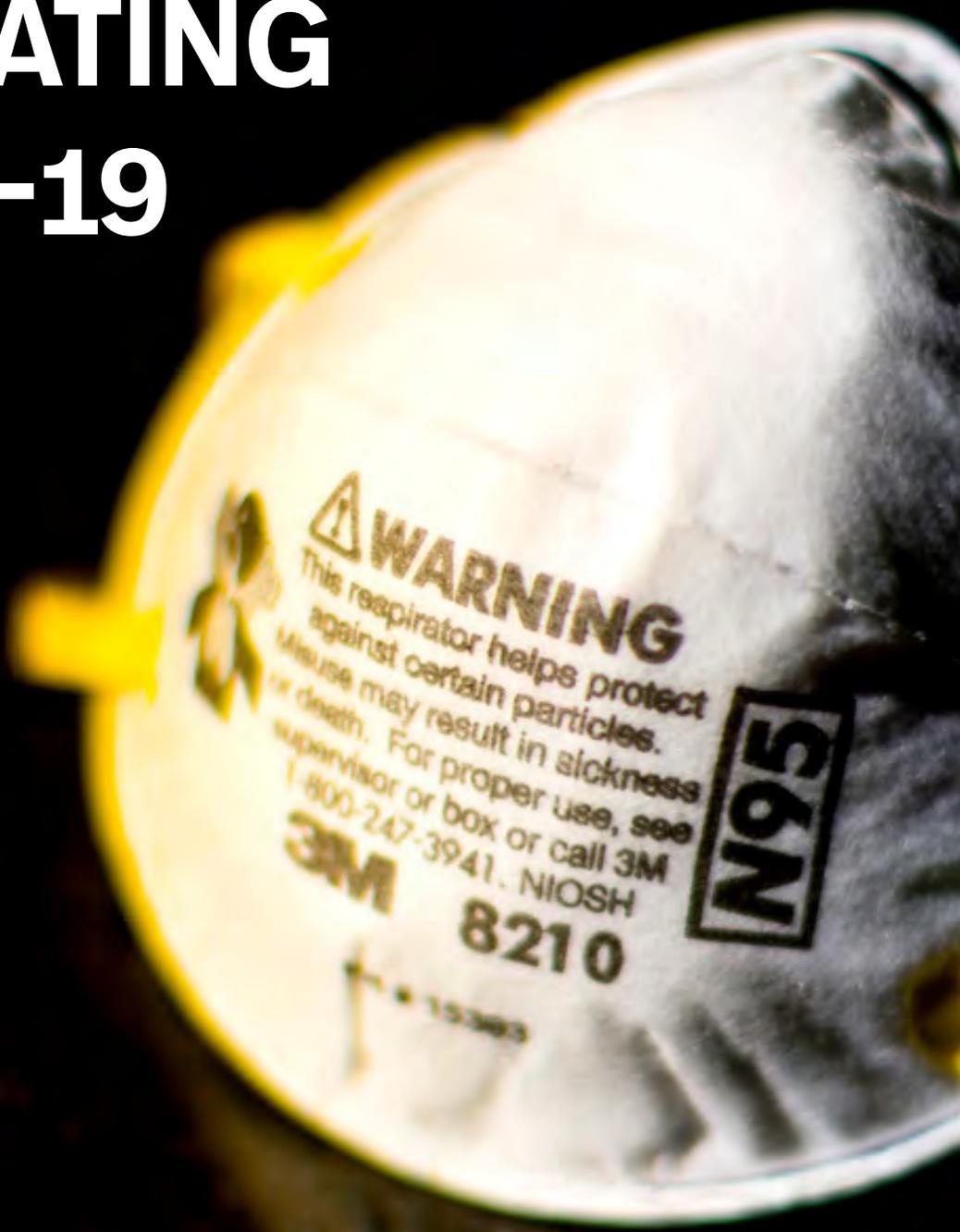
A nearby group had also focused on hygiene. The students built a kit to clean dental implements, like an aligner or a retainer. One piece is a portable case, which disinfects using a 30-second cycle of ultraviolet light. The second piece, intended to be plugged in at home, uses ultrasonic vibrations to clean stains and debris.

“We did testing in the optical science laboratory here at Northeastern, with staining using a baby food and coca cola mixture, as well as debris contamination using chocolate frosting,” a mixture suggested by a local dentist who consulted on the project, said Michael Brockman, who recently graduated.

Brockman and his teammates are intending to file for a patent on their technology. Other projects are the first steps of larger designs—the remote-controlled arm is going to be part of an entire suite to control a humanoid robot in a 2022 competition.

COMBATING COVID-19

As true engineers, Northeastern's College of Engineering faculty are conducting research in a myriad of areas to fight the COVID-19 virus for the health and safety of people. From developing healthcare optimization planning tools freely available to all, to building parts for protective personal equipment for hospitals, and improving the safety of homemade masks, our faculty are working with hospitals, industry, government authorities, and other academic institutions to find solutions to mitigate virus risks. The following are just a few highlights.



View all engineering COVID research news at
coe.northeastern.edu/covid-research



Developing Virus Contact-Kill Surface Treatments for Public Spaces

ARM RAILS, DOOR HANDLES, SEATS—these are all surfaces in public spaces that can spread viruses with so many people touching them as part of their daily lives. Distinguished University and Cabot Professor Laura Lewis, chemical engineering, jointly appointed in mechanical and industrial engineering, was awarded a National Science Foundation RAPID grant to mitigate this problem. Her research project, titled, “Lattice-Defective Copper Oxides as a Biocidal Tool for COVID-19 and Beyond,” addresses a need for new types of surface treatments that exhibit antipathogenic “contact-kill” capabilities to protect public health and welfare.

Cuprous oxide is reported as a highly effective antimicrobial compound. While the origin of its antimicrobial property remains unknown, it is hypothesized to be a consequence of atomic-level copper vacancies in its crystal lattice that provide highly charged atomic environments. These locally energetic regions in the lattice are thought to disrupt and destroy cell membranes and/or the protein shell of viruses. Lewis’ interdisciplinary research will quantify connections between the cuprous oxide lattice condition and its biocidal activity to permit rational engineering of this abundant, inexpensive, and easily handled material for incorporation into coatings for public spaces.

Lewis notes that one potential consequence of current widespread hand sanitizer usage is antibiotic-resistant bacteria; however, she is hopeful that these studies will quickly lead to materials design recipes (strategies, methods, prescriptions, rules) to develop solutions for public spaces.



This Model Can Help Hospitals Prepare for a Surge of COVID-19 Cases

BY ROBERTO MOLAR CANDANOSA, NEWS@NORTHEASTERN

WHILE LARGE-SCALE EPIDEMIOLOGICAL MODELS are proving to be a crucial tool for governments to control the spread of the novel coronavirus, those tools do not provide precise projections for local hospitals—each with different needs and capacities—to get ready.

“All of those models give us the big picture—that a state is going to be under siege a month from now—but they don’t really help an individual hospital address day-to-day questions,” says James C. Benneyan, who directs Northeastern’s Healthcare Systems Engineering Institute. “How many patients am I going to have in the ICU? How many are going to be ventilated? How long will they be in my hospital? When should I convert routine space to ICU or isolated beds?”

Benneyan, who is a professor of mechanical and industrial engineering, partnered with the Lahey Hospital & Medical Center to develop a modeling tool that can answer those questions. The model can help hospitals produce their own projections and consider possible shortage scenarios up to 30 days in advance, as they prepare for potential waves of patients that could strain their facilities.

Hospitals can run the tool with data specific to their facilities to project when the demand for hospital equipment is going to exceed the supply. It can also model the availability of hospital staff, Benneyan says, with the idea of helping health systems that have no idea about what’s coming their way.

“It can tell you when you aren’t going to have enough beds, ventilators, or equipment,” he says. “It will allow hospitals to work with their networks, and figure out—for example, in terms of personal protective equipment consumption—whether they have more or less of what they need and start early to make plans.”

To generate those projections, hospitals can update the tool with data from a census-like count of medical equipment, beds, and patients, as well as data and estimates on how long patients are staying in the hospital and whether they require ventilators and other equipment for intensive care.

Those tools, which can project short timeframes, are crucial for healthcare workers around the world trying to keep up with the COVID-19 pandemic, Benneyan says.

Even one day could be decisive. If they know in advance that they won’t have enough resources, hospitals can start making decisions about their equipment and admission criteria. That includes freeing up or converting spaces for patients in critical conditions—COVID-19 or not.

“If three days from now it looks like you won’t have enough ICU beds,” Benneyan says, “you need about a day (maybe two for systems that don’t do this routinely) to open up new space and convert a floor or a unit that’s for other types of patients into a makeshift ICU—and also open up ancillary space where you can put those other regular patients.”

That ability to make projections of scenarios that could take place in the near future will gain even more importance as COVID-19 cases pass their peak numbers and start decreasing in different locations, Benneyan says.

It can help hospitals spot potential new outbreaks as the spread of the disease slows and governments begin to relax their measures to restart activities in different sectors of their countries. A standard strategy is to relax governmental interventions and monitor for local outbreaks.

“But how are we actually going to detect when this starts to flare up and plan accordingly?” Benneyan says.

Benneyan’s tool runs on simple inputs that hospital managers can update every day to assess the near future. Like a weather forecast, it’s fairly accurate in the short term, and, while not flawless in the long term, still a powerful planning tool.

“To the user, it’s just a spreadsheet with a bunch of hidden tabs that do a bunch of math,” Benneyan says. “A hospital obtains a rolling forecast one to four weeks out, much like a weather forecast or hurricane models, that is updated each day as time moves forward, allowing them to make specific plans for the next week or so and start more general planning for the next month.”

To create the surge capacity tool, Benneyan teamed up with Dr. Michael Rosenblatt, chief medical officer at the Lahey Hospital & Medical Center in Burlington, Massachusetts, and other hospitals associated with research at the Healthcare Systems Engineering Institute at Northeastern, repurposing other models they have developed over the past decade to accurately predict epidemic trends, outbreaks, and the flow of patients within a health system.

And, as hospitals in the U.S. and internationally test and run the model, Benneyan and his team are updating the tool every day.

“With healthcare staff also at risk, in addition to time-varying bed and ICU occupancy, how to plan for the next several days and weeks is similarly critical” he says. “This is a huge opportunity to help health systems know what’s coming.”



Repurposing the Machine Shop

**BY LAURA CASTAÑÓN,
NEWS @ NORTHEASTERN**

photos by Adam Glanzman

WHEN NORTHEASTERN'S Boston campus moved to online instruction in March in accordance with guidance from public health agencies, Ben Macalister, a senior machinist in the Department of Mechanical and Industrial Engineering, needed to find something to do with his hands.

Macalister has been using Northeastern's machine shop in the Forsyth building to manufacture parts for machines that will build protective gear for hospital workers.

His work is part of a larger effort led by Artisan's Asylum, a non-profit community fabrication center in Somerville, Massachusetts. The group is working with several local healthcare providers to ensure that they have enough face shields, gowns, and masks to stay protected while they care for patients with COVID-19.

Macalister is currently working with the team making surgical masks. His job includes manufacturing a device to pleat mask material and a mount to hold a plastic spot-welder used to attach the elastic bands.



Switching Gears to Help Others

EXCERPT OF FULL STORY BY LINDA MATCHAN, NEWS@NORTHEASTERN

photo by Azita Lotfi/Lacerta

MOSTAFA, ALI, AND MORY LOTFI—all mechanical engineering alumni—founded in 1993 Lacerta Group, a family-owned business that manufactures plastic packaging. With the COVID-19 pandemic, they quickly switched gears producing protective face shields.

"It took us basically two days to design and go to production," Mostafa says. They saw the need to move quickly after getting a group email from a doctor friend who was looking for face masks for his hospital, which had a shortage of N95 masks, the standard for filtering out coronavirus.

Mostafa already had 500 of these masks at Lacerta because his workers used them to filter out dust. "We decided that instead of us using them we'd donate them to his hospital," says Mostafa. "And then we decided to start making plastic face shields."

The company has 370 employees and three facilities in Mansfield, Massachusetts, plus an operation in California and a sister company in Mexico. It has the in-house capability to perform every aspect of production for face shields from designing and creating molds to making plastic sheets and thermoforming (converting plastic sheets to plastic parts.)

They started production the last week of March. Intended for one-time use, the shields cover the face from the forehead to an inch or so below the chin and are fully adjustable. "We can produce 400,000 to 500,000 per day and can ramp up to millions per day," Mostafa explains.

Lacerta's shields are packaged in groups of 200 and delivered to hospitals, health workers, EMTs and others on the front lines of battling COVID-19. Lacerta will donate up to 1,000 face shields to hospitals and other organizations, and sell others at cost—about 40 cents each.

