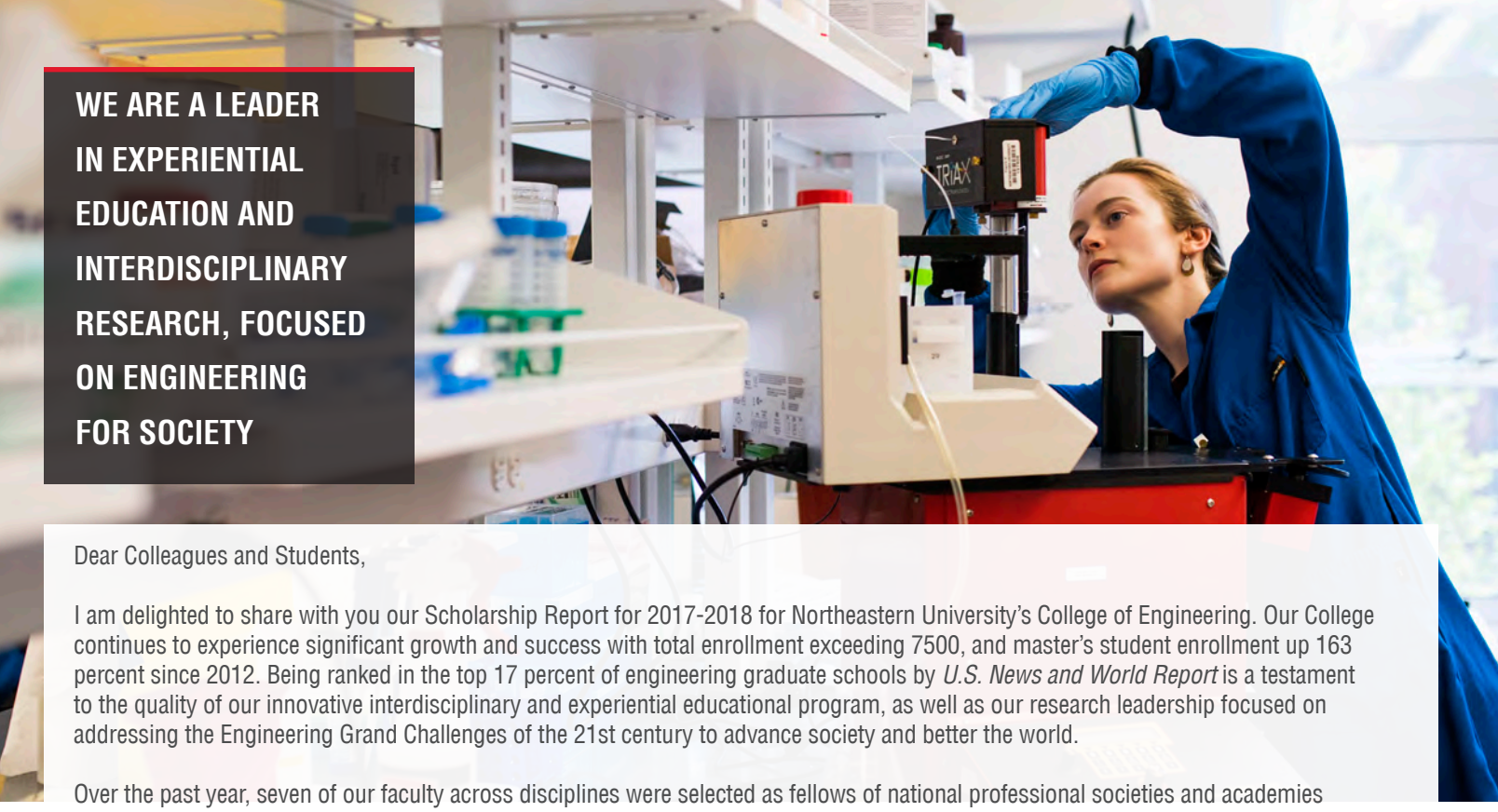
Northeastern University
College of Engineering

Engineering for Society

Boldly innovating to better our world

2017 | 2018
SCHOLARSHIP REPORT
College of Engineering



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

Dear Colleagues and Students,

I am delighted to share with you our Scholarship Report for 2017-2018 for Northeastern University's College of Engineering. Our College continues to experience significant growth and success with total enrollment exceeding 7500, and master's student enrollment up 163 percent since 2012. Being ranked in the top 17 percent of engineering graduate schools by *U.S. News and World Report* is a testament to the quality of our innovative interdisciplinary and experiential educational program, as well as our research leadership focused on addressing the Engineering Grand Challenges of the 21st century to advance society and better the world.

Over the past year, seven of our faculty across disciplines were selected as fellows of national professional societies and academies and five of our faculty were honored with young investigator awards from the National Science Foundation, Army Research Office, and National Institutes of Health. Our faculty have also been selected to lead multimillion-dollar research awards such as Snell Professor and Associate Dean for Research Akram Alshawabkeh who received a $13M grant from the National Institutes for Health to lead a renewal of the multi-institutional and interdisciplinary Environmental Influences of Child Health Outcomes in Puerto Rico (ECHO-PRO) research project. Additionally, University Distinguished Professor Vincent Harris received an $8 million award in collaboration with Qorvo, Inc. from the Defense Advanced Research Projects Agency to advance RF materials science.

With the ever-evolving complexities of the world, the next-generation of engineering leaders need to be multifaceted. Since 2012, we have introduced 51 new degrees, minors, and graduate certificate programs with an emphasis on interdisciplinary programs, such as our new MS in Robotics, 3+3 BS/JD degree, BS/MS in Environmental Engineering, BS in Electrical Engineering and Music, and BS in Environmental Engineering and Health Science. Currently, 42 percent of degree programs offered are combined with other Northeastern University colleges and the number of engineering students taking non-engineering minors has increased 113 percent since 2012.

Experiential learning is the heart of a Northeastern education, anchored by our signature cooperative education program. We are one of only a few universities to offer graduate students the opportunity to participate in co-op. Since 2013, the number of graduate students participating in co-op has increased 157 percent, enabling them to gain real-world industry experience as part of the academic program.

This Scholarship Report is designed to showcase some of the past year's achievements of our faculty, highlight our cutting-edge research efforts, and describe our long-term performance in strategic areas. I hope you find it helpful and encourage you to reach out to us and visit our website, coe.neu.edu, for further information.

