Northeastern University
College of Engineering

2020 | 2021

SCHOLARSHIP REPORT
COLLEGE OF ENGINEERING

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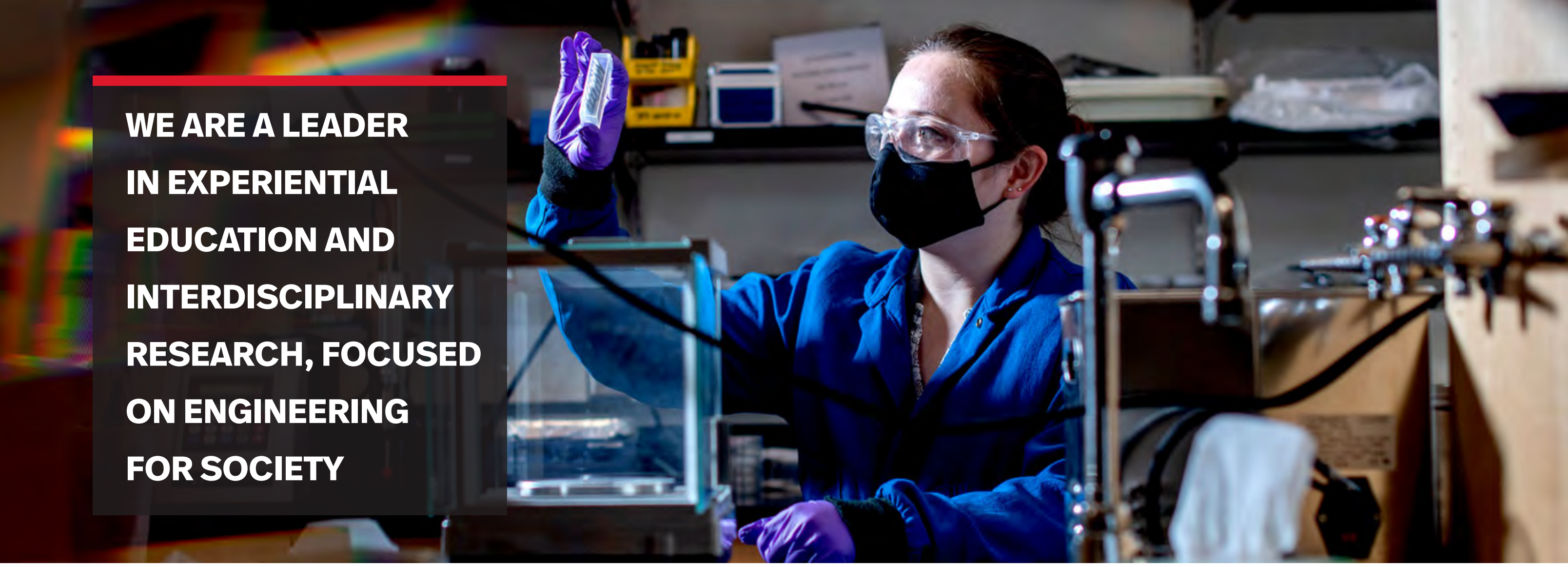


WE ARE A LEADER IN EXPERIENTIAL EDUCATION AND INTERDISCIPLINARY RESEARCH, FOCUSED ON ENGINEERING FOR SOCIETY

Dear Colleagues, Friends, and Students,

With a focus on translational and transformative research, we continue to push the bounds of innovation to new heights, embracing interdisciplinary collaborations at Northeastern and with industry, government, and academic partners. Despite the pandemic, our research enterprise is vibrant, with $82 million in external research awards in FY21, up 82% from 2015. Additionally, our college's graduate ranking by *U.S. News and World Report* remains strong at 31, up from 43 in the 2016 edition. We also have the highest enrollment of graduate engineering students in the U.S.

New university research institutes in emerging areas of robotics, artificial intelligence, and the wireless internet of things, for example, are providing hubs of expertise, resources, technology platforms, and partnerships to forge exciting advances for society. We are very proud that seven of our faculty were recognized with CAREER Awards from the National Science Foundation in the past academic year—the greatest number in our history. Other notable achievements include a $7.5 million Multidisciplinary University Research Initiative (MURI) award from the Department of Defense for control and learning enabled verifiably robust AI. Also, we received a $10 million award from the National Science Foundation for Engineering PLUS (Partnerships Launching Underrepresented Students) Alliance to build a system and a network to increase engineering degrees among women and BIPOC (Black, Indigenous, and Other People of Color) nationally.

Collaborative, interdisciplinary research is a must in our evolving complex world. We've added 22 new faculty for the 2021-2022 academic year, with several also holding appointments with other Northeastern colleges. More than a third of these faculty are women or historically underrepresented minorities, supporting our commitment to providing a diverse, equitable, and inclusive environment for all.

Northeastern is a global university and the College of Engineering is expanding our research and graduate educational offerings across the global network. Our newest campus locations offering graduate programs include Portland, Maine, and Toronto, Canada. Additionally, we've added state-of-the-art research capabilities in Portland, Maine in artificial intelligence and digital engineering. At Northeastern's Innovation Campus in Burlington, Massachusetts, our researchers are benefiting from the latest technology for 6G development and cybersecurity. More academic programs and research efforts are planned to be added to these and other Northeastern campus locations—nationally and globally—in the future.

Experiential education is the heart of a Northeastern education. We are proud to be ranked No. 1 in cooperative education nationally again this year. Even with a challenging employment climate, 950 of our graduate students were placed in co-op positions in the past academic year as well as 93 percent of eligible undergraduate students; fall 2021 is seeing even higher placements. This remarkable resilience is due to our large employer partner network, strong industry connections, agile program, talented students, and dedicated co-op faculty.

These are just some of the many accomplishments and initiatives happening in the College of Engineering. I invite you to explore this Scholarship Report and to contact us for more information.

Sincerely,

Gregory D. Abowd
Dean, College of Engineering
Northeastern University

QUICK FACTS

COLLEGE OF ENGINEERING

Five-year performance 2015 to 2020

ENROLLMENT AND OUTCOMES

GRADUATE DEGREE CONFERRALS

1805

Up 150% vs. 2015

1476

Mean 2-part SAT score up 28 points vs. 2015

TOTAL ENROLLMENT

7873

50.2% Graduate
49.8% Undergraduate

Enrollment Growth
vs. 2015

- 52% MS
- 33% PhD
- 16% BS

34%

New first year students are women, up from 27% in 2015

INTERDISCIPLINARY AND EXPERIENTIAL LEARNING

GRADUATE CO-OP PLACEMENTS

949

Up 48% vs. 2016

2660

Total Co-op Placements

2025

Co-op Employer Partners 2019-2021

94 Degrees, minors, and graduate certificates on five campuses and online

OVER 450

PlusOne accelerated master's degree pathways, including interdisciplinary with other Northeastern University colleges, and for engineering and non-engineering enrolled undergraduates

45

Academic programs interdisciplinary with other Northeastern University colleges

TRANSFORMATIONAL RESEARCH

$82M

2021 External Research Awards up **82%** vs. FY2015

104

Young Investigator Awards (YIAs) including **58** NSF CAREER Awards and **18** DOD YIAs

7 NSF CAREER Awards in 2020-2021 Academic Year

200 **TENURED/ TENURE-TRACK** faculty

84 Professional Society Fellowships

140 Patents (2015-August 2021)

The College of Engineering welcomes 22 new faculty for the 2021-2022 academic year, including eight jointly appointed in other colleges at Northeastern and 36% being women or historically underrepresented minorities.

GREGORY D. ABOWD
Professor, Electrical and Computer Engineering, and Dean of the College of Engineering
D.Phil, University of Oxford, United Kingdom, 1991
Scholarship focus: Mobile and ubiquitous Computing, human-computer interaction

SRIRUPA CHAKRABORTY
Assistant Professor, Chemical Engineering, jointly appointed in College of Science
(Joining January 2022)
PhD, University of Buffalo, 2017
Scholarship focus: Theoretical biology and biophysics

BENYAMIN DAVAJI
Assistant Professor, Electrical and Computer Engineering
(Joining January 2022)
PhD, Marquette University, 2016
Scholarship focus: Integrated microsystems, data-guided design and nanofabrication, ultrasound microsystems for sensing and computation, and MEMS calorimetry for microbiology and biosensor development

KRISTEN DORSEY
Associate Professor, Electrical and Computer Engineering, jointly appointed in Bouve College of Health Sciences
PhD, Carnegie Mellon University, 2013
Scholarship focus: Soft robotics, wearable devices, active and multifunctional materials, flexible electronics

CANEK FUENTES-HERNANDEZ
Associate Professor, Electrical and Computer Engineering
PhD, University of Arizona, 2004
Scholarship focus: Flexible and stretchable organic microelectronics and optoelectronics, device physics and engineering for sensing and energy generation, high throughput manufacturing and heterogeneous integration

FATEMEH GHOREISHI
Assistant Professor, Civil and Environmental Engineering, jointly appointed in Khoury College of Computer Sciences
PhD, Texas A&M University, 2019
Scholarship focus: Design and decision-making under uncertainty, machine learning and data analysis, multidisciplinary design optimization, autonomous and cyber-physical systems

AILEEN HUANG-SAAD
Associate Professor, Bioengineering, and Director of Life Science and Engineering Programs, the Roux Institute
PhD, John Hopkins School of Medicine, 1996
Scholarship focus: Entrepreneurship education microenvironments and their impact on the engagement of diverse populations, the influence of I-Corps on university ecosystems, and transforming BME education through instructional design

MAHDI IMANI
Assistant Professor, Electrical and Computer Engineering
PhD, Texas A&M University, 2019
Scholarship focus: Machine learning and data analytics, control theory and reinforcement learning, bayesian optimization and statistical learning, statistical signal processing and integrated sensing

JACK LESKO
Professor, Mechanical and Industrial Engineering, jointly appointed in Civil and Environmental Engineering, and Director for Engineering Research, the Roux Institute
PhD, Virginia Tech, 1994
Scholarship focus: Emerging interdisciplinary design involving lightweight polymeric multifunctional materials, structural design and reliability, with additional experience in distributed energy systems (storage, power transfer, packaging, and manufacturing), polymeric separation membranes, building energy efficiency design and construction, technology transfer

FRANCISCO LOTH
Professor, Mechanical and Industrial Engineering, and Bioengineering
(Joining January 2022)
PhD, Georgia Institute of Technology, 1993
Scholarship focus: Biological flows, experimental fluid mechanics, computational fluid mechanics, blood flow simulation, cerebrospinal fluid simulation, Chiari malformation, syringomyelia, medical image processing, magnetic resonance imaging

SUNIL MITTAL
Assistant Professor, Electrical and Computer Engineering
PhD, University of Maryland, 2014
Scholarship focus: Topological phenomena, non-Hermitian physics, quantum photonics, nonlinear photonics, two-dimensional materials

BETH NOVECK
Professor, Mechanical and Industrial Engineering, primary joint appointment in the School of Law and Director of the Burnes Family Center for Social Change and Innovation
PhD, Yale, 1997
Scholarship focus: Industrial and software engineering; solving public problems

OZAN ÖZDEMIR
Assistant Professor, Mechanical and Industrial Engineering
PhD, South Dakota School of Mines and Technology, 2017
Scholarship focus: Advanced metal additive manufacturing, compressible flows, multiphase flows, heat and mass transfer, thermodynamics, and failure analysis

DAVID ROSEN
Assistant Professor, Electrical and Computer Engineering, jointly appointed in College of Science
PhD, Massachusetts Institute of Technology, 2016
Scholarship focus: Robotics, optimization, geometry and topology, probability and statistics, machine learning

HANNAH SAYRE
Assistant Professor, Chemical Engineering, jointly appointed in College of Science
PhD, The Ohio State University, 2018
Scholarship focus: Design photocatalysts to improve efficiency and reactivity. Understand light-activated chemical reactions with time-resolved spectroscopy

SHAHIN SHAHRAMPOUR
Assistant Professor, Mechanical and Industrial Engineering
PhD, University of Pennsylvania, 2015
Scholarship focus: Machine learning, optimization and control, distributed and sequential learning, with a focus on developing computationally efficient methods for data analytics

MAX SHEPHERD
Assistant Professor, Mechanical and Industrial Engineering, jointly appointed in Bouve College of Health Sciences
(Joining January 2022)
PhD, Northwestern University, 2019
Scholarship focus: Prosthetics and wearable robotics design and control, gait rehabilitation, preference optimization, and machine learning

SEUNGMOON SONG
Assistant Professor, Mechanical and Industrial Engineering
(Joining January 2022)
PhD, Carnegie Mellon University, 2017
Scholarship focus: Modeling the neuromechanics of human movement and applying it to assistive devices and rehabilitation treatment

JULIA VARSHAVASKY
Assistant Professor, Civil and Environmental Engineering, jointly appointed in Bouve College of Health Sciences
PhD, University of California, Berkeley, 2017
Scholarship focus: Environmental exposures and maternal-child health outcomes and will continue to work on biomonitoring studies and advancing risk assessment in vulnerable communities

RAIMOND WINSLOW
Professor, Bioengineering, and Director of Life Science and Medicine Research, the Roux Institute
PhD, John Hopkins School of Medicine, 1985
Scholarship focus: Computational modeling of the cardiac myocyte to understand the molecular basis of arrhythmias; machine learning in critical care medicine to identify those patients who require urgent care

XUFENG ZHANG
Assistant Professor, Electrical and Computer Engineering
(Joining January 2022)
PhD, Yale University, 2016
Scholarship focus: Spin wave dynamics; magnon-based coherent information processing; quantum hybrid magnonics; integrated microwave, photonic, magnonic, and mechanical devices

QING ZHAO
Assistant Professor, Chemical Engineering
(Joining January 2022) PhD, Massachusetts Institute of Technology, 2019
Scholarship focus: Computational catalyst and material design for sustainable energy applications

17 Multidisciplinary Research Centers and Institutes

FUNDING BY EIGHT FEDERAL AGENCIES

ALERT Awareness and Localization of Explosives-Related Threats; a multi-university Department of Homeland Security Center of Excellence

BTIC Beyond Traffic Innovation Center; designated by the U.S. Department of Transportation, BTIC leads interdisciplinary research on transportation challenges of the next three decades for the Northeast region

CHEST Center for Hardware and Embedded Systems Security and Trust; a multi-university National Science Foundation Research Center, part of the Industry-University Cooperative Research Centers Program

CHN Center for High-rate Nanomanufacturing; a multi-institution National Science Foundation Nanoscale Science and Engineering Center

CIBC Center for Integrative Biomedical Computing; a National Institutes of Health university collaborative Research Center producing open-source software tools

CRECE Center for Research on Early Childhood Exposure and Development; a U.S. Environmental Protection Agency and National Institute of Environmental Health Sciences multi-project, multi-institution Research Center

CURENT Center for Ultra-wide-area Resilient Electric Energy Transmission Networks; a National Science Foundation and Department of Energy multi-university Engineering Research Center

GORDON-CenSSIS Bernard M. Gordon Center for Subsurface Sensing and Imaging Systems; a National Science Foundation graduated multi-university Engineering Research Center

HSyE Healthcare Systems Engineering Institute; a Department of Health and Human Services Center through the CMMI program; a university-level institute focused on healthcare improvement

IIA Institute of Information Assurance; a National Security Agency/Department of Homeland Security Center of Academic Excellence

INSTITUTE FOR CHEMICAL IMAGING OF LIVING SYSTEMS An interdisciplinary Northeastern University institute focused on creating technologies to view chemical processes in the brain and body in real time

INSTITUTE FOR EXPERIENTIAL ROBOTICS An interdisciplinary, Northeastern University institute focused on designing machines that adapt to people in real time for a more collaborative human-robot experience

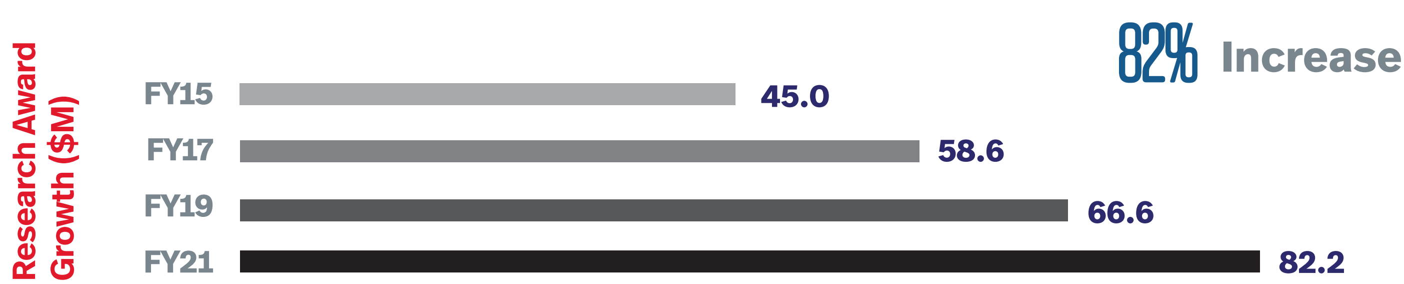
INSTITUTE FOR THE WIRELESS INTERNET OF THINGS An interdisciplinary, Northeastern University institute focused on advancing wireless technologies for next-generation networked systems

NORTHEASTERN SMART CENTER A Northeastern College of Engineering research center aimed at conceiving and piloting disruptive technological innovation in smart devices and systems to make everyday life safer, easier and more efficient

PROTECT Puerto Rico Testsite for Exploring Contamination Threats; a National Institute of Environmental Health Sciences multi-project, multi-institution Research Center

SPIRAL Center for Signal Processing, Imaging, Reasoning, and Learning; a federation of collaborating research laboratories

TANMS Center for Translational Applications of Nanoscale Multiferroic Systems; a National Science Foundation university collaborative Research Center



Northeastern Wins $10 Million NSF Grant to Boost People of Color and Women in Engineering Nationally

Karl Reid, Chief Diversity Officer, Northeastern University

Michael Silevitch, Robert D. Black COE Distinguished Professor, electrical and computer engineering

Claire Duggan, director of STEM programs and operations, College of Engineering

Richard Harris, assistant dean for Academic Scholarship, Mentoring, and Outreach

Despite decades of scattered efforts to improve diversity in engineering, the number of women and people of color remains far below their representation in the U.S. population as a whole.

To solve this problem, Northeastern's College of Engineering has won a prestigious $10 million grant from the National Science Foundation to build a system and a network to increase engineering degrees among women and BIPOC (Black, Indigenous, and Other People of Color).

"Our goal is to scale up things that are already working, not reinvent the wheel," says Robert D. Black College of Engineering Distinguished Professor **Michael Silevitch**, electrical and computer engineering, who led the grant writing team. "We want to identify strategies that work and have momentum, then expand them regionally and across the nation."

The five-year goal of the new Engineering PLUS (Partnerships Launching Underrepresented Students) Alliance is to increase the annual number of engineering degrees among underrepresented groups to 100,000 among undergraduates and 30,000 among graduate students. Currently, the BIPOC community accounts for just 18 percent of engineering graduates and 34 percent of the population as a whole, while women account for 23 percent of the graduates and 51 percent of the total population.

The failure to tap into this enormous pool of talent compromises our competitiveness as a nation, according to **Karl Reid**, Northeastern's Chief Diversity Officer and PI for the new Engineering PLUS Alliance.

"We need everyone involved in innovation and invention," says Reid. "Diversity makes us better. It helps us identify new problems in engineering and shapes the way we solve them. Engineering is a collaborative effort and research shows that diverse groups are more effective than homogeneous teams at solving complex problems and generating new ideas."

To rectify this siloed approach, the Alliance will create a regional structure that is both sustainable and can be replicated across the nation. The first step will be the creation of a New England and a Midwest regional hub of academic, business, and nonprofit institutions to work cooperatively to build diversity. The next step will be to replicate this structure in four other major regions across the country, involving 150 education institutions.

"We will be taking an engineering approach to address a complex problem that has persisted in our society," says **Claire Duggan**, director of STEM programs and operations in the College of Engineering. "We need to accelerate the replication of best practices and need to develop buy-in from the institutional leaders."

The Alliance will work in cooperation with existing organizations such as the NSF Louis Stokes Alliance for Minority Participation (LSAMP), the National GEM Consortium, the National Action Council for Minorities in Engineering (NACME), and representative members of the 50K Coalition, which includes affinity groups that support Black, Latinx, Native American, and women engineering students.

To ensure this regional concept takes hold, the Alliance will establish a Peer Leadership Training Academy to prepare 450 academics, administrators, and industry leaders to become change agents among universities, high schools, community colleges, and businesses in the region.

Why Northeastern?

One distinctive value Northeastern will bring to this effort is its close ties with industry leaders, who will be essential to both the training pipeline and funding a sustainable national effort.

"Northeastern has more than 2,000 industry co-op partners for engineering students," notes **Richard Harris**, assistant dean for Academic Scholarship, Mentoring, and Outreach and director of NU Program in Multicultural Engineering. "We have been working intensely on engineering diversity for 30 years. The university's first Rhodes Scholar was a Black, female engineer."

Harris also notes that the three pillars of research at Northeastern are health, security, and sustainability—all are top national priorities and all require innovative engineers.

In addition, the four leaders of the Alliance—Reid, Silevitch, Harris, Duggan, and Karen Horting of the Society of Women Engineers—each have decades of experience working to increase engineering diversity at all levels of the pipeline from the K-12 to the PhD level.

Collective Impact

"There are structures and institutions in our society that are unwelcoming to women and BIPOC students. Through collective impact, the Alliance will catalyze systems change that lower barriers and increase opportunities for success. We're working on changing the K-PhD systems by identifying and scaling successful initiatives that address academic and social challenges, with a particular emphasis on transition points," explains Reid.

Silevitch believes that a focus on transition points is key. "It's so important to replicate successes like Summer Bridge programs, which provide additional instruction, mentoring, and social skill building so students will thrive in a new environment that may be foreign to their everyday experience."

"There are pockets of successful programs that are siloed across the nation," says Harris. "We need to align and integrate these initiatives systematically to create a transformative and sustainable approach to K-PhD education nationally."

$7.5 Million DoD MURI Award for Control and Learning Enabled Verifiably Robust AI

Mario Sznaier, Dennis Picard Trustee Professor, electrical and computer engineering (ECE), is leading a multi-university team that was awarded a $7.5 million, five-year grant from the Department of Defense (DoD), as part of the annual Multidisciplinary University Research Initiative (MURI) competition.

Sznaier's project, titled "Control and Learning Enabled Verifiable Robust AI (CLEVR-AI)," is sponsored by the Office of Naval Research and includes co-PIs from Northeastern—Professor Octavia Camps and Assistant Professor Milad Siami, both from ECE, and University Distinguished Professor Eduardo Sontag, ECE and bioengineering—and from UC Berkeley, the University of Michigan, and Johns Hopkins.

Sznaier and his team are designing control systems capable of utilizing artificial intelligence (AI) and machine learning methods to learn from and interact within complex environments in a safe way. Like living systems, the resulting systems will adapt to novel scenarios, where data is generated—and decisions are made—in real time.

The research will lead to a new neurally inspired framework for learning and control, where insights from dynamical systems are used to design verifiable and safe machine learning algorithms, and insights from machine learning and neuroscience are used to design the next generation of learning-enabled control systems. This framework will be a key enabler for designing a new class of truly autonomous systems that are aware of high-level mission specifications and low-level physical constraints and capabilities.