The company is scaling back on its other products for now. As for how the company will make money, "we'll leave that for later," Ali says. "We are a healthy company and we've been growing."

"We are trying to do a good deed," Mory adds.

Mostafa is hoping the company's face shield phase won't need to go on endlessly but "we will do whatever it takes," he says. "If people ask us, we will make them. It's our duty to help each other."



Panty Hose? Toilet Paper? Coffee Filters? Which Materials Make the Best Masks?

BY ROBERTO MOLAR CANDANOSA,
NEWS@NORTHEASTERN

photo by Matthew Modoono

THE NOVEL CORONAVIRUS is an extremely small particle that hitches a ride with droplets of saliva and mucus expelled through breathing, speaking, sneezing, coughing, and laughing. That's why using simple fabrics to cover the mouth and nose of an infected person reduces the spread of the virus as it *leaves* their body.

But the extent to which masks prevent the virus from *entering* another person's body through the airway varies. And, amidst the bombardment of online tutorials on face masks, questions abound about how to make them at home, and

what materials to use.

Arguably, the one question to rule them all is how well those masks—made with t-shirts, pillowcases, coffee filters, toilet paper—will perform in sealing your nose from the coronavirus.

Even for masks that might not filter out everything, a tight fit against the face significantly lowers the chances of viral droplets making it to the airway, says Loretta Fernandez, assistant professor of civil and environmental engineering at Northeastern.

That's why any sort of filtering and interfacing that people can use in their masks could be highly protective. The idea is to create an efficient series of layers with bends within the fabric that make it harder for the virus to have a straight shot at a person's nose. Every bend of that path provides more chances for the viral particles to stick to the fibers, instead of a person's throat.

"By including a filter layer—coffee filters, toilet paper, any sort of thing in there that is safe to breathe—you're just making the air have to follow a more circuitous route to get to your nose," Fernandez says. "Putting a layer of nylon over improves that."

Fernandez's research focuses on pollutants in the environment, including

harmful microscopic particles, and how they end up in the air we breathe, the water we drink, and the food we eat.

After the COVID-19 pandemic forced researchers to consider how their work could be repurposed to help with research to slow the spread of the novel coronavirus, Fernandez had a hunch. She started considering the tiny pollutants she studies and the laboratory instruments she uses.

"One of them is a particulate matter counter," she says about a machine that can analyze the concentrations of hazardous particles suspended in the air.

But particles of SARS-CoV-2, the virus that causes COVID-19, aren't easy to count. They are as small as they are hard to catch, with a diameter several times smaller than bacterial cells. That is tiny—too tiny to be blocked by most materials in a mask without making it hard to breathe through, and too small to be detected by Fernandez's instruments.

Still, she knew her expertise in sampling complex and microscopic particles could help. She just needed the right machine to do it.

At Northeastern, the Office of Environmental Health and Safety had started looking into university inventories, and found an old instrument that Fernandez could repurpose to count particles the size of the new coronavirus. Pfizer, the multinational biopharmaceutical corporation, also donated an instrument that served as the perfect complement to that machine.

Then, Fernandez enlisted Amy Mueller, an assistant professor of civil and environmental engineering at Northeastern, along with people and businesses in the Boston area who donated their masks.

"What's really been the most remarkable thing is how quickly these connections formed, and how willing everyone is to share what they know, to share their equipment, and to do whatever they can to contribute," Fernandez says.

Fernandez herself donned 10 different types of homemade masks, generated non-hazardous particles of a similar size to those that carry the novel coronavirus, and counted the amount of particles that the masks filtered.



Loretta Fernandez, assistant professor of civil and environmental engineering | photos courtesy of Loretta Fernandez

But the instruments Fernandez and Mueller were using had not been devised to count viruses. Their software normally produces rigorous pass-or-fail assessments on whether a mask will protect firefighters from inhaling dangerous smokes and fumes.

And more than a yes-or-no answer, the goal was to determine how efficiently those masks performed, Fernandez says.

As the machines measured particles passing through the masks, they flashed values taken at every second. Fernandez and Mueller recorded those readings on video. The process required a group effort that also involved engineering students, who watched each video and paused at every second to record the data.

The preliminary results, available at www.masktestingatnu.com, show that the most important factor to determining whether a mask will protect a person is not the material used, but how well it fits on the wearer's face.

The tests included N95 respirators, the masks designed specifically to protect healthcare professionals who treat patients with infectious diseases, as a standard to test the efficiency of other homemade and commercial masks made with different

layers of fabric, interfacing, and filters.

Commercial surgical masks performed better, filtering out about 75 percent of particles released from a particle generator located about two meters away. Homemade masks, which fit loosely over the face, generally filtered out less than 60 percent of the particles.

To improve the fit, Fernandez and Mueller wore cutouts of nylon pantyhose over the masks. That improved the effectiveness of all masks considerably, by as much as 50 percent. The idea of the nylon layer, which presses the masks closer to the face and keeps the air from circuiting around the filters, came from the past.

The early 1980s, to be specific.

John M. Price, who directs Northeastern's Office of Environmental Health and Safety, conducted research in 1983 on methods to make homemade masks to protect people from the radioactive fallout following the Three Mile Island nuclear accident.

"We were in the laboratory trying to recreate the seal that one would get with the N95 masks by just pressing the material around the breathing zone, and Jack said, 'you know, in the 80s, we just

used pantyhose,'" Fernandez says. "The next day, we came into the lab, cut a little section to fit over the masks, and used that as a more reproducible way to hold the material to our faces."

Fernandez says she hopes other researchers use data from her tests to study more materials and conclude which work best.

The key part, she says, is to use the results and help people at home produce the best masks they can make with whichever materials they have—as well as helping businesses put their manufacturing muscle to work.

"That information can be shared, and these masks can be put into production locally, using the best materials we can identify," Fernandez says. "I'll be sharing the information directly back with all the people who shared their masks with me, and hopefully that can help them toward crowdsourcing a better design."

Matching COVID-19 Care Workers with Open Massachusetts Jobs



photo by Brooks Canaday

OZLEM ERGUN, professor of mechanical and industrial engineering, has recently partnered with the Commonwealth's Executive Office of Elder Affairs (EOEA) to help match qualified workers to healthcare facilities with open positions around the state.

With the outbreak of COVID-19, healthcare centers are experiencing a huge surge in need for qualified professionals to care for patients, but each facility has different needs—in terms of open positions, availability, and capabilities—and each applicant has constraints, such as how far they are willing to travel.

In late March, Ergun received a request from the EOEA to see if she and the PhD students in her lab could create a process to facilitate hiring for more than 300 long-term care facilities throughout the entire Commonwealth.

Ergun and her team, in collaboration with the Commonwealth of Massachusetts, created a matching optimization algorithm and an online portal called COVID-19 Long Term Care Facility Staffing Team. The portal coordinates the intake of job applicants' information and matches it automatically to an ever-changing list of facility staffing needs.

"We designed the questions for the applications to match up with the needs of the facilities so we can screen for location, job skills, and transportation needs to match workers up with jobs almost immediately," explains Ergun. "Facilities receive a report of applicants and have a 24-hour window to hire who they need; after that timeframe, the applicants go back into the pool and are offered to other facilities because the demand for workers far outweighs the supply at the moment."

Ergun and her team also receive daily urgent requests for specific facilities that come through the Commonwealth's command center. They are able to enter them into the system with a preference so that site's needs are given a higher weight.

The portal is highly efficient, with approximately 1,000 applicants in the pool at any given time. The number of roles filled per day varies, but an example day in mid-April saw 826 people matched to jobs at 161 different facilities.

"The PhD students in my lab are running the whole project," says Ergun. "They built the algorithm, acquire the data and make sure it's clean, run the matching—everything. They are doing an excellent job."

Ergun and her team will be working on the COVID-19 LTC project for the foreseeable future to ensure that the healthcare needs of the Commonwealth are being met during these unprecedented times.



Cybersecurity: Your Secrets Are Safe with Us

Northeastern researchers are at the forefront of cybersecurity research, protecting everything from the phone in your pocket to the city of the future.

BY AND LARGE, the constantly connected and ever-growing internet that is so ubiquitous to everyday life is being run on an infrastructure that was created in the 1970s and 1980s.

“The world was different then; things like privacy weren’t baked into the system,” says Associate Professor Kaushik Chowdhury, electrical and computer engineering. “Now that devices have gotten so much faster, but the core network is still the same, we are working to learn the proper offenses and defenses to keep our information and ourselves safer.”

Institute of Information Assurance

Northeastern is at the cutting edge of cybersecurity research with a number of on-site research centers and institutes dedicated to various aspects of this burgeoning and deeply specialized field. Professor Engin Kirda, jointly appointed in computer sciences and electrical and computer engineering (ECE), is the director of Northeastern’s Institute of Information Assurance (IIA), which focuses on issues of cybersecurity and privacy. Kirda and

his multidisciplinary team from across Northeastern’s colleges of engineering, computer science, and social sciences considers everything from the theoretical (such as encryption and data security), to the practical (such as how users recover from attacks).

“Cybersecurity itself is an issue that has been around for at least 15 years, but only recently has the internet become a critical infrastructure to our everyday lives,” says Kirda. “While the technology giants like Google and Facebook are, of course, interested in cybersecurity, so is everyone else because everything is connected, including your home and all your devices.”

In addition to large tech organizations, the IIA works with many other funding agencies, such as the National Science Foundation (NSF), the Office of Naval Research, and the U.S. Army and Air Force. Because of their ongoing research and education, the Institute contributes to Northeastern’s stature as a National Security Agency/Department of Homeland Security Center of Academic Excellence in Information Assurance Research and Education.

Multi-university collaboratives

Another hotbed for cybersecurity research at Northeastern is a new multi-university research center called the Center for Hardware and Embedded Systems Security and Trust, or CHEST. ECE Professor Yunsi Fei is the Northeastern lead working with a consortium of five other universities, each responsible for a \$750K, five-year grant from the NSF.

Part of the Industry-University Cooperative Research Centers Program, CHEST seeks to tackle common issues faced by industry. The idea is that funding will come both from the NSF and member companies at each university site to work on applicable solutions for their largest challenges. The insights and innovations are then shared throughout the consortium, making the greatest impact possible.

“CHEST is different from usual research centers, because the work is use-inspired, case-driven, and highly practical,” says Fei. “Because the needs come directly from industry, we have to align our research with their biggest issues right now.”

CHEST started running in October of 2019, and they are now in the process of kicking off their initial projects. They’ll be focusing on understanding and preventing security vulnerabilities in both hardware and software systems, as well as on different computing platforms, and ultimately in various applications supported by cyber-physical systems and infrastructures. Current members run the gamut from commercial to nonprofit to governmental and include AFRL, Boston-based electronics manufacturer Analog Devices, Draper Laboratory, Booz Allen Hamilton, and more.

Institute for the Wireless Internet of Things

Also established in fall 2019 was the Institute for the Wireless Internet of Things (WIOT), which is directed by ECE William Lincoln Smith Professor Tommaso Melodia.

“WIOT is focused on advancing research in wireless systems topics in our increasingly connected world and how they interact digitally as well as physically,” says Melodia. “We’re trying to advance the systems that create this interface, as well as the technologies that make this possible.”

One of the important problems WIOT seeks to conquer is expanding our ability to manipulate the wireless spectrum to use more devices. Right now, most devices operate on a tiny portion of the spectrum between 0 and 6 gigahertz, so by adding accessibility in higher frequency bands, Melodia and his team can expand the network capabilities exponentially.

“WIOT would not have been possible without the strengths of all of the participating faculty, who have expertise in everything from AI to networks to sensors to business,” says Melodia. “This complementary group of motivated people that also very much enjoys working together ensures that some very impactful research will come out of WIOT in the coming years.”

Through WIOT, Melodia and his team are involved in Colosseum, the world’s largest radiofrequency channel emulator. Located at Northeastern and developed by DARPA, the Colosseum is a data center that can emulate complex interactions, such as how wireless devices deployed in a metropolitan area behave and interact.

“Colosseum will enable us to create intelligent, autonomous,



collaborative wireless technologies for everything from commercial to military use,” says Melodia. “We’re also operating under the philosophy that we can accelerate the industry by making our research and learnings available for everyone, as opposed to keeping it all proprietary.”

Can you see me now?

On the individual research front, ECE Assistant Professor Xue “Shelley” Lin is working to determine deep neural network vulnerabilities by rendering people virtually invisible to the network—simply by wearing a T-shirt.

Working with researchers from Northeastern, IBM, and the Massachusetts Institute of Technology, Lin and her colleagues have created a colorful, somewhat psychedelic pattern that, when worn by a person on an otherwise plain white T-shirt, confuses the deep neural network into thinking they aren’t a person at all.