Sincerely,

Nadine Aubry, PhD
University Distinguished Professor
Dean, College of Engineering
dean@coe.northeastern.edu

Quick Facts - College of Engineering

Five-year academic period ending 2017

Since 2012, under the leadership of Dean Nadine Aubry, the College of Engineering has experienced significant growth and success.

ENROLLMENT AND OUTCOMES

1110
Graduate degree conferrals, up **108%**

1487
Mean 2-part SAT score up 91 points

34%
Freshmen are women, up 124%

72%
Student body increase to 7536

163%
MS enrollment growth
BS - 40% | PhD - 23%

INTERDISCIPLINARY AND EXPERIENTIAL LEARNING

42%
Degree programs with other colleges

51
New degree programs and graduate certificates on four campuses and online

113%
Increase in non-engineering minors

157%
Graduate co-op increase since 2013

TRANSFORMATIONAL RESEARCH

$258M
Total active research funding for the College of Engineering (in millions)

97
Patents since 2012

83
Young Investigator Awards

43
NSF Career Awards

CRISTIAN CASSELLA

Assistant Professor
Electrical and Computer Engineering
PhD, Carnegie Mellon University, 2015

Scholarship focus: acoustic resonators, nonreciprocal components, zero-power sensors for IoT, nonlinear dynamics, ultrasonic transducers

BABAK HEYDARI

Associate Professor
Mechanical and Industrial Engineering
PhD Univ. of California, Berkeley, 2008

Scholarship focus: socio-technical systems, systems engineering and design, social and economic networks, resilience of networked systems, computational social sciences, platform-based systems, sharing economy systems, computational social sciences, game theory, artificial intelligence

EREL LEVINE

Associate Professor (joining Jan. 2019)
Bioengineering
PhD, Weizmann Institute of Science, 2005

Scholarship focus: analysis of big biological data by developing statistical physics approaches to deep learning; statistical learning approaches to the dynamics, plasticity and evolvability of small regulatory RNA; host-pathogen interaction: in-host dynamics and inter-species systems biology

JIAHE LI

Assistant Professor (joining Jan. 2019)
Bioengineering
PhD, Cornell University, 2015

Scholarship focus: engineering dynamic interactions between synthetic materials, proteins and nucleic acids for their pharmaceutical applications

KAYSE LEE MAASS

Assistant Professor
Mechanical and Industrial Engineering
PhD, University of Michigan, 2017

Scholarship focus: large-scale optimization, stochastic optimization, deterministic optimization, network theory, queueing theory, mental health, facility location modeling, supply chain design, social inequality, human trafficking, healthcare operations

HERBERT LEVINE

University Distinguished Professor
(joining January 2019)
Physics, jointly appointed in Bioengineering
PhD, Princeton University, 1979

Scholarship focus: mechanics of motility at both single cell and multicellular levels, genetic and metabolic networks underlying phenotypic changes en route to cancer metastasis, effective detection by and activation of the adaptive immune system

ALIREZA RAMEZANI

Assistant Professor
Electrical and Computer Engineering
PhD, University of Michigan, 2014

Scholarship focus: analysis and feedback control of nonlinear systems; control of bipedal robot locomotion; formal methods for highly dynamic systems; bio-inspired robotics; spacecraft design; control, guidance & navigation of swarms of spacecraft

SARA ROUHANIFARD

Assistant Professor (joining Jan. 2019)
Bioengineering
PhD, Albert Einstein College of Medicine, 2014

Scholarship focus: developing chemical approaches to track and quantify important RNA processing events and modifications in single cells; understanding how these differences drive disease and neuronal development

MOHSEN MOGHADDAM

Assistant Professor
Mechanical and Industrial Engineering
PhD, Purdue University, 2016

Scholarship focus: smart manufacturing, complex adaptive systems, machine intelligence

HAO SUN

Assistant Professor
Civil and Environmental Engineering
PhD, Columbia University, 2014

Scholarship focus: smart and resilient infrastructure; innovative sensing, data analytics and machine learning with applications to infrastructure engineering; computational mechanics and uncertainty quantification

YANZHI WANG

Assistant Professor
Electrical and Computer Engineering
PhD, Univ. of Southern California, 2014

Scholarship focus: energy-efficient and high-performance implementations of deep learning and artificial intelligence systems; neuromorphic computing and non-von Neumann computing paradigms; cyber-security in deep learning systems; emerging deep learning algorithms/systems such as Bayesian neural networks, generative adversarial networks (GANs) and deep reinforcement learning

WEI XIE

Assistant Professor
Mechanical and Industrial Engineering
PhD, Northwestern University, 2014

Scholarship focus: interpretable AI, computer simulation, data analytics, data-driven stochastic optimization for end-to-end cyber-physical-system risk management with applications: pharmaceutical supply chains, smart power grids with renewable energy, healthcare, semiconductor manufacturing, transportation infrastructure, and metal additive manufacturing

13 STATE-OF-THE-ART RESEARCH CENTERS
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

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 multi-university Engineering Research Center

HSyE CMS Innovation Center for Healthcare Systems Engineering; a Department of Health and Human Services Regional Systems Engineering Extension Center

IIA Institute of Information Assurance; a National Science Foundation Center of Academic Excellence

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

ROBOTICS CENTER Multidisciplinary effort focused on robotics research and education spanning field robotics, manipulation and grasping, folding robots, humanoids, bio-inspired robotics and planning.

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

VOTERS Versatile Onboard Traffic Embedded Roaming Sensors; a multi-institutional National Institute of Standards and Technology (NIST) Technology Innovation Program project

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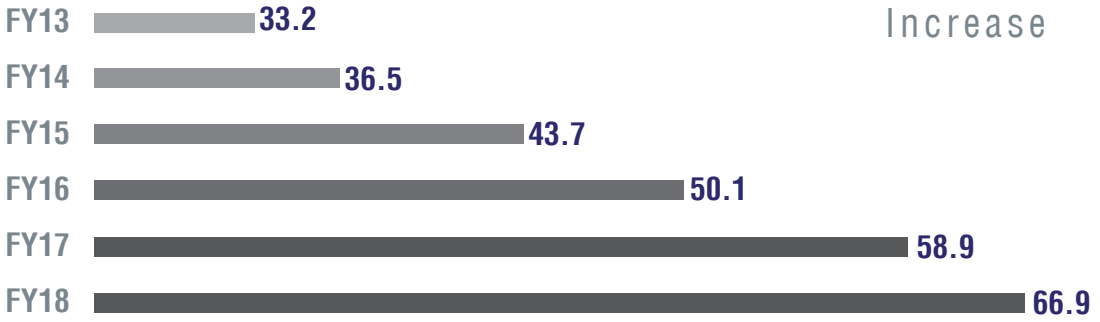
TENURED/ TENURE-TRACK Faculty

Research Award Growth ($M)



101% Increase

Research Conferences Spur Innovation and Collaboration

Select Highlights

Northeastern's College of Engineering hosted over 15 research conferences and workshops during the past academic year, furthering collaboration among engineers and scientists and with professional societies, academia, government, and industry.