This capability will benefit a variety of mission-critical applications such as providing situational awareness to humans like first responders experiencing information overload in a disaster area, and for monitoring large uninhabited spaces such as coastlines and forests for potential hazardous situations.

"There is a disconnect between the promise of AI and the low level of autonomy in existing systems," explains Sznaier. "The issue we are working to solve is how to make an autonomous system learn about new situations in its environment while still making safe decisions in real time. This is something that researchers have struggled with; it's hard to task something that is self-learning to perform safety-critical actions in unknown, previously unseen environments."

Self-learning autonomous systems need to operate in a closed loop system, meaning they are making continuous corrections on their actions and learning as they go. The problem is that if a system makes an incorrect action, then those continuous corrections compound themselves. In extreme examples, the self-driving car hits a stop sign, or the self-driving drone crashes.

Sznaier's team members comprise a wealth of knowledge in diverse areas, such as control theory, machine learning, computer vision, and bioengineering. This academic expertise is enhanced by university capabilities, such as Northeastern's flight facility for unmanned autonomous systems and the University of Michigan's Mcity Test Facility, a purpose-built proving ground for testing automated vehicles under controlled and realistic conditions.

Mario Sznaier, Dennis Picard Trustee Professor, electrical and computer engineering

Octavia Camps, professor, electrical and computer engineering

Milad Siami, assistant professor, electrical and computer engineering

Eduardo Sontag, University Distinguished Professor, electrical and computer engineering, jointly appointed in bioengineering

Northeastern Receives Rare FCC Designation as a Spectrum Innovation Zone

First to enable experimentation for wireless communications and sensing technologies above 100 gigahertz

Northeastern University was designated as a Spectrum Innovation Zone by the Federal Communications Commission, a status that affords researchers at the university new opportunities to build and test the next generation of wireless technology. The Innovation Zones at Northeastern's campuses in Boston and Burlington, Massachusetts, establish the university as the fourth such hub in the United States.

"This designation consolidates Northeastern University's role as a leader and innovator of wireless research," says **Tommaso Melodia** who is the William Lincoln Smith Professor of electrical and computer engineering at Northeastern, as well as director of the Institute for the Wireless Internet of Things.

The university joins Raleigh, North Carolina; New York City; and Salt Lake City in conducting groundbreaking research of 5G, 6G, and other wireless modalities. The work is supported by the National Science Foundation through its Platforms for Advanced Wireless Research, which is part of Northeastern's Institute for the Wireless Internet of Things.

The Northeastern University Innovation Zone is the first to enable experimentation for wireless communications and sensing technologies above 100 gigahertz, including a frequency band that "is crucial for the development of 6G technologies," Melodia says.

Such designation by the FCC streamlines the experimentation process so that researchers can quickly test a broader range of wireless capabilities.

Department Research Areas

BIOENGINEERING
Biomechanics, Biotransport and MechanoBiology
Computational and Systems Biology
Imaging, Instrumentation, and Signal Processing
Molecular, Cell, and Tissue Engineering

CHEMICAL ENGINEERING
Biomolecular & Biomedical Systems
Complex & Computational Systems
Energy & Sustainability
Engineering Education & Pedagogy
Materials & Nanotechnology

CIVIL AND ENVIRONMENTAL ENGINEERING
Civil Infrastructure Security
Environmental Health
Sustainable Resource Engineering

ELECTRICAL AND COMPUTER ENGINEERING
Communications Control and Signal Processing
Computer Networks and Security
Computer Systems and Software
Computer Vision, Machine Learning, & Algorithms
Electromagnetics and Optics
Microsystems and Devices
Power Electronics, Systems and Controls
Robotics

MECHANICAL AND INDUSTRIAL ENGINEERING
Biomechanics and Soft Matters – Solids & Fluids
Energy Systems
Healthcare Systems
Impact Mechanics
Mechatronics and Systems – Control, Robotics, and Human Machines
Multi-phase Structured Matter
Multifunctional Composites
Resilient Systems
Smart and Sustainable Manufacturing

Upon Graduation, Masters and PhD Students Take Positions at Top Organizations

Sampling of Positions

RESEARCH
National Institutes of Health
Boston Children's Hospital
Brigham and Women's Hospital
Draper Laboratory
NASA Jet Propulsion Lab
NASA Ames
MIT Lincoln Lab
Merck & Co.
Takeda
National Labs such as Argonne, Brookhaven, Oak Ridge, Pacific Northwest, Sandia
Pfizer
Children's Hospital – Philadelphia
Massachusetts General Hospital
Novartis

ACADEMIA
University of California (Berkeley, Los Angeles, San Francisco)
Massachusetts Institute of Technology
Johns Hopkins University
Boston University
Rensselaer Polytechnic Institute
Harvard Medical School
Worcester Polytechnic Institute
University of Maryland
University of Minnesota
University of Wisconsin
University of Toronto
Baylor College of Medicine
University of Massachusetts, Lowell and Amherst
Columbia University

INDUSTRY
Google, Microsoft, Bristol-Myers Squibb, Caterpillar, Cisco, Qualconm, Johnson & Johnson, Moderna, Intel, Dana Farber Cancer Institute, Dell, Amazon, BAE Systems, Raytheon, Walmart, PayPal, Apple, Schneider Electric, Proctor & Gamble, General Electric, Wayfair, JetBlue, Facebook, SpaceX, Tesla, Akamai, iRobot, Pratt & Whitney, Lockheed Martin, Biogen, Fidelity, Liberty Mutual, Thermo Fischer Scientific, PwC, Eversource, Naval Sea System Command, Oracle, Sanofi, Defense Advanced Research Projects Agency, Simpson Gumpertz and Heger

Qiyong Chen, PhD'20
MECHANICAL ENGINEERING

Advised by Sinan Müftü, Professor of Mechanical and Industrial Engineering

Qiyong Chen joined the Applied (Bio) Mechanics and Tribology Laboratory while pursuing his master's degree in the Department of Mechanical and Industrial Engineering at Northeastern University in 2014, and continued on to pursue his PhD after obtaining his MS in 2015.

Chen worked on two separate projects for his MS and PhD degrees. His MS thesis revolved around a medical procedure called radiofrequency (RF) ablation of hepatic tumors. In an effort to optimize pre-treatment planning, he integrated analytical solutions of the physical model and quadratic and nonlinear programing algorithms. With the same enthusiasm for mathematics and science, Chen shifted his research focus to the mechanics and material behavior of micron-scale metal particles in cold spray impacts during his PhD program. By leveraging finite element (FEM) simulations, the research work investigated various material responses such as adiabatic shear instability during supersonic impacts of Aluminum particles, which would otherwise be extremely difficult to observe and record with experimental measurements due to the ultra-high strain rates and extremely-short scale of the events. He also demonstrated an innovative approach to incorporate simulation results with artificial intelligence to drastically reduce the computational load of predicting particle impact results. Chen has published a total of six manuscripts, three as first author with several more in drafting and submission.

During his PhD program, Chen also completed an internship at Abaqus, the maker of a renowned finite element software company owned by Dassault Systèmes Simulia Corporation, and was ultimately recruited as a full-time employee after graduating. He is now applying his expertise in mechanics and simulation in the field of manufacturing and materials while working with colleagues and clients around the globe.

David R. Dias Vera, PhD'20
CHEMICAL ENGINEERING

Advised by Abigail Koppes, Associate Professor of Chemical Engineering

After receiving his bachelor's degree in chemical engineering from the Universidad Autonoma de Santo Domingo in 2013, David R. Diaz Vera worked at Falconbridge Dominicana for almost two years before joining Northeastern University. As a PhD student in the Department of Chemical Engineering, his research focused on neural regeneration strategies and tissue engineering. His work included gene therapy with viral targeting and photostimulation of the peripheral nervous system for which loss of function causes significant socioeconomical costs and lower quality of life due to lack of functional recovery with conventional methods. Using in vitro models of neurons involved in sensory and motor function, Diaz Vera has studied the nervous system's responses to a genetic manipulation and stimulation with light, a less invasive and more targeted approach than electrical stimulation. Importantly, he found that photo stimulation alone can manipulate how neurons grow and behave, which is important for defining boundaries of clinical applications. He also contributed to works focused on using other non-invasive neuromodulation techniques such as ultrasound and optogenetics to target and control nerve regrowth for improved injury recovery. This work was featured in the *Journal of Neuroscience Research, Women in Neuroscience* special issue in 2021. Overall, Dias Vera contributed to multiple manuscripts and peer reviewed conference presentations during his time at Northeastern. He also took advantage of the competitive graduate co-op program, working at Momenta Pharmaceuticals in Cambridge, Massachusetts, in platform development for protein glycosylation and enzymatic manipulation assays. He was also an outstanding teaching assistant for the Unit Operations Laboratory and Biology Laboratory where students enjoyed his hands-on approach to learning and depth of knowledge. Upon graduation, Dias Vera joined Sanofi Pharmaceuticals in Waltham, Massachusetts, as a scientist in the Genomic Medicine Unit in the Chemistry, Manufacturing and Control group.

Ramin Mohammadi, PhD'20
INDUSTRIAL ENGINEERING

Advised by Sagar Kamarthi, Professor of Mechanical and Industrial Engineering

Ramin Mohammadi's dissertation for his PhD in Industrial Engineering at Northeastern University was in applied artificial intelligence techniques to healthcare problems to maximize patients' quality of life, while minimizing the potential financial burden for healthcare organizations. He used natural language processing methods to understand clinical notes to predict complications for patients who had undergone surgery. He built predictive models and automated decision support tools to help healthcare providers identify at-risk patients. For example, he developed a neural network model that prescribes a weekly activity target for individuals using their Fitbit activity data. The model combined both physical activity and behavioral data to come up with personalized activity targets.

As part of the PhD program, Mohammadi worked as a data science intern at Partners Healthcare Connected for Health. He also developed a neural network model for combining data from multimodal sensors for machine learning at Philips Lighting (Signify). The company filed a patent for his work. Additionally, he worked as a deep learning engineer intern at Mitsubishi Electric Research Laboratories, where he developed a reinforcement learning model to improve the quality of HVAC systems.

Mohammadi presented his research at prestigious conferences and published seven journal papers. In addition, he actively contributed to several grant proposals. He received the 2020 Akira Yamamura Excellence in Research Award from the Department of Mechanical and Industrial Engineering (MIE) at Northeastern. He was also a finalist in the Boston Scientific Connected Patient Challenge III for his research on breast cancer.

In addition to being an active researcher, Mohammadi mentored fellow graduate students in their research. He also taught machine learning related topics as part of the Institute for Operations Research and the Management Sciences (INFORMS) workshop series and R programming as part of the Institute of Industrial and Systems Engineers (IISE) workshop series. Additionally, he built high-performance computing machines for Professor Sagar Karmarthi's research lab.

After receiving his PhD, Mohammadi joined Tausight as a machine learning engineer, where he leads a technical team focusing on data confidentiality, integrity, and the security of patients' protected health information. In addition, he is an MIE adjunct faculty member at Northeastern where he teaches graduate courses in machine learning and data visualization.

Cassie Nickles, PhD'21
CIVIL ENGINEERING

Advised by Edward Beighley, Professor of Civil and Environmental Engineering

Originally from Los Angeles, Cassie Nickles began her PhD journey with Northeastern's Department of Civil and Environmental Engineering in 2017 after graduating from Loyola Marymount University with her bachelor's in civil engineering. The same year, she received the Cochrane Fellowship, and in 2019 was awarded the prestigious National Science Foundation Graduate Research Fellowship. In her time working under the guidance of Professor Edward Beighley, Nickles' research focused on large-scale river networks and hydrologic applications enabled by NASA's upcoming Surface Water and Ocean Topography (SWOT) mission. Her dissertation specifically found that despite the SWOT mission's unique space-time sampling, derived discharges can be used to estimate river discharge frequency distributions, calibrate hydrologic models, and inform regional hydrology. In the four years of her PhD, she published four articles in top journals: *Remote Sensing, Water Resources Research, and Geophysical Research Letters*. She also presented her findings at ten conferences, nationally and internationally. From connections made at these conferences, she had the opportunity to intern at NASA's Jet Propulsion Laboratory in the summer of 2020. In addition to academic success, Nickles served as both a member and then president of the Civil and Environmental Engineering Department Graduate Student Council, intentionally facilitating and cultivating community between students, faculty, and the department with social events, orientations, and town hall meetings. In her future endeavors, Nickles seeks to continue combining her passions for service and intellectual stimulation, benefiting society through hydrologic and remote sensing applications.

Michael Stahl, PhD’21
BIOENGINEERING

Advised by Octavia Camps, Professor of Electrical and Computer Engineering

After earning his undergraduate degree in biomedical engineering from Boston University, Michael Stahl joined Northeastern University’s College of Engineering to pursue his master’s in computer engineering with a concentration in digital signal processing. As a master’s student, he studied the effectiveness of a psychophysical procedure to detect hearing loss. Upon graduating in 2004, Stahl entered the workforce, spending the next 8 years as a senior research engineering and project manager at Convergent Engineering, Inc. and Xhale Diagnostics Inc., developing medical diagnostics for breathing pathologies. He returned to Northeastern to pursue a PhD in Bioengineering. Stahl, who is legally blind, was excited to use his engineering skills to help the visually impaired. His research, in collaboration with Schepens Eye Research Institute in the Ophthalmology department at Harvard Medical School, developed a wearable, hands-free electronic travel aid (ETA) for the blind and visually impaired based on structured light principles. The device detects tripping hazards by analyzing laser light projected in front of the user and can be used in day and night conditions. The National Eye Institute awarded Stahl an F31 fellowship to pursue this research. He additionally won funding from Edmund Optics, Barrington, New Jersey, as well as a grant from the Stiftelsen Promobilia Foundation, Stockholm, Sweden, to construct a prototype and measure its impact on safe and effective travel for people with visual impairments. Stahl plans to continue research in low vision rehabilitation—specifically focused on increasing independent and safe travel—and to productize and market the electronic travel aid developed during this PhD dissertation.

Alexandria Will-Cole, PhD’23
ELECTRICAL ENGINEERING

Advised by Nian Sun, Professor of Electrical and Computer Engineering

Alexandria Will-Cole joined Professor Nian X. Sun’s Advanced Materials and Microsystems Lab in 2019 to pursue a PhD in Electrical Engineering at Northeastern University. Prior to her doctoral studies, she completed her MS in Materials Science and Engineering from Drexel University and her BA in Physics from the University of Arizona. Though her educational background is not traditional for an electrical engineering student, it has aided in her interdisciplinary doctoral studies. Her research lies at the intersection of materials physics and spintronics, with a focus on multifunctional materials, particularly magnetoelectric composites and multiferroics. In 2020, she was awarded the National Defense Science and Engineering Graduate (NDSEG) Fellowship sponsored by the Office of Naval Research for magnetoelectric heterostructures and device research. Magnetoelectric composites, which are layered magnetic and piezoelectric materials, allow for coupling between magnetism and electricity. These multifunctional composites can enable novel devices for communication, energy harvesting, and magnetic field sensing applications. Prior to the NDSEG fellowship, she was the recipient of two other graduate fellowships, the Alsaif Doctoral Fellowship, and the National Science Foundation Translational Applications in Nanoscale Multiferroic Systems (NSF TANMS) Doctoral Fellowship. TANMS is a multi-institutional engineering research center focused on research, technology translation, and education associated with magnetism on the micro- to nano-scale. Since joining Northeastern, Will-Cole has fostered and participated in research collaborations with the National Institute of Standards and Technology and Department of Energy Sandia National Laboratories. Particularly inspired following a workshop on machine learning implementation, she pursued a collaboration with the National Institute of Standards and Technology focused on optimizing magnetoelectric materials with machine learning. Alongside her research pursuits, she has mentored several undergraduate students through the TANMS Undergraduate Research Program in 2020 and 2021. In alignment with her passion for uplifting other women in engineering, she has organized virtual professional development events for women and allies in physical science and engineering through the Multiferroics Women’s Conference for Research and Fellowship. After graduation, Will-Cole aims to continue her research career at a national laboratory with continued emphasis on applied multifunctional nanomaterials and device development.

Yulun Zhang, PhD'21
COMPUTER ENGINEERING

Advised by Yun Raymond Fu, Professor of Electrical and Computer Engineering

After completing an MS in Control Engineering at Tsinghua University, Yulun Zhang joined the Department of Electrical and Computer Engineering PhD program at Northeastern University in 2017, working in the Synergetic Media Learning Lab, advised by Professor Yun Raymond Fu. The SMILE Lab, as it is known, focuses on the frontier research of artificial intelligence, especially machine learning, computer vision, and data mining. Zhang's research broadly includes computer vision applications: image/video restoration (e.g., super-resolution, denoising, deblurring), synthesis (e.g., style transfer, texture transfer), biomedical image enhancement and analysis, and deep model compression, computational imaging (e.g., spectral compressive imaging). His doctoral study mainly focuses on image restoration and generation by designing more efficient network structures. In addition to his research at the SMILE Lab, Zhang was a fellow at Harvard University in the Visual Computing Group. He also was a research intern at Adobe Research for two summers.
To date, over 30 of Zhang's publications have been accepted, including several papers in top computer vision conferences, like CVPR, ICCV, ECCV, ICLR, and top IEEE transaction journals, such as IEEE TPAMI (IF: 17.730) and IEEE TIP (IF: 10.865). His image super-resolution works residual dense network (RDN) and residual channel attention network (RCAN) rank as top 10 most cited papers on the CVPR 2018 and ECCV 2018 conferences, respectively. Additionally, he has over 4375 citations, according to Google Scholar, and his released code in Github has received over 2000 stars. He received the Best Student Paper Award at the IEEE International Conference on Visual Communication and Image Processing (VCIP) in 2015. He also won the Best Paper Award at the IEEE International Conference on Computer Vision (ICCV) RLQ Workshop in 2019. After graduation, Zhang plans to continue conducting research at a university.

Expanding the Global Network

The College of Engineering is extending its reach–locally and globally–by conducting research and offering educational offerings across Northeastern's global network. From new state-of-the-art research labs, facilities, and collaborations to academic programs, the college is pushing the bounds of innovation to new heights and increasing flexible, personalized learning opportunities for students.

Newest Academic Programs

Graduate

MS in Advanced and Intelligent Manufacturing

MS in Data Science – ALIGN bridge program
(offered in Portland, Maine, and Silicon Valley)

MS in Data Science
(now also offered in Portland, Maine)

MS in Information Systems
(now also offered in Toronto, Canada)

Undergraduate

Minor in Aerospace

Innovative Combined Majors

BS in Chemical Engineering and Bioengineering

BS in Chemical Engineering and Environmental Engineering

BS in Chemical Engineering and Computer Science

BS in Civil Engineering and Computer Science

BS in Mechanical Engineering and History

The College of Engineering continues to expand graduate education across Northeastern's global network. Newest locations offering select master's degree programs include Toronto, Canada, and Portland, Maine; in addition to programs offered in Seattle, Silicon Valley, and Boston.

The Institute for Experiential AI
at Northeastern University

Pioneering a Human-Centric Artificial Intelligence Research and Applications Hub

Northeastern University has allocated $50 million to the new Institute for Experiential AI, a pioneering research hub that places human skills and intelligence at the forefront of artificial intelligence applications. Leading experts in computer science, engineering, ethics, humanities, law, public policy, health, security, and sustainability will collaborate to develop applied human-centric AI solutions that tackle the world's toughest challenges.

The Institute for Experiential AI is university-wide, based out of the Roux Institute at Northeastern—a graduate education and research campus in Portland, Maine, born from a $100 million investment in the university by David and Barbara Roux (see page 17). Designed to educate generations of talent in the digital and life sciences sectors, the Roux Institute also acts as a driving force for sustained economic growth in Portland, the state of Maine, and northern New England.

"Northeastern has committed to building the top research institute in the world focused on Experiential AI," says founding Executive Director **Usama Fayyad**. "No one has claimed this space yet and I'm excited for our chance to lead this field."

To accelerate research and advance practical applications of AI in several domains, the Institute for Experiential AI is recruiting 30 new research and teaching faculty, data scientists, and postdoctoral fellows. In addition, faculty from colleges within the university such as the College of Engineering and Khoury College of Computer Sciences will conduct and collaborate on multidisciplinary research as part of the institute.

The Institute for Experiential AI will partner with industry, government, and academia to educate the next generation of AI professionals and lead efforts to create ethical and responsible human-centric AI. The institute also plans to be a prominent contributor to the global AI ecosystem and a key driver of experiential AI in New England through targeted activities in the region.

Pushing Engineering Research to New Levels at the Innovation Campus

Located at the Innovation Campus in Burlington, Massachusetts, Northeastern's George G. Kostas Research Institute, commonly known as KRI, brings together university-wide faculty and students, with industry and government to help solve important security, intelligence, and resilience challenges.

KRI's approach to partnership is highlighted in the variety of partners who are an integrated component of the collaborative ecosystem. Along with several onsite government labs—such as the Army Research Lab Northeast and Air Force Systems Integration Lab—KRI has 22 industry partners across its campus, among them Raytheon Technologies, Rogers Corporation, VRC Metal Systems, and AeroVironment. The Innovation Campus is planning to add a Rosslyn, Virginia, location in the heart of the Washington D.C. area, to advance its "defense-based" programs and research.

KRI is home to several of Northeastern's engineering research centers and labs, including Colosseum, the world's largest wireless testbed built by the Defense Advanced Projects Research Agency (DARPA) and part of the Institute for Wireless Internet of Things (see page 50); the Awareness and Localization of Explosives Related Threats (ALERT) research center lab; the Center for High Rate Nanomanufacturing, the Cold Spray Research Group, and the Laboratory for Structural Testing of Resilient and Sustainable System, which is the largest of its kind east of the National Earthquake Center.

In 2019, the Expeditionary Cyber & Unmanned Aircraft Systems Lab was added and is the first of its kind in the U.S. (see page 48). In 2020, the Innovation Campus added a $70 million mixed-use facility, open to industry partners, with research labs such as Colosseum, convening space for 300 people, and a 10,000 square foot maker space. With this facility, the Venture Creation Center (VCC) tripled in size, expanding entrepreneurial space to 30,000 square feet for faculty, students, and alumni. The VCC currently has 18 "spinout" early-stage companies in resident. And in 2021, Northeastern received the rare designation as a Spectrum Innovation Zone by the Federal Communications Commission. Located at the Burlington and Boston, Massachusetts, campuses, it is the fourth such hub in the U.S. and the first to enable experimentation for wireless communications and sensing technologies above 100 gigahertz, including a frequency band that is crucial for the development of 6G technologies (see page 8).

Expanding Research and Education with the Roux Institute at Northeastern

The Roux Institute at Northeastern University is a graduate education and research campus in Portland, Maine, made possible by a $100 million investment in the university from David and Barbara Roux in 2020. It is designed to transform Maine's economy by making it a hub for innovation in experiential artificial intelligence, digital engineering, advanced life sciences, and entrepreneurship. Its new model of graduate education and entrepreneurship is powered by Northeastern's experience forging industry partnerships. Currently, the Roux Institute has over 40 industry, academic, and civic partners.