“Most of my previous work has been in virtual examples in the digital world, when we try to alter the computer’s processes to see if there’s a change in the outcome,” explains Lin. “With this real-world example, we were able to prove that in more than 60 percent of cases, the computer did not recognize that what it was seeing was a person.”

Lin’s work also has ramifications for the future—for example, driverless cars not being able to recognize humans as objects to be avoided would have disastrous consequences.

Making autonomous vehicles smarter and safer

Another of Lin’s cybersecurity projects works directly with autonomous systems, such as cars and drones, this time working to make the deep neural network models for UAVs more robust and to strengthen their resistance against adversarial attacks.

As the principal investigator of a \$500K grant from the NSF, Lin works in collaboration with Alfred Chen from the University



(right) Xue "Shelley" Lin, assistant professor of electrical and computer engineering

photo by Matthew Modoono

of California Irvine, who is an expert on cybersecurity for autonomous vehicles. By working with Northeastern's Center for STEM Education and the Office of Access and Inclusion Center at UC-Irvine, Lin's research is particularly focused on engaging undergraduates, women, and minority students.

"Our hypothesis is that in deep learning, it's very important for systems to have full autonomy so that they can make decisions about detection, prediction, and control quickly," says Lin. "As we work to explore additional vulnerabilities of autonomous systems through their deep learning algorithms, we're also seeking to develop countermeasures to make these potential attacks less costly."

Some of the adversarial examples Lin and her team use in attempting to confuse the network are stickers placed on stop signs, or imperceptibly altering the pixels on a digital image. Though Lin's research is focused on UAVs, these security techniques in general can apply to other systems, such as object detection, facial recognition, and a language model.

Privacy in the palm of your hand

ECE Associate Professor Kaushik Chowdhury is working to bring more data privacy to individual devices that transmit personal data, from your smartphone to pacemakers, fitness watches, and more. "One of the ways in which we are trying to ensure security in the Internet of Things (IoT) age is to identify that each device is the one it claims to be," explains Chowdhury. "People who intend to steal

personal information or otherwise do harm can spoof a device's unique ID, so through my research we are working to detect and identify devices based on the unique radio signals that they are transmitting."

Chowdhury and his faculty colleagues— ECE Assistant Professor Stratis Ioannidis, ECE Professor Jennifer Dy, and Professor Melodia—and their student researchers have created a deep neural network that can learn the subtle differences inside each of the many types of devices signals in the world today, adding another layer of authentication that a device is what it claims to be, called radio fingerprinting.

"This research also has ramifications for more nationwide and global security," says Chowdhury. "We can take this concept and apply it to secret communications, in which we can intentionally inject variation in the way radio signals are being transmitted to encode additional information."

In fact, Chowdhury's interest and expertise in this area at the intersection of machine learning and theory of wireless communications started nearly two years ago. He leads a university research team that was selected for a Defense Advanced Research Projects Agency (DARPA) Radio Frequency Machine Learning Systems (RFMLS) Program, which tasks the team with classifying 10,000 different radio signals with 99 percent accuracy.

After the initial DARPA funding, Chowdhury's work has garnered additional interest and support from the NSF, Air Force Research Laboratory, Office of Naval Research, and other defense-centric organizations.

Making security move faster

Also in the realm of protecting personal data, Assistant Professor Stratis Ioannidis and ECE Professor Miriam Leeser are collaborating on large-scale and secure data mining using field-programmable gate arrays (FPGAs) to protect data privacy.

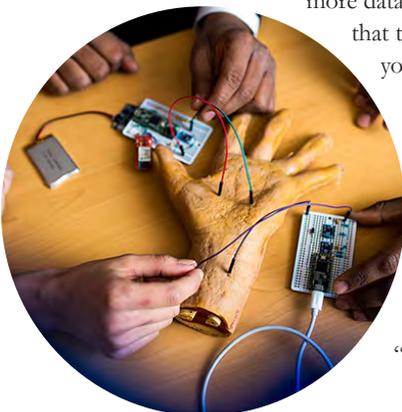


Photo by Adam Glanzman

Today, it's commonplace for users to want to share their data with various web services, from healthcare to social media. The issue is the knowledge that at some point, their individual data could fall into the wrong hands and be compromised.

"Data coming from human subjects is used from medicine to sociology to economics," says Ioannidis. "On one hand, this is critically important for scientific discovery, so we can learn, for example, whether certain genes correlate to certain disease. However, this process also raises inherent and well-documented privacy concerns, so it comes down to a question of whether you can use people's data while also offering them guarantees."

Currently, the personal information you provide to various web services is transmitted in an encrypted format, but then gets decrypted for processing. With this new method that Ioannidis and Leeser are developing for secure function evaluation methods—funded first by Google, and now through the NSF—the data is used to perform only very specific tasks that users have agreed upon, and nothing more. In particular, data never gets decrypted, so no one would ever have the opportunity to access your information directly.

Accomplishing this level of privacy is computationally expensive—it is 500,000x slower to run this kind of security, so Leeser is using FPGAs to make secure function evaluation more efficiently.

"FPGAs are hardware that can be reconfigured like software, so you get the advantage of specializing your computation to what it is that you want it to do," explains Leeser. "FPGAs are good at some things and not at others, but solving cryptography is a place where they can shine."

The team is partnering with Amazon Web Services and using their specialized hardware on this project. Beyond the benefits of acceleration, enabling such secure computations in the cloud can also help with making secure function evaluation more broadly available.

Finding weaknesses in deep neural networks

Another team interested in data privacy are ECE faculty members Fei and Lin and Northeastern's Khoury College Associate Professor Thomas Wahl, who are working together on a \$1.2 million NSF grant to secure deep neural networks against side-channel and fault attacks.

Side-channel attacks are covert and based on passive information leakage about how a computer system executes sensitive applications, while fault attacks are much more active: They manipulate a device in a physical way—such as laser beaming or electromagnetic pulsing—to try to generate temporary errors that lead to system failure or secret retrieval.

In order to understand and prevent against these kinds of assaults, the team's research is threefold:

- Studying the vulnerability of deep neural networks to model reverse engineering to prevent side-channel attacks
- Investigating how likely active fault attacks are to disrupt the

execution of deep neural networks

- Identifying ways to protect, detect, and shore up secure execution of deep neural networks

The team is considering these issues holistically from a backend/analytical way and a front end/practical way. And like Ioannidis and Leeser's research, all of the team's findings, methodologies, and software tools will be made available to the public to facilitate community usage.

The future lies with the students

No matter which piece of the cybersecurity puzzle Northeastern's faculty are trying to understand, one of the constants is the invaluable input and innovation that comes from students.

"They are at the core of what we do," says Melodia. "At WIOT, they're not only doing research on groundbreaking technology, but they're being trained on becoming the tech and cybersecurity leaders of tomorrow. Our graduates are highly prepared and are taking jobs immediately in industry, from Google to manufacturing to academia."

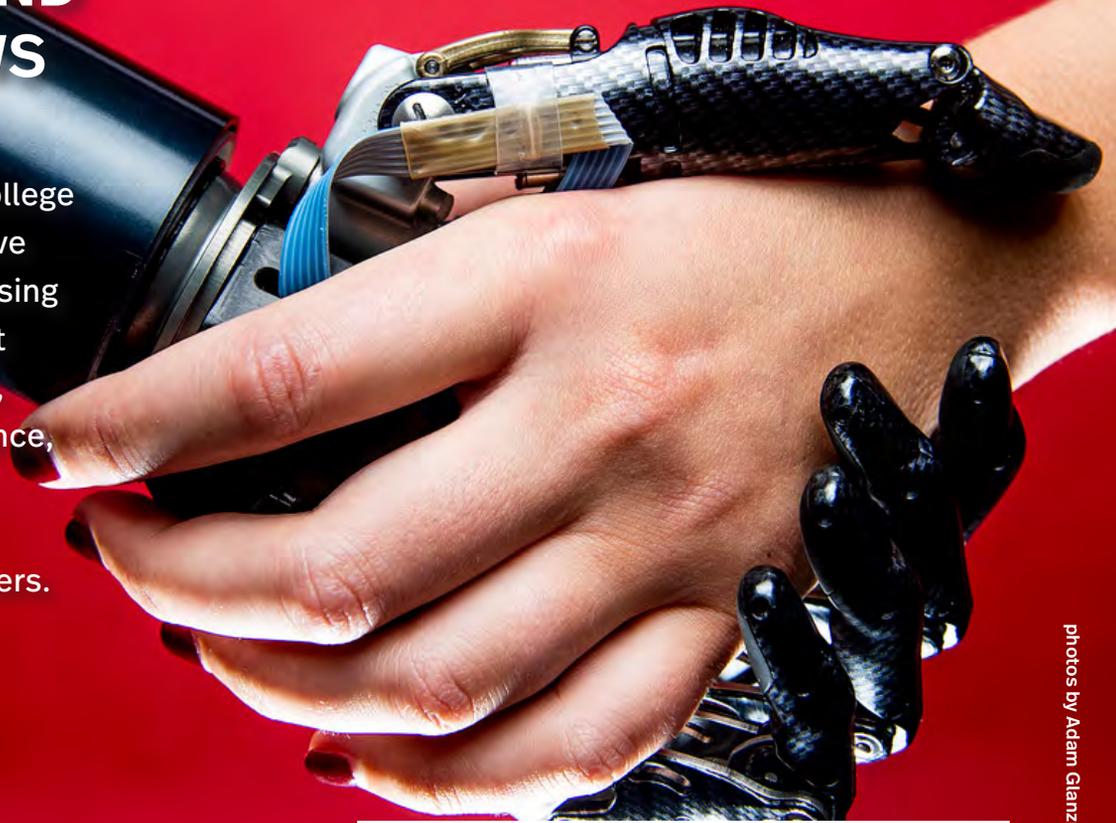
"Today, there are more attacks and the bad guys are getting better and more sophisticated, so defending against them requires more thought and preparation, especially from an interdisciplinary point of view," says Kirida. "We're proud that Northeastern's students and alumni are there to safeguard us in the future."



William Lincoln Smith Professor Tommaso Melodia,
electrical and computer engineering
photo by Ruby Wallau

SECURITY AND SAFETY NEWS

A variety of research is occurring across the College of Engineering to improve security and safety by using robots, inventing airport screening technologies, studying coastal resilience, improving batteries and video recognition capabilities, among others. Here are some recent highlights.



photos by Adam Glanzman

THAT'S A JOB FOR...THE HUMANOID ROBOT

PERFORMING ANY OPERATION in a nuclear facility is a dangerous, painstaking process. What if a robot with human-like capabilities could be guided by humans to safely and effectively carry out the most dangerous tasks?

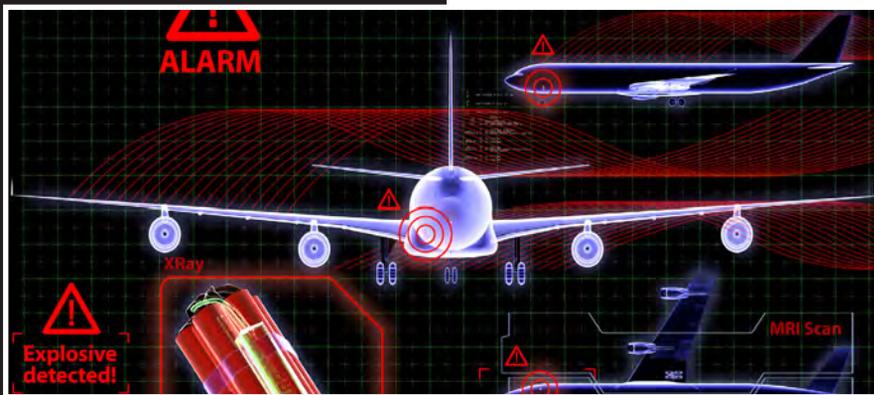
That's the goal of Electrical and Computer Engineering Associate Professor Taskin Padir whose research project, "Cooperative Control of Humanoid Robots for Remote Operations in Nuclear Environments," recently earned him and his counterpart at University of Massachusetts Lowell a one-year, \$400K National Science Foundation grant. Padir and his team seek to enhance the capabilities of NASA's Valkyrie robot to perform operations in science "glove boxes" prevalent in nuclear facilities. These glass boxes feature two ports through which a human operator, wearing thick plastic gloves to prevent exposure to lethal materials, can insert his hands to run experiments, for example.

"Glove boxes are intended to provide safety for humans, but so many accidents can happen," says Padir. The solution: embody the specific skill set required to use glove boxes in the robot avatar, then enable the human supervisor to safely control the robot from a distant location. "A robot like Valkyrie can put its hands in the glove ports and perform experiments guided by humans," he says.



Controlling a complex humanoid robot is no small task, according to Padir, with safety being a primary concern. "On the robot side, we need to create safe behaviors, he says, "for example, being able to walk to the ports, putting its hands in the glove ports, avoiding obstacles, not colliding with the environment. Converting human action to robot actions to guarantee no failures and completion of the task—that's the research challenge; it's what we're trying to advance on the robotics side."