International Union of Theoretical and Applied Mechanics General Assembly and Congress Committee Meetings Take Place at Northeastern

Influential engineering leaders and scientists from 29 countries attend the 2018 IUTAM General Assembly Meeting at Northeastern University.

The prestigious International Union of Theoretical and Applied Mechanics (IUTAM) 2018 General Assembly and Congress Committee Meetings—which occur only once every two years—took place at Northeastern University, July 22-25, 2018, in Boston, Massachusetts. Hosted by Nadine Aubry, dean of the College of Engineering at Northeastern, and president of IUTAM, the event brought together nearly 85 engineering leaders and scientists in the field of mechanics and their guests from 29 countries, including many members of the various countries' National Academies of Sciences and Engineering.

Left: Dean Nadine Aubry, president of IUTAM, hosts the IUTAM General Assembly Meeting. **Middle:** Carol Livermore, associate professor of mechanical and industrial engineering at Northeastern, gives a scientific talk, entitled, "Carbon Nanomaterials and Origami Tissue Engineering: Bringing Nanoscale Mechanics into the Macroscale World." **Right:** University Distinguished Professor Eduardo Sontag, electrical and computer engineering, jointly appointed in bioengineering, at Northeastern, presents "Mathematics of Feedback Control Theory: From Mechanical Systems to Molecular Biology."

First Single Cell Proteomics (SCP) Conference

Hosted by Bioengineering Assistant Professor Nikolai Slavov of Northeastern, and Dr. Bogdan Budnick, director of Proteomics at the Harvard University Mass Spectrometry and Proteomics Resource Lab.

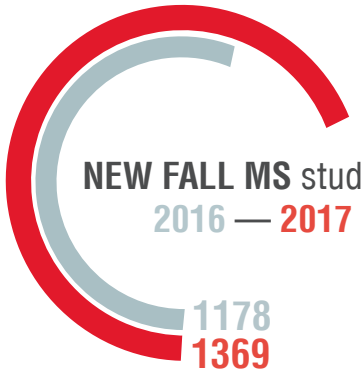
2017 New England Computer Vision Workshop

Led by Professors Yun Raymond Fu and Octavia Camps, electrical and computer engineering, NECV brought together researchers in computer vision and related areas with a full day of presentations and posters.

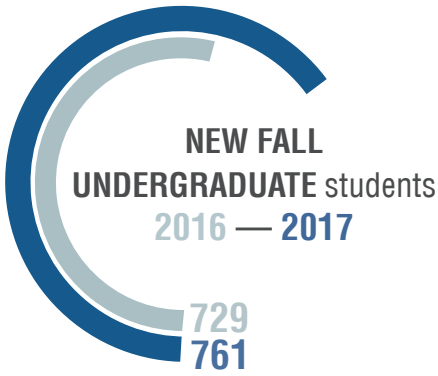
First International Conference on Biomaterials and Chemical Biology

Led by Professor Ming Su and University Distinguished Professor Art Coury, chemical engineering, the keynote speaker was Xingdong Zhang, Professor and Honorary Director of the National Engineering Research Center for Biomaterials at Sichuan University.

3717
GRADUATE
students



3819
UNDERGRADUATE
students



5 ENGINEERING DEPARTMENTS

Bioengineering
Chemical Engineering
Civil and Environmental Engineering
Electrical and Computer Engineering
Mechanical and Industrial Engineering

332
Conference Proceedings in 2017

545
Journal Papers in 2017

Departmental Research Areas

BIOENGINEERING
Biocomputing
Bioimaging and Signal Processing
Biomechanics and Mechanobiology
BioMEMS/Bionano
Biochemical and Bioenvironmental Engineering
Cell and Tissue Engineering
Motor Control

CHEMICAL ENGINEERING
Advanced Materials Research
Biological Engineering

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, & Human Machines
Multifunctional Composites
Multiphase Structured Matter
Resilient Systems
Smart and Sustainable Manufacturing

Angelina Jay, PhD'17

ADVISOR: ANDREW MYERS, ASSOCIATE PROFESSOR, CIVIL AND ENVIRONMENTAL ENGINEERING

Angelina Jay graduated in 2017 with a PhD in civil engineering after working on a joint industry-academic research project with Keystone Tower Systems, a start-up company developing an innovative, potentially mobile, process for manufacturing wind turbine towers. She designed and implemented a series of large- and component-scale tests at Northeastern's Laboratory for Structural Testing of Resilient and Sustainable Systems (STReSS lab) to characterize the structural performance of wind towers made with this new process. During her studies at Northeastern, Jay received an Integrated Graduate Education and Research Traineeship (IGERT) fellowship and was awarded a scholarship by the Structural Engineers Association of Massachusetts. Jay currently works as an associate in the Buildings and Structures group at Exponent in New York City.