With the Roux Institute's focus in AI and digital engineering, Northeastern's Institute for Experiential AI, led by Executive Director **Usama Fayyad**, will be based at the Roux Institute, and Professor **Jennifer Dy**, electrical and computer engineering, has been appointed director of experiential AI postdoc education there. New bioengineering faculty have joined as part of the Roux Institute's leadership team. Associate Professor **Aileen Huang-Saad** is director of life science and engineering programs, focused on developing interdisciplinary, experiential learning programs that will embed learners in the growing life sciences and engineering industries in Maine and at the Roux. Professor **Rai Winslow** is director of life sciences and medicine research. He will work at the leading edge of computational medicine, harnessing Big Data for predictive disease outcomes. Additionally, Professor **Jack Lesko**, mechanical and industrial engineering, jointly appointed in civil and environmental engineering, joins as director of engineering research. A materials researcher, he will focus on building deep industry collaborations. Also, Assistant Professor **Francesco Restuccia**, electrical and computer engineering, joined the Roux Institute to lead research conducted there as part of the Institute for the Wireless Internet of Things.

A research agreement was signed in May 2020 between the Roux Institute at Northeastern and the University of Maine as part of the mission to help build the Maine tech and life science economy with the power of Northeastern's research and learning enterprise in the areas of artificial intelligence, Earth and climate sciences, health and life sciences, manufacturing, and marine science. Seed funding was awarded to five collaborative research teams—including bioengineering, and electrical and computer engineering faculty. The one-year projects were selected from a pool of twenty-one applications through a rigorous review process and are the first funded as part of the collaborative research initiative established between the two universities. Each team was awarded $50,000, and they work together to pursue larger external funding programs through federal and private sponsors.

As part of this, **Jiahe Li**, assistant professor, bioengineering, is leading a project to develop a new, cost-effective, easily deployable ingredient to help create a stronger immune response in fish. He is working with PhD student **Xin Sun**, bioengineering, and University of Maine collaborators. **Mingyang Lu**, assistant professor, bioengineering, and **Ataur Katebi**, associate research scientist, bioengineering, in collaboration with University of Maine, are leading a project team to better understand the immune system's response to the Influenza A virus infection and develop an automated AI-based network modeling approach to find new antiviral therapeutic targets. Assistant Professor **Sarah Ostadabbas**, electrical and computer engineering, in collaboration with the University of Maine, is leading a project to look at artificial intelligence's role in examining the interplay between newborns' pacifier use and Sudden Infant Death Syndrome. **Srinivas Tadigadapa**, professor and chair of the Department of Electrical and Computer Engineering, in collaboration with the University of Maine, is leading a project to develop a new biofluid analysis instrument that would have unprecedented sensitivity and selectivity, and could have broad applications for health care and medical diagnoses. And, Assistant Professor **Xue Shelley Lin**, electrical and computer engineering, in collaboration with a team at the Virtual Environment & Multimodal Interaction Laboratory at the University of Maine, is working to improve accessibility, safety, and situational awareness within self-driving vehicles with a new model of human-AI vehicle interaction.

The Roux Institute has also spurred engineering research collaborations with industry, such as College of Engineering Distinguished Professor **David Kaeli**, electrical and computer engineering, who is conducting data visualization research with Maine fisheries. And Associate Professor and Director of the Institute for Experiential Robotics **Taskin Padir** who is working with industry partners in Portland to develop collaborative robots for recycling and seafood industries to provide workers with better experiences in challenging work environments.

In October 2020, the Harold Alfond Foundation donated $100 million to the Roux Institute to provide financial aid for graduate-level students, funding for post-doctoral research, and support for co-ops with Maine employers. The Roux Institute will create additional research, entrepreneurship, education, and experiential learning opportunities for students and faculty across Northeastern' global network as it expands.

Stefano Basagni, professor, electrical and computer engineering

Sara Wadia-Fascetti, vice provost, PhD Network, and professor, civil and environmental engineering

Luca Caracoglia, associate professor, civil and environmental engineering

One Program, Two PhDs, Two Continents

Northeastern's new international doctorate program—the Global Experiential PhD—provides students with an opportunity to earn separate PhDs from two universities in two continents while dramatically expanding the breadth of their research. As an added benefit, the program also expands the international job opportunities for graduates.

"It's like having two passports," says Professor of Electrical and Computer Engineering **Stefano Basagni**, a thesis research advisor in the program. "To get a job at an American company, it helps if you have an American PhD, and the same is largely true of a European degree in the European Union."

For **Irene Tallini**, PhD'24, computer engineering, the program provides the opportunity to conduct research in the United States while maintaining her relationship with Sapienza University of Rome, where she earned both her undergraduate and master's degrees.

"This program provides huge intercultural opportunities," Tallini says. "The professors in Northeastern's electrical and computer engineering department are experts in their sectors and I'm also excited about having access to the university's unique facilities."

As an engineer focused on wireless communication among underwater and aerial drones, Tallini is particularly interested in Colosseum, the world's largest radio frequencies emulator (which is part of Northeastern's Institute for the Wireless Internet of Things), and the Cyber and Unmanned Aircraft Systems R&D facility, both of which are situated at Northeastern's Innovation Campus in Burlington, Massachusetts.

Because students spend half of their time at each institution, they are exposed to two different research cultures and the expertise of faculty with different areas of specialization. The program is also intentionally flexible to enable interdisciplinary research, thereby allowing students to pursue research in different fields at each institution. They must apply to each program independently and fulfill all of the academic requirements of both programs. Under the supervision of a research supervisor from each institution, they write a single dissertation that earns them a separate PhD in each country.

The first two partners with the Northeastern program are Sapienza University of Rome and the University of Hong Kong. There are additional partnerships in the works.

"Northeastern is building a selective network of educational institutions around the globe," says Vice Provost **Sara Wadia-Fascetti**, who is head of Northeastern's PhD Network and professor of civil and environmental engineering. "We are a global institution—a networked institution. This increases mobility for our students and further extends our research outside Boston."

"This program is based on the concept of convergence, which is a key component of interdisciplinary research," says Wadia-Fascetti. "It's important to maximize a student's exposure to many different concepts and cultural experiences that connect ideas to one another and translate disciplines to one another. This exposure influences both the scope and direction of their research."

Students aren't the only ones who benefit from these partnerships, says Associate Professor of Civil and Environmental Engineering **Luca Caracoglia**, who along with Basagni has a longstanding relationship with Sapienza University and helped spearhead the new partnership.

Caracoglia, who is an expert on wind engineering and wind load effects, recently hosted a workshop bringing together Northeastern and Sapienza faculty who focus in structural engineering and geotechnical/geo-environmental engineering and who are currently advising civil engineering PhD students.

"For faculty, it's a way to bring new perspectives to our research ideas and collaborate with experts in Italy through our students," Caracoglia says.

Basagni agrees, adding that the program also provides important benefits for the university as a whole. "This is a way to attract the best students from universities around the world while enhancing our international visibility and connectedness."

ADVANCING NANOTECHNOLOGY THROUGH INNOVATION IN MATERIALS ENGINEERING

The Advancing Nanotechnology through Innovation in Materials Engineering (ANIMatE) initiative combines modeling and experiments with materials design and nanomanufacturing to enable manufacturing at the nanoscale through innovative design of functional and structural materials at the atomistic level.

- Materials design
- Nanomanufacturing
- Sensors

NSF CAREER Award to Exchange Massive Data in Crowded and Noisy Mediums

Cristian Cassella, assistant professor, electrical and computer engineering

Cristian Cassella, assistant professor, electrical and computer engineering, received a $409K National Science Foundation CAREER Award for “Giant Tunability through Piezoelectric Resonant Acoustic Metamaterials for Radio Frequency Adaptive Integrated Electronics.”

For advanced technologies to succeed, such as cloud-storage, edge-computing, machine learning, artificial intelligence (AI), and fifth-generation (5G) wireless communication, new hardware components such as more stable frequency synthesizers (FSs) based on novel materials and techniques need to be developed. Also, the internet of things has created a growing number of wireless nodes within an already congested spectrum.

To address this, Cassella and his research team are developing a new class of passive, tunable, and high-performance integrated resonant devices called Piezoelectric Resonant Acoustic Metamaterials (pRAMs). pRAMs have unique, artificially produced, and reconfigurable modal features that can be leveraged to form more stable frequency synthesizers as well as to increase the limited resilience to interference of the existing radios. They will enable new stable frequency synthesizers, adaptive front ends for IoT radios, and many other on-chip transducers for sensing and communication.

For several years, Cassella has been developing communication devices that utilize the unique and combined features of electrical and acoustic domains, including components that provide frequency references similar to those used to regulate the motion of a clock. He realized that by leveraging these components, future radios can more easily and more efficiently discriminate data streams from different service bands—such as Bluetooth or Wify—making sure that any received electromagnetic wave reaches the most adequate radio component responsible for extracting the desired information.

Cassella hopes pRAMs will enable future generations of connected wireless nodes to be more immune from cyberattacks, while consuming less and less power in favor of longer battery lifetimes. This new technology has ramifications not only in communications, but also in sensing applications where the strong magnetosensitive response of pRAMs will be investigated to form new chip-scale magnetometers with exceptional sensitivities suitable for critical biomagnetic applications and more.

Sinan Müftü, professor, mechanical and industrial engineering, and associate dean for faculty affairs

Ozan Ozdemir, assistant professor, mechanical and industrial engineering

Andrew Gouldstone, professor, mechanical and industrial engineering, and associate chair of experiential innovation

$1 Million NIST Award to Improve Sensing and Optimize Cold Spray Additive Manufacturing

National Institute of Standards and Technology (NIST) awarded $999,464 to the Cold Spray Research Group in the Department of Mechanical and Industrial Engineering to improve sensing approaches and create a suite of sensor technologies that will help optimize cold spray additive manufacturing. The research team includes **Sinan Müftü**, professor and associate dean for faculty affairs, **Ozan Ozdemir**, assistant professor, and **Andrew Gouldstone**, professor and associate chair of experiential innovation. The award is part of nearly $4 million in NIST grants to help accelerate the adoption of new measurement methods and standards to advance U.S. competitiveness in metals-based additive manufacturing.

According to NIST, additive manufacturing typically creates parts and components by building them layer by layer, based on a 3D computer model that is virtually sliced into many thin layers. Metals-based additive processes form parts by melting or sintering material in powder form. The process offers advantages such as reduced material waste, lower energy intensity, reduced time to market, and just-in-time production.

Cold spray additive manufacturing processes have the potential to create parts that are more durable and stronger than those made with other additive manufacturing processes. New sensors will help characterize the properties of the powder feedstock and the key parameters of the process, such as temperatures and part dimensions, and allow for better control of this promising technique.

This research program addresses morphological characterization of metal powders, process monitoring via in-situ sensory devices, residual stress control by path planning and, non-destructive, post-print defect characterization. In each one of these categories, novel use of existing measurement systems will be combined with comprehensive modeling approaches.

Cold spray is a solid-state powder consolidation technology where micron-sized powder particles are accelerated to velocity levels of 300 – 1,500 m/s, in a supersonic inert gas. Under the right processing conditions, a fraction of the impact energy enables bonding between the powder particles. Functional, micrometers-to-centimeters thick coatings of metals, ceramics, and polymers can be obtained. Next-generation of cold spay machines will be capable of printing non-oxidized, low porosity, low residual stress near net-shape components.

Joshua Gallaway, DiPietro assistant professor, chemical engineering

NSF CAREER Award to Make Batteries Safe and Inexpensive for the Electrical Grid

Joshua Gallaway, DiPietro assistant professor, chemical engineering, received a $400K National Science Foundation CAREER Award for "Engineering Electrochemical Reversibility in Disordered Materials for High Energy Density Batteries." The award will address the challenge of rechargeability of a battery material, manganese dioxide (MnO_2), that could speed the development of large, low cost, non-flammable batteries capable of powering the electrical grid, leading to widespread adoption of renewable energy.

"We've learned that you can make this material, MnO_2, rechargeable by doping it with other atoms," Gallaway explains. "If you use bismuth—a high molecular weight atom—to dope the MnO_2 material, it becomes rechargeable. Then you can conceivably make batteries for the electrical grid that are inexpensive and safe."

The project is also researching why bismuth makes MnO_2 rechargeable. Gallaway and his research team are making MnO_2 that has several different forms of bismuth doped into it. "The large part is synthesis work with different amounts of bismuth incorporated in different ways," he says. "We are going to characterize that material, where it is and how much of it is there. We'll cycle the material in different ways to see what happens to it and study the relationship between bismuth and the rest of the atoms."

Aiding the team in watching materials while they're doing electrochemistry is a synchrotron, a type of particle accelerator called NSLS-II and located on Long Island in New York. "These facilities make very high-quality X-rays that are also very bright and very high energy," explains Gallaway. "We use powerful X-rays from the synchrotron to focus on bismuth during charging and discharging of the battery to see what the bismuth is doing."

Additionally, Gallaway is researching a unique characteristic of the MnO_2/bismuth pairing: While cycling in a battery, the MnO_2 material is initially ordered, showing general regularity, but it becomes disordered, and thus more difficult to characterize. "In the past, we looked at materials from an ordered perspective," he says. "Now we look at these materials from the point of view of disorder, using different X-ray techniques…The point is knowing what bismuth is doing. Then we can engineer it to do better."

Novel Sustainable Material to Cool Buildings Without Electricity

Yi Zheng, associate professor, mechanical and industrial engineering

Associate Professor **Yi Zheng**, mechanical and industrial engineering, invented a sustainable material that can be used to keep buildings or other objects cool without relying on conventional cooling systems. The material is made of paper and is recyclable. Tests indicate that it can reduce a room's temperature by as much as 10 degrees Fahrenheit. The process for creating and testing the new material was described in the American Chemical Society journal *Applied Materials & Interfaces*.

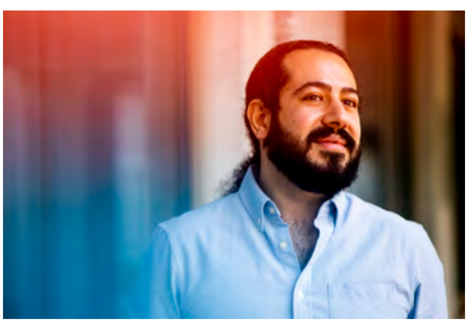
Zheng envisions this material, which he refers to as "cooling paper," covering the roofs of houses, warehouses, office buildings, or other edifices. It also could be incorporated into the materials used to construct the buildings. The material works in two ways. Its light color reflects warm solar rays away from the building, and it also sucks heat out of the interior from electronics, cooking, human bodies, and other things that generate warmth. The porous microstructure of the natural fibers in the cooling paper absorbs that warmth and re-emits it away from the building.

To invent the cooling paper, Zheng made a pulp out of paper waste and the material that makes up Teflon. Then he formed it into water-repelling "cooling paper" that could coat homes. Then, he and his research team tested its capacity to keep cool under various temperature and humidity conditions.

The cooling paper is also recyclable. The material can be used, exposed to solar radiation, weather, and varying temperatures, then reduced to a pulp (again) and reformed without losing any cooling properties. Zheng has tried it. And the recycled cooling paper performed just as well as the original.

"The ultimate goal is to reduce global warming," Zheng says. "The starting point is to reduce the use of carbon-based materials and also to reduce global warming."

$1.8 Million NSF Award to Design and Control Geopolymers Structures



Safa Jamali, assistant professor, mechanical and industrial engineering

Assistant Professor **Safa Jamali**, mechanical and industrial engineering, is leading a $1.8 million DMREF (Designing Materials to Revolutionize and Engineer our Future) grant from the National Science Foundation to create "Rheostructurally-Informed Neural Networks for Geopolymer Material Design." The award is in collaboration with the University of Delaware, Georgetown University, and the Air Force Research Laboratory.

Geopolymers are inorganic and non-crystalline structural materials that can be obtained from natural soils via a chemical activation. They have great potential as additives to reduce cement consumption in construction and thus can help to reduce green-house gas emissions of cement manufacturing. They also promote the adoption of local soil resources for traditional and 3D printing-based construction. Important for human space exploration, geopolymers can be also formed from lunar and Martian soils with limited water, and thus are excellent candidates for space infrastructure such as landing pads and shelters.

At present, however, processing of geopolymers into desirable structures remains far behind their laboratory scale performance due to the wide range of chemistries and characteristics of different indigenous geopolymers.

Geopolymers are amorphous and porous solid matrices that develop as gels when an alumino-silicate source (typically from clays) reacts with an alkali hydroxide or alkali silicate solution, yielding ceramic-like structures and mechanics. The range of multiscale pore morphologies and material strengths of geopolymer gels makes them ideally versatile and potentially smart binders. However, the primary challenge hindering wide adoption of these sustainable materials is the complexity of controlling property development and processing, given the significant chemical variability that makes their design cycle difficult and empirical.

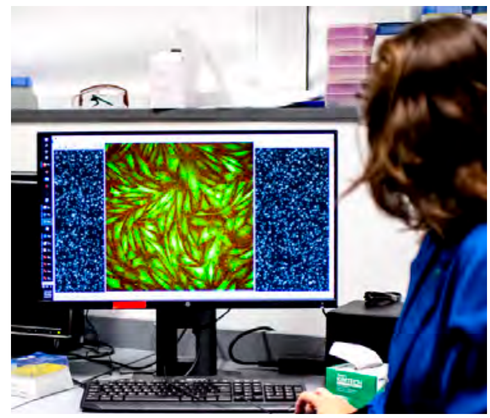
Artificial intelligence approaches are required to bridge the gap between the deep fundamental understanding of a few materials and the need for sustainable processing of a wide range of material resources on earth and other planets with limited experimentation efforts. The team will construct a data-driven platform informed by integrated multiscale modeling and experiments, to accelerate the design of processing routes for geopolymers into desirable structures. The research team will develop rheology-informed neural networks that use the multi-scale and multi-component dynamics of geopolymeric systems under load and in flowing conditions through a comprehensive interrogation of experiments and simulations that hierarchically span from the atomistic to macroscale.

BIOMACHINE INTEGRATION

BioMachine Integration tackles grand challenges that span health, security, and sustainability with engineering solutions to involve an integration of advanced materials, devices and machines with living systems to yield synthetic bio-machine technologies.

- Molecular to human scale
- Living sensors
- Cell technologies
- Medical robotics
- Human/machine dynamics
- Environmental health factors

Harikrishnan Parameswaran, assistant professor, bioengineering



Suzanne Stasiak, PhD'22, bioengineering, looks at a microscope image of human airway smooth muscle cells stained with fluorescent calcium dye for asthma research.

NSF CAREER Award for Better Treatment of Asthma

Harikrishnan Parameswaran, assistant professor, bioengineering, received a $602K National Science Foundation CAREER Award for “Elucidating the Role of Collective Cell-Matrix Interactions in the Mechanobiology of Airway Narrowing.” He seeks to understand how the smooth muscle detects inhaled irritants and generates force at the cellular level to develop better treatment for people with asthma.

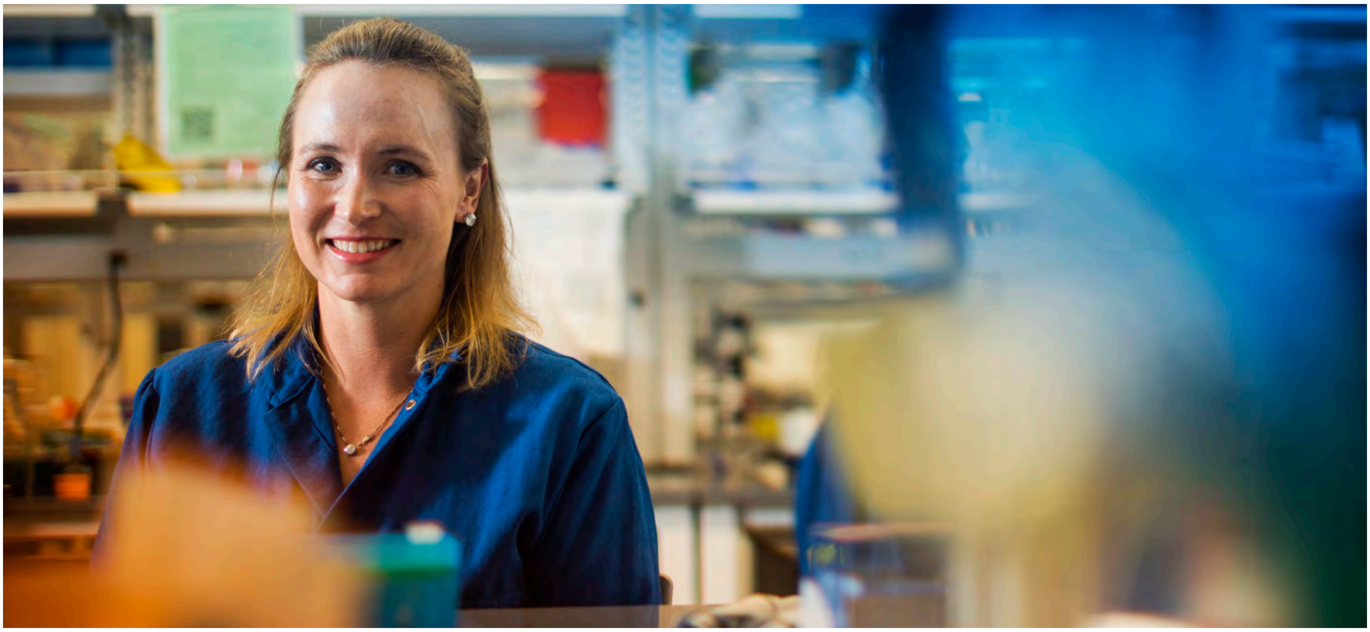
Any organ in the human body that requires constriction—such as the airways or blood vessels—is lined with smooth muscle that aids in its contraction. In asthmatics, the smooth muscle lining the airways undergoes exaggerated constriction in response to a small amount of inhaled irritants, making it difficult to breathe. The exact mechanisms that lead to this behavior are unknown, making effective and universal medical treatment difficult.

In the airway, human smooth muscle cells are supported by a complex scaffold of proteins called the extracellular matrix. This extracellular matrix undergoes substantial changes in asthma. Parameswaran’s research discovered that when smooth muscle cells from healthy human donors are placed on a synthetic substrate mimicking diseased tissue, even a tiny dose of an irritant molecule is perceived as a high dose and causes an increased contraction response.

However, the most curious finding is that this abnormal reaction doesn’t occur in single smooth muscle cells, but only with a group of cells—meaning the cells are somehow communicating and responding to inhaled irritants as a collective.

“When inhaled irritant molecules bind to the smooth muscle, the smooth muscle cells communicate with each other using calcium waves,” says Parameswaran. “These calcium waves are frequency modulated—just like those used in radio communications—and, together like a committee, these cells decide the amount of inhaled irritant molecules. This method of sensing inhaled irritants is fundamentally different from what is currently known. It brings up the intriguing possibility that the individual smooth muscle cell might not be at fault in asthma. Instead, the problem might be in how these cells talk to each other in an asthmatic airway.”

“The idea that the extracellular matrix may have a role in regulating smooth muscle cells is new and exciting,” says Parameswaran. “If we’re able to understand better how the underlying matrix modulates intercellular communication, we may be able to learn more about what drives the disease of asthma and develop methods to target the cause and not the symptoms of this disease.”