For Padir, his ultimate goal is using robotics technology to create a better quality of life, whether that's saving time and resources, increasing productivity, or aiding in the monumental task of nuclear waste cleanup. "If we can develop capabilities on both the robot side and human-robot side—to enable seamless human-robot collaboration, to understand human action and intent, to replicate useful robot actions in a distant location—this scenario can be a game changer."



Northeastern Spearheading Advances in Travel Safety

Working closely with Homeland Security, Northeastern researchers are making flying the friendly skies even friendlier.

NORTHEASTERN'S ALERT (Awareness and Localization of Explosives-Related Threats) is one of nine Department of Homeland Security Centers of Excellence (COEs) located across the country. A multi-university center, ALERT conducts research and development for effective responses to explosives-related threats.

ALERT is funded by a core grant from the U.S. Department of Homeland Security Science and Technology Directorate that equates to roughly \$3.6 million a year. In addition to the Center's ongoing core research award, DHS also provides each COE with an ability to obtain task order contracts targeted to develop specific security technologies and methods.

Since June 2019, five such task orders involving initiatives to make airports safer have been awarded to ALERT at Northeastern. These projects focus on making baggage and cargo scanning processes more effective, streamlined, and cost-effective; improving the experience of people traversing airport security checkpoints; and developing consistent and measurable methods for explosives detection.

The first task order is focused on **improving the detection capabilities of airport passenger screening systems** to make physical pat-downs in the airport

security checkpoint less necessary. This project is funded at \$1.2 million, with Carey Rappaport, ALERT researcher and College of Engineering Distinguished Professor, electrical and computer engineering, serving as technical lead.

"Airports spend millions of dollars over the course of every year double-checking the information that agents receive from personal screening devices, so making this process better and faster is a win for both the public and the industry," says ALERT Director and College of Engineering Distinguished Professor Michael Silevitch, electrical and computer engineering.

A second task order looks at improving a crucial piece of secondary airport screening by **systematizing the swabbing** of hands, liquid containers, shoes, and the like, looking for traces of chemicals or explosives. With this \$650K grant, ALERT is seeking to compare and evaluate the performance of all of the swab kits used by airports across the country.

"If we can benchmark the performance of these swabs and create a gold standard, we can better define the protocol to measure the performance from airport to airport—apples to apples," says Silevitch.

Enhancing the efficiency of airport security checkpoints is the focus of the \$1.3 million task order **leveraging video analytics to improve the airport checkpoint process**. This project's aims include understanding checkpoint wait times, supporting risk-based screening to improve throughput rates, and helping identify when someone may have forgotten an item at the checkpoint, or a possible theft.

"Not only could we possibly make the process more user-friendly and streamlined, but we could also catch anomalies, such as theft and accidental leave-behinds," says Silevitch. "The TSA can't just throw those items away, so the documentation, as well as



Airports spend millions of dollars over the course of every year double-checking the information that agents receive from personal screening devices, so making this process better and faster is a win for both the public and the industry."

MICHAEL SILEVITCH, ALERT DIRECTOR

handling and storage, is time-consuming and costly—I even heard of someone who left a snake behind, which then had to be cared for by TSA! If we can flag events like that in real-time, we can eliminate the issue altogether."

Out of the terminal and into the parts of the airport most of us never go are the areas impacted by the fourth and fifth task orders: an \$800K grant to **create simulation tools to visualize the contents of air cargo containers**, and a \$690K grant to develop a **more effective system to detect opioids transmitted through international mail**.

"More than one million international postal items come through JFK Airport every day—and that's just a single airport," says Rappaport. "Most of it is legitimate, but it's our job to better judge which ones have the bad stuff in them."

There are several approaches to tackle the problem, but Rappaport and technical lead Silevitch are seeking a non-invasive way to screen packages that optimizes worker safety and minimizes sensing time. One option is to use millimeter wave scanning devices to search relatively small packages for loose pills or powder and target them for closer inspection.

"Throughout all five of these task orders, DHS wants the U.S. and the world, in general, to be safer," says Rappaport. "At ALERT, we try to develop expertise to address these hard problems."

This work was funded by DHS, Science and Technology Directorate, Office of University Programs, under Grant Award 2013-ST-061-ED0001 and Task Orders 70RS.AT18FR0000115, 70RS.AT18FR0000141, 70RS.AT19FR0000041, 70RS.AT19FR0000155, 70RS.AT19FR0000115.



photo by Matthew Modono

Video Data Used in AI Applications Has Far Reaching Implications

ADVANCES IN ARTIFICIAL INTELLIGENCE (AI) hold great promise for improving public safety and national defense, as well as benefiting society at large. With a grant from the Army Research Office, Electrical and Computer Engineering Professor Yun Raymond Fu, who is jointly appointed in the Khoury College of Computer Sciences, and his team are working hard to make that vision a reality.

Fu's research project focuses on developing a knowledge transfer network using image-based object recognition to enhance capabilities for video-based object recognition. The results could have far-reaching implications by improving and enabling everything from high-performance drones to surveillance systems, self-driving cars, robot intelligence, and social media and content search and retrieval.

Existing video-based object recognition techniques are often inadequate for addressing real-world challenges. "A practical system should be able to rapidly recognize objects from streaming video captured in unconstrained scenarios," says Fu. Since large-scale images can be easily obtained from the web, Fu proposes transferring knowledge learned from these images to assist in video recognition, specifically by creating a framework to transfer knowledge across heterogeneous domains—a potentially groundbreaking application that would improve the accuracy of tools to understand image and video content and speed up analysis of a large amount of data collected every day.

"Understanding video data is at the core of many AI applications, including Army Next-Gen Autonomous Vehicles, where threats and hazards need to be detected in real-time," says Dr. Hamid Krim, program manager, Information Processing and Fusion at the Army Research Office, an element of the U.S. Army Combat Capabilities Development Command's Army Research Laboratory. "To get a machine to learn to detect threats in real-time is very complex, not just because of the cost of training the machine, but also for the machine to be able to operate in unpredictable environments. Dr. Fu's research is working to simplify the training by teaching AI using plain images collected in various places. While the goal is ambitious, the outlook is promising."

"The Army mission inspired me to invent tools from the knowledge/AI domain to facilitate their needs," says Fu. "The Army's support allows us to extend our knowledge set, explore new technologies in AI—and bring Northeastern to the forefront in this field globally."



photo by Ruby Wallau

Hongli (Julie) Zhu, assistant professor of mechanical and industrial engineering

Security ‘Power’

BATTERIES ARE USED in seemingly every part of most people’s lives: cars, computers, even phones. But they can come at a price. “Batteries use electrolytes which are highly flammable from organic electrolyte, and the issue can lead to vehicles and even airplanes catching fire,” Hongli (Julie) Zhu, assistant professor of mechanical and industrial engineering, explains. Then there is also a desire for increased performance to enable applications from portable electronics to transportation, such as automobiles and airplanes. What may be guessed as opposite goals—increasing safety and performance—may actually be achieved by solid-state batteries.

Awarded a \$480K National Science Foundation grant, Zhu and Joshua Gallaway, assistant professor of chemical engineering, are leading teams for a study of solid-state electrolytes, a key component that enables high energy density battery chemistries while providing safety and durability benefits. Using famed Argonne National Laboratory near Chicago, the teams are analyzing the contents of a standard electrolyte battery and an experimental one to improve metal sulfide stability in solid-state electrolytes for solid-state lithium metal batteries.

The findings will be used to modify the metal sulfide chemistry through elementary doping and to stabilize the interface through engineering, Gallaway says. “Hongli’s group has synthesized and will make modifications and characterizations to the fundamental materials in the battery. Our group will use high power techniques to observe the batteries in an operando state, looking inside them without opening them,” Gallaway says. “It’s trickier than it sounds. During the project, both groups are going to contribute to the overall design of how to assemble them.”

The study has another important application, according to Zhu. “Energy security is a key opportunity,” she says. “A solar panel with window energy for renewable energy is intermittent so you need a battery for large-scale grid storage. Of course, solid-state has a long way to go because now costs compared to organic electrolytes are still relatively higher.”

If the work leads to what they hope, Gallaway believes everyone could potentially benefit. “When you consider how technology has changed our lives, we forget the role of the battery in this,” he says. “Its limitations sometimes hold us back, but it’s exciting to think we have a chance to take this huge leap forward.”



Joshua Gallaway, DiPietro assistant professor of chemical engineering



photo by David Deeter

Making (and Understanding) Waves

SINCE EARLY 2019, Qin Jim Chen, a civil and environmental engineering professor with a joint appointment in the College of Science, has been using Big Data to help protect society from climate and ecological changes.

Chen leads a \$866K CyberSEES grant from the National Science Foundation, in collaboration with Louisiana State University and Texas A&M University, titled “A Coastal Resilience Collaboratory: Cyber-enabled Discoveries for Sustainable Deltaic Coasts.” As the principal investigator and executive project director leading the Coastal Resilience Collaboratory, Chen works to leverage the shared expertise of coastal engineers, earth scientists, and cyberinfrastructure specialists, as well as massive amounts of data from real-time observation and modeling of hurricanes, ocean waves, storm surges, and more to develop strategies for coastal sustainability.

Over the past year working with the CyberSEES program, Chen’s team has completed several models—including on vegetal drag force induced by nonlinear

waves over inundated wetlands, and a 20-year coupled ocean-wave-sediment transport model for the Northern Gulf of Mexico—and shared them on the open source platform called the Coastal Modeling Repository.

“Our hope is that people who don’t have the supercomputing expertise but do have the data can still use the models to gain information about their own regional issues,” says Chen. “Some of the products are being used by federal agencies like the U.S. Army Corps of Engineers, who are tasked with designing resilient coastal infrastructure.”

In the time since the grant began, Chen and his team have published frequently on their research findings, such as in the *Journal of Geophysical Research: Oceans*, the *Journal of Physical Oceanography*, and *Coastal Engineering*. Chen and his team also presented their work at a number of conferences, including “Coastal Sediments 2019: Advancing Science and Engineering for Resilient Coastal Systems,” American Society of Civil Engineers Engineering Mechanics Institute Annual Conference, and Community Surface Dynamics Modeling System Annual Meeting.

Taking Graduate Experience-Powered Learning to the Next Level

IT WAS THE MAGNET that drew Andy (Qingchao) Kong halfway around the world.

With co-op now available to graduate engineering students, Kong could work at an American company as part of his education. Not only would this allow him to apply his academic training to real-world challenges, it would also expand his professional network and help launch his career.

“It has always been a dream of mine to do something meaningful for humanity and I’m willing to do whatever I have to do to achieve that goal,” says Kong, who came to Northeastern from China.

During his co-op at Abiomed—the company that developed the first artificial heart—Kong worked on the design team for the company’s flagship Impella heart pump. His supervisor at the company was Caitlyn Hastie, E’06, who holds 10 patents and has 13 more patents pending, most of them focused on the heart pump she was working on with Kong.

“We were working on real-world engineering problems,” explains Kong. “When you’re at a company like Abiomed, you have to take the fundamentals you learn in textbooks and apply them to a final product. We were making a real impact on the lives of patients so they could return to their families and have a good quality of life.”

Kong earned two master’s degrees at Northeastern—the first in mechanical engineering, ME’14, and the second in bioengineering, ME’16,—and now works full-time at Abiomed.



photo by Matthew Modono



(left) Piotr Kulik, PhD electrical engineering

The biggest and best

Northeastern has been building its worldwide network of co-op partners for more than a century and in 2020 was ranked No. 1 in the nation for co-ops/internships by *U.S. News and World Report*.

In recent years, the College of Engineering has expanded the program to open opportunities for co-op experiences specifically geared to the expertise of graduate students. “Master’s level students can do more advanced work and don’t need as much training because they’re already professionals,” says Mariela Pirozzi, director and lead co-op coordinator for multidisciplinary engineering degrees in targeted areas. Co-op is available for doctoral students too. During this time, they work on a project that is related to their dissertation research.

In keeping with their professional status, graduate engineering co-ops typically earn between \$20 to \$30 an hour, with those in certain specialties earning more than \$40 an hour. Last year, the college placed nearly 1,000 engineering graduate students in co-ops at Microsoft, NASA, Amazon, Draper, iRobot, Hasbro, Tesla, Facebook, and more. “We offer co-ops in companies ranging from Google to two-person start-ups—and everything in between,” says Lorraine Mountain, assistant dean of cooperative education in the College of Engineering.

Employer partners also provide the college with valuable feedback needed to ensure the curriculum is responsive to the rapidly evolving workplace. In recent years, this collaboration has contributed to the creation of a dozen certificate programs, curriculum updates, and new majors in robotics, data analytics engineering, human factors, cyber-physical systems, and data architecture and management.