Jaclyn Lock, PhD'18

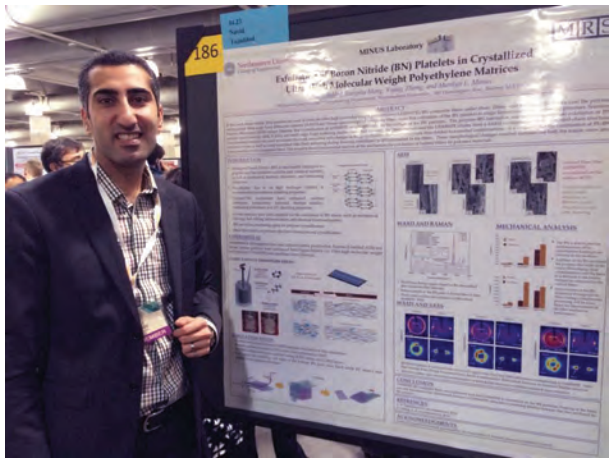
ADVISOR: REBECCA CARRIER, PROFESSOR AND ASSOCIATE CHAIR OF RESEARCH, CHEMICAL ENGINEERING

While pursuing her PhD in the Department of Bioengineering, Jaclyn Lock investigated the impact of external stimuli and disease on the intestinal mucus barrier. Her graduate studies were supported by a National Science Foundation Graduate Research Fellowship, Northeastern Dissertation Completion Fellowship, Biomedical Engineering Society Career Development Award, and conference travel awards. Additionally, Lock was awarded first place for her poster presentation at the American Institute of Chemical Engineers Annual Conference. After graduation, she plans to join the biotech industry as a research scientist utilizing her skills to work on projects that improve overall health.

Navid Tajaddod, PhD'17

ADVISOR: MARILYN L. MINUS, ASSOCIATE PROFESSOR, MECHANICAL AND INDUSTRIAL ENGINEERING

Navid Tajaddod received his PhD from the Department of Mechanical and Industrial Engineering (MIE) in the fall of 2017, and as a student was part of the Macromolecular Innovations in Nano-Material Utilizing Systems (MINUS) laboratory. His graduate studies were supported by grants from the Army Research Office and Air Force Office of Scientific Research. During Tajaddod's time in the MINUS lab, he contributed to five published peer-reviewed journal articles, and seven conference posters and presentations. His research work focused on polyacrylonitrile (PAN)/carbon nanotube (CNT) precursors for carbon fiber production and investigating the formation and structure of interfacial regions to dictate property trends, and demonstrated the ability to use confined interphase regions within the PAN/CNT composite to induce early onset of graphitic formation. In 2016, Tajaddod was selected as a finalist to participate in the Society for the Advancement of Material and Process Engineering (SAMPE) Student Research Symposium. He was so impacted by his



experience that he returned to start a SAMPE student chapter at Northeastern, where he served as the chapter president. In 2016, Tajaddod was also awarded the MIE department's Alfred Ferretti Student Travel Award, which supports costs to present work at a non-local conference. Furthermore, in 2017 Tajaddod was selected for the MIE Departmental Ferretti and Yamamura Fellowship Award. He is currently an LTD process engineer at Intel Corporation in Portland, Oregon.

Mohammad Khavari Tavana, PhD'18

ADVISOR: DAVID KAELI, COLLEGE OF ENGINEERING DISTINGUISHED PROFESSOR, ELECTRICAL AND COMPUTER ENGINEERING

Mohammad Khavari Tavana received his PhD in Computer Engineering from the Department of Electrical and Computer Engineering in May 2018. Since joining Northeastern in 2015, Khavari Tavana has led cutting-edge research in the Northeastern Computer Architecture Research Laboratory, focused on the design of dependable, non-volatile memory systems. In just the past year, he produced seven high-quality journal/conference publications, including a Best Paper Award at the 2017 IEEE International Conference on Computer Design. These publications are seven out of the 22 papers he has published. Khavari Tavana joined Intel Corporation in the role of a performance architect in the Platform Architecture Group in Hillsboro, Oregon in August 2018. In this role, he carries out architectural explorations, evaluates design alternatives, produces performance and power projections, and provides performance validation using state-of the-art simulation and analysis tools and technology to ensure future Intel Architecture systems deliver industry-leading performance.

Belinda Slakman, PhD'17

ADVISOR: RICHARD WEST, ASSOCIATE PROFESSOR AND ASSOCIATE CHAIR OF GRADUATE STUDIES, CHEMICAL ENGINEERING

While pursuing her PhD in the Department of Chemical Engineering, Belinda Slakman developed open-source software to automatically predict complex networks of chemical reactions. She devised new ways to predict the effect a solvent has on reaction rates, and extended the software toward predicting chemical vapor deposition of silicon compounds. During her PhD, she completed two internships at Intel Corporation, and an intensive eight-week data science bootcamp with a fellowship from The Data Incubator. She was also a consultant at the Chemical Engineering Writing Center, advising fellow students and postdocs on technical writing of scientific manuscripts. After completing her PhD, Slakman joined a Japanese start-up, Kyulux, as a research scientist in their Boston office, where she uses data science techniques to optimize molecules for OLED applications.

Graduate Students Take Positions at Top Organizations

RESEARCH

National Institutes of Health
Boston Children's Hospital
Brigham and Women's Hospital
Draper Laboratory
NASA Jet Propulsion Lab
MIT Lincoln Lab
Merck & Co.
Shire
National Labs such as Argonne, Brookhaven, Oak Ridge, Pacific Northwest

ACADEMIA

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

INDUSTRY

Google, Microsoft, Bristol-Myers Squibb, Caterpillar, Cisco, Ford Motor Company, Johnson & Johnson, Visa, Samsung, Intel, Dominion Energy, MITRE, PepsiCo, Dell EMC, Amazon, BAE Systems, Raytheon, IBM, PayPal, Siemens, Apple, EMD Millipore, Schneider Electric, Proctor & Gamble, General Electric, Wayfair, Leidos Engineering, JetBlue, Facebook, SpaceX, Tesla

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*

Marilyn Minus , associate professor, mechanical and industrial engineering

$1.25 Million AFOSR Award for Forming Nano-Material Polymer Blends

The Air Force Office of Scientific Research awarded a $1.25 million grant to fundamentally explore the possibility of forming "true blends" between polymers and nano-materials. The overarching goal for this research is to develop a completely new processing approach for nano-materials. To date, all processing approaches for these materials follow traditional composite processing methods. Led by Marilyn Minus, associate professor of mechanical and industrial engineering, the research provides an important opportunity to create blends or mixtures using these two classes, which would lead to new materials with unique physical properties comparable to metal alloys or polymer blends.

Research findings will solve several key unresolved fundamental scientific issues pertaining to understanding (i) the inherent polymer-1D filler interactions, (ii) the solvation of 1D nano-fillers using a polymer molecule, (iii) the parameters and limits associated with forming these blends, and (iv) control of properties by tuning nano- to meso- to macro-scale structures. The funded work is centered around two research objectives, to: (1) understand the fundamental scientific mechanisms for phase separation and its behavior in facilitating the formation of polymer-1D nano-material blends; and (2) build a new tunable processing route for fabrication of blended polymer-1D nano-materials.