Abigail Koppes, associate professor, chemical engineering

NSF CAREER Award to Understand How the Nervous System Regulates the Gut

There's a growing awareness of the connection between the human brain and the intestinal tract, but many questions remain. Why do human neurological disorders, such as anxiety, often manifest themselves with irritable bowel syndrome and other conditions? Why do Crohn's disease and other intestinal disorders have broad implications for the nervous system?

Associate Professor **Abigail Koppes**, chemical engineering, received a National Science Foundation CAREER Award, titled "Defining the Regulators of Enteric Plasticity in Engineered Microfluidic Environments," to further her research in this area.

"The human body is incredibly complex, with a nervous system that acts as an 'information highway,' sending signals and triggering reactions," Koppes notes. "Because we don't understand the invisible mechanisms at work, we are unable to intervene in a helpful way. If we can figure out why the brain triggers a certain response in the gut—and vice versa—we can develop better treatments and improve patient outcomes significantly."

Koppes' research focuses on developing new, non-invasive methods of exploring human cellular responses to biological signals in her Advanced Biosystems for Neuroengineering Laboratory. As part of the CAREER Award research, she and her team will engineer and apply microphysiological systems to better understand how the nervous system regulates the gut in response to inflammation. Plastic, disposable handheld devices will be developed that expose engineered tissue to a range of signals, then measures its response. These models have wide applications to other organs in the body and will advance knowledge in neurobiology and engineering for human health discovery.

"This new platform will enable researchers to discover ways of turning pathologies 'on and off' via different kinds of biosignals," explains Koppes. "It's a cost- and time-effective means of testing tissue behavior, without risking the health of human or animal subjects. We can easily study reactions at the benchtop, then apply those findings in a clinical setting."

Koppes's lab is partnering with doctors at Massachusetts General Hospital and Boston Children's Hospital, as well as collaborators in Northeastern chemical engineering, bioengineering, and biology faculty.

Mark Niedre, professor and associate chair for research, bioengineering

Mansoor Amiji, University Distinguished Professor, chemical engineering, and pharmaceutical sciences

Wearable to Detect Cancer Cells in the Blood

Mark Niedre, professor and associate chair for research, bioengineering, and University Distinguished Professor **Mansoor Amiji**, chemical engineering, and pharmaceutical sciences, were awarded a $400K grant, titled "Fluorescence Molecular In Vivo Liquid Biopsy of Circulating Tumor Cells" from the National Cancer Institute and National Institutes of Health. The grant will advance their research in developing a wearable, or a test at the doctor's office or hospital, that can scan the blood for cancer cells optically—as the cells go by, directly in the body.

When most people die of cancer, it's not from the original, or primary, tumor; rather, it's from the spread of that tumor to other organs and tissues of the body. This spread is called metastasis, and it often happens via the bloodstream—the tumor cells get into the blood and circulate to other parts of the body.

Currently, the method for detecting circulating tumor cells involves a liquid biopsy, where a small amount of blood is extracted, about 7.5 milliliters, and tumor cells are looked for under a microscope.

There are serious drawbacks to this method, though. First, it's a very small blood draw: 7.5 milliliters is about half a tablespoon, and an adult human has about five liters of blood. So, it's challenging to make a conclusive diagnosis on such a small sample of the overall blood volume. And then there's the fact that the number of cancer cells present is such a tiny percentage of any sample.

"These tumor cells are really rare. You get maybe a few per milliliter of blood, and your blood has literally billions of cells per milliliter," Niedre says. "So there are very few of them."

That's where Niedre and Amiji's research comes in to scan the blood in the body optimally.

"It's hundreds of milliliters of blood running through body vessels in a minute," Niedre explains. "You could theoretically put on some sort of wearable on your wrist and you could sample the whole blood volume continuously."

The team is currently perfecting the optics, and making the device as sensitive as possible, and able to measure as much blood as possible. Niedre says. "The dream would be you have someone who has cancer, or has their cancer come back, and we're able to detect metastasis as early as possible, ultimately improving many patients' outcomes, and saving lives."

Carolyn Lee-Parsons, associate professor, chemical engineering

Erin Cram, professor, biology

Programming Plant Cells to Produce Anti-Cancer Compounds

Vincristine is a chemotherapy drug used to combat childhood cancers such as leukemia, lymphoma, and brain tumors. This life-saving compound, however, is in low supply, forcing doctors to ration doses and preventing children who need this drug from receiving it.

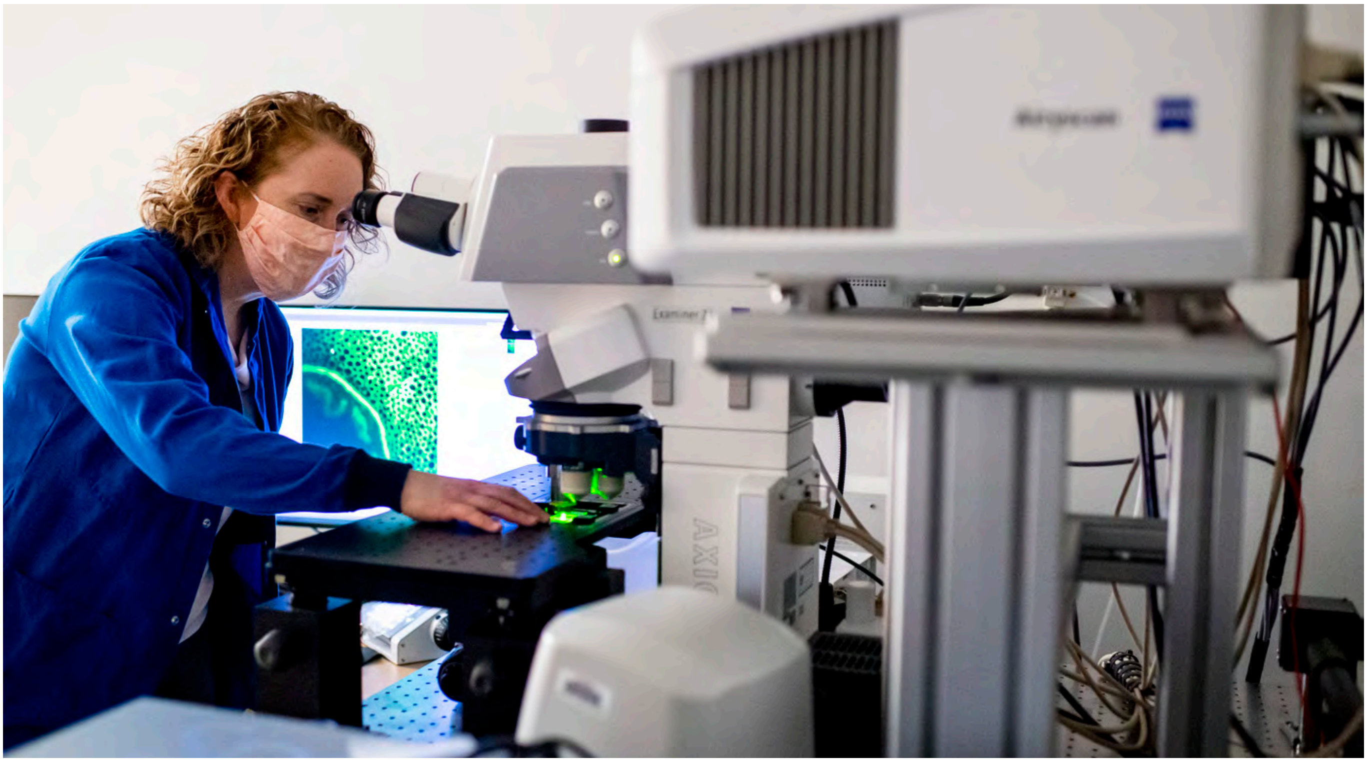
As part of a three year $800K National Science Foundation grant, titled, "A Novel CRISPR SynBio Tool for Investigating and Reprogramming the Regulation of Alkaloid Biosynthesis in *Catharanthus roseus*," **Carolyn Lee-Parsons**, associate professor of chemical engineering, and her collaborator, **Erin Cram**, professor of biology, are studying the *Catharanthus* roseus plant. The plant is the only source of the anti-cancer compounds vinblastine and vincristine, and through their research they hope to increase the production of these critical compounds. "The reason why I studied this plant is because the compounds that it produces are so critical for the treatment of cancer and there's no other substitute," says Lee-Parsons.

Catharanthus roseus is commonly referred to as the Madagascar periwinkle, and like any plant, it uses carbon dioxide for photosynthesis, which ultimately enables plant growth and the production of specialized compounds such as UV protectants and insect repellants that are valuable to its survival. However, there are limited amounts of sugars available, thus the plants need to wisely decide how to use this. In this way, plants are adaptable and can allocate the available sugars based on what is going on in their environment.

Lee-Parsons and her team are growing tissue cultures derived from the Madagascar periwinkle in a controlled carbon-rich environment so that the cultures do not need to photosynthesize. This allows the plant tissues to produce more of the anti-cancer compounds.

One of the challenges of this project is that the plant doesn't produce a lot of vinblastine and vincristine because the plant has ways of turning off production once its production has been turned on. Therefore, one of Lee-Parsons' goals in this project is to understand how the plant regulates production so that she can develop a strategy to increase it. She is also addressing this limitation by developing a synthetic biology tool, which will allow her team to reprogram the DNA within the cells of the plant to instruct it to produce more anti-cancer compounds.

"Ultimately we want to produce these compounds through engineered plant cultures that will produce enough of this critical drug so that all patients who need it can have it—right now that isn't the case. Some kids are not receiving the treatment they need [because] there's not enough of the drug," Lee-Parsons explains.



Heather Clark, professor, bioengineering, jointly appointed in the College of Science, and director of the Institute for the Chemical Imaging of Livings Systems

New Nanosensor Holds Promise for Diagnosing, Treating Neurological Disease

Every movement in the human body—from lifting our arms to our beating hearts—is regulated in some way by signals from our brains. Until recently, scientists often tracked and understood that brain-body communication only after the fact, sort of like listening to a voicemail as opposed to being on a call.

But researchers at Northeastern have developed a new type of nanosensor that allows scientists to image communication between the brain and the body in real-time. Professor and Director of the Institute for the Chemical Imaging of Living Systems **Heather Clark**, bioengineering and chemistry, and Associate Professor **James Monaghan**, associate professor of biology, along with colleagues at Northeastern and researchers from the University of California, San Francisco, developed a DNA-based nanosensor that detects a specific neurotransmitter, acetylcholine, as it's released and picked up by target cells in living animals. They published their findings in the journal *Proceedings of the National Academy of Sciences* this month.

A burgeoning field of medicine known as bioelectronic medicine seeks to use highly specific nerve stimulation to treat neurological diseases. In order to precisely target the nerves, scientists need to know how they react in real time and in living organisms—Clark and Monaghan's nanosensor represents a step in that direction.

"If you're going to use nerve stimulation as a medicine, you need a readout of how much stimulus you provided," Monaghan says. "Dr. Clark's chemistry and innovation in this area of sensor development would provide that readout for the neurotransmitter acetylcholine."

The nanosensor consists of a fluorescent component that glows in the presence of acetylcholine and can be seen in living mice, in real time. It's kind of like seeing someone's cell phone light up for a phone call, but on a molecular level.

Existing tools such as microelectrodes and microdialysis enable scientists to detect acetylcholine in the central nervous system but fall short when it comes to the peripheral nervous system, which is everything outside the brain and spinal cord.

Clark, Monaghan, and their colleagues utilized powerful microscopes housed at Northeastern, to watch the fluorescent markers light up as the neurotransmitter was activated in their experiments. The development of this nanosensor is just the beginning, though, and the researchers hope to create even hardier sensors in the future.

CRITICAL INFRASTRUCTURE SUSTAINABILITY AND SECURITY

Critical Infrastructure Sustainability and Security will promote the development of fundamental engineering to embed resilience into the design strategies, standards and regulatory frameworks of critical infrastructure systems through predictive understanding of climate and security hazards with geospatial Big Data and computational solutions. It will develop a framework for establishing translational solutions in collaboration with academic partners, industry leaders and startups, as well as national laboratories and federal agencies.

- Resilient water/energy systems
- Hazard Identification and risk management

AI and Machine Learning to Optimize the Solar Power Grid

Ali Abur, professor, electrical and computer engineering

Professor **Ali Abur**, electrical and computer engineering, has been studying and researching how electricity is generated, transmitted, and distributed within power systems for 30 years. He received a $750K Department of Energy (DOE) grant from the Solar Energies Technologies Office in the category of Systems Integration for "Graph-Learning-Assisted State and Event Tracking for Solar-Penetrated Power Grids with Heterogeneous Data Sources."

The project uses artificial intelligence and machine learning techniques to integrate a diverse set of measurements and use them to calculate the state of the power grid. The resulting tool will be able to detect topology changes and faults in the grid and update grid models accordingly, which will improve the situational awareness of power grids that contain large amounts of solar energy sources. This will be accomplished by exploiting a large volume of data and measurements available from a highly diverse set of measurement devices. The project will also provide tools to detect and identify unexpected disturbances or switching events by exploiting the recently developed sparse estimation methods in the data analytics area.

A power grid contains many substations which are interconnected through power lines. These substations can either generate and supply power to the grid or connect to distribution feeders that withdraw power from the power grid. All substations have multiple types of sensors which collect various measurements such as power flows and voltages. This information is automatically processed and passed along to system operators who are constantly monitoring the power system to avoid power outages or violation of safety limits for equipment by taking appropriate corrective actions.

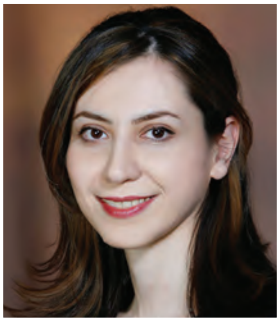
Abur explains, "Over the last 10-15 years, the connection of renewable energy sources in distribution systems has complicated the monitoring process of the power grids. Historically, distribution systems have withdrawn power from the transmission system; however, with the increasing numbers of solar energy sources, power flows became bi-directional between the two systems."

In the first part of the research project, Abur and his collaborators from UMass-Lowell and Brandeis University will use machine learning tools to reconcile measurements obtained at different rates and resolution from different sets of measuring devices.

"The differentiating feature of this project is that we take the output of the state estimator, and we feed it back into this machine learning tool. This feedback loop allows continuous improvement of both applications, helping the machine learning tool to receive less noisy measurements and the state estimator to receive better approximations to missing measurements."

The second goal of this project is to heighten and strengthen the situational awareness in the power system by creating monitoring techniques to detect, identify, and locate unexpected disturbances such as a line outage or a short circuit fault in the grid. After the theoretical development is complete, Abur and his collaborators will develop the necessary software and use simulated measurements to test and validate their approach. In the final year of the grant, they will partner with Commonwealth Edison, a utility company in Chicago, to use actual measurements from their microgrid network to prove that the developed state estimator will work in a real utility system.

NSF CAREER Award to Improve Renewable Energy Systems



Mahshid Amirabadi, associate professor, electrical and computer engineering

An energy system is only as reliable as its weakest link, which is why **Mahshid Amirabadi,** associate professor of electrical and computer engineering, has received a $400K CAREER Award from the National Science Foundation to improve the weakest links in renewable energy systems.

"Our main goal is to reduce the cost of electricity from renewable energy," says Amirabadi. "That's what we have to do to make renewables dominant, which is so important to the environment. Additionally, increasing the reliability of renewable energy systems is crucial to building public trust."

Power converters are a key component in transferring power from solar panels and wind turbines into the grid. Amirabadi is developing the next-generation power converter—a universal, silicon-carbide based, converter that will be smaller, cheaper and more reliable than those that rely on traditional electrolytic capacitors.

The current converters used in residential solar systems have an average life of 5 to 10 years compared to the 25-year life of solar panels, which means that the overall reliability of the system is cut by more than half. The cost to repair, replace, ship, or install new converters in the system due to this unreliability drives up the overall cost of renewable energy. Because Amirabadi's converter will be universal it eliminates the need for a series of cascading converters to handle power conversion between sources, and loads with different forms, voltage amplitudes, and frequencies in a complex power system. "Therefore, the same converter can be used throughout complex systems, as opposed to our current situation where you need many different kinds of converters," she says.

Amirabadi's research builds upon her previous work, including two recent patents: a reliable converter for systems with unequal instantaneous input and output power such as residential solar systems (2019) and a general capacitive-link universal converter that uses soft switching technology to increase efficiency (2020).

Several of Amirabadi's proposed converters have been successful in the prototyping process and she is approaching the commercialization stage for those topologies. For now, she hopes to license the inventions through an existing company, but in the future she hopes to launch a startup of her own.

Pau Closas, assistant professor, electrical and computer engineering

Deniz Erdogmus, professor, electrical and computer engineering

Edward Beighley, professor, civil and environmental engineering

Spaceborne Imaging for Observation-Driven Flood Monitoring Methods

Assistant Professor **Pau Closas** and Professor **Deniz Erdogmus**, electrical and computer engineering (ECE), and Professor **Edward Beighley**, civil and environmental engineering, and ECE Associate Research Scientist **Tales Imbiriba** were awarded a grant from the National Geographic Society's Committee for Research and Exploration for "Spaceborne Multispectral Image Fusion for Water Mapping and Flood Management."

Natural disasters such as floods lead to enormous economical and social impacts as property is damaged, crops are lost, and people are relocated or lose their lives. The occurrence of such natural hazards is increasing due to climate change making prediction models less accurate, which is particularly relevant for flood risk assessment, underscoring the need for observation-driven flood monitoring methods. Improved remote sensing tools are needed for monitoring, detecting, and estimating the intensity of key natural phenomena.

The research project focuses on the flood estimation and detection problems leveraging multispectral satellite imaging using instruments with different spatial, spectral, and temporal (revisiting times) resolutions. The main drawback in flood assessment with satellite images is related to the resolution/revisiting time tradeoff where lower resolution images (in the order of kilometers) are available at smaller revisiting time (1 to 2 days) while higher resolution images (in the order of tens of meters) are available at larger revisiting times (5 to 16 days).

The goal is to provide a methodology and software capable of providing a spatially detailed assessment of flooding incidents by exploiting multiple spaceborne imaging sources. This will ultimately lead to improvements in water mapping, flood detection, and flood mapping.

Kelsey Pieper, assistant professor, civil and environmental engineering

Early-Career Research Fellowship from the National Academies of Sciences, Engineering and Medicine

Assistant Professor **Kelsey Pieper**, civil and environmental engineering, was named an inaugural member of the Early-Career Research for New Human Health and Community Resilience track Fellowship by the National Academies of Sciences, Engineering, and Medicine's Gulf Research Program. She is one of seven fellows selected for this honor. Fellows in this cohort will conduct research that advances health equity and explores social detriments to health in the U.S. Gulf Coast states and Alaska.

The Gulf states face a variety of crises over the decades, from frequent hurricanes to man-made environmental disasters such as the Deepwater Horizon Oil Spill. These crises have been exacerbated by climate change and can cause adverse health outcomes.

Pieper and her team focus their research on disparities in drinking water infrastructure and quality, with an emphasis on the effects on underserved and marginalized communities. Some of her current work examines unregulated water sources, such as private wells. "We want to understand the link between hurricanes, well water quality, and health outcomes. Water infrastructure plays a critical role in the health of a community," says Pieper. "In the United States, we unfortunately see a wide range of water quality between communities, often linked to complex social, economic, and historical factors."

According to the Gulf Research Program, "Fellows' projects will explicitly focus on the root causes of individual and community health and well-being, known as social determinants of health (SDOH)… Fellows will apply a health equity lens and consider SDOH in emergency preparedness, response, and recovery activities. They will also work closely with communities to develop locally relevant resilience building strategies."

Samuel Muñoz, assistant professor, marine and environmental sciences, jointly appointed in civil and environmental engineering

Qin Jim Chen, professor, civil and environmental engineering, jointly appointed in marine and environmental sciences

Modeling Hurricanes of the Past to Predict the Climate-Charged Storms of the Future

Assistant Professor **Samuel Muñoz**, marine and environmental sciences, jointly appointed in civil and environmental engineering, and Professor **Qin Jim Chen**, civil and environmental engineering, jointly appointed in marine and environmental sciences, in collaboration with Woods Hole Oceanographic Institution, were awarded a $590K National Science Foundation grant for "Morphodynamic Simulations of Coastal Storms and Overwash to Characterize Back-Barrier Lake Stratigraphies."

The research project focuses on historic overwash in the New England area. "We will study the process of coastal overwash (i.e., when sand from a beach overtops a barrier during a storm) and deposition to understand the sensitivity to overwash deposition to geomorphic (i.e., landscape) change, and how overwash is influenced by storm magnitude and track," says Muñoz. Barriers are common coastal landforms that consist of sandy ridges that form parallel to the shoreline.

Muñoz, a geoscientist with expertise in sedimentology and paleoclimatology, will collect sediment samples from lakes and ponds and analyze their age and texture. For his part, Chen, a leading expert in hurricane modeling and coastal hydrodynamics, will build morphodynamic models to simulate overwash in the areas. Muñoz's work will be used to inform Chen's models. "We will ultimately apply this information to develop reconstructions of landfalling hurricanes in southern New England over the last 2,000 years or so," says Muñoz.

As the planet faces a shifting climate caused by human activity, it is crucial for coastal communities to understand how the frequency, severity, and behavior of severe storms shifts in response to changes in climate. "Overwash deposits are often used by geologists to understand the history of coastal storms in a region. This information is useful for hazard assessment and mitigation, but has been limited to qualitative assessments of storm occurrence," Muñoz explains. "Overwash is also a critical process that shapes coastlines through erosion and deposition; our project will clarify the controls on overwash along the heavily populated coastline of southern New England." Their work could help coastal communities better prepare for coastal storms as the planet's climate changes and sea levels rise.

ENGINEERED CYBER-SOCIAL-PHYSICAL SYSTEMS

Research in this area will use engineering solutions to develop the Engineered Resilient Cyber-Social-Physical Systems needed to design, operate, and evolve complex cyber-physical systems upon which people can confidently depend to perform both mundane and safety critical tasks, and that can better withstand, rapidly recover from, and adapt to local, regional, and global disruptions at multiple timescales.

- Sensing
- Control
- Communications/networking
- Big Data analytics
- Embedded systems
- Man-machine interface

NSF CAREER Award for a Smart and Energy Efficient Home Thermostat

Michael Kane, assistant professor, civil and environmental engineering

In the Automation in the Built and Living Environment (ABLE) Lab at Northeastern, Assistant Professor **Michael Kane**, civil and environmental engineering, and his students look at how people and automation interact in man-made environments such as buildings and transportation. The ABLE Lab's latest project—of which he received a prestigious $763K National Science Foundation CAREER Award, titled "Human-Centric Automation in the Built Environment"—is focused on improving the automation of the home thermostat to not only use less energy, but eventually to anticipate comfort needs.

"The 'brains' of thermostats as we know them today are simple rules that help your home hold a temperature," says Kane. "People don't really know how much energy they're consuming until about a month later when their utility bill arrives, making it hard to know how to save energy. We want to shorten that feedback loop to real-time, and to use human-centric automation to make it something you don't have to worry about."

The science behind Kane's work is to understand all the physiological and psychological factors that affect how people perceive their home's temperature in that moment and change it to make them comfortable. This data could help build artificial intelligence (AI) that predicts how comfortable they are feeling—even before they know it themself—and it helps them understand how to work with the AI to make their energy consumption friendlier to an electric grid with variations in available renewable energy.