The experiential PhD

The same educational philosophy gave birth to Northeastern’s Experiential PhD. The program is designed to help doctoral students conduct academic research with practical application to real-world issues through an internship, corporate fellowship, embedded-employee fellowship, and special initiative programs.

To give students the skills to design applicable research questions, they work closely with companies, government



I’ve always been interested in the bridge between academics and industry... Because we are working with industry, the product of our research has to be repeatable, cost-effective, and capable of being potentially mass-produced.”

PIOTR KULIK, PHD ELECTRICAL ENGINEERING

agencies, nonprofits, and private research labs. “When a student goes to an outside partner, they are exposed to an authenticity they’re not exposed to in an academic research lab,” says Sara Wadia-Fascetti, vice provost for Northeastern’s PhD Network. “They learn to identify real-life challenges and use that insight to craft the research questions they will ask in their dissertation.”

The goal is to blend basic research (the quest for new knowledge) and translational research (building on existing knowledge to develop new solutions). The result is “use-inspired research” —a concept that lies at the heart of Northeastern’s PhD philosophy.

“I’ve always been interested in the bridge between academics and industry,” says Piotr Kulik, who is working on a radio frequency project funded by Raytheon and conducted at Northeastern’s Kostas Research Institute. Kulik is working toward his PhD in electrical engineering. “I’m trying to solve a research question, in a way that is both academically challenging and of use to industry,” he explains. “Because we are working with industry, the product of our research has to be repeatable, cost-effective, and capable of being potentially mass-produced.”

The goal of this academic/industry collaboration is to push students beyond their campus comfort zone and equip them with the professional skills, creativity, and cultural agility needed to translate research discoveries into practical solutions. “We are one of the only universities in the world to offer all PhD students experiential learning opportunities outside of their primary

NEWEST ACADEMIC PROGRAMS

UNDERGRADUATE DEGREES

COMBINED MAJORS

- BS in Bioengineering and Biochemistry
- BS in Civil Engineering and Architectural Studies
- BS in Environmental Engineering and Landscape Architecture
- BS in Mechanical Engineering and Design

GRADUATE DEGREES

- MS in Cyber Physical Systems
- MS in Data Architecture and Management
- MS in Human Factors
- Information Systems Bridge Admissions Pathway for non-STEM backgrounds

DOUBLE HUSKY SCHOLARSHIP

Alumni are eligible for a 25% Double Husky discount on over 30 engineering Master of Science and graduate certificate programs, many of which allow for a streamlined application process.

coe.northeastern.edu/doublehusky

research group,” says Wadia-Fascetti. “When we brought co-op to our master’s programs, enrollment went through the roof. We expect the Experiential PhD to do the same thing for the doctoral program.”

Visionaries

Students at both the master’s and doctoral levels can apply to LEADERS (Leadership Education Advancing Discovery through Embedded Research), a certificate program designed to enhance a student’s career impact by providing skills that will help them shape future innovation. The program, developed by Northeastern’s PhD Network and the Gordon Institute of Engineering Leadership, begins with a semester of coursework in organizational systems, project management, teamwork, and leadership. This is followed by eight months leading a project at a partner company. Students use this experience to shape a dissertation question that’s related to their LEADERS project.

Kulik said the program helped him shape a dissertation that will use magnetic and non-magnetic techniques to develop devices to address the radio-frequency congestion problem. “With the growth of 5G and the Internet of Things, there are going to be more devices competing for a piece of the radio-frequency spectrum allocated by the government,” he says. “I’m looking into methodologies to solve this critical communication issue.”

He said LEADERS also exposed him to doctoral students in other disciplines such as healthcare and biotechnology. One student in his class was applying artificial intelligence to psychology, while another was investigating the impact of social media on the environment. “It’s important to learn how people think in different industries,” says Kulik. “We live in a world now where everything is connected, and we are going to be more effective in solving problems if we collaborate.”

Other experiential options

In addition to a four-to-eight-month co-op, the College of Engineering offers a variety of other ways for students to gain professional work experience. This includes a corporate-sponsored project at one of Northeastern’s research centers or working with a faculty member who has

won a research contract from a corporation or government agency. For example, one engineering doctoral student is now working at Intel in California on a project sponsored by the Department of Defense, while another is working on a project sponsored by the Oak Ridge National Laboratories.

In some cases, the flow of this university/industry collaboration is reversed. In this scenario, a company identifies a promising employee and has them earn their PhD through Northeastern while continuing to work for the company. “It’s like we’re extending our university into the company,” says Wadia-Fascetti. In this case, the student has two PhD advisors, one from Northeastern and one from the company. “The impact on a student’s career is dramatic because their research has an application to the real world,” says Wadia-Fascetti.

Personalized education

All of these options contribute to Northeastern’s commitment to a personalized education.

Global co-ops in industry and for research—including those associated with Northeastern’s Global University System—help graduate engineering students improve their cultural agility while broadening their professional network. They also allow international students the choice to work in their home country.

“Our international program has grown quickly because Northeastern provides so much support,” said Sally Conant, global co-op coordinator. “Most colleges have an internship office, but it’s just that—an office. We have a team of advisors specifically for co-op, and each student has one of these advisors assigned throughout the co-op process.”

In the spirit of personalization, the college has a flexible graduate curriculum that allows students to take electives throughout the degree program. “They can plan their coursework and choose technical electives based on what sparked their interest during co-op,” says Mountain.

Because Northeastern is an R1 research university, engineering students can participate in a research co-op in several federally funded research centers in the College of Engineering or across the

university. They also have access to an extensive partner network of research labs, medical institutions, and universities.

“We are the leader in experiential learning because we weave it throughout every aspect of education—from project-based coursework and research, to student groups and co-op,” says Mountain. “We’re different from many other universities trying to break into this area because it is so thoroughly embedded in our educational model.”

International students

The graduate programs provide an added benefit for international students, many of whom come to school in the U.S. hoping to begin a career with an American company. Co-op allows international students to gain valuable job experience and exposure to American culture without all the complications of obtaining an H-1B visa.

But not all international students want to work in the U.S. Some want to do their co-op at home to save money or to position themselves for a top-flight job after graduation. Multinational companies like Apple in China or Schneider Electric in India want students who have been educated in the U.S. because they can speak English fluently and understand American culture.

While earning his MS in Engineering Management, Vatsal Prakash completed a co-op at Schneider Electric in New Delhi. As a part of the marketing team, he worked on programmable logic controllers (PLCs), which are specialized computers that can automate an entire industrial process. “The good thing about this was that I spent most of my time working in the lab,” says Prakash. “The lab is Schneider’s LEVEL 2 technical support

team for all of the Southeast Asia region. It was fun because I was surrounded by engineers who were friendly, super smart, and helped me learn. I made a lot of friends and it was pretty relaxed.”

Prakash said he found the position through NUCareers. “Applying to companies through the university was much faster compared to finding a company on LinkedIn or Indeed. The process is very direct. My global co-op coordinator, Sally Conant, helped me with sending my applications.”

A boon for employers

One reason the graduate co-op program is so strong is that employers benefit as much as the students. “Try before you buy,” says Wadia-Fascetti to describe the pipeline of tested job candidates that co-op provides.

And because graduate co-op lasts up to eight months compared to the standard three-month internship, students are with the company long enough to have a significant impact. “We like to work with Northeastern because it takes two months to get a student up to speed,” says Hastie, who built the co-op program at Abiomed. “With co-op students, you have them doing significant work for four-to-six months instead of just one.” Hastie’s first contact with Abiomed was on co-op as an engineering student at Northeastern.

Vaishali Tripathi, who earned her MS in Information Systems, completed a six-month co-op at Amazon, culminating in a full-time job offer upon her graduation in spring 2020. She developed an operational excellence tool from scratch that automates the processing of vendor agreements. “Hundreds of these agreements failed to bill for a variety of reasons and needed special attention from the technical team to look into them,

figure out the root cause, and come up with the appropriate fixes,” says Tripathi.

The system is now entirely self-service. The agreement lists are added to the website and from there, all of the communication and updates are automated. “The tech team doesn’t have to even take a look into it anymore!” says Tripathi. Each manual agreement

previously took 10 minutes, but now Tripathi’s tool can process 100 agreements in 30 seconds. What took the tech team three days to accomplish is now done automatically in just 30 seconds—with 100 percent customer satisfaction.

Hiring international students can also benefit employers because, on average, they’re likely to stay longer. “I ask employers about the lifecycle of a typical new employee, and they usually tell me two years,” says Pirozzi. “International students are likely to stay much longer because their H-1B visa can last up to six years and they can’t change jobs without reapplying for their work visa.”

Support

To ensure that students get the most out of the vast array of experiential opportunities, the college provides extensive support services, including a mandatory co-op preparatory class—covering everything from resume writing and interviewing to networking and communication skills in the workplace. While valuable to prepare for the co-op experience, the program offers much more—students gain skills they can carry with them for a lifetime.

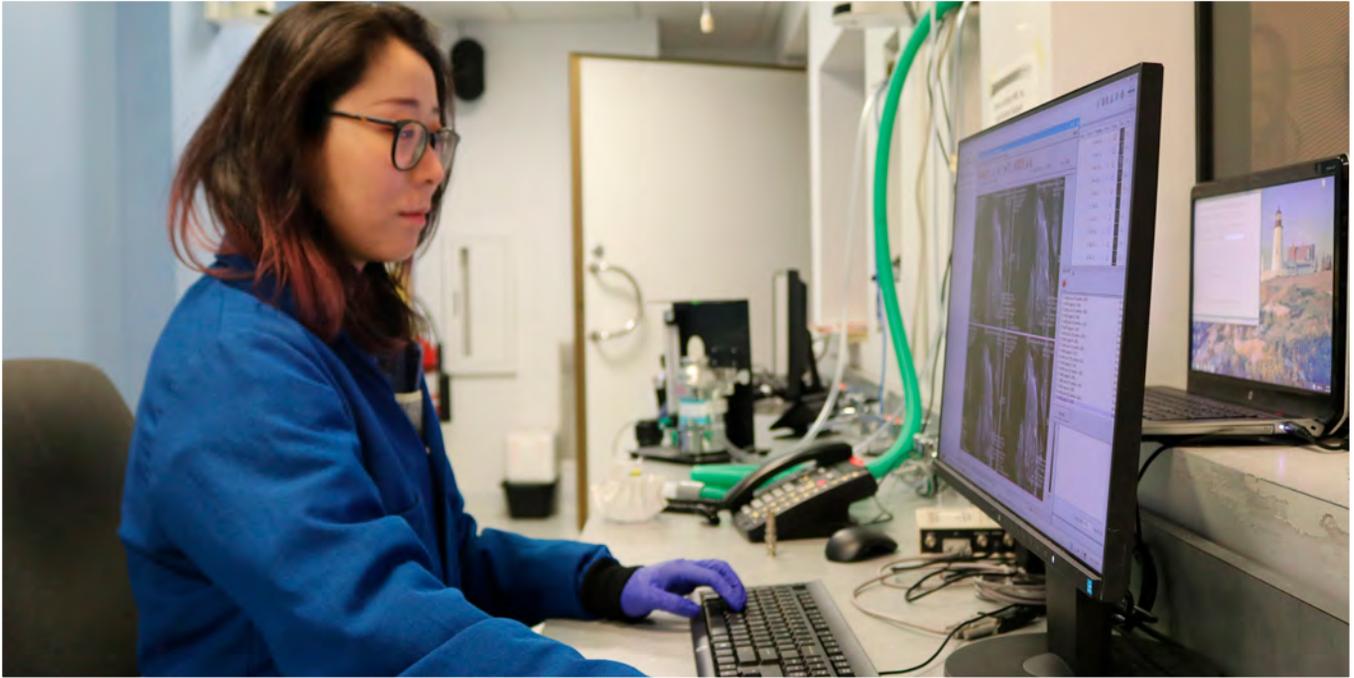
Each student is also assigned a co-op advisor who specializes in their field of engineering and follows them throughout their graduate education. “Our knowledge of the companies and the fields they operate in runs much deeper than at most graduate engineering programs,” says Pirozzi. “Our co-op advisors know the field like the back of their hands.”

Another benefit to students is the College of Engineering’s partnership with Northeastern’s Employer Engagement and Career Design organization. Students can take advantage of additional career programming, workshops, and networking opportunities, including those targeted to graduate students.

“Our vision at Northeastern has been to build a network of learners, alums, and employers to form an ecosystem for lifelong learning, career design, and partnerships,” says Mountain. “The results can be seen in our students’ success.”



Vatsal Prakash, MS engineering management
photo courtesy of Vatsal Prakash



Xuezhu Cai, PhD bioengineering
photo by Thomas Spierito

Making Her Mark

XUEZHU CAI HAS A THEORY about Parkinson's Disease.