Machine Learning Algorithm to Discover Metamaterials

In a paper published in *ACS Nano*, Associate Professor Yongmin Liu, mechanical and industrial engineering and electrical and computer engineering, and his co-authors described a machine learning algorithm they developed and trained to identify new metamaterial structures, including those allowing for strong light absorption and maybe someday an invisibility cloak, like that used in the Harry Potter fantasy novels.

Metamaterials are artificially engineered materials. Scientists create them by combining multiple elements from composite materials such as metal and dielectric. To achieve an invisibility cloak, a metamaterial needs to possess certain optical properties. Specifically, scientists would have to design the material so that they could control how light moves around an object without being reflected or absorbed. This design is possible, but it would take just the right material with just the right structure.

There are hundreds of thousands of potential material structures with optical responses that fall somewhere along the optical spectrum. Sifting through them to find a new material design has traditionally taken hours or even days, but with Liu's new algorithm, the method is much faster and more accurate than previous approaches. Engineers can now use the algorithm to discover new materials with specific useful characteristics. For example, current solar panels can only convert 20 to 30 percent of sunlight to energy. Liu is interested in finding a material capable of 100 percent light absorption to create more efficient solar panels. As for invisibility, Liu said, he's confident the algorithm would be able to identify the right material but the current fabrication technology still needs significant advances to make a large-scale, wearable invisibility cloak come true.

Richard West, associate professor, chemical engineering

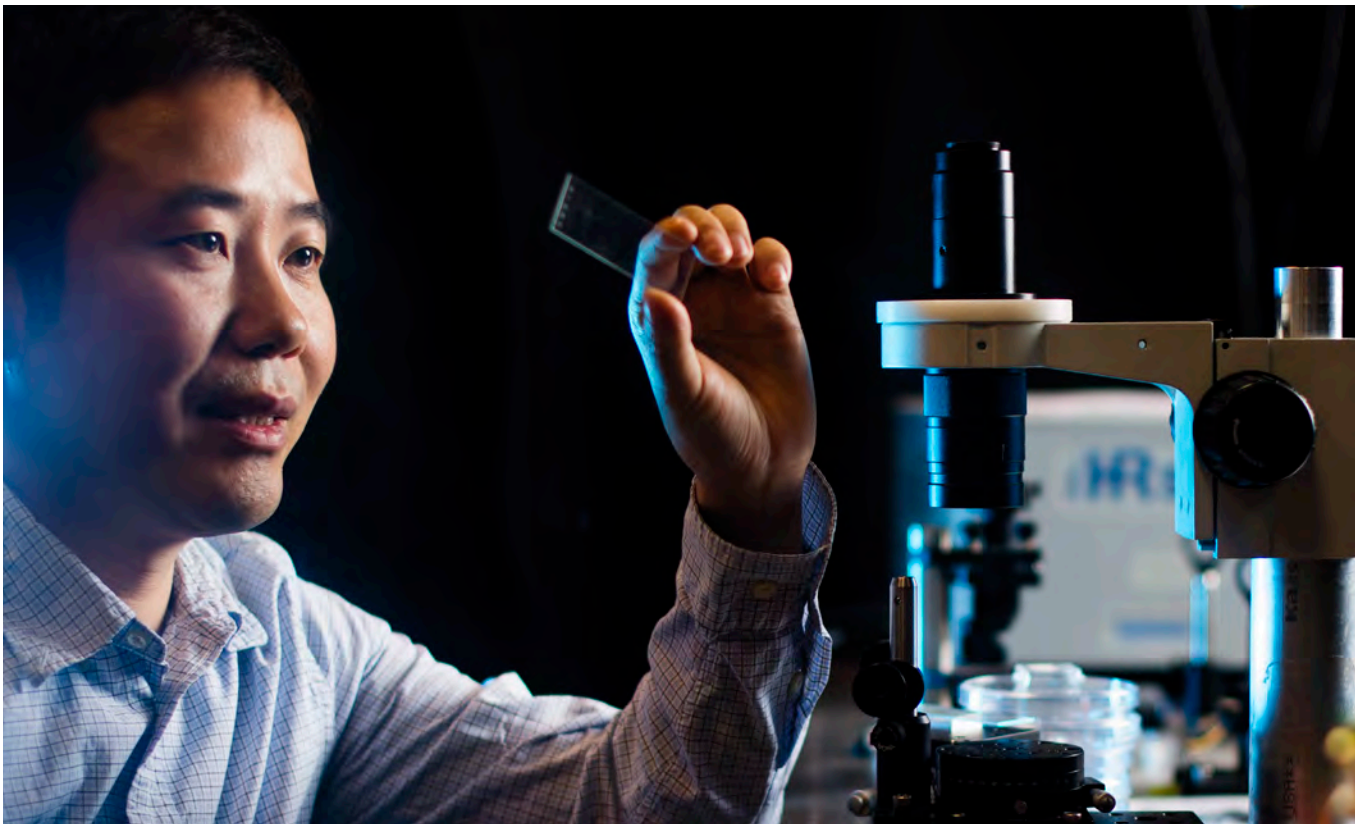
NSF CAREER Award to Predict Combustion

Associate Professor of Chemical Engineering Richard West has received a CAREER Award from the National Science Foundation for Predictive Kinetic Modeling of Halogenated Hydrocarbon Combustion. West will research how to predict the complex networks of chemical reactions that comprise a chemical mechanism, specifically combustion, which could ultimately provide real-world, life-saving solutions in preventing fires aboard airplanes or in car wrecks.

Halogenated hydrocarbons (HHCs) are widely used as both refrigerants and fire suppressants. Driven by environmental and economic considerations, there is rapid innovation in the industry, but the next generation of HHC compounds raise fire safety concerns. "We've been trying to predict combustion—how hydrocarbons like fuels will burn—for a while. So people are now generating models with thousands of different intermediate steps. This research project is about trying to take those same techniques but extending them to model hydrocarbons that have chlorine, bromine, iodine or fluorine attached," explained West.