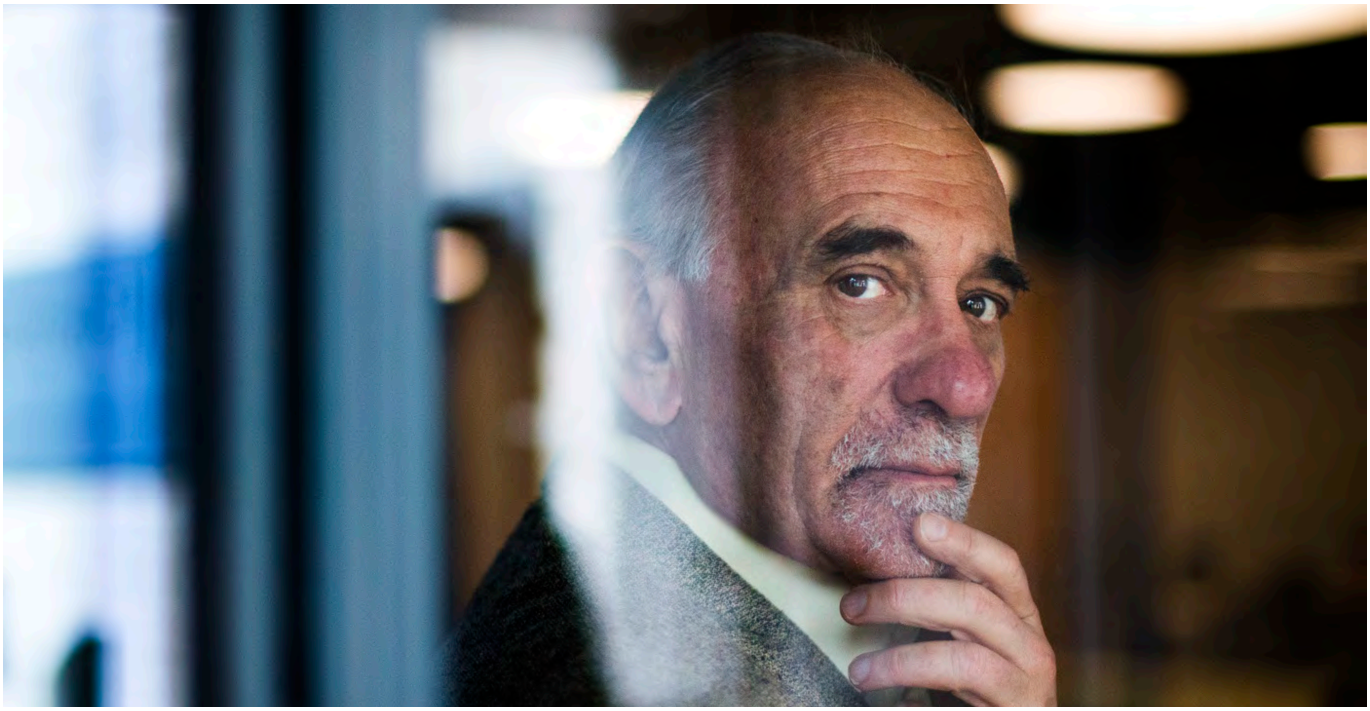
Kane and his team are partnering with Professor Misha Pavel from the Bouvé College of Health Sciences at Northeastern, an expert on health behavior and using smart technology, as well as ecobee, a company that creates smart thermostats and other home technologies.

"Human comfort is a very personal and subjective thing," says Kane. "Sixty-five degrees Fahrenheit in March in Boston feels very different than 65 degrees in August in San Diego. In order to get accurate data, we can't study thermal comfort only in a lab setting."

With the funding from the NSF, Kane seeks to overcome this limitation by recruiting 100 homes across the U.S. for a pilot study. Over a period of several years, they will track their home heating and cooling data with ecobee thermostats. Real-time algorithms will monitor irregular changes in the environment or user behavior and prompt participants to take a second to answer a question with a swipe on their smart watch.

"With this info, we can probe into all of the physical and psychological factors that contribute to a person's comfort," says Kane. "The ultimate goal is to understand these personal internal processes using data from the large cohort of participants to homes comfortable to the people living there while using energy when the grid is clean and cheap, and holding off on heating and cooling for short periods when the grid is dirty and expensive."

Kane is aiming to collect three years of data from this pilot study, which will then be combined with an existing data set from 100,000 ecobee users who have opted in to anonymously donate their temperature data to science. He hopes to start experimenting with different control algorithms within one to two years.



Eduardo Sontag, University Distinguished Professor, electrical and computer engineering, jointly appointed in bioengineering

AFOSR Grant for Investigating Feedback Systems in Nature and Engineering

University Distinguished Professor **Eduardo Sontag**, electrical and computer engineering (ECE), jointly appointed in bioengineering, and affiliate faculty in chemical engineering and mathematics, was awarded a $750K grant from the Air Force Office of Scientific Research, titled "Network Motifs and Responses of Nonlinear Systems."

The award will support his research into the mathematical foundations of biomolecular feedback control and signal processing. The project aims to explain how responses to external stimuli provide information regarding the internal structure of synthetic and natural cellular networks, elucidating the behavior of natural systems as well as helping to improve feedback control in engineered systems.

The feedback mechanisms underlying a wide variety of unrelated applications can be studied through the common lens of the field of mathematics called control theory. Sontag has devoted much of his professional life to this area of work, and specifically to the development of the theoretical foundations of nonlinear control systems analysis and design.

In engineering, feedback control plays a central role in aerospace, manufacturing, robotics, chemical processes, electrical power systems, consumer products, medical devices, self-driving cars, mobile communications, and many other areas. In nature, physiological feedback loops are key to homeostatic mechanisms that finely tune temperature, blood pressure, calcium, sugar levels, body fluids, and balance, in humans and animals. They also manage the delicate interplay between infections, tumors, and the immune system, and help marshal defenses against invading pathogens. Inside individual cells, feedback systems regulate the dynamic behavior of complex molecular reaction networks composed of interacting genes, mRNA's, proteins, small molecules, and metabolites, orchestrating exquisite information processing, regulatory, and dynamic behaviors that constitute life itself. In synthetic biology, bioengineered cells are endowed with circuits that control gene expression for therapeutic applications. At the level of entire populations, the stability of ecological systems depends on predator/prey as well as competitive and cooperative interactions. In economics, money supply and interest rates are employed as feedback controls. In pandemics, interactions of individuals are tuned through levels of "social distancing" and other "non-pharmaceutical interventions" designed to balance intensive care unit usage.

ENGINEERED WATER, SUSTAINABILITY, AND HEALTH

The Engineered Water, Sustainability and Health initiative will develop engineered solutions for sustainability and health, focusing on clean water and environmental protection as key grand challenges.

- Surface and groundwater contamination
- Impact of climate change and environmental hazards on health
- Water quality and health
- Management and protection of the environment

Hongli Zhu, assistant professor, mechanical and industrial engineering

A Novel Biodegradable Material as an Alternative to One-Time Use Plastics

"Single-use plastic containers at supermarkets and restaurants are cheap and convenient, but most of these containers are not biodegradable," says **Hongli Zhu**, assistant professor, mechanical and industrial engineering.

According to the Environmental Protection Agency, 27 million tons of plastic were diverted to landfills in 2018. Plastic doesn't decompose over time. It gets broken into smaller pieces known as microplastics that pollute rivers and oceans.

To address this, Zhu and her PhD students turned a sugarcane byproduct into a sustainable, compostable, and inexpensive material that's durable enough to serve as tableware, and that biodegrades within 60 days. The material is made of sugarcane pulp, known in the industry as bagasse, and bamboo fibers to add strength. Since bagasse and bamboo fibers are made up of similar underlying chemicals (cellulose, hemicellulose, and lignin), the material doesn't require any additional processing during the recycling and reusing processes to separate different components, unlike some currently available options. The result is a completely natural and biodegradable material that is sufficiently durable to be molded into containers strong enough to hold food and liquids.

To test how the material would degrade over time, Zhu and her students buried a container made of the new material outside and checked on the container every 10 days. They found that the material began breaking down after about 30 days and disintegrated almost completely after 60 days. This is a huge improvement over currently available compostable containers, some of which require specialized industrial equipment and high temperatures to actually decompose, Zhu says.

She believes this is a practical approach to tackle plastic pollution. It is low cost, sustainable, and can upgrade the byproducts in the sugar industry to valuable and sustainable products everyone needs daily. Her research was published in the journal *Matter*.



Mark Patterson, professor, marine and environmental sciences, and civil and environmental engineering

Fulbright U.S. Scholar Award to Study Kelp Forests and Climate Change in Canadian Arctic

Mark Patterson, professor of marine and environmental sciences, and civil and environmental engineering, developed Fetch, the autonomous underwater robot, in 1998 to compile data about the ocean more efficiently than human divers. In the past two decades, Fetch has investigated krill populations in the Antarctic ocean and coral-killing sea sponges in reefs in the Caribbean.

Now, Fetch will travel to the Canadian Arctic to explore kelp forests, an ecosystem largely uncharted by marine biologists. Patterson recently received a Fulbright U.S. Scholar Award to facilitate this research, which will be conducted in partnership with Université Laval in Quebec City.

The primary goal of Patterson's research is to map the kelp forests. "First we need to know where they are," he says. "Then we can look at how climate change affects the beds. It could be that kelp forests actually expand and do better under this warming scenario in the Arctic."

Additionally, Patterson and his team will investigate whether changes to the kelp forests affect Canada's First Nations people, who rely on species that live in the kelp beds for food.

"There are a lot of fish and other species that use the kelp beds as a habitat," says Patterson. "The Arctic cod are a good example. The First Nations people rely a lot on cod for food."

Patterson also hopes to involve the local First Nations communities in the research. "I want to let the people interact with the robots," he says. "I think that's the fun part. Most people are interested in robots on some level."

Patterson, who will conduct this research during his sabbatical, is looking forward to living in Canada, where he has family roots. "As a Fulbright Scholar, I'll be representing the United States, but I'm a dual national, so it'll be nice to be in my other country," he says.

Andrew Myers, associate professor and associate chair for graduate studies, civil and environmental engineering

Reimagined Floating Wind Turbine Wins Startup Accelerator Competition

Associate Professor **Andrew Myers**, civil and environmental engineering, was a winner of the 2020 Cleantech Open Northeast startup accelerator program, which featured 47 startups focused on various aspects of sustainability, including green tech, agriculture, clean energy, and more. Myers' startup, T-Omega Wind, is an innovative floating wind turbine based around technology and research developed and patented at Northeastern along with co-founder Jim Papadopoulos.

"Floating wind turbines are an important part of the energy future of the world, and an important part of overcoming the climate crisis," says Myers. "They can be installed in a wide range of water depths and can be constructed at port, where the waters are calm."

The most common design for offshore wind turbines is a large structure affixed to the sea bed. This presents a variety of obstacles for rapid and large-scale realization of U.S. and global wind potential and is limited to relatively shallow water depths. Given that there is enough wind power off the U.S. eastern seaboard to power the entire country, Myers reimagined wind turbine floats to be purposefully redesigned for ocean use.

His startup's solution is a floating wind turbine that is lightweight but strong and easy to move because of its shallow draft. It is also low-cost and can be manufactured and launched in shallow ports using capabilities and infrastructure presently available in Massachusetts and the U.S. It's designed intentionally to be buildable with only modest marine fabrication capabilities that exist in abundance all over the world. This is essential to scaling the technology, so turbines can be built quickly and in huge volumes to decarbonize significant portions of the global energy sector.

In 2020, Myers received funding from the Massachusetts Clean Energy Center's Catalyst InnovateMass program to further develop the novel floating wind turbine.

Plastics in the Earth System Research Published in 'Science'

A research paper, titled "Plastics in the Earth System" by Professor **Aron Stubbins**, marine and environmental sciences (MES), College of Science, and civil and environmental engineering (CEE), and Assistant Professor **Samuel Muñoz**, MES/CEE, was published in the journal *Science*. The research covers plastics in the air and water, and their growing importance to geochemists given their abundance and ubiquity in our environment.

Abstract: Plastic contamination of the environment is a global problem whose magnitude justifies the consideration of plastics as emergent geomaterials with chemistries not previously seen in Earth's history. At the elemental level, plastics are predominantly carbon. The comparison of plastic stocks and fluxes to those of carbon reveals that the quantities of plastics present in some ecosystems rival the quantity of natural organic carbon and suggests that geochemists should now consider plastics in their analyses. Acknowledging plastics as geomaterials and adopting geochemical insights and methods can expedite our understanding of plastics in the Earth system. Plastics also can be used as global-scale tracers to advance Earth system science. *Science, 02 Jul 2021: Vol. 373, Issue 6550, pp. 51-55, DOI: 10.1126/science.abb0354*

Developing a Floating Wetlands Wave Mitigation System

Julia Hopkins, assistant professor, civil and environmental engineering, was named the lead scientist on a new Small Business Innovation Research (SBIR) grant from the National Science Foundation. The grant funds the research and development of a nearshore solution for coastal flooding.

As climate change worsens, coastal flooding from extreme storms pose an increasing threat. Novel solutions are needed to serve coastal communities. Boston is one such threatened city, and the grant will fund the development of a wave mitigation system originally conceived for the Massachusetts Bay area and referred to as "Emerald Tutu."

Intended to be easily deployed and expanded in any city with need, the "Emerald Tutu" is an interconnected system of floating wetland and walkways that hug the shoreline in half-ring formations. The floating wetlands will be populated using local flora varieties and will consist of marsh grass above and seaweed below. The long roots of the seaweed disrupt and mitigate wave movement while also providing habitat for nutrient-regulating zooplankton. On the outskirts of the system will be a series of walkways, providing a community recreation resource for walking and biking, while remaining navigable for boats and small craft.

This SBIR Phase I project is a natural coastal resilience technology designed to be pre-fabricated, modular, and easy to implement for a variety of coastal environments and communities. The technology consists of robust vegetated mats linked in a network and deployed in the nearshore. The mats are colonized by local varieties of semi-aquatic marsh flora above the water line, and aquatic seaweeds below. Research objectives to validate this approach include comparing mat network performance in a range of flow conditions, including extreme waves, to inform mat design. A second research thrust will measure biomass accumulation and ecological performance through in situ deployments of mat structures.

INTEGRATED MODELING, INFERENCE, AND COMPUTING

Integrated Modeling, Inference, and Computing will focus on the advancement of the integration of core areas of engineered modeling approaches, machine learning, and computation to address barriers in smart modeling with applications in bioengineering for health and disease, environmental health monitoring and climate change, and engineering and design of advanced material systems. It will identify testbeds that define broad application areas that demand new developments in our three fundamental core areas to address barriers in smart modeling.

Stratis Ioannidis, associate professor, electrical and computer engineering

Edmund Yeh, professor, electrical and computer engineering

$1 Million NSF Award to Pioneer a Data-Centric Approach to Distributed Machine Learning

Associate Professor **Stratis Ioannidis** and Professor **Edmund Yeh**, electrical and computer engineering, in collaboration with Carnegie Mellon University, have been awarded a $1 million grant from the National Science Foundation to pioneer a data-centric approach to distributed machine learning. The project utilizes advances in Named Data Networking (NDN) to enable new types of distributed learning algorithms that intelligently move data and model components through heterogeneous networks of sensors, while optimally harnessing the networks' diverse computation, energy, and bandwidth resources. The project is expected to improve the performance of machine learning algorithms in a vast number of potential applications, ranging from smart cities to satellite data analysis to augmented reality.

Machine learning algorithms have revolutionized many fields by giving them the ability to use historical data for making predictions or detecting patterns that can then be used to automate various tasks and create new applications for users. The data that many of today's machine learning applications require, however, is often collected by a network of multiple sensors. For example, data from environmental sensors in smart cities can be used to predict air pollution or traffic at different locations in the city. Analyzing this data with machine learning algorithms then requires these devices to cooperate with each other, exchanging data and models. This project designs mechanisms for devices to efficiently cooperate.

Distributing machine learning algorithms is particularly challenging when devices are heterogeneously resource-constrained, e.g., with varying computer, power, or bandwidth limitations, as is often the case in today's networks. Traditional learning algorithms either bring all data to a single location for analysis, or entirely distribute the learning algorithm to the data sources. A more flexible approach that instead intelligently brings data to the computing components of the learning algorithms, and conversely brings computing to data sources, can better harness these devices' resources, but raises a natural question of how data and model components should be moved through the network. This project develops a data-centric approach to distributed learning that utilizes advances in Named Data Networking (NDN) to simplify the process of exchanging information, enabling new types of distributed learning algorithms.

NSF CAREER Award for Causal Inference in Large-Scale Studies

Muhammad Noor E Alam, assistant professor, mechanical and industrial engineering

Assistant Professor **Muhammad Noor E Alam**, mechanical and industrial engineering, received a $500K National Science Foundation CAREER Award for developing "Robust Matching Algorithms for Causal Inference in Large Observational Studies." The research will utilize the power of Big Data to infer causality in large-scale observational studies.

In many situations, particularly in the public health domain, it may be difficult or prohibitively expensive to design controlled studies to evaluate effective public policies. As large-scale data collection increases, the design of methods to infer causality between treatment and outcome by partitioning observations into appropriate sets has become an attractive alternative. Current methods underlying causal inference suffer from several fundamental challenges that may lead to sub-optimal policy selection. This project will develop tractable computational approaches to facilitate better policy decision making. As an important use case, the project will evaluate policies for improving treatment quality of Opioid Use Disorder (OUD) using large-scale U.S. healthcare data.

Using a modern optimization perspective, this project will advance existing methods for causal inference by developing a theoretical and computational framework that encompasses both inference and matching to identify causality from an observational study. The research objectives are to (1) establish a robust causal inference framework with matching methods to reduce uncertainty, (2) ensure covariate balance in high dimensional space, (3) develop optimal covariate balance techniques to reduce bias and model dependency by ensuring desired distributional properties, and (4) evaluate and advance U.S. healthcare policies based on this framework. To this end, a rigorous optimization framework will be employed to explicitly account for uncertainties in causal inference, maintain neighborhood structures of high dimensional data in low dimensions with matching requirements, and ensure optimal distributional properties of observational data. Efficient exact solution algorithms will be developed exploiting problem structure. Scalability will be addressed through algorithmic schemes with desirable convergence properties and data structure-based decomposition methods. These algorithms are expected to be useful to a wide variety of optimization problems such as quadratic assignment, convex-nonlinear feasibility, and binary feasibility.

AI Jumpstart Program to Bring AI to Massachusetts Businesses

Michael Silevitch, Robert D. Black Distinguished Professor, electrical and computer engineering

Most people who run small and midsize businesses know that they ought to take advantage of artificial intelligence to make their companies competitive in the digital age. But many don't know how to go about it.

To meet this demand, Robert D. Black College of Engineering Distinguished Professor **Michael Silevitch**, electrical and computer engineering, is leading a new Massachusetts program, AI Jumpstart, to connect small business owners in the state with academic faculty experts to learn how machine learning can grow their companies.

The initiative is aimed at a broad range of small and midsize enterprises in defense, manufacturing, health, and other industries whose leaders would like to incorporate artificial intelligence but aren't quite sure where to turn. It's open also to companies that want to upgrade data-driven computing to glean new insights into customers, suppliers, and competitors.

Artificial intelligence is "like an injection of innovation into the Massachusetts economy," says Silevitch. "My job is to make sure that this program meets its potential and that it's running correctly."

"The College of Engineering is proud to be leading this engagement between world-class researchers in AI and critical industries in Massachusetts. It is a reflection of years of commitment to use-inspired research, experiential learning, and a promise for continued innovations to impact our economy and society," says **Gregory D. Abowd**, Dean of the College of Engineering at Northeastern.

Northeastern received a $2.2 million state grant that will be used primarily for high-speed computer equipment and also to provide for faculty consultants, both of which will be available to selected companies to get the pilot effort up and running. Northeastern contributed an additional $2 million, raising the program's total value to more than $4 million.

Most of the equipment will be installed at the Holyoke Mass Green High Performance Computing Center, an inter-collegiate research venture involving Northeastern and other universities in the state. Northeastern's Innovation Campus in Burlington, Massachusetts, will receive new equipment too. It will be directly connected to the Institute for the Wireless Internet of Thing's Colosseum facility, the world's largest wireless emulator, hardware or software.

SECURITY, SENSING, AND SURVEILLANCE

Security, Sensing and Surveillance Systems will focus on providing engineering solutions to outstanding mission-critical challenges in areas of surveillance, reconnaissance, imaging, and detection enabled by innovative advances in next-generation radar, sonar, video, optical/IR and communication platforms. It will build upon the current international reputation and success of Northeastern's College of Engineering in the broad area of physical threat sensing, detection, imaging, and remediation in the field of security systems.

- Resilient infrastructure
- Cybersecurity
- Transportation security

Xue "Shelley" Lin, assistant professor, electrical and computer engineering

$1 Million DARPA Award to Make Machine Learning Safer for More Applications

Artificial intelligence and machine learning are two of the most exciting developing technologies in the world. From self-driving cars, to robotics, to healthcare, their potential to help people is virtually unlimited. As with many technologies, however, it comes with potential security issues.

The threats for machine learning come in many forms, but can be broken down into machine-centric and human-centric attacks. As you might guess, machine-centric attacks target machine learning decisions, and human-centric attacks aim to fool humans making decisions. Both types of attacks aim at "information deception"—manipulating the input data on machine learning models or producing falsified media and other information with machine learning models.

Countering these attacks is at the heart of Electrical and Computer Engineering Assistant Professor **Xue "Shelley" Lin's** research that she is doing in collaboration with Michigan State University. The project, titled "Intelligent Diagnosis for Machine and Human-Centric Adversaries," recently received $1 million in funding from the Defense Advanced Research Projects Agency (DARPA), and will build a scalable learning system for reverse engineering of deception (RED). It aims to develop and scale technology that can automatically recover and index attack toolchain signatures in both machine-centric and human-centric attacks.

Lin's project will develop ways to identify attacks, and also index them for future use. "Our project is the first one to develop a unified attack toolchain that covers a broad range of attacks, both human-centric and machine-centric," Lin says. "And then to index each attack, we have different families of attacks, and even reverse engineer the data to extract the unique adversary signature, and also the supervised attack classifier."

In the end, this project should help make machine learning safer to use for a wider variety of tasks. "Machine learning can be powerful, but there are many uncertainties holding us back from using it more widely," Lin says. "We need to gain more understanding of it and the potential security issues to use it more confidently. This project is about helping in the fundamental direction of being able to use it more."

Bolstering UAV Cybersecurity Education

Xiaolin Xu, assistant professor, electrical and computer engineering

The development of unmanned aerial vehicles (UAVs), or drones, is unleashing the increasing application in civilian and military scenarios. At the same time, serious cybersecurity concerns have been raised about UAVs, wherein they are identified as targets of cyber-attacks or potential attack vectors for malicious actors.

Assistant Professor **Xiaolin Xu**, electrical and computer engineering, in collaboration with Embry-Riddle Aeronautical University and UMass Dartmouth, was awarded a $500K National Science Foundation grant for "Bolstering UAV Cybersecurity Education through Curriculum Development with Hands-on Laboratory Framework."