What if the disease is caused by a failure of glymphatic system, the recently-discovered network that drains toxic biological waste produced by brain cells. If this theory is correct, it could lead to earlier diagnosis and intervention that can restore the drainage system before too much damage is done.

"The problem now is that once a person shows motor symptoms of Parkinson's, it's already too late," said Cai, who is earning her PhD in bioengineering and participating in the Experiential PhD program. "The harmful protein accumulation (alpha-synuclein) and an enormous loss of dopaminergic neurons, which are the major pathological hallmarks of the disease, are an irreversible process that cannot be stopped with treatment."

In August 2019, Cai published a paper in the Proceedings of the National Academy of Sciences that confirmed that the glymphatic system varies with the dark/light circadian cycle despite the subject's state of wakefulness. The paper also establishes a strong correlation between glymphatic activity and brain temperature.

"The discovery that this is driven by brain temperature is a game-changer," said Professor of Psychology and Pharmaceutical Sciences Craig Ferris, director of the Center for Translational Neuroimaging at Northeastern and Cai's PhD faculty advisor. "It has the potential to open a new line of investigation into the glymphatic system and degenerative brain disease."

Ferris said Cai's upcoming paper on traumatic brain injury is likely to have an even bigger impact. This paper will demonstrate that mild knocks to the head in a 48-hour period can damage the glymphatic system in rats. Although there appears to be no

significant injury at first, her research shows that three weeks later the flow of the glymphatic system has declined.

Cai believes that this finding could explain health problems among several groups prone to minor head injuries, including veterans, football players, and the elderly.

Her ultimate goal

In addition to her research at Northeastern, in 2018 Cai did an internship at Sanofi Genzyme, where she worked with neuro fluorescent imaging and Micro CT imaging.

"I learned a lot of things I couldn't have learned working in a lab, including how pharmaceutical companies operate and process data," she said.

This experience sparked her fascination with the blend of bioengineering and data science, and she spent the next year earning seven online certificates in programming, AI, and machine learning.

While working on her PhD, Cai is also enrolled in LEADERS, a graduate program that provides leadership training to graduate students interested in managing teams of future innovators. As part of the program, she's working at Merck 20 hours a week in the safety assessment team, which is analyzing 50 years of company data to make safety projections for new medicines. She is currently leading a project on content-based image retrieval with digitized histopathology images.

"Goal is to combine bioengineering knowledge with advanced AI technology," she said. "This is the direction I would like my career to take. I want to stay in healthcare but want to do more computational work rather than work in a lab. I want to be working on product-related tasks."

On the Road to SUCCESS

MICHAEL TORMEY, E'20, has used his time at Northeastern to map out a unique career path in responsible, sustainable, and economically sound transportation planning.

Along the route, he has received several recognitions. Recently, he was one of 10 students nationwide named a New Face in Civil Engineering 2020 by the American Society of Civil Engineers for “demonstrating an astounding focus, ambition, and dedication to helping others.” He was also honored with the 2020 Marshall Scholarship. A prestigious award given to only 46 U.S. students, it offers exceptional students an opportunity to pursue post-graduate degrees in England.

As a Marshall Scholar, Tormey plans to pursue two master’s degrees. First, he will earn a degree in transportation planning and engineering at the University of Leeds, then move on to the London School of Economics, where he will study regional and urban planning.

This unique combination of interests is nothing new to Tormey, a dual major in civil engineering and economics. “Most people think of effective transportation planning as a simple matter of efficiency—how to get people from point A to point B in the fastest or cheapest way,” says Tormey. “But a variety of experiences at Northeastern have made me realize the huge implications of transportation for society and the environment. It’s a big, complex problem that I want to spend my career solving.”

Tormey focused on urban transportation planning and management during three co-ops with urban planning agencies in the U.S., including the Boston Transportation Department. He balanced this real-world work experience with participation in three Dialogue of Civilizations—intensive, faculty-led programs where students study topics abroad for four to six weeks during the summer. Tormey studied climate-change science and policy in India, green space planning in Singapore and Indonesia, and political science and urban development in Tokyo.

“Northeastern has really given me a global perspective on transportation planning,” Tormey points out. “There are certainly matters of convenience, cost, and speed to consider, but also larger and broader societal considerations such as sustainability, climate change, and resilience. We also need to ensure that people have equal access to transportation, since that has an enormous impact on quality of life, health, and employment opportunities.”

Tormey believes he will gain an even broader perspective as a Marshall Scholar, because the UK is an established world leader in public transportation innovation, including the introduction of the steam railway, underground subways, the Chunnel and London’s global style-defining transit map.

Eventually, Tormey hopes to return to the U.S. and assume a leadership role in transportation planning, where he can help make decisions and trade-offs that benefit society as a whole. “U.S. cities rely heavily on single-car ownership, which is not equitable or sustainable,” he explains. “We need to look to other regions of the world that are implementing more socially responsible models, then apply those lessons here at home.”



photo by Ruby Wallau

WELCOME NEW FACULTY

The College of Engineering has hired over 90 faculty since 2012, and 12 in 2019.



ROUZBEH AMINI
Associate Professor of Mechanical and Industrial Engineering, jointly appointed in Bioengineering
PhD, University of Minnesota



KELSEY PIEPER
Assistant Professor of Civil and Environmental Engineering
PhD, Virginia Tech



SARA HASHMI
Assistant Professor of Chemical Engineering
PhD, Yale University



MILAD SIAMI
Assistant Professor of Electrical and Computer Engineering
PhD, Lehigh University



ANDREW JONES
Assistant Professor of Chemical Engineering
PhD, Massachusetts Institute of Technology



BEN WOOLSTON
Assistant Professor of Chemical Engineering
PhD, Massachusetts Institute of Technology



JOSEP JORNET
Associate Professor of Electrical and Computer Engineering
PhD, Georgia Institute of Technology



MOHAMMEND ABBAS YASEEN
Assistant Professor of Bioengineering
PhD, Rice University



YANING LI
Associate Professor of Mechanical and Industrial Engineering
PhD, University of Michigan



YANG ZHANG
Professor of Civil and Environmental Engineering
PhD, University of Iowa



MONA MINKARA
Assistant Professor of Bioengineering
PhD, University of Florida



YI ZHENG
Associate Professor of Mechanical and Industrial Engineering
PhD, Columbia University

Faculty Promotions

UNIVERSITY DISTINGUISHED PROFESSOR

AKRAM ALSHAWABKEH

civil and environmental engineering, and senior associate dean for research and graduate education

PROFESSOR AND CHAIR

MARILYN MINUS

mechanical and industrial engineering

PROFESSOR

RAYMOND FU

electrical and computer engineering, jointly appointed in Khoury College of Computer Sciences

YINGZI LIN

mechanical and industrial engineering

PURNIMA RATILAL-MAKRIS

electrical and computer engineering

SANDRA SHEFELBINE

mechanical and industrial engineering, jointly appointed in bioengineering

ASSOCIATE PROFESSOR

ENO EBONG

chemical engineering

RANDALL ERB

mechanical and industrial engineering

JOSE MARTINEZ-LORENZO

mechanical and industrial engineering, jointly appointed in electrical and computer engineering

YOUNG INVESTIGATOR RECOGNITIONS

These faculty recognitions bring the total young investigator awards in the college to 91, including 48 NSF awards.

Assistant Professor **Ambika Bajpayee**, bioengineering, was awarded a \$628K NIH Trailblazer R21 grant for New and Early Stage Investigators from the National Institute of Biomedical Imaging and Bioengineering (NIBIB) for “Anti-Catabolic Drug Anchored Cationic Exosomes for Cartilage Targeting and Repair.” See page 5.

Associate Professor **Yi Zheng**, mechanical and industrial engineering, received a \$500K National Science Foundation CAREER Award for the “Investigation of Nanoscale Radiative Heat Transfer for Enhanced Thermal Infrared Energy Conversion and Cooling.” See page 9.

Assistant Professor **Xiaoning (Sarah) Jin**, mechanical and industrial engineering, has received a \$500K CAREER Award from the National Science Foundation for “Unifying Sensing, Machine Perception and Control for High-Precision Micromanufacturing.” See page 11.

Assistant Professor **Yanzhi Wang**, electrical and computer engineering, received a Young Investigator Program Award from the Army Research Office (ARO) on ultra-efficient, real-time DNN acceleration on mobile platforms. See page 8.

RECENT FELLOWS

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



Professor **Debra Auguste**, chemical engineering, was selected as an American Institute for Medical and Biological Engineering

(AIMBE) Fellow in recognition of “her distinguished and continuing achievements in medical and biological engineering.”



University Distinguished and William Lincoln Smith Professor **Vincent Harris**, electrical and computer engineering, has been named

a 2020-21 Jefferson Science Fellow by the National Academies of Science, Engineering, and Medicine with the U.S. Department of State, Office of Environmental Quality and Transboundary Issues with the Bureau of Oceans and International Environmental and Scientific Affairs. He was also selected as a Distinguished Fellow of the International Engineering and Technology Institute.

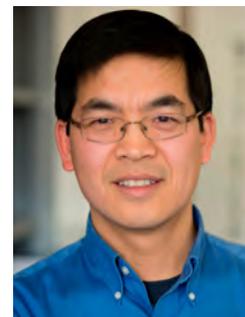


Yiannis Levendis, College of Engineering Distinguished Professor, mechanical and industrial engineering, has been elected a

Fellow of the National Academy of Inventors. He has also been admitted by the council to The Royal Society of Chemistry as a Fellow for his impact in the field of the chemical sciences.



Professor **Sandra Shefelbine**, mechanical and industrial engineering, jointly appointed in bioengineering, was selected as an American Institute for Medical and Biological Engineering (AIMBE) Fellow in recognition of “her distinguished and continuing achievements in medical and biological engineering.” She also received a Fulbright Futures Scholarship to the University of Melbourne to work on skeletal mechanobiology.



Professor **Nian Sun**, electrical and computer engineering, has been named an IEEE Fellow for his contributions to integrated magnetic

and magnetoelectric materials and devices. He also received the Humboldt Research Award by the Alexander von Humboldt Foundation.

FACULTY NEWS

Selected Highlights



Professor **Hameed Metghalchi**, mechanical and industrial engineering, was awarded the 2019 ASME George Westinghouse Gold Medal "for 40

years of scientific research and educational efforts in the field of power generation, which have contributed to improved plant operation and efficiency, and reduced pollutants; and for successfully promoting the dissemination of research as editor of ASME's *Journal of Energy Resources Technology*."

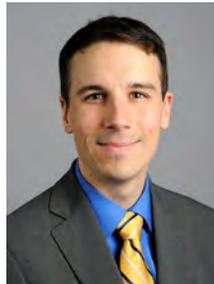


Assistant Professor **Xue (Shelley) Lin**, electrical and computer engineering (ECE), is leading a \$1.2M National Science Foundation

grant, in collaboration with ECE Professor Miriam Leeser and the University of Southern California, on developing "A Unified Software/Hardware Framework of DNN Computation and Storage Reduction Using ADMM."



Professor **Surendra M. Gupta**, mechanical and industrial engineering, was awarded the 2019 IEOM Society International Distinguished Professor Award in "recognition and appreciation of his dedication in teaching, learning and mentoring, and achievements in the field of industrial engineering and operations management."



The U.S. Department of Energy awarded Northeastern \$2.2 million to create an open dataset characterizing occupant-

centric control of grid-interactive efficient buildings. Assistant Professor **Michael Kane** (PI), civil and environmental engineering (CEE), is joined by co-investigators **David Fannon**, assistant professor of architecture and CEE, and **Misha Pavel**, ECE affiliated faculty and professor of practice of computer science and health sciences. They, in collaboration with the National Renewable Energy Laboratory (NREL) and industry partners ecobee and Packetized Energy, will design smarter occupant-centric building control algorithms that learn user behavior, are easy to use, and can correctly predict HVAC performance and power draw.



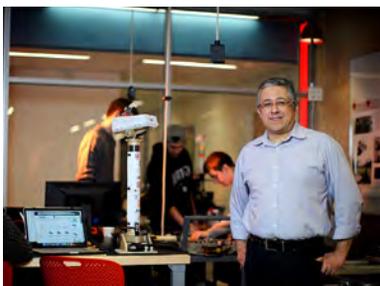
Assistant Professor **Sarah Ostadabbas**, electrical and computer engineering, is the

Northeastern principal investigator of a collaborative \$1.2M National Science Foundation grant with the University of Pittsburgh on "SCH: INT: Collaborative Research: Detection, Assessment and Rehabilitation of Stroke-Induced Visual Neglect Using Augmented Reality (AR) and Electroencephalography (EEG)." The project will develop a brain-computer interface (BCI) system that will be implemented in an augmented reality (AR) environment for detection, assessment and rehabilitation of unilateral neglect during activities of daily living.