The challenge is finding a way to have computers predict what the parameters will be because there are thousands of individual reactions. If this can be accomplished, there will be a precise idea of how certain compounds burn—enabling the prevention of dangerous fires. West's research will use a computational approach known as machine learning to help model the complex reacting systems, leading to a breakthrough development of an automated reaction mechanism generation tool to create detailed kinetic models for combustion of HHCs.

"Being able to predict how a material will burn before making a lot of it would save an awful lot of time and expense," West said. "What we need is a way to predict the combustion properties of halogenic compounds. That means building detailed models with thousands of intermediates just based on someone drawing a picture of a molecule and saying, 'what would happen to this?'" The end result could be a compound stored on airplanes to be injected in case of fire, he said. If they know the exact chain of reactions that causes the fire, they can create a compound that will effectively contain or extinguish it, potentially saving lives.



Associate Professor Yongmin Liu, mechanical and industrial engineering and electrical and computer engineering

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*

Developing 3D Biochips to Improve Anticancer Drug Screening

Assistant Professor of Chemical Engineering Sidi A. Bencherif has been awarded funding from the Burroughs Wellcome Fund for a research project, titled "Cryogel-supported liver-on-a-chip for ex-vivo hepatotoxicity and anticancer drug screening." The research is focused on developing biomimetic cryogel-integrated biochips intended to accurately model the 3-D structure and function of hepatic microtissues in both healthy and diseased states. The ultimate objective is to reconstruct more reliable miniature tumoral and healthy liver tissues for drug discovery and testing safety of new therapeutics, reducing the need for often unreliable animal models. It is a multidisciplinary collaborative research project between Northeastern University and the University of Technology of Compiègne (Sorbonne University), France.

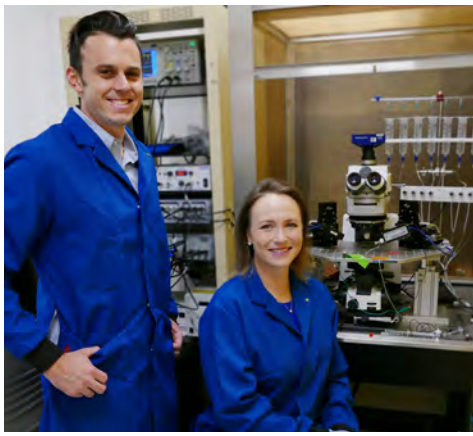
Sidi A. Bencherif, assistant professor, chemical engineering

The objective of this emerging project between the French and American teams is to develop in vitro models for drug testing and toxicity that will not only drive costs down but will also more accurately recapitulate human biochemistry and hence recapitulate human reactions to the drugs tested. Bencherif said, "This project is intended to take our research to the next level and to foster a collaborative research relationship in the broad areas of liver tissue engineering and drug screening. The basis of the current research is to bring to light alternative and more realistic platforms that surpass the ones currently used in the field of drug screening."

The Burroughs Wellcome Fund is an independent private foundation dedicated to advancing the biomedical sciences by supporting research and other scientific and educational activities.

NIH Trailblazer New/Early Career Investigator Award for 'Brain-Gut' Research

Chemical Engineering Assistant Professors Abigail and Ryan Koppes are researching how the brain and gut communicate under a three-year, $632K Trailblazer New/Early Career Investigator R21 Award from the National Institutes of Health (NIH) National Institute of Biomedical Imaging and Bioengineering.



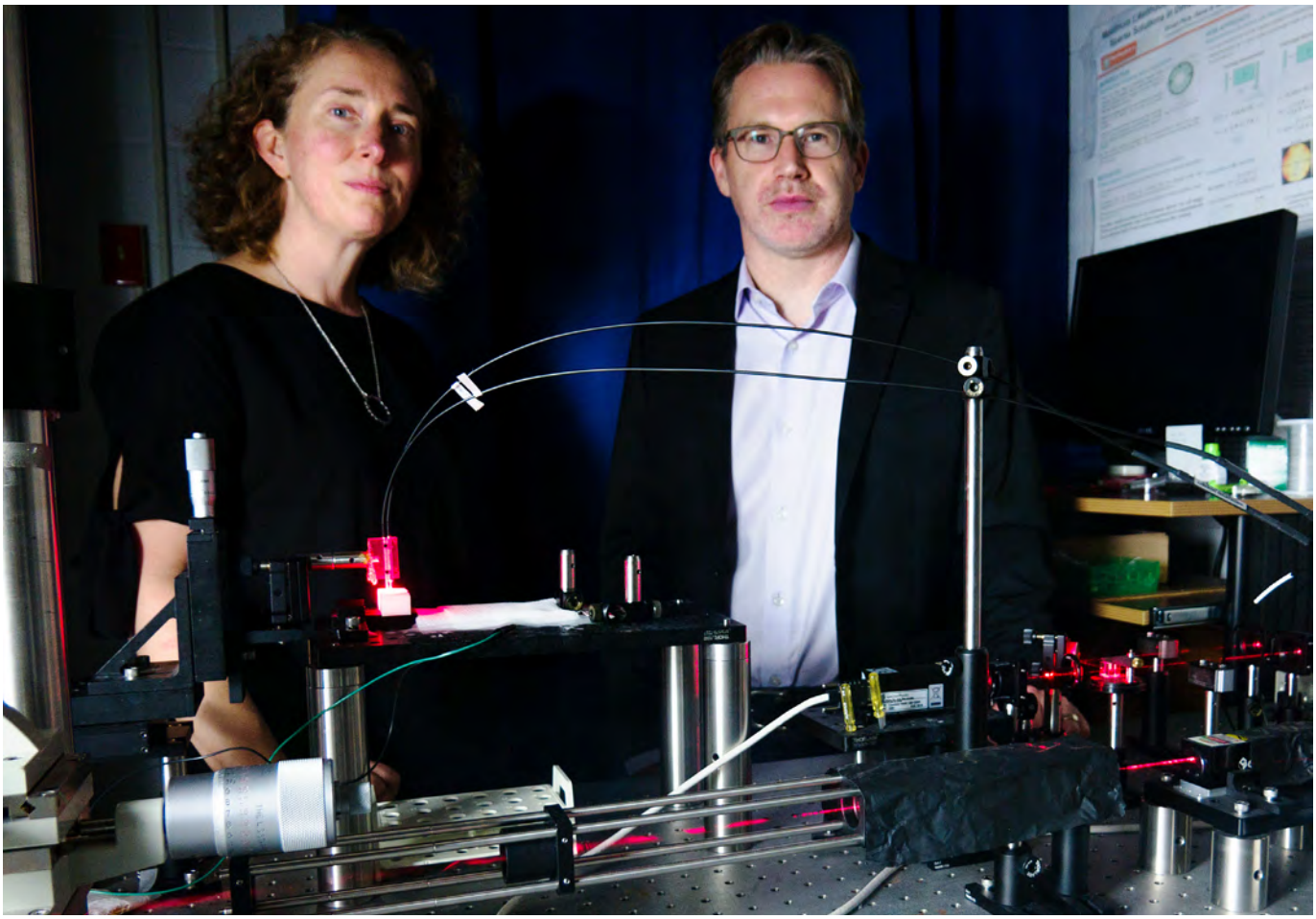
Ryan and Abigail Koppes, assistant professors, chemical engineering