The project seeks to improve UAV and cybersecurity education through the development of curriculum materials and a hands-on laboratory platform. It will include the development of a set of cohesive course modules that systematically cover UAV cybersecurity topics; a UAV cybersecurity laboratory platform that provides a series of exercise modules and can be easily deployed; an open and collaborative UAV cybersecurity repository for educators, students, and researchers to discuss, collaborate, contribute, and share; and faculty development summer workshops for UAV cybersecurity education.

This project is the first to provide education materials, including hands-on labs on UAV cybersecurity systematically, and it will include novel, effective, and engaging course modules on UAV cybersecurity. The deliverables include a low-cost hardware-in-the-loop (HIL) UAV experimental kit; the integrated development environment (IDE) to use the tool kits; and multiple hands-on labs covering the hardware security, communication security, network security, and data security.

Nian Sun, professor, electrical and computer engineering, and Hongwei Sun, professor, mechanical and industrial engineering

Surveillance System to Detect Air and Water Pathogens Wins Trinity Award

As part of a collaborative team of researchers from multiple institutions, Professor **Nian Sun**, electrical and computer engineering, and Professor **Hongwei Sun**, mechanical and industrial engineering, were awarded $660K in pledged funding as one of five third place winners of The Trinity Challenge (TTC)—a competition to invent the most effective methods to ensure that health emergencies similar to the COVID-19 pandemic don't upend societies in the future.

Their winning project, titled "Disease Surveillance with Multi-modal Sensor Network & Data Analytics," is a wastewater surveillance system designed to operate in remote areas with little access to health services. It is a wireless sensor network, with patented sensor technologies, that detects pathogens in air and water up to one week before cases present in humans.

Winners were selected by a prestigious international panel of judges out of 340 applications from 61 countries, narrowed down to 16 finalists and 15 "highly commended" teams.

TTC is a coalition of 42 organizations from the private, public, philanthropic, and academic sectors, working towards protecting the world from future pandemics, by using data, analytics, and digital tools. Dame Sally Davies, master of Trinity College, Cambridge, and former chief medical advisor to the United Kingdom, in September 2020, brought together Northeastern University, Microsoft, Google, the Bill & Melinda Gates Foundation, and other industry leaders to participate in the challenge.

Guardion Startup Wins NASA Entrepreneurs Challenge

Yung Joon Jung, professor, mechanical and industrial engineering

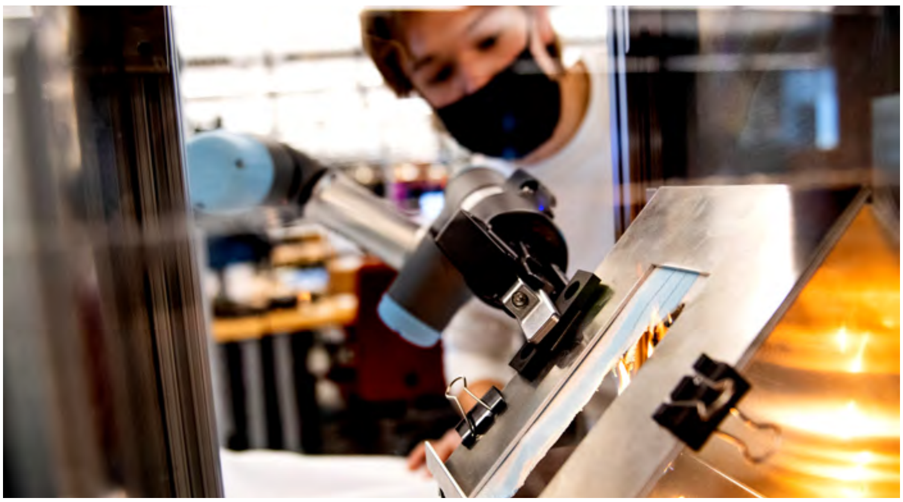
Guardion, co-founded by Professor **Yung Joon Jung**, mechanical and industrial engineering, was a winner of the NASA Science Mission Directorate Entrepreneurs Challenge. The startup is a spin-out of the work Jung has done in his lab at Northeastern, initially through National Science Foundation ECCS and PFI grants.

Guardion uses nanotechnology to create highly sensitive, low-cost, networked detectors of radioactivity and nuclear radiation. The radiation sensor is at least an order of magnitude more sensitive than currently available options. It's also smaller and less expensive to build. A network of the sensors can be deployed in cities where they act as guards, sensing radiation-generated ions to preventatively detect the early presence of specific radiation from nuclear or radiological terrorism. They may also be given to first responders who are responsible for isolating an effected area. Having a network of sensitive detectors would allow first responders to instantaneously and remotely map the perimeter, which could save lives.

In 2017, Guardion won a $50K prize at the MassChallenge Accelerator Program and a $550K additional grant through the CASIS-Boeing Prize for Technology in Space.

The NASA Entrepreneurs Challenge sought to identify individuals and promising commercial companies working on technology that will advance the state-of-the-art in three broadly defined technology focus areas: Physics-based transfer learning and artificial intelligence, Advanced mass spectrometry, and Quantum sensors.

EXPERIENTIAL ROBOTICS



Using Robotics to Accelerate Face Mask Testing for Healthcare Workers

Taskin Padir, associate professor, electrical and computer engineering, and director of the Institute for Experiential Robotics

Face masks worn by healthcare staff must undergo a specific set of tests to ensure that they will be safe for hospital personnel. But those tests are difficult to perform, requiring specialized facilities that are only available at some laboratories in the U.S. And because of the logistics of sending materials to an external facility during a pandemic, that kind of testing can take more than a few weeks to complete, resulting in slow distribution times for manufacturers.

To overcome this challenge, Associate Professor **Taskin Padir**, electrical and computer engineering, and director of the Institute for Experiential Robotics, began creating robotic technology that can assist manufacturing workers and eliminate the need to send masks to outside labs for testing. He is building a system that integrates robotic components and machine learning to speed up the testing, while using the intelligence of a human, who can supervise and assist the robot. The system, he says, includes sensors that would help a robotic arm handle different objects quickly and efficiently.

Recently, he was selected by the Advanced Robotics for Manufacturing Institute to receive funding from the U.S. Department of Defense for this effort. The plan is to help manage the current and future pandemics.

In May 2020, Padir began discussions with Massachusetts General Hospital, when the hospital was analyzing different contingency plans to prepare for potential shortages in surgical masks. They were considering producing their own masks, Padir says, and needed to ensure their compliance to the guidelines established by the U.S. Food and Drug Administration.

In this $1.1 million project funded by the Office of the Secretary of Defense, Padir is partnering with Merrow Manufacturing, the largest producer of US-sourced PPE in Fall River, Massachusetts, and Boston Engineering Corporation in Waltham, Massachusetts. The system Padir is building with Merrow is a type of robotic arm that, instead of handling the fabric directly, can interact with test gadgets used by human beings. After placing the test piece in a frame specifically designed for the robot to handle, the human can step away and let the system conduct the tests automatically.

Padir also has a grand vision of automating the entire testing process from beginning to end, from putting the raw materials in, to getting a piece of gear, such as a mask, out—with the sewing, the welding, and the cutting all done automatically. A robotic system that can begin handling materials as they undergo testing is one link in the chain of that vision.

Autonomous Vehicle Assistant Project Wins DOT Inclusive Design Challenge

Xue "Shelley" Lin, assistant professor, electrical and computer engineering

Assistant Professor **Xue "Shelley" Lin**, electrical and computer engineering, in collaboration with University of Maine Professor **Nicholas Giudice**, won the U.S. Department of Transportation's (DOT) Inclusive Design Challenge for their project "Autonomous Vehicle Assistant (Ava): Ride-Hailing and Localization for the Future of Accessible Mobility" and received a $300K Stage I cash prize and advanced to Stage II as a semifinalist.

According to the DOT, an estimated 25.5 million Americans experience a travel-limiting disability that impacts their access to employment, medical care, and other activities of daily living. Automated vehicles, particularly those designed to be operated exclusively by Level 4 and Level 5 Automated Driving Systems (ADS), hold great promise to enhance freedom of movement for these individuals.

The DOT's Inclusive Design Challenge sought innovative, inclusive design features to enable people with physical, sensory, and cognitive disabilities to use automated vehicles, particularly ADS-dedicated vehicles (ADS-DV).

As a Stage I winner, Lin and the project team will develop "Ava", the Autonomous Vehicle Assistant, an innovative ride-hailing and localization smartphone application designed to seamlessly assist passengers with visual impairment and older adults during pre-journey planning, travel to pick-up locations, and vehicle entry. It will use innovative human-machine interfaces and technologies such as GPS and computer vision to help users find and ultimately arrive at an ADS-DV safely. The initial rollout of Ava's training modules can be fully deployed and utilized via users' existing smartphones, representing a cost-effective and timely solution to the problem of trust in automated vehicles.

The project builds upon a seed-grant funded joint project between Northeastern and the University of Maine to improve accessibility, safety, and situational awareness within the self-driving vehicle with a new model of human-AI vehicle interaction. Lin is combining real-time deep learning and human-vehicle collaboration techniques in autonomous vehicles to assist older and visually impaired passengers. Working with a team of researchers from the Virtual Environment & Multimodal Interaction Laboratory at the University of Maine, she is building algorithms to lay the foundation of work so engineers can integrate deep learning–a branch of artificial intelligence that can help algorithms analyze huge amounts of high-dimensional info rapidly—and plug that information into the computing systems in self-driving cars.

Robotics Students Invited to Elite Robotics Summer School in Denmark

Stephen Alt, E'22, computer science, and Syed Mohammad Ajad, ME'22, robotics, work in the robotics lab at Northeastern.

Six robotics engineering students attended an elite, selective robotics summer school organized by the Danish government and private companies there. It was held at the University of Southern Denmark in Odense, Denmark, the hub for more than 50 robotics companies. Global universities with renowned robotics departments were invited to participate, according to **Taskin Padir,** associate professor of electrical and computer engineering at Northeastern and director of the university's Institute for Experiential Robotics.

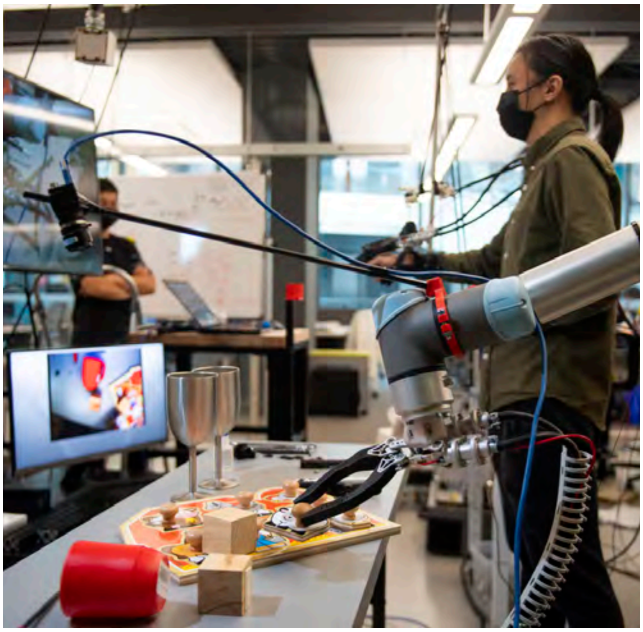
"They want to focus on geographical diversity around the globe as well as proven leadership in research in robotics at these institutions," Padir says of the schools chosen for the program. Besides Northeastern, other selected schools include the Korea Advanced Institute of Science and Technology, the Technical University of Munich, and several Danish universities. A total of 50 students worldwide.

"Experiential robotics is about our researchers experiencing different cultures and opening them up to new research directions," Padir says. "This summer school program is one vehicle that we saw as an opportunity for our students."

Northeastern's robotics lab located at the Interdisciplinary Science and Engineering Complex houses more than $1 million worth of robots. Among research specialties is advancing the relationship between humans and machines. For example, collaborative robots "are robot arms that can work in human environments," says Padir. The market for these task-specific robots is expected to grow significantly in the next few years, he adds, and was Northeastern's focus at the summer program in Denmark.

Students that attended the Denmark program include **Stephen Alt**, E'22, computer science, **Sadjad Asghari-Esfeden**, PhD'21, computer engineering, **Syed Mohammad Asjad**, ME'22, robotics, **Areeba Aziz Rajput**, ME'22, electrical and computer engineering, **Nathaniel Hanson**, PhD'24, computer engineering, and **Jagatpreet Nir**, PhD'23, computer engineering.

Advancing Remote Robotic Technology



Rui Luo, PhD'23, computer engineering, tests the remote robotic arm that the Northeastern team entered into the Avatar XPrize global competition and was selected as a semi-finalist.

A Northeastern University team of researchers is creating an avatar system that can transport human presence to a remote location in real time and their research is part of a global competition, ANA Avatar XPrize. Avatar technology uses a combination of AI, haptics, robotics, and more to make it possible to transport ourselves to another place entirely, and make the user feel like they are there. The Northeastern team led by College of Engineering faculty is one of 37 clubs out of 150 around the world to advance to the semifinal stage of the $10 million competition.

The researchers are working to make robotic arm motion graceful and deft enough to gently pick up an egg or sturdy enough to stack dinner plates. The findings could one day allow doctors to remotely perform surgery on a distant battlefield or help bomb disposal experts safely remove an explosive device.

Their project involves building remote-controlled robot arms that do not have heavy motors traditionally installed in the wrist joints. Instead, they are placed in the base of the machine.

"With no motors in the arm, they are much lighter than a traditional arm," says **Peter Whitney,** assistant professor of mechanical and industrial engineering. "So now if you have a lighter arm, it's much easier to move it around."

The engineering advancement has the potential to overcome a fundamental obstacle humans face when controlling robots remotely—understanding the environment the machine is in.

"It's hard to perceive exactly where the robot is, relative to the environment—whether it's touching something or not, or how or how hard it is touching an object," explains Whitney, whose research is focused on the design of robots, the materials they are made of, and how they are operated and controlled.

"These are all factors that can influence how we can get good performance, but also maintain safety," he adds.

Researchers now have the ability to do machine learning with real-time information that tells how much force is being applied. "So when we try to grasp an object or manipulate an object, we can actually make use of those contact forces, similar to how human muscles sense forces such as how heavy something is," says Whitney.

Machine learning is an active area of research among Northeastern faculty, Whitney says. He is working with Professor **Hanu Singh**, electrical and computer engineering and mechanical and industrial engineering, and **Robert Platt**, associate professor of computer science in the Khoury College of Computer Sciences, on an Office of Naval Research project on explosive ordinance disposal.

Whitney is also collaborating with **Taskin Padir**, associate professor of electrical and computer engineering and director of the Institute for Experiential Robotics, to study the potential for robots that are controlled remotely to be used to physically interact with friends and family, serving as a mechanical stand-in. The technology could allow people to hug a loved one in quarantine as one example of its potential, Whitney says.

WIRELESS INTERNET OF THINGS

Wirelessly Reprogramming Neurons to Restore or Enhance Memories

Josep Jornet, associate professor, electrical and computer engineering

Matteo Rinaldi, professor, electrical and computer engineering

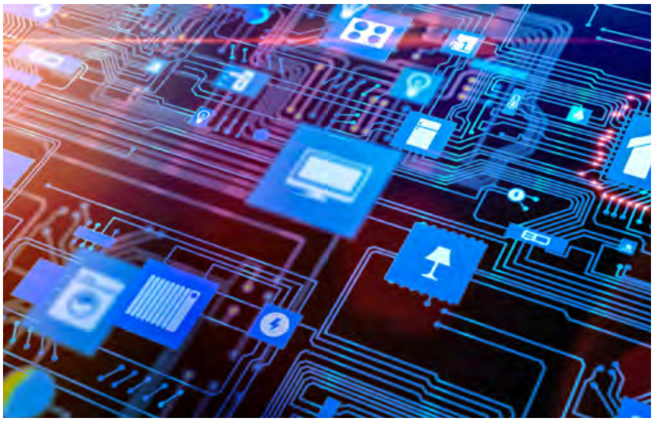
Associate Professor **Josep Jornet** (PI), and Professor **Matteo Rinaldi**, electrical and computer engineering, in collaboration with the University at Buffalo, the State University of New York, were awarded a $600K National Science Foundation grant for "Control of Information Processing and Learning in Neuronal Networks through Light-mediated Programming of Genomic Networks."

The physical DNA interactions within the genome, or network of genes, determine gene activities and thereby the development and function of cells, similarly as the software determines the operation of the hardware in a computer. Being able to program genomic interactions in cells is at the basis of transformative applications. Optogenomics, or the control of the genome function through light, offers an unprecedented means to, for example, control brain development and function and design new corrective treatments of cancer and other diseases.

The research project will study information processing and learning (and, thus, memory) in neuronal networks orchestrated by the light manipulation of the genome. For this, new photonic and electronic tools will be developed to program the genome in neurons and to study both the resulting changes in the structure and activity in networks of living neurons.

"Each cell in our body has the same DNA, the same source code, and different cells just run different parts of it, kind of like running different apps on your cellphone. Our goal is to study how we can wirelessly reprogram neurons to fix broken apps, such as restoring or enhancing memories, or even to install new apps," explains Jornet.

"Since 2015, we have been working on the different elements to actually do this: smaller lasers and antennas for light and light-triggered molecular switches to trigger or stop molecular processes in the genome. In this new project, we go one step further and, beyond refining the tools, we use them specifically to study how information is processed in the brain, by controlling the genome of one cell at a time. This can be used to stop neurodegenerative diseases and restore lost functionalities in neurons, or, even more ambitious, enhance certain brain abilities," says Jornet.



AI-EDGE: New NSF Artificial Intelligence Research Institute

In 2021, the National Science Foundation established 11 new NSF National Artificial Intelligence Research Institutes, building on the first round of seven institutes funded in 2020. Northeastern University College of Engineering is part of a team led by the Ohio State University that was awarded $20 million over five years for the NSF AI Institute for Future Edge Networks and Distributed Intelligence (AI-EDGE). Professor **Kaushik Chowdhury**, electrical and computer engineering (ECE), is the Northeastern lead, with co-PIs ECE William Lincoln Smith Professor **Tommaso Melodia** and ECE Associate Professor **Stratis Ioannidis** responsible for $1.8 million of the award.

AI-EDGE will leverage the synergies between networking and AI to design future generations of wireless edge networks that are highly efficient, reliable, robust, and secure, and facilitate solving longstanding distributed AI challenges. The focus will be on edge networks since most of the growth is expected to happen with wireless devices, services, and applications at the network edge rather than the traditional network core. These edge networks will encompass mobile and stationary end devices, wireless and wired access, and computing and data servers.

New AI tools and techniques will be developed to ensure that these networks are self-healing and self-optimized. Collaboration over these adaptive networks will help solve long-standing distributed AI challenges making AI more efficient, interactive, and privacy preserving for applications in sectors such as intelligent transportation, remote health care, distributed robotics, and smart aerospace. It will create a research, education, knowledge transfer, and workforce development environment that will help establish U.S. leadership in next-generation edge networks and distributed AI for many decades to come. AI-EDGE is also partially funded by DHS.

Apart from contributing to theoretical research that advances applied machine learning in distributed wireless edge networks, Northeastern PIs will also help to demonstrate these outcomes within practical use-cases and community-scale experiential platforms. Specifically, Northeastern will lead two use-cases. The first is called "Ubiquitous and Immersive Sensing and Networking in 6G+ Systems." It will generate, deliver, and process data from pervasively deployed multimodal sensors, enabling AI agents to become cognizant of the environment. The second is called "End-to-End Programmable and Virtualized 6G+ Cellular Networks," which will lead to an unprecedented ability to control the entire network infrastructure end-to-end by AI.

AI-EDGE collaborators with the Ohio State University in addition to Northeastern University include Carnegie Mellon University, Purdue University, University of Wisconsin-Madison, University of Michigan, University of Texas-Austin, University of Washington, University of Massachusetts-Amherst, University of Illinois-Urbana-Champaign and University of Illinois-Chicago. It will also work with its industrial partners including AT&T, IBM, Microsoft and Qualcomm and the Air Force Research Lab, Army Research Lab and Naval Research Lab to translate the research so that it is widely adopted.

Kaushik Chowdhury, professor, electrical and computer engineering

Tommaso Melodia, William Lincoln Smith Professor, electrical and computer engineering, and director of the Institute for the Wireless Internet of Things

Stratis Ioannidis, associate professor, electrical and computer engineering

New Wireless Testing and Emulation Facilities Push Innovation to New Heights

Northeastern is at the leading edge of wireless research and in recent years has added to its sophisticated facilities. In 2019, the Expeditionary & Unmanned Aircraft Systems Lab was opened at the Innovation Campus in Burlington, Massachusetts. In 2020, Colosseum, the world's largest wireless testbed built by the Defense Advanced Research Projects Agency (DARPA) and part of Northeastern's Institute for Wireless Internet of Things, was added at the Burlington location. And in 2021, Northeastern received a rare designation as a Spectrum Innovation Zone by the Federal Communications Commission. The Innovation Zones at the Boston and Burlington, Massachusetts, campuses establish the university as the fourth such hub in the U.S. and the first to enable experimentation for wireless communications and sensing technologies above 100 gigahertz, including a frequency band that is crucial for the development of 6G technologies (see page 8).

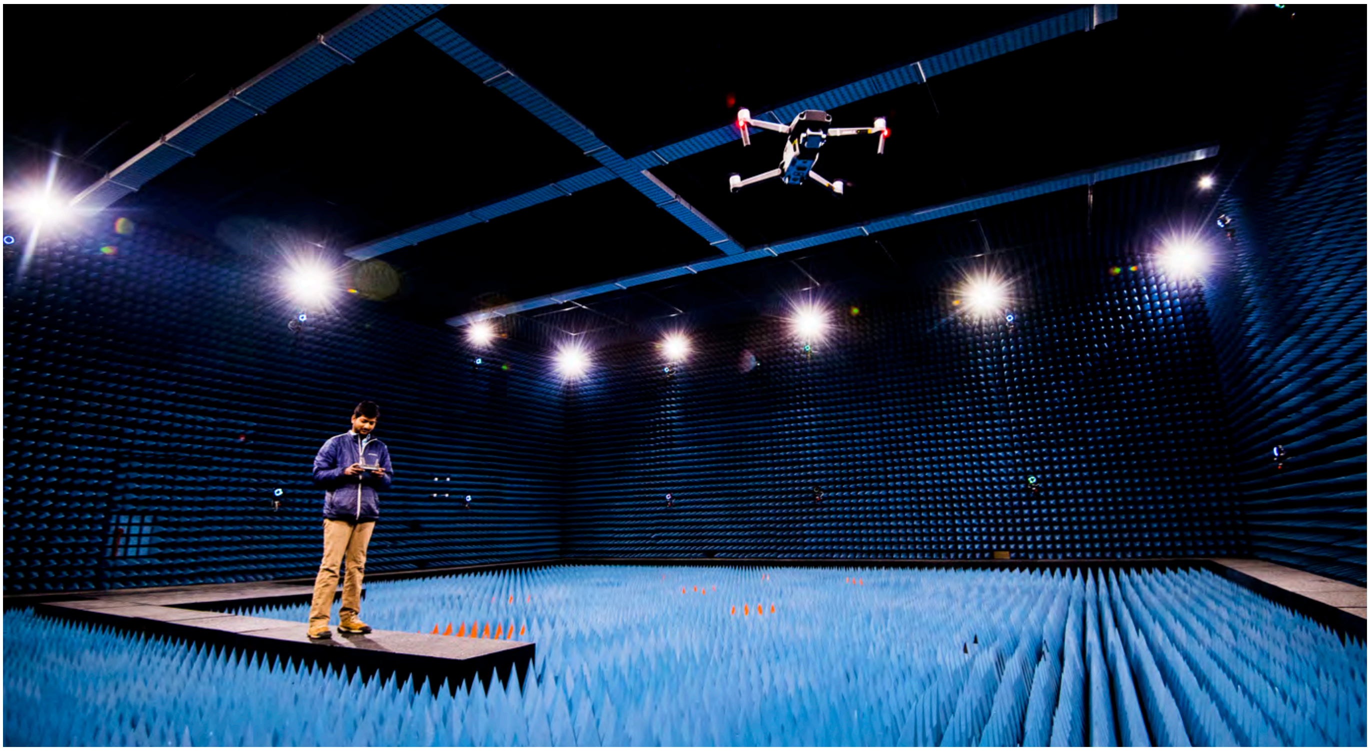
The Expeditionary Cyber & Unmanned Aircraft Systems Lab

A 1.8 million cubic-foot outdoor test cage with flight path to the 50'x50'x22' indoor anechoic chamber, the Expeditionary Cyber and Unmanned Aircraft Systems (UAS) Lab, funded by the U.S. Navy Office of Naval Research, is the first of its kind in the United States. It is designed for military and business leaders to partner with the university in cyber-security testing on drones. In 2019, the Air Force Life Cycle Management Center provided a $2.8 million grant to fund research through its unit at nearby Hanscom Air Force Base.