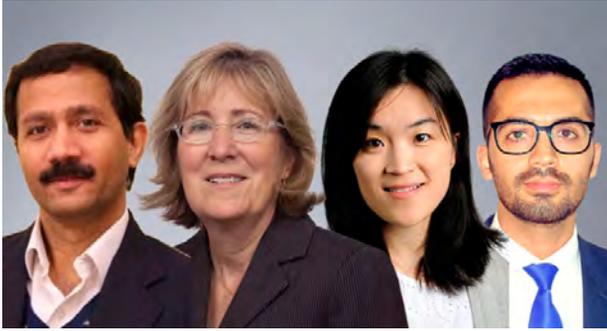


Associate Professor **Andrew Myers**, civil and environmental engineering, in collaboration with Johns

Hopkins University and Vestas Wind Systems, was awarded an \$899K National Science Foundation grant for "Optimization of Infrastructure-Scale Thin-Walled Tube Towers including Uncertainty," to understand structural imperfections of thin-walled tubes as they have high potential for use in a variety of civil infrastructure applications.



Associate Professor **Taskin Padir**, electrical and computer engineering, is principal investigator of a \$2.5M grant from the National Science Foundation's Big Idea, Future of Work at the Human Technology Frontier Program. The grant, which includes researchers in the College of Engineering, College of Social Sciences and Humanities, and the College of Arts, Media, and Design will create "Co-worker Robots to Impact Seafood Processing (CRISP): Designs, Tools and Methods for Enhanced Worker Experience."



Professors **Sagar Kamarthi** and Interim Dean **Jacqueline Isaacs**, as well as Assistant Professors **Xiaoning Jin** and **Mohsen Moghaddam**, all of mechanical and industrial engineering, and Assistant Vice Chancellor for Digital Innovation and Enterprise Learning Kemi Jona were awarded a \$2M National Science Foundation grant for the Integrative Manufacturing and Production Engineering Education Leveraging Data Science program to develop free online courses to help people working in manufacturing modernize and retool their skills.



Professor **Ahmed Busnaina**, mechanical and industrial engineering, has received the 2020 William T. Ennor Manufacturing

Technology Award from the American Society of Mechanical Engineers "for the development of a scalable directed assembly-based nanoscale technology to print bio and chemical sensors, power electronics, and light emitting diodes using inorganic or organic materials on flexible or rigid substrates.



Assistant Professor **Yanzhi Wang**, electrical and computer engineering, is the Northeastern lead of a \$1.2M National Science

Foundation grant that is in collaboration with the University of Southern California to create, "FASTLEAP: an FPGA-based Compact Deep Learning Platform." The research will develop a Field Programmable Gate Array (FPGA)-based platform for accelerating deep learning, not only inference, but also training and model compression.



Assistant Professor **Stratis Ioannidis**, electrical and computer engineering (ECE), is leading a \$1M National Science Foundation grant with ECE Professors Jennifer Dy and Tommaso Melodia, Associate Professor Kaushik Chowdhury, and Assistant Professor Yanzhi Wang to develop "Efficient and Adaptive Real-Time Learning for Next Generation Wireless Systems."



Professor **Milica Stojanovic**, electrical and computer engineering, was awarded the 2019 IEEE Women in Communications Engineering Outstanding Achievement Award for having done outstanding technical work in the broad field of communications engineering, and achieving a high degree of visibility in the field.



Electrical and Computer Engineering Affiliated Associate Professor **Peter Desnoyers** (PI)

and Professor **Miriam Leeser** (co-PI), electrical and computer engineering, are the Northeastern University leads of \$1.55M National Science Foundation grant that is part a \$5M total award in collaboration with the University of Massachusetts Amherst (lead) and Boston University.



Civil and Environmental Engineering Professor **Auroop Ganguly's** spinout company, risQ, founded by him and his former

doctoral student Evan Kodra, has announced a relationship with Intercontinental Exchange (NYSE:ICE) to help enable the municipal bond ecosystem to incorporate climate risk into project and investment decisions.



Assistant Professor **Hongli (Julie) Zhu**, mechanical and industrial engineering, was awarded a \$1M grant from the Department of

Energy's Advanced Manufacturing Office to work on "Enabling Advanced Electrode Architecture through Printing Technique." It is one of 55 projects nationwide awarded by the DOE to support innovative advanced manufacturing research and development.

STUDENT NEWS

Selected Highlights

NATIONAL SCIENCE FOUNDATION GRADUATE RESEARCH FELLOWSHIP STUDENT AND ALUMNI AWARD RECIPIENTS

Award Offered

Corrine Casey Bowers, E'18,
civil engineering

Sofia Kristina Catalina, E'20,
chemical engineering

Benjamin Gincley, E'19,
bioengineering, PhD'24, interdisciplinary

Maria Rain Jennings, E'18,
chemical engineering

Emma Therese Kaeli, E'18,
chemical engineering

Chase Patrick Kelley, E'17,
chemical engineering and physics

Justin Mayer, E'17,
chemical engineering and physics

Catherine McManus, E'16,
civil engineering

Joanne Truong, E'19,
electrical and computer engineering

Bryan Wang, E'19,
chemical engineering and biochemistry

Elizabeth Paige Wig, E'20, ME'20,
electrical engineering



Bioengineering student **Jake Potts**, BS/MS'20, received a prestigious Fulbright Fellowship. Potts will conduct research at Sorbonne University in Paris, France to try to determine how certain cancerous mutations happen as DNA is "misrepaired," a process that occurs when radiation or harsh chemicals break the two strands of DNA, and the body's cells respond by trying to repair this damage.



Madeline DuBois, E'20, environmental engineering, was awarded a prestigious Fulbright scholarship to continue studies at the University of Copenhagen in Denmark. The scholarship will enable DuBois to study agriculture with a specialization in production and the environment.

Kerry Eller, E'21, bioengineering, has been named a Truman Scholar. This is the most prestigious award for junior-level undergraduate citizens of the United States who possess outstanding leadership skills and are interested in a career in public service.



Katie Hoyt, PhD'24, chemical engineering, won the prestigious national Ford Foundation Fellowship to support her doctoral research. Advised by Assistant Professor Benjamin Woolston, she is using metabolically engineered acetogenic microbes to convert renewable single-carbon feedstocks into chemicals and fuels.

Bioengineering student **Erica Wagner**, E'20, earned the prestigious Barry Goldwater Scholarship in 2019, the United States' premier award for outstanding young researchers in STEM fields.





The Paradigm Hyperloop student team competed in the 2019 SpaceX Hyperloop Competition in California and placed eighth in the world and third in North America.



Chang Liu, PhD mechanical engineering, was awarded first place in the ASME Noise Control and Acoustics Division student paper competition for the paper "Preliminary Results of Microwave-Induced Thermoacoustics Imaging in Geological Media" which

was presented at the 2019 International Mechanical Engineering Congress & Exposition.



The Northeastern student team, advised by Associate Professor Taskin Padir, electrical and computer engineering, was one of 10 teams selected as finalists for the NASA 2020 RASC-AL Special

Edition: Moon to Mars Ice and Prospecting Challenge.



Northeastern's **Black Engineering Student Society** (BESS) was selected to receive the 2019-2020 National Society of Black Engineers Medium Chapter of the Year award. This accomplishment happened under the

leadership of electrical engineering student James Tukpah, E'20, who is the BESS president. Tukpah has been accepted to Northeastern's graduate school in the mechanical engineering/robotics program.



The Northeastern Graduate Structural Engineering Association (NGSEA) was selected by the Structural Engineering Institute Local Activities Division as the Graduate Student Chapter of the Year.

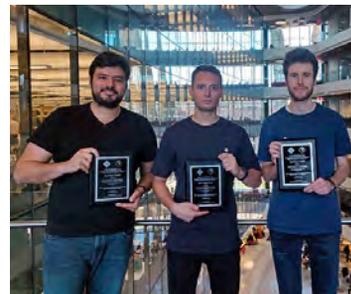
Chemical engineering student, **James Sinoimeri**, E'21, working in the laboratory of Assistant Professor Sidi A. Bencherif, earned second place at the 2019 Falling Walls Lab Boston Competition—an international forum to promote exceptional ideas and to connect promising scientists and entrepreneurs from all fields on a global level.



Northeastern's student team was one of eight student groups from U.S. colleges selected to compete in NASA's Breakthrough, Innovative and Game-changing (BIG) Idea Challenge. With a \$90K grant and access to testing facilities at different NASA centers over the next 10 months, the students will develop a new robotic system with four legs vs. wheels which could be part of a lunar mission by 2023.



Northeastern's Engineers without Borders chapter was selected for the 2019 Premier Chapter Award from EWB-USA.



Computer engineering students, **Lorenzo Bertizzolo**, PhD'21, and **Leonardo Bonati**, PhD'21, along with Research Assistant Professor **Emrecan Demirors**, and William Lincoln Smith Professor

Tommaso Melodia, electrical and computer engineering, won the Best Paper Award at the 13th ACM Workshop on Wireless Network Testbeds, Experimental Evaluation & Characterization (WiNTECH) in Los Cabos, Mexico.



photos by Matthew Modoono



He Has Created 110 Ways to Treat Diseases and Save Lives

BY IAN THOMSEN, NEWS @ NORTHEASTERN

MANSFIELD, MASSACHUSETTS—A 14-year-old girl in Toronto was suffering from a cancerous tumor embedded within the bone of her leg. Her doctor sought help from Bob Rioux, a Northeastern graduate who has invented scores of medical devices. The tumor was growing and pressing against a hard layer of cortical bone. The overwhelming pain prevented her from sleeping for more than an hour at a time.

“Her doctor, Murray Asch, called me and said, ‘Can we do something for her?’” says Rioux, an inventor with 110 patents for medical devices.

Rioux hurried to find an answer. Years earlier, he had developed a device that probed soft tissue and then opened like an umbrella to remove tumors. He modified that device and then tested it on pig bone (“It’s tougher than human bone,” Rioux says). Within two weeks, the device was drilled by hand into the girl’s leg, where it was expanded within the soft tissue of the bone marrow to remove the tumor. That night, she slept 14 hours.

“The family wanted to meet me,” Rioux says. “It’s the most fulfilling part of the job for me: helping people.”

Rioux, who has another 40 patents pending, backed into his role as inventor after dreaming of flying planes for the Air Force. After graduating with a degree in mechanical engineering from Northeastern in 1985 on an ROTC scholarship, Rioux failed to qualify as an Air Force pilot.

“I was ‘too aggressive with the aircraft,’” he says with the slightest smile.

He moved into military intelligence as an air-defense analyst in Germany, where he was charged with gauging Soviet weaponry. He enjoyed the work—having minored in Russian at Northeastern—but the Warsaw Pact was crumbling, the Cold War was ending, and he didn’t see a future for himself in the military.

While searching for his next move, Rioux recalled how much he had enjoyed one of his Northeastern co-ops with a medical devices company. In 1988, he moved back home to Massachusetts to become a product development engineer for a biotech firm.

Rioux’s first inventions were especially difficult; Not only was he trying to solve difficult problems, but he was teaching himself how to solve them. Over the course of a decade, he developed a methodology of asking “a lot of dumb questions” and then turning the answers into mechanical and electrical solutions. He routinely goes into operating rooms to watch procedures. He asks what is going wrong. Sometimes he notices problems and inefficiencies that the doctors and nurses have failed to recognize. Then he designs equipment to help solve the issues.

His devices cover a variety of medical fields—gynecology, orthopedics, wound care, and oncology. One of his specialties is radiofrequency (RF) ablation, by which electricity generates heat to kill cancer cells.

“My initials are R.F.R., so I was born for radiofrequency ablation,” he says. “My mother gets a kick out of that.”

He is currently developing products at Proven Process Medical Devices in Mansfield, Massachusetts, where he works every day with one of his former co-op supervisors of three decades ago, chief financial officer James Sluetz. Rioux has an ability to translate sophisticated medical techniques and language in order to arrive at fundamentally simple solutions.

“He has a rapport with clinicians and end users that enables him to garner the real problem that they’re trying to solve,” says Sluetz, who, like his two fellow co-founders of Proven Process, is a Northeastern graduate.

Rioux has built a rapport with attorney Robert Tosti, another Northeastern graduate, who executed Rioux’s first and 100th patent, and many others.

“We run things by each other and collaborate,” Rioux says. “He taught me to develop not just good inventions, but good patents.”

Rioux puts in 50 to 55 hours a week, but his mind works around the clock on the latest riddles. Instead of carrying a notebook, he relies on his phone for the questions that are puzzling him. (He often tests his products on store-bought meat products.) Over the past four years, he has begun earning equity from his inventions.