Under the grant, the Koppes' team will create a benchtop model or platform called "body on a chip" to mimic certain aspects of the brain and gut. Their research will focus on the enteric nervous system—the system associated with the 'butterflies in the stomach' feeling. "The system controls how the body absorbs nutrients and is viewed as a gatekeeper to regulate gut function," said Abigail. "We want to model that system to understand how it is controlled and what cellular players are involved from the nervous system."

Working with researchers at Boston Children's Hospital and Harvard Medical School, the Koppes are developing a "humanized" system using primary sourced cells to create a platform that is more representative of native human states. The research will address the as-yet unproven theory that it may be possible to harness the nervous system to reduce inflammation present in diseases such as Irritable Bowel Syndrome."We hope to use the

new field of bioelectronic medicine, which is using electrical stimulation to turn cells on or off to reduce inflammation," said Abigail. "Ultimately our goal is to use the body's own neural network to mitigate inflammation." In addition to improving the understanding of how the nervous system and gut regulate each other's function, the team hopes to translate the technology they are developing to other systems, for example, the blood/brain barrier, to enable researchers to find new pathways to drug therapies.

$1.4 Million NIH Award for Continuous, Real-Time Drug Monitoring



Professor Heather Clark and Associate Professor Mark Niedre, bioengineering

Bioengineering Professor Heather Clark and Associate Professor Mark Niedre were recently awarded a $1.4 million, four-year grant from the National Institutes of Health's National Institute of Biomedical Imaging and Bioengineering. The project, titled, "Circulating Red Blood Cell Based Nanosensors for Continuous, Real-Time Drug Monitoring," will develop new technology for non-invasive and continuous therapeutic drug monitoring using drug-sensitive fluorescent nanosensors that will use circulating red blood cell (RBC) ghosts as a vehicle for circulation.

Drug dosing is normally prescribed based on population averages, but in most cases direct clinical testing of systemic drug levels is performed infrequently or not at all. This is particularly problematic for drugs with narrow therapeutic indices, where treatment can be ineffective or outright toxic. But by using near-infrared fluorophores at high local concentrations, drug-dependent signals are produced that are measurable with an external optical reader. Additionally, because unmodified RBCs are known to stay in circulation for weeks or months, long-term, continuous monitoring directly in the peripheral blood is possible.

The technology will first be developed for monitoring lithium and sodium as examples of a prescribed drug and its toxic side-effect. Longer term, many uses are anticipated for the f-RBC nanosensor technology for personalized therapeutic dose monitoring in many areas of medicine. The technology could also be extended to monitor effects on downstream drug targets 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*

Determining the Effect of Climate on Mississippi River Flooding

Flooding along the Mississippi River is a hazard that negatively impacts industry, shipping, and the millions of people that live in or near its floodplain. Yet to predict a major flood, researchers need a history of the river's natural rhythm. The problem is that written data on flooding in the Mississippi only dates back about 150 years. Samuel Munoz, assistant professor of marine and environmental sciences, interdisciplinary with civil and environmental engineering, and his team have developed a way to look back centuries further by analyzing sediment from the flood plain lake and tree rings. His findings, published in the journal *Nature*, show that the probability of a 100-year flood has increased 20 percent from 500 years ago due to river engineering.

Munoz is now leading a $595K award from the National Science Foundation, entitled, "Extreme Floods on the Lower Mississippi River in the Context of Late Holocene Climatic Variability." Under the grant, Munoz will seek to understand the influence of climate variability on flood activity and improve predictions of flooding by developing records describing the timing and magnitude of flooding across the Mississippi basin over the last millennium. The research will be useful for planned and ongoing efforts to slow coastal land loss in the Mississippi River delta.

Samuel Munoz, assistant professor, marine and environmental sciences, interdisciplinary with civil and environmental engineering

Munoz will reconstruct the frequency and magnitude of overbank floods along the lower Mississippi River and its major tributaries using the sedimentary archives preserved in oxbow lakes. Creating the novel hydrological record is due to recent developments in paleoflood hydrology that demonstrate the unique ability of floodplain lake sediments to record individual flood events and their associated magnitude. Once developed, reconstructions will be used to characterize decadal- to centennial-scale variability of flood activity, to compare with simulated discharge extremes in climate model ensembles, and to identify the regional and hemispheric circulation patterns associated with increased likelihoods of extreme floods on the lower Mississippi River and its major tributaries.

Matthew Eckelman, associate professor, civil and environmental engineering

Honored with Clemens Herschel Award

Associate Professor of Civil and Environmental Engineering Matthew Eckelman and his former PhD student Mithun Saha have won the Clemens Herschel Award from the Boston Society of Civil Engineers Section of the American Society of Civil Engineers, for their paper, entitled "Urban Scale Mapping of Concrete Degradation from Projected Climate Change," published in *Urban Climate* in 2014. The Clemens Herschel award is given each year to a paper that has been "…particularly useful and commendable, and worthy of grateful acknowledgment."

Ergun Selected for National Committee on Building Adaptable and Resilient Supply Chains

Professor of Mechanical and Industrial Engineering and Global Resilience Institute Faculty Affiliate Özlem Ergun has been appointed to a national committee tasked with capturing key lessons about supply and distribution networks under strain during Hurricanes Harvey, Irma and Maria.