The walls, floor, and ceiling of the radio-silent drone testing facility are lined with hundreds of blue protruding arrowheads, made of foam, which are designed to absorb radio frequency waves. They transform the square room into an anechoic chamber that enable government and private researchers to join with Northeastern and other universities in creating defenses against potential drone attacks. The facility is also encased with a Faraday cage of conducting material that creates an electromagnetic shield.

The indoor facility is connected to a netted enclosure outdoors, measuring 150 feet by 200 feet—large enough for GPS testing. Drones can be navigated in and out between the two areas for seamless exercises in all conditions. Additionally, sophisticated equipment enables researchers to understand expeditionary cyber, including handling electromagnetics and cyber over a very large frequency range; effects on navigation; and effects on global positioning signals, and how those can be corrupted at the expeditionary edge.

William Lincoln Smith Professor **Tommaso Melodia**, electrical and computer engineering, and director of the Institute for the Wireless Internet of Things, conducts research on unmanned aerial systems and on using drones to create new applications for societal benefit. "As a user of the UAS lab, my work is at the intersection of autonomous robotic drones and connectivity; how these drones are connected with each



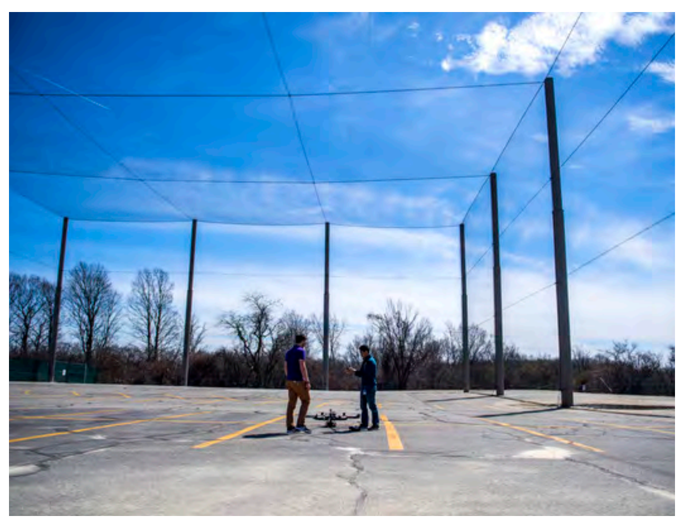
The 50'x50'x22' indoor anechoic chamber of the Expeditionary Cyber and Unmanned Aircraft System Lab allows for cybersecurity testing of drones.

other so they can exchange information," says Melodia. "We're working on new technologies to connect drones that operate at a high frequency rate—specifically 60 GHz—that's known as millimeterwave communications, one of the foundational technologies for 5G and beyond. What this facility enables us to do is fly drones of different sizes that carry payloads, like millimeter-wave radios, and test their performance."

Among the applications that Melodia and his team are working on are creating an on-demand mobile network of drones to provide additional wireless connectivity in specific locations when needed. They are also looking at using drones to provide connectivity in disaster scenarios. For example, in catastrophic hurricanes where entire wireless networks are wiped out, a network of drones could provide temporary connectivity to help locate survivors or provide disaster relief. Melodia and his team fly connected drones in the large anechoic chamber and its Faraday cage, which prevents signals generated outside to get inside the chamber. "That means you get a much higher fidelity performance because there's no interference," he says. It's a great tool for doing research in this space and for evaluating use cases."

Likewise, the outdoor facility provides the team with the ability to fly multiple drones in a controlled situation. "We conducted a demo for the Air Force with eight different drones flying in this environment," says Melodia. "We could not have created a credible demo without access to a facility of this size."

Other researchers are also benefiting from the capabilities of the UAV Lab, including Dennis Picard Trustee Professor Mario Sznaier, electrical and computer engineering, who is leading a $7.5 million DoD Multidisciplinary University Research Initiative Award for control and learning-enabled verifiable robust AI (see page 7).



The indoor facility is connected to a netted enclosure outdoors, measuring 150' by 200' – large enough for GPS testing. Drones can be navigated in and out between the two areas.

Colosseum, the world's largest radio frequency emulator, is part of the Institute for the Wireless Internet of Things, directed by William Lincoln Smith Professor Tommaso Melodia, electrical and computer engineering.

Colosseum–the World's Largest Wireless Emulator

Part of the university's Institute for the Wireless Internet of Things (WIOT), Colosseum is the world's largest wireless network emulator with hardware in the loop. It was originally developed by DARPA through an investment of $20 million and transferred to Northeastern in 2020 through an additional $6 million investment by the National Science Foundation to make Colosseum a shared instrument open to the research community. It is part of the WIOT's Platforms for Advanced Wireless Research Program Office (PAWR), which is co-led by U.S. Ignite and Professor Tommaso Melodia of Northeastern. PAWR provides researchers with facilities to experimentally evaluate wireless networked systems in real-life testing scenarios. Colosseum allows researchers to virtually test their ideas before taking them to one of the program's real-world testing sites.

Colosseum is a data center with 24 racks of 256 software-defined radios, 128 servers, and a vast number of FPGA and GPU processors, enabling the implementation of artificial intelligence and machine learning algorithms with radio hardware in the loop. This massive processing power means that Colosseum can emulate, in real-time, the 65,536 channels generated between all the radios, and their evolution in time. The system generates more than 52 terabytes of data per second, far exceeding the amount of information contained in the entire print collection of the Library of Congress. As a result, Colosseum can create virtual complex wireless environments and emulate wireless signals traveling through space and reflecting off multiple objects between transmitters and receivers. With Colosseum, any realistic network scenarios can be created, investigated, and reproduced. In addition to its simulation capabilities, Colosseum can do AI and machine learning processes. Extensive AI research at Northeastern is benefiting from Colosseum such as the Institute for Experiential AI and the Massachusetts-funded AI Jumpstart Program.

Colosseum offers a tremendous opportunity for users in academia, industry, and government. It can help advance research, translate it to the real world, and support innovation to commercialize technologies for real-world impact.

Faculty News and Honors

Selected Highlights

Faculty Receive Seven NSF CAREER Awards
Academic Year 2021-2022

Muhammad Noor E Alam, assistant professor, mechanical and industrial engineering (see page 39)

Mahshid Amirabadi, associate professor, electrical and computer engineering (see page 29)

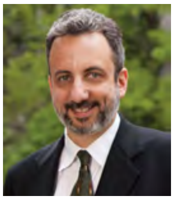
Cristian Cassella, assistant professor, electrical and computer engineering (see page 19)

Joshua Gallaway, DiPietro assistant professor, chemical engineering (see page 21)

Michael Kane, assistant professor, civil and environmental engineering (see page 32)

Abigail Koppes, associate professor, chemical engineering (see page 24)

Harikrishnan Parameswaran, assistant professor, bioengineering (see page 23)



Jerome Hajjar, CDM Smith Professor and Chair of the Department of Civil and Environmental Engineering, has been honored with the **American Institute of Steel Construction 2021 Lifetime Achievement Award** for his impact on AISC and the structural industry as a whole. The award bestows a special recognition to individuals who have provided outstanding leadership over a sustained period of years to AISC and the structural steel design, construction, and academic community. Hajjar has made significant contributions to the development of innovative steel and composite steel/concrete structures through experimental testing, computational simulation, and the development of design concepts and criteria. He has developed new resilient and sustainable structural systems, strength and stability design provisions for steel and composite structures, and nonlinear analysis formulations for structural stability and performance-based seismic design of steel and composite structures.

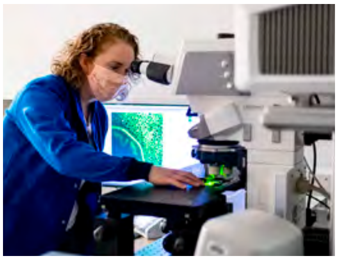
Research from Assistant Professors **Sidi A. Bencherif**, chemical engineering, and **Ambika Bajpayee**, bioengineering, on "Hyaluronic Acid-Based Shape-Memory Cryogel Scaffolds for Focal Cartilage Defect Repair" was featured on the **cover of the June 2021 *Tissue Engineering Part A* journa**l.

University Distinguished Professor **Dagmar Sternad**, biology, jointly appointed in electrical and computer engineering, has been selected for the **Fulbright Award** for the academic year 2021-2022 to work on "Variability and Redundancy in Motor Learning" at the Santa Lucia Foundation at the University of Rome Tor Vergata, Italy. The Fulbright Program is devoted to increasing mutual understanding between the people of the United States and the people of other countries. Fulbright is the world's largest and most diverse international educational exchange program.

A core feature of our neuromotor system is that it affords a manifold of strategies for the same task goal. Due to this redundancy, sensorimotor learning means identifying this subset of solutions and shaping the ever-present variability along this manifold. Sternad will develop a novel mathematical approach that quantifies this progression from exploration to exploitation of the solution manifold. Using throwing as model task, the research team will show that variability in high-dimensional full-body movements and its distribution reveals mechanisms underlying learning and adaptation. Results from this research allow more fine-grained insights into learning, essential for many disciplines including rehabilitation.

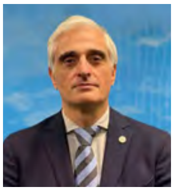
Professor **Peter Furth**, civil and environmental engineering, was awarded the **2020 Lifetime Achievement Award by the Association of Pedestrian & Bicycle Professionals (APBP)**. The award was conferred for Furth's "enthusiasm as an educator, advocate, and researcher who elevated the discourse for better bicycling and walking while empowering professionals with proven research." Furth is a leading voice in the effort to improve transportation systems in the U.S. and make cities more friendly towards bicycles and pedestrians. His pioneering work developing the Bicycle Level of Traffic Stress was a main driver behind his being honored with the award. The award stated that Furth's development of the Bicycle Level of Traffic Stress tool gave practitioners a new approach to assess community bicycling conditions.

Assistant Professor **Sidi A. Bencherif**, chemical engineering, was selected as one of the **2021 Young Investigators by the American Chemical Society's Division of Polymeric Materials: Science and Engineering (ACS PMSE)**. ACS PMSE Young Investigators are early-career scientists and engineers from academia, national labs, and industry within seven years of beginning their independent careers. He was also named one of the **2021 Rising Stars by the Cellular and Molecular Bioengineering (CMBE) Special Interest Group (SIG)** within the Biomedical Engineering Society (BMES). Additionally, Bencherif received a **R01 $2 million grant from the National Institutes of Health** for "Overcoming Vaccine-Associated Hypoxia with Advanced Biomaterials to Enhance Cancer Immunotherapy." He was a **2021 Biomaterials Science Emerging Investigator** and his **research was featured on the front cover** of the *Biomaterials Science Emerging Investigator Issue 2021*.



Professor **Heather Clark**, bioengineering, jointly appointed in chemistry and chemical biology, and director of Northeastern University's Institute for Chemical Imaging of Living Systems, has been named a **2021 AIMBE Fellow**. She was nominated, reviewed, and elected by peers and members of the College of Fellows for the development of nanoscale optical probes for chemical imaging within live cellular and tissue environments.

Assistant Professor **Yanzhi Wang**, electrical and computer engineering, received the **IEEE Technical Committee on Secure and Dependable Measurement (TCSDM) Early-Career Award** for his "contribution to deep learning model compression and real-time, mobile deep learning AI acceleration for precise calibration." The award recognizes a junior researcher from either academia or industry who has demonstrated outstanding contributions to the field of secure and dependable measurement and systems in the early stage of his/her career development.



Associate Professor **Luca Caracoglia**, civil and environmental engineering, was selected as a **Fellow of the American Society of Civil Engineers** for his contributions in research, education, and outreach in the areas of structural engineering, structural dynamics, probabilistic mechanics, wind engineering and wind energy.

David Luzzi, senior vice provost for research and vice president of the Innovation Campus at Burlington, and professor of mechanical and industrial engineering, has been named a **Fellow of the National Academy of Inventors (NAI)**. The NAI Fellows Program highlights academic inventors who have demonstrated a spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development, and the welfare of society. Election to NAI Fellow is the highest professional distinction accorded solely to academic inventors.

Professor **Ozlem Ergun**, mechanical and industrial engineering, is part of the UN World Food Programme team that won the **INFORMS 2021 Franz Edelman Award** for their project "Towards Zero Hunger with Analytics." The award recognizes and rewards outstanding examples of operations research, management science, and advanced analytics. Ergun was also named a **Franz Edelman Laureate** for authoring the Edelman finalist paper in *INFORMS Journal on Applied Analytics*. Laureates are recognized for their significant contribution to work that is selected as representative of the best applications of analytical decision making in the world.

Associate Professor and Allen Distinguished Investigator **Nikolai Slavov**, bioengineering, published a perspective article in ***Nature Biotechnology***, titled "Increasing Proteomics Throughput" highlighting new mass-spectrometry technologies transcending limitations in the throughput of proteomics and opening the stage for many exciting applications.

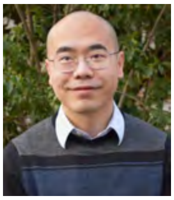
University Distinguished and William Lincoln Smith Professor **Vincent Harris**, electrical and computer engineering, has been named a **Senior Member of the National Academy of Inventors** (NAI)**.** NAI Senior Members are active faculty, scientists, and administrators from NAI Member Institutions who have demonstrated remarkable innovation producing technologies that have brought, or aspire to bring, real impact on the welfare of society. They also have growing success in patents, licensing, and commercialization.

Faculty News and Honors

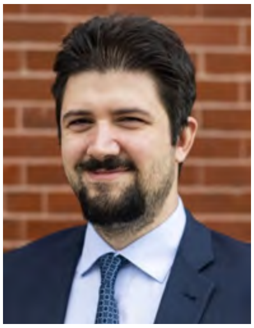
Selected Highlights

Professor **Sagar Kamarthi**, mechanical and industrial engineering, was selected as the winner of the **2021 Data Analytics & Information Systems (DAIS) Data Analytics Teaching Award** from the DAIS division of the Institute of Industrial and Systems Engineers, which is a primer national society for industrial engineering. There is one winner annually.

Assistant Professor **Benjamin Woolston**, chemical engineering, is the **2020 recipient of the Jay Bailey Young Investigator Award in Metabolic Engineering within the International Metabolic Engineering Society**. The award recognizes outstanding research accomplishments in the field of metabolic engineering by a young investigator who has advanced the frontiers of metabolic engineering through originality and creativity of experimental or computational concept application. He also received the **2021 Daniel I.C. Wang Award** sponsored by *Biotechnology & Bioengineering* which honors a younger member of their dynamic community.



Assistant Professor **Qi Ryan Wang**, civil and environmental engineering (CEE), is leading a **$1.5 million National Science Foundation grant**, in collaboration with Assistant Professor **Yanzhi Wang**, electrical and computer engineering, CEE and Marine Sciences Assistant Professor **Amy Mueller**, Northeastern's College of Arts, Media, and Design, and the Louisiana State University Health Science Center, to work on "Toxic-Free Footprints to Improve Community Health Against Respiratory Hazards." The research aims to build smart and connected toxic-free communities.



Professor **Kaushik Chowdhury** (PI), William Lincoln Smith Professor **Tommaso Melodia** (co-PI), and Assistant Professor **Francesco Restuccia** (co-PI), electrical and computer engineering, are leading a **$1.8M National Science Foundation grant**, in collaboration with Rice University, for "RFDataFactory: Principled Dataset Generation, Sharing and Maintenance Tools for the Wireless Community." Applied machine learning research in wireless faces challenges due the inability of domain experts to easily access existing well-curated, well-structured, and open-access datasets. There is also a lack of direct access to a software framework that automates dataset creation and distribution based on detailed user requirements. RFDataFactory aims to make available categorized datasets suitable for research related to machine learning in 5G and beyond networks, and advance fundamental understanding and design tools for accessing, creating, sharing and storing wireless datasets. Restuccia was also awarded, in collaboration with University of California-Irvine, a $415K NSF grant for "Reliable Task Offloading in Mobile Autonomous Systems Through Semantic MU-MIMO Control."

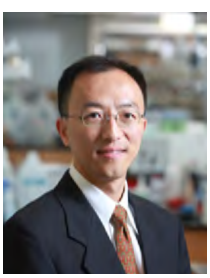
Assistant Professor **Mingyang Lu**, bioengineering, and University Distinguished Professor **Herbert Levine**, physics, jointly appointed in bioengineering, in collaboration with the University of Texas at Dallas, were awarded a **$1.4 million National Science Foundation grant** for "Genome Editing Approaches to Unravel MicroRNA Roles in Stochastic Multistable Networks." One of the fundamental questions in biology is to understand the roles of the gene regulatory networks driving cellular decisions. MicroRNAs (miRNAs) are small RNA molecules that bind to the mRNA of target genes, acting as regulators of gene expression. Previous studies have demonstrated the critical roles of miRNAs in a variety of biological processes such as cell growth and cell differentiation. However, what is still not well-understood concerns possible synergistic effects from multiple miRNA molecules targeting different binding sites of the same mRNA and concerns how miRNA interactions operate within a complex gene regulatory network. To address these issues, an interdisciplinary platform that combines genome editing, live-cell imaging, and mathematical modeling will be developed in this project.

Assistant Professor **Ambika Bajpayee's** research was published on the **cover of the Biomaterials Science Emerging Investigator Issue 2021** of the journal *Biomaterials Science*. The paper, titled "Milk Exosomes with Enhanced Mucus Penetrability for Oral Delivery of siRNA," was in collaboration with Sanofi. Key authors in addition to Bajpayee, include first author Matt Warren, E'21, and Chenzhen Zhang, PhD'24, and Armin Vedadghavami, PhD'21–all working in the Bajpayee Lab.

Abigail Koppes, associate professor, chemical engineering, received the **2020 Cellular and Molecular Bioengineering (CMBE) Young Innovator Award**, in which *CMBE* publishes the most innovative and impactful bioengineering studies carried out by junior faculty in the field.

Richard Harris, assistant dean of academic scholarship, mentoring and outreach, director of the NU Program in Multicultural Engineering (NUPRIME), co-chair DEI Committee, and special advisor for Educational Pathways Programs in the Office of the Provost, has been appointed a **member of the Board of Directors of the National GEM Consortium**. The mission of the National GEM Consortium is to enhance the value of the nation's human capital by increasing the participation of underrepresented groups at the master's and doctoral levels in engineering and science.

Distinguished University and Cabot Professor **Laura Lewis**, chemical engineering, jointly appointed in mechanical and industrial engineering, in collaboration with the University of Warwick, UK, was awarded a **$900K National Science Foundation - EPSRC grant** for "Multi-Driver Furnace Processing of Magneto-Functional Materials." This U.S. – U.K. collaborative project investigates new ideas and approaches to streamline the manufacture of advanced magnetic materials, while also minimizing the use of critical elements. This work is funded under the NSF-EPSRC "Manufacturing the Future" theme and features the development of a bilateral cohort of under-represented minority students who have an interest in conducting research at the intersection of manufacturing, energy and environment.



Associate Professor **Guohao Dai** (PI), bioengineering, Assistant Professor **Ryan Koppes** (PI), chemical engineering, and Associate Professor **Abigail Koppes** (co-PI), chemical engineering, were awarded a **$430K National Institutes of Health grant from the National Institute of Neurological Disorders and Stroke** for "Bioengineer a Humanized Autonomic Neurovascular Innervation on a Chip" to improve clinical outcomes of vein grafts. The incomplete adaptation of vein grafts to arterial hemodynamics may be the primary reason of vein graft failure. One of the missing links in the vein graft is the lack of innervation, whereas arteries are closely associated with the sympathetic/parasympathetic nerves. A recent study in embryonic development suggested that sympathetic innervation is critical for the proper development of arteries through releasing sympathetic neurotransmitters, raising the possibility that providing innervation to the vein graft may facilitate the better switch of vein to artery, thus potentially leading to better clinical outcomes. To explore this possibility, the research will examine autonomic neural derived signals on the arterialization of vascular endothelial cells (ECs) and their impact on smooth muscle cells (SMC) phenotypes, by establishing a novel humanized vascular innervation model on a microphysiological chip.

Assistant Professor **Kayse Lee Maass**, mechanical and industrial engineering, in collaboration with Northeastern's College of Social Sciences and Humanities, is a co-principal investigator of a **$759K National Institute of Justice grant**, titled "Identification of Effective Strategies to Disrupt Recruitment of Victims in Human Trafficking: Qualitative Data, Systems Modeling, Survivors and Law Enforcement." Maass is also co-PI on a **$1 million National Science Foundation multi-university collaborative grant**, titled "Modeling Effective Network Disruptions for Human Trafficking."

Professor **Mieczyslaw Kokar**, electrical and computer engineering, received a **$1.2 million award from the Defense Advanced Research Projects Agency's** (DARPA) to work on the Intent-Defined Adaptive Software (IDAS) program. This award is part of a larger award to SNC. The IDAS program leverages SNC's agile development and model-based systems engineering and Northeastern's self-controlling and adaptive software, to enable rapid software development. IDAS' goal is to automate code generation, derived from software intent and associated constraints, to rapidly adapt to late changes in requirements and operating environments.

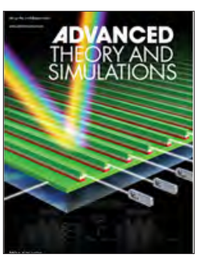
Assistant Professor **Devesh Tiwari**, electrical and computer engineering, was selected to receive the **IEEE/IFIP DSN-2021 Rising Star in Dependability** for outstanding contributions and potential for creative ideas and innovative research in the field of dependable and resilient computer systems and networks. He is also leading a **$500K National Science Foundation grant** for creating "HARMONIA: New Methods for Colocating Multiple QoS-Sensitive Jobs." The project will provide a family of novel unconventional resource strategies leveraging the principles of Bayesian Optimization (BO), but introducing novel innovations to BO and demonstrating its usefulness toward data center resource management.