“Maybe I should have done that before, but my family and I were happy,” says Rioux, who was a salaried employee for most of his career. “I joined the military for a sense of purpose, and developing medical devices gives me that same sense of purpose.”

Rioux is hoping to venture into commercial products. He has two patents for a device that prevents kids from playing video games until they’ve done their homework. If they are able to answer a series of educational questions, then they’re allowed to play.

“My sons tell me it’s evil,” Rioux says. “And I counter with, then it must be good.”

DEAR ALUMNI AND FRIENDS,

This year's magazine closes a unique new chapter in the history of Northeastern's College of Engineering. Comprehensive classes—on campus and online—challenged our students to become better, stronger engineers. Co-op programs around the globe united us, creating partnerships between today's companies and tomorrow's new leaders. We broke new ground in research, and created new opportunities for it through new makerspaces and remodeled laboratories.

None of it would be possible without you, our donors—and we thank you for it.

Community is important at the College of Engineering—now more than ever. COE alumni and friends live and work in a global society. They are examples of how generosity and good works can push the boundaries of engineering, finding new solutions for problems in a quickly evolving period. As a part of our community, you have contributed to this mission through your support of undergraduate scholarships and graduate fellowships, as well as cutting-edge education and

research. You have lifted up our COVID-19 research efforts as we create new initiatives and programs to address the changing situation. You have served as mentors and guides, inspiring students and building bridges between our campus and the broader scientific world.

The pages to come cover only a fraction of the ways your giving has impacted the College of Engineering. From renovating our undergraduate labs to student and faculty support for our departments, your philanthropy brings the College to new heights. We look forward to continuing to work with you in the year ahead, with virtual meeting capabilities (including phone, web, email, and video/meeting conferencing) available in addition to our usual round the country visits in order to stay connected.

And from all of us in COE, thank you and be well!

With appreciation,

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photo by Thomas Spierito

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Hard Work Pays Off

NO ONE KNOWS THE VALUE OF HARD WORK more than David House, ME'69, electrical engineering. Growing up in Muskegon, Michigan, where nearly everyone worked in a factory, House had an early love of science and a dream of becoming an engineer.

But because he lacked the financial resources to spend four years at a university, he attended Muskegon Community College for general education credits—then transferred to Michigan Technological University, where he ambitiously crammed three years of study into two, earning his BS in Electrical Engineering in 1965.

The value of education

“It was a great time to graduate as an engineer, and I received 19 job offers from all over the U.S.,” recalls House. “I worked hard for those opportunities, and I wanted to explore them all.” He only had one caveat: He wanted to work near a leading engineering university, where he could earn a master’s degree.

The winning combination turned out to be a job at Raytheon and a graduate degree in the (then) Department of Electrical Engineering at Northeastern. “I was attracted to the broad range of classes at Northeastern and the faculty’s industry experience,” House says. “It was the hands-on, problem-solving nature of the engineering curriculum that attracted me.”

For three-and-a-half years, House worked a full-time job at Raytheon while attending classes from 6 to 9 p.m. at Northeastern. “When I wasn’t working or in the classroom, I was doing homework,” House states. “I capitalized on the opportunity to learn everything I could, including computer design and digital systems.”

Those skills paid off in 1974 when he was recruited by a little-known, \$68 million company in Northern California called Intel. In a wildly successful 23-year career at Intel, House rose to senior vice president, coining the famous tagline “Intel Inside” and leading the development of the revolutionary 386, 486 and Pentium microprocessors. As general manager for microprocessors, he grew that business from \$40 million to \$4 billion in revenues.

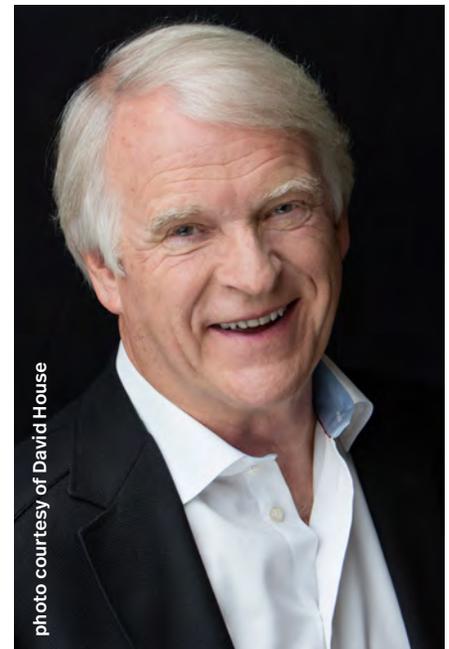
Paying it forward

These days, David House owns House Family Vineyards on 73 acres of Silicon Valley real estate that he started amassing in the early 1990s. He spends time with his children and grandchildren, who live nearby. He enjoys racing cars, yachting, and heli-skiing.

Equally important to House is giving back to organizations like Northeastern’s College of Engineering that helped fuel his success. Since 2012, House has served on Northeastern’s Board of Trustees.

Currently he and his wife, Devi Kamdar, are helping to finance a much-needed renovation of the Electrical and Computer Engineering Undergraduate Lab in Hayden Hall. The new facility will include a teaching laboratory and a maker space that encourage the kinds of hands-on problem-solving House experienced at Northeastern 50 years ago.

Why is it so important for House to support this project? “Education is one of the most powerful gifts you can give to someone,” he explains. “I grew up modestly and improved my circumstances, in part, because of the education I received in the College of Engineering. I want to give younger people those same opportunities to learn and advance themselves.”



I grew up modestly and improved my circumstances, in part, because of the education I received in the College of Engineering. I want to give younger people those same opportunities to learn and advance themselves.”

DAVID HOUSE, ME '69



photo courtesy of the Maddocks

Giving Back and Forward

WHEN IT COMES TO SUPPORTING his alma mater, Bob Maddock, E'72, is proud to follow the example set by his father Tom, a 1942 Northeastern graduate who, like his son, earned a chemical engineering degree, achieved professional success, and went on to give back to the university through generous financial support.

The first in his family to attend college, Tom Maddock endowed two undergraduate scholarships—The Davies Semple Maddock Engineering Scholarship and the Davies Semple Maddock Health Scholarship—to benefit future engineering and nursing students, the latter in honor of his wife and daughter who were nurses.

Today Bob and his wife Loretta, who is also a chemical engineer, are poised to continue that philanthropic tradition with a significant gift through their estate. The majority of their gift will establish a first-of-its-kind graduate fellowship in chemical engineering—a key recruiting tool for Northeastern—while the remainder will fund an undergraduate scholarship.

As a steward for his father's scholarship, Bob visited Northeastern as often as possible with Loretta to meet with scholarship recipients and professors and sit in on classes, experiences that left the couple consistently impressed with both

the growth of the college and the caliber of students and faculty. It was a meeting with Chemical Engineering Professor Rebecca Carrier and her grad students that ultimately inspired the couple's desire to create their own plan to give back. "I sensed at that meeting that both Rebecca and her grad students struggled with finances," says Bob. "The school wants to attract and retain a high level of student and it's expensive to go to school and live in the Boston area. Those are the sorts of things that cemented our idea to go ahead and establish something to support the university and students."

"We spent a lot of time figuring out what we could do," says Loretta who credits Senior Development Officer Kit McCarthy and Carrier for providing help and direction as the couple considered various options. "Funding a graduate fellowship enables Northeastern to attract top candidates and enhances the quality of engineering education," she says. "We think grad level students have already established a commitment to an engineering career by completing the undergrad program. And this fellowship would allow that person to establish a career in teaching or research."

"When you start to reach the age I'm at, you start to think about the mark you have left and what you can do for the future," says Bob. "There was an opportunity for us to give back and give forward. We wanted to do something more forward looking, something that would help the university as much as the students."

"This is our first opportunity to give back on a big scale," adds Loretta. "For us, it's very meaningful and we can see what impact it has. You don't have to have millions to make a difference in this world. Having the ability to go forward with this plan, it just feels good."

As the Maddocks move ahead with their philanthropic support, the family's generational connection to Northeastern continues: their niece, Katherine Hall, attends Bouve's nursing school, pursuing the same career as many of her family members. "She's in her second year and loves it," says Bob.

LIVING THE AMERICAN DREAM



photo courtesy of the Salmons

GROWING UP IN RURAL NEW ZEALAND, David Salmon, ME'65, electrical engineering, seized every technical opportunity, building radios, electric motors, and model planes from scratch.

His school-vacation jobs included laboring on wharfs, houses, and barns. He scraped sludge from the feeder of a fertilizer factory and the tanks of a paper mill. He surveyed land for a new road and measured the strength of concrete samples.

"I realized I would not be satisfied with any of those jobs as a career," Salmon says. "I was motivated to continue studying."

Salmon earned his BS in Electrical Engineering from the University of Auckland. He worked a year for the New Zealand Broadcasting Corporation. At that time, they were introducing television to the country. The work was interesting, but he still was not satisfied.

Professor Bogle, of the University of Auckland, visited U.S. engineering schools. On Bogle's recommendation, Northeastern University accepted Salmon sight-unseen as a lab assistant, enabling him to secure an immigrant visa.

The Chair of the Department of Electrical Engineering at Northeastern, Dr. Clayton, met Salmon and his wife, Diana, at the Boston airport with an advance check for \$500. That enabled them to buy groceries and pay rent.

From 1963 to 1965, Salmon earned his master's degree at Northeastern, while Diana worked as an administrative assistant in the College of Engineering co-op program. The then Dean Scott was a welcoming mentor. His excellent textbooks were a revelation. "I was learning rapidly, and between the earnings of Diana and myself, we were saving more than we had been earning in New Zealand."

An entrepreneur is born

Salmon next traveled to the University of Illinois to earn his PhD. Upon graduation, he spent a year at Stanford Research Institute, then joined Systems Control—a think tank that solved technology problems for the military. He left the company in 1975 to chase his own dream.

Salmon tried twice to found technology start-ups. With his brother, an engineer at Intel, he formed a company to develop a thermal printer. The idea had merit and the company gained venture capital, but it failed due to inability to manufacture thin-film print heads at adequate yield and cost. Then he led an effort to develop manufacturing management software. That failed due to inadequate financial backing and marketing acumen.

Salmon wrote software to support his own trading. After five years of solo effort, he made an alliance with Campbell and Company, a commodity trading advisor. For the next 25 years, his code made the buy and sell recommendations, as the firm grew from \$1 million to \$1 billion in invested capital.

Looking back — and giving back

At 80 years of age, Salmon still writes code for his own use.

After undergoing open-heart surgery in 2019, he looks back at critical moments in his life. "Northeastern's hospitality to me and Diana comes immediately to mind," states Salmon. "We are grateful and will include the College of Engineering in our estate plan."

"Northeastern took my knowledge to a new level, forming the foundation for my success. My journey to America was life-changing."

“Northeastern was directly responsible for me getting my first job.”

—JEFFREY KONTOFF,
E’74, ME’76



A Planned Gift: It’s Just Good Chemistry

Jeffrey Kontoff, E’74, ME’76, knew that landing a full-time job during the deep recession of the mid-1970s would be challenging. As a chemical engineering major at Northeastern, he had held co-ops in his home state of Connecticut—but after earning his bachelor’s degree, the economy tightened and businesses pulled back on hiring.

“There weren’t many companies interviewing or hiring,” Kontoff recalls. So, he opted to pursue his master’s degree at Northeastern, also in chemical engineering, hoping that the job market would improve in time. It did, and after a fortuitous conversation with the head of the department, Kontoff secured an interview at Monsanto in Springfield, Massachusetts. The economy was on an upswing and he was hired.

“Northeastern was directly responsible for me getting my first job, in addition to my education,” says Kontoff. “I moved out to western Massachusetts and spent my career with Monsanto.”

When talking about the university’s influence on their lives, Kontoff and his wife, Diane, include their

extended family. “Our son studied music business at Northeastern, and a couple of my cousins went there too,” he shares. Diane’s aunt and uncle are also alumni, and “Jeff and I both have a big family connection to Northeastern,” she adds.

Visiting Northeastern now, the couple is impressed with the changes on the Boston campus, from new buildings to academic progress. “The engineering department is really focused on research and solving cutting-edge problems,” says Kontoff.

Kontoff knows that Northeastern made a difference in his life, and he has decided to do the same for future students. Through a simple estate gift intention to the university, he is including beneficiary designations in a trust and retirement plan. Inspired by Northeastern’s commitment to research, Kontoff encourages graduates to visit the campus to see how much it’s changed.

Proud of the university’s global reach, Kontoff adds, “It’s been a remarkable transformation.”



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photo by Matthew Madoono

Northeastern's new pedestrian bridge connects the two ends of campus (as well as the Roxbury and Fenway neighborhoods of Boston) and provides quick access to the Interdisciplinary Science and Engineering Complex along a path that is better suited to crossing the railroad tracks.