Faculty News and Honors

Selected Highlights

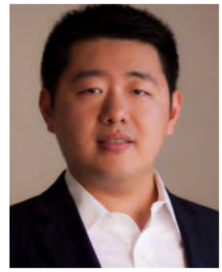
Professor **Fabrizio Lombardi**, electrical and computer engineering, was selected for several **IEEE leadership positions**, including president-elect for 2021 and president for 2022-2023 of the IEEE Nanotechnology Council, the vice president for 2021 of the IEEE Computer Society, and was one of three elected as a member of IEEE of the 2021 Publications Services and Product Board (PSPB).

Professor **Edmund Yeh**, electrical and computer engineering, was a **voting member** of the Board of Governors of IEEE Information Theory Society in the role of Treasurer, starting in January 2021. He was also named an **IEEE distinguished lecturer** and the **inaugural Area Editor in Networking and Computation** for *IEEE Transactions on Information Theory*.



The research of Professor **Hossein Mosallaei**, electrical and computer engineering, titled "Machine Learning: TCO-Based Active Dielectric Metasurfaces Design by Conditional Generative Adversarial Networks" was featured on the **cover of *Advanced Theory and Simulations***.

Associate Professor **Charles Dimarzio**, electrical and computer engineering, has been named a **Senior Member of SPIE**, the international society for optics and photonics. Senior members are members honored for their scientific excellence across the broad spectrum of optics and photonics research and applications, their active involvement with the optics community and SPIE, and significant performance that distinguishes them from their peers.

College of Engineering Distinguished Professor **David Kaeli** and Assistant Professors **Yanzhi Wang**, **Xue (Shelley) Lin**, and **Devesh Tiwari**, electrical and computer engineering, were awarded a **$570K National Science Foundation grant** for the "Acquisition of a Heterogeneous Multi-GPU Cluster to Support Exploration at Scale." The project aims to acquire a heterogeneous Multi-GPU cluster, constructed out of state-of-the-art GPUs devices, interconnected with emerging NVLink and HDR networks, network-attached non-volatile memory (NVM) storage for GPU caching, and interconnected by a smart HDR infiniband switch, to enable, accelerate, explore, and support applications at scale from different domains. It will enable computational scientists to exploit GPU parallelism in new ways by programming the smart network switch and caching selectively to hide memory and interconnect latency.

Assistant Professor **Mohsen Moghaddam**, mechanical and industrial engineering, is leading a **$2 million National Science Foundation grant** in collaboration with other colleges and centers at Northeastern for "Fostering Learning and Adaptability of Future Manufacturing Workers with Intelligent Extended Reality (IXR)." The research imagines the future of work in precision manufacturing where the spatial and causal reasoning and decision-making abilities of workers are augmented through teaming with IXR technologies. The project team will partner with PTC, Inc. to streamline the development of intelligent XR technologies. In collaboration with MassBay Community College and Festo Didactic, the intelligent XR technologies will be validated at Northeastern's state-of-the-art Cyber-Physical Factory lab. The project will work closely with GE Aviation as well as with L.S. Starrett Company to design validation studies on precision machining and inspection tasks. The project's partners at Massachusetts Manufacturing Extension Partnership (MassMEP) will facilitate collaboration with local manufacturers to study the implications of the project for complex, interactive production and inspection work.

Professor **Hameed Metghalchi**, mechanical and industrial engineering, was selected as an **Honorary Member of the American Society of Mechanical Engineers** "for distinguished services in promoting mechanical engineering through teaching, administrative and mentoring efforts; for contributions to the international community through research publications; and for sustained leadership in the Advanced Energy Systems Division of ASME's Energy Resources Board." Honorary Membership is awarded for a lifetime of service to engineering or related fields. In addition, Metghalchi was selected as an **Honorary Fellow of the International Society for Energy, Environment and Sustainability** for the Class of 2020, for pioneer research and education in thermodynamics and combustion for the last four decades improving thermal system efficiency and effectiveness while reducing pollutant formation.

Learn more about our accomplished faculty

Student Highlights

Anthony Stohr, E'21, chemical engineering, received a **National Defense Science and Engineering Graduate Fellowship** to support his doctoral work in chemical and biomolecular engineering. The fellowship is awarded to students who have demonstrated ability and special aptitude for advanced training in science and engineering.

Paola Kefallinos, E'23, mechanical engineering, was recently awarded the **Department of Defense Science, Mathematics, and Research for Transformation (SMART) Scholarship**. This award provides students with full tuition for up to five years, summer internships, a stipend, and full-time employment with the Department of Defense after graduation.

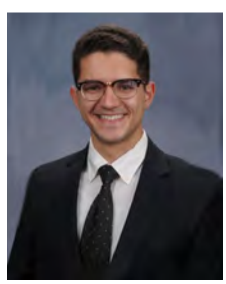
Cameron Young, E'22, chemical engineering and biochemistry, and **Spencer Lake Jacobs-Skolik**, E'22, electrical engineering, were awarded the **Barry Goldwater Scholarship**–the United States' premier award to encourage and foster outstanding students to pursue research careers in the fields of the natural sciences, engineering, and mathematics.

PhD student **Hussein M. E. Hussein**, electrical engineering, and Professor Matteo Rinaldi, Associate Professor **Marvin Onabajo**, and Assistant Professor **Cristian Cassella** of the Department of Electrical and Computer Engineering, had their research on "A Chip-less and Battery-less Subharmonic Tag for Wireless Sensing with Parametrically Enhanced Sensitivity and Dynamic Range" **published in *Scientific Reports*** from the Nature group.

Eight College of Engineering current students and alumni received **National Science Foundation Graduate Research Fellowships**. The program recognizes and supports outstanding graduate students who are pursuing full-time research-based master's and doctoral degrees in science, technology, engineering, and mathematics (STEM) or in STEM education.

Michael Ben Eck, PhD'24, civil engineering
Sydney Anne Morris, E'21, chemical engineering
Nicholas Roy O'Hare, PhD'24, chemical engineering
Diego Felipe Rivera, E'21, mechanical engineering
Rachel Lauren Shapiro, E'17, chemical engineering
Nathaniel James Silvia, PhD'24, bioengineering
Evan Zachary Toth, E'21, chemical engineering
Erica Kristen Wagner, E'20, bioengineering

Three students received **Fulbright U.S. student awards**. **Tyler Gogal**, E'21, mechanical engineering, will pursue a master's degree in Iceland; **Jacob Kaplan**, E'21, computer engineering and computer science, will pursue an English teaching assistantship in Taiwan; and **Sagi Ravid**, E'21, chemical engineering, will pursue cancer treatment research in Spain. The Fulbright U.S. Student Program is America's premier international exchange fellowship, with a mission to promote mutual understanding between the people of the United States and the people of other countries.



James Sinoimeri, E'21, ME'21, chemical engineering, was selected for the **Future Leaders in Chemical Engineering Symposium** organized by North Carolina State University. Sinoimeri was invited to present his research on the use of Hypoxia-Inducing Cryogels for Preclinical Anticancer Drug Screening, which was performed under the supervision and guidance of Assistant Professor **Sidi A. Bencherif**. Also, while on co-op, Sinoimeri **worked in mRNA process development at Moderna**, which developed a COVID-19 vaccine. His primary responsibilities related to the scale-up, characterization, and optimization of the manufacturing process for mRNA-1273. He also worked on similar projects for the company's variant booster shot and seasonal flu vaccine. He joined Moderna after graduating as a process development engineer to continue his work.

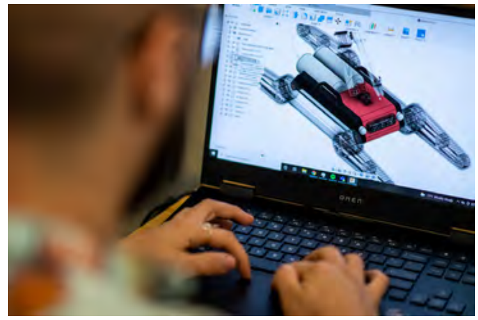
The **Society of Women Engineers (SWE) student group** is the recipient of **two 2020 Society of Women Engineers Mission Awards**: Collegiate Gold, and Best Practice – Membership Retention & Engagement. The Gold award is the highest overall award level for the new SWE Mission Award structure and recognizes our section's commitment to SWE's Core Values and Strategic Goals based on results from our activities across 10 categories.

Venkata Shashank Konduri, PhD'21, interdisciplinary engineering, took classes from various departments like civil engineering, marine science, policy, electrical engineering, and others. His research consisted of elements from AI, machine learning, data science, computing, remote sensing, ecology, and hydrology. Advised by Professor **Auroop Ganguly**, civil and environmental engineering, Konduri worked at **Oak Ridge National Laboratory** since 2018, examining the spatial distribution of plant communities in Alaska and their environmental drivers. After graduation, he joined **NASA's Goddard Space Flight Center** as a research associate surveying savannah ecosystems using spaceborne Lidar imagery.

During the COVID-19 pandemic, **Caitlynn Tov**, E'21, bioengineering, conducted research in the laboratory of MIT Assistant Professor Giovanni Traverso at Brigham and Women's Hospital while on co-op, working on the **TEAL Bio face mask**. The mask is made of a clear silicone rubber material with removable filters and is equally as effective as the N95 mask. When the filters are removed the mask can be sterilized and new, clean filters are put in which allows the mask to be reused. Tov assisted in the design elements of the mask by analyzing face scans with the goal of optimizing the fit and comfortability of the mask. She was also involved in the clinical trials. For all her contributions, Tov was listed as an **author/contributor in two papers and three patents** for the TEAL Bio face mask.

Laura Bilal, E'21, and **Meghan Quon**, E'22, bioengineering, were third place **winners of the 2020 Husky Startup Challenge** of Northeastern's Entrepreneurs Club, taking home $1,000 in funding to pursue their venture, Klip Tech. Their invention offers an app connected to a rechargeable device that clips onto clothing and can be activated with either one or two clicks in situations where the wearer may be in some form of distress and unable to quickly access their phone. They are now furthering its development working with Generate, the College of Engineering's student-run product development studio that is part of the Sherman Center for Engineering Entrepreneurship Education.

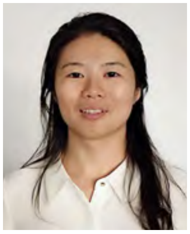
A civil and environmental engineering **2020 capstone team placed second in the International Water Environment Federation Student Design Competition** in the Environment Competition for their project: Rock Meadow Parking Lot and Stormwater Design. There were 28 participating schools, representing 22 member associations and five countries.



A **Northeastern faculty and student team was awarded a $200K prize as a finalist for Phase 1 of the U.S. Department of Energy's American-Made Challenges E-ROBOT Prize**. In Phase 2, up to four teams (from the 10 finalists) will receive a $500K award. The team's submission proposed development of a Precise Air-sealing Robot for Inaccessible Spaces (PARIS). PARIS is designed to traverse over ceiling joists, create a 3D feature map of existing conditions via sensor fusion, and seal identified gaps with spray foam sealant. The Northeastern team is advised by Associate Professor Taskin Padir, electrical and computer engineering (ECE), Assistant Professor Michael Kane, civil and environmental engineering, and College of Engineering Distinguished Professor Carey Rappaport, ECE.

The Structural Engineering Institute selected the **Northeastern Graduate Structural Engineering Association for the 2021 SEI Graduate Student Chapter of the Year Award** for their commitment to structural engineering through their innovation and creativity in providing unique events that engage members and promote the structural engineering profession.

Undergraduate engineering students, under the supervision of Teaching Professor Bala Maheswaran, **published and presented five papers at the American Society of Engineering Education–Northeast Section Virtual Conference 2020**. The paper on "OSCILLUS: Harnessing Wave Energy" won first place.



Li Jiao, PhD’21, chemical engineering, working in affiliated faculty **Sanjeev Mukerjee’s** research group, was **published in *Nature Materials*** for "Chemical Vapour Deposition of Fe–N–C Oxygen Reduction Catalysts with Full Utilization of Dense Fe–N4 sites," developing a model catalyst with scientific breakthroughs and practical significance.

Aleksei Krotov, PhD’24, bioengineering, received a **Best Student Paper Award** at the 8th IEEE Biomedical Robotics and Biomechatronics Conference.

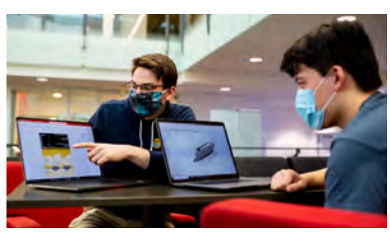
Engineering students won Northeastern's inaugural **2021 Innovator Awards** for their entrepreneurship. **Emily Man**, E’19, ME’19, bioengineering, and **Valeria Martinuzzi**, ME’18, bioengineering, were first-place winners in the Young Alumnae Graduate Award category for their work on Venova Technologies, which is developing a novel contraceptive device for women. **Gabrielle Whittle**, E’21, mechanical engineering, was a first-place winner in the Undergraduate Student Award category for her company Phoenix Footwear, which is developing a transformable high heel shoe.

Bayley St. Jacques, E’21, and **Julia Szabla,** E’21, civil engineering, were each awarded a **2020 Education Foundation Scholarship by the American Institute of Steel Construction (AISC)**. The fund is part of a program dedicated to support 37 college juniors, seniors, and master’s-level graduate students studying civil engineering, architectural engineering, construction engineering, construction management, and architecture at schools in the United States.

Louiza Wise, E’21, environmental engineering, won a **2021 Compass Award**, which recognizes exemplary students from the senior class who, during their time on campus, have demonstrated a true dedication to a core set of values: leadership, volunteerism, academic integrity, and commitment to Northeastern.

Alex Bender, E’20, industrial engineering, was named as a **finalist of the 2020 INFORMS Undergraduate Operations Research Prize** for his paper titled “Estimating Effectiveness of Identifying Human Trafficking Victims: An Application of Data Envelopment Analysis on the Nepal–India Border.” The research was completed in collaboration with Assistant Professor **Kayse Lee Maass** and researchers from Worcester Polytechnic Institute, John Jay College of Criminal Justice, and Love Justice International.

A research paper, titled, “Flexural Bending Resonance of Acoustically Levitated Glycerol Droplet” by **Zilong Fang**, PhD’22, mechanical engineering, and professors **Kai-Tak Wan** and **Mohammad Taslim**, mechanical and industrial engineering, was selected as the **Editor’s Choice and published in the journal of *Physics of Fluids***.



The Northeastern University team was selected as a **finalist in NASA’s 2021 RASC-AL Competition**, which stands for Revolutionary Aerospace Systems Concepts-Academic Linkage. They presented to NASA and aerospace industry leaders their “Venusian Atmospheric and Land Exploration: a Human-Assisted Low-Latency Approach (VALHALLA)” project at the virtual event.

Malith Jayaweera, PhD’23, computer engineering, won **first place in the student research competition** at the International Symposium on Code Generation and Optimization (CGO) 2021 for his research on “Data vs Instructions: Runtime Code Generation for Convolutions.”

Siyue Wang, PhD’22, computer engineering, **won first place for Best Presentation** in the Fourth Workshop for Women in Hardware and Systems Security (WISE 2020). She presented her recent work on “Intrinsic Examples: Robust Fingerprinting of Deep Neural Networks” with her advisor Assistant Professor **Xue Shelley Lin**.

Zach Rogers, PhD’23, chemical engineering, in the Bencherif Lab, was awarded his **third Alpha Fund Prototype Grant** for his proposal, “Oxygen-Controlling Cell Culture (OCC) Systems.” The Alpha Fund, which is sponsored by both Northeastern’s venture accelerator, IDEA, and the Center for Research Innovation aims to help early-stage innovations to test their concept and gain market feedback.

Kerry Eller, E'21, bioengineering, is a recipient of the 2021 Harold D. Hodgkinson Award and the 2020 Truman Scholarship. During her time at Northeastern, she gained an interdisciplinary, experiential education, and studied, researched, and worked in four countries.

Work in Four Countries Prepares for a Global Career

It might seem unusual that Kerry Eller, E'21, bioengineering with a minor in political science, discovered her passion for bioengineering during a month-long Dialogue of Civilizations to the United Nations in Geneva, Switzerland. After all, it was an international relations program with courses on disarmament and international law.

But in addition to her classes, Eller conducted independent research for a paper on global engineering.

"My paper was on the policy initiatives needed to create the infrastructure for bioengineering in low-income countries," she says. "That's what sparked my interest in the field."

While at the United Nations, Eller also had an opportunity to talk with diplomats from around the world about the role scientists play in shaping international policy initiatives.

"I want to help create low-cost medical devices that are designed specifically for use in low-income countries," she says. "But I want to do more than just the technical side of engineering. I also want to be involved in the interventions that make engineering in low-and-middle income countries possible. I'm interested in how engineering, politics, and global health interact."

In addition to Switzerland, Eller pursued her global engineering interests in Ethiopia, Uganda, and Chili.

She went to Ethiopia as a member of the student club Innovators for Global Health, a trip that planted the seed for her senior capstone project in which she and five other students are designing a low-cost wireless pulse oximeter with telemetry to replace the constantly failing equipment at St. Paul's Hospital in Ethiopia.

She also traveled to Uganda as a member of the Northeastern chapter of the Global Med student organization to help female leaders of a grassroots organization improve water sanitation in their rural villages.

"I like the grassroots model of Global Med," says Eller. "Their philosophy is the people who live there should identify their needs while we provide the financial resources to help them meet those needs autonomously. We're there to support them, not tell them what we think is best for them."

For professional experience, Keller self-designed her co-op in Chile at the Universidad del Desarrollo, working on two primary projects—a mosquito trap to track vector-borne diseases as they spread, and a wearable pesticide monitor to gauge the exposure of agricultural workers to harmful chemicals.

The challenge was that no one at the university was well-versed in the paper-based diagnostics that were to be used in the mosquito trap. "That was my assignment, and so they expected me to become the expert and figure it out," she recalls. "So, I had to do a ton of research. I had to educate myself in a hurry about immunobiology."

She also had to quickly improve her rudimentary Spanish, since neither her host family nor the university researchers spoke fluent English.

"I knew what I was getting into," she says. "I purposefully threw myself into the deep end to force myself to learn."

After graduation, Eller is pursuing a PhD in bioengineering at Duke University, which will be partially funded by the prestigious Truman Scholarship she won in 2020. She is also the recipient of the Harold D. Hodgkinson Award for academic and experiential excellence, one of Northeastern's highest honors for graduating seniors.

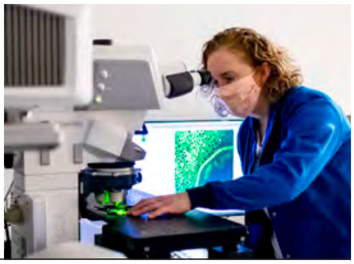
Once she completes her doctorate, she plans to devote the early portion of her career to designing low-cost medical devices, then transition into a leadership role where she can influence policies that help low-income countries develop bioengineering capacity of their own.

"I plan to work from a ground-up perspective during the first portion of my career and from the top down in the second portion," she says.

View Scholarship Reports of our Five Engineering Departments

Bioengineering

bioe.northeastern.edu/faculty/scholarship-reports



Chemical Engineering

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Founded in 1898, Northeastern is a global research university and the recognized leader in experience-powered lifelong learning. Our world-renowned experiential approach empowers our students, faculty, alumni, and partners to create impact far beyond the confines of discipline, degree, and campus.

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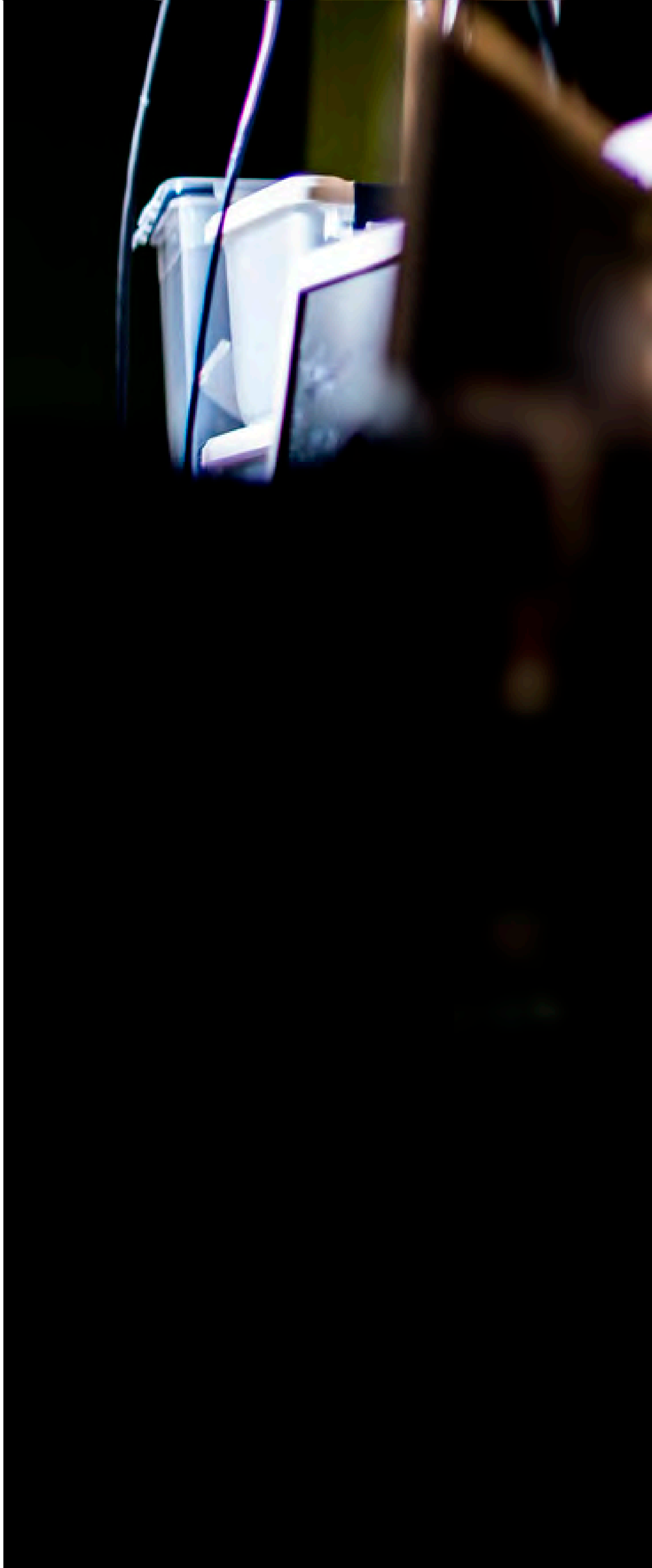

COVER IMAGE

Evelyn Mendoza, PhD'21, mechanical engineering, advised by Peter Whitney, assistant professor, mechanical engineering, is researching how to make robotic arms that are graceful and deft enough to gently pick up an egg or use sharp tools. The findings could one day enable robotic arms that could be capable of remote surgery such as MRI-compatible remote needle biopsy.