Ozlem Ergun, professor, mechanical and industrial engineering

The FEMA-sponsored committee, established by the National Academies of Sciences, Engineering, and Medicine, and the Chair of Policy and Global Affairs (PGA), will address questions such as:

- What was the state and knowledge of the pre-incident networks and capacity of critical supply chains, distribution systems, and infrastructure?
- How were these systems impacted by the storms and how did subsequent response actions produce further effects on network integrity and operations?
- What are the network structures, linkages, and/or behavior most susceptible to effective intervention?
- How can supply chain systems be strengthened in the short term to be efficient in day-to-day operations and adaptable to sustain integrated disaster and humanitarian supply chain operations during catastrophic events?

At the close of the 18-month project, the committee will produce and release a report which:

- Describes how the supply systems were impacted by or during Hurricanes Harvey, Irma, and Maria in terms of commonalities and differences among effects seen in Texas, Florida, Puerto Rico, and the US Virgin Islands.
- Identifies crucial interdependencies, nodes, or key sub-systems within the supply chain system that have the potential to amplify or constrain supply chain function, operations or resilience.
- Presents options or recommendations to build robust supply chains, distribution systems, and infrastructure that operate in ways that day-to-day operations can adopt and that can be integrated with disaster and humanitarian supply chains during catastrophic event operation.

Ergun's research focuses on the design and management of large-scale networks. Her development of a decision support tool using a mathematical framework that can analyze data inputted after a disaster and provide immediate recommendations for prioritizing relief efforts was recently published in the journal *PLOS ONE*.

Research to Add Solar to the Grid

Ali Abur, professor of electrical and computer engineering, was recently awarded a $792K grant from the Enabling Extreme Real-time Grid Integration of Solar Energy (ENERGISE) funding program. Abur's research was one of 13 projects selected by the Department of Energy's Office of Energy Efficiency and Renewable Energy SunShot initiative, which is focused on enabling grid operators to access up-to-the-minute measurement and forecasting data from distributed energy sources and optimize system performance using sensor, communication, and data analytics technologies.

Ali Abur, professor, electrical and computer engineering

The research project led by Abur aims to develop and implement a comprehensive state estimation framework to facilitate combined monitoring of transmission and distribution systems in order to utilize highly volatile power received from a very large number of solar photovoltaic (PV) units at the distribution feeder nodes. Professor Abur commented, "The research will develop tools to accurately monitor a large number of solar power sources in distribution systems enabling their efficient integration and dispatch under varying operating conditions."

The project has the potential to enable DOE to establish new planning and real-time operations platforms by enabling:

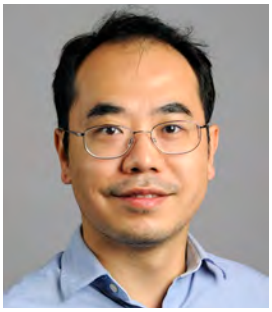
- Efficient dispatching of PV sources by increasing their observability at the distribution and transmission level
- Accurate monitoring of the interactions between the transmission and distribution systems
- Development of a "scalable distributed computational framework" for implementing robust power system state estimation techniques in very large scale distribution and transmission systems.
- Detailed modeling and integration of VSC based solar PV unit interfaces in state estimators
- Seamless integration of results from multiple estimators that use multi-phase distribution feeders with solar PV units and balanced positive sequence transmission system models

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*

Personal Wayfinding Information Systems for First Responders



"Ryan" Wang, assistant professor, civil and environmental engineering

Yingzi Lin, associate professor, mechanical and industrial engineering

Assistant Professor Qi "Ryan" Wang (PI), civil and environmental engineering, and Associate Professor Yingzi Lin (co-PI), mechanical and industrial engineering, were awarded a grant from the National Science Foundation in collaboration with Texas A&M University for "Personalized Systems for Wayfinding for First Responders." The project will contribute to the NSF's Big Idea "Harnessing Data for 21st Century Science and Engineering" by conducting fundamental research in information processing and engineering in the field of disaster management.

First responders face serious risks when responding to emergencies, and disorientation induced by complex building features is a major cause of injuries. In order to successfully navigate complex, dangerous buildings during a crisis, first responders need to build accurate spatial memories of unfamiliar spaces in a timely manner. This requires retention and processing of a large amount of information such as maps and verbal instructions. An apparent gap between the enormous information processing needs during a mission and the limited processing capacity of people creates a potentially fatal situation in emergency wayfinding.

To address this gap, the project will test the theoretical foundation of personalized wayfinding information systems that can effectively minimize the cognitive load of first responders on the individual level. Semantic metrics, a quantitative model of the relationship between spatial information and cognitive load, and Virtual Reality based multi-mission experiments will be used. The outcome will include an adaptive wayfinding information system that dynamically tailors the way spatial information is presented based on the real-time cognitive load of individual first responders, measured by a set of neurobiological and physiological metrics. The project will immediately impact first responders, primarily firefighters, for their missions.

NSF Grant for 'Deep Learning' Computer Vision Systems

Professors of Electrical and Computer Engineering Octavia Camps and Mario Sznaier were awarded a $500K grant from the National Science Foundation for "Dynamic and Statistical Based Invariants on Manifolds for Video Analysis." The research project will create a set of well-designed neural network modules, or "layers," that a programmer can snap together to build a working computer vision system that can teach itself to recognize the goal concepts.

Computer vision systems can benefit society in many ways. For example, spatially distributed vision sensors endowed with activity analysis capabilities can prevent crime, help optimize resource use in smart buildings, and give early warning of serious medical conditions. The most powerful computer vision systems employ a "deep learning" approach, in which simulated networks of neurons transform the input video pixels into high-level concepts, such as, in the crime example, someone breaking into a

Octavia Camps, professor, electrical and computer engineering

Mario Sznaier, professor, electrical and computer engineering

building. Designing an intelligent neural network, however, is difficult, taking great expertise and trial and error.

Training of deep architectures requires learning the optimal value of a very large number of parameters through the numerical minimization of a non-convex loss function. While in practice, using stochastic gradient descent to solve this problem often "works," the analysis of what the network learned or why it failed to do so, remains an a-posteriori task requiring visualization tools to inspect which neurons are firing and possibly to look at intermediate results.

Camps and Sznaier along with their research team will address this issue by incorporating a set of structured layers to current deep architectures, designed using dynamical systems theory and statistics fundamentals, which capture spatio-temporal information across multiple scales. At its core is a unified vision, invariants on latent space manifolds as information encapsulators, that emphasizes robustness and computational complexity issues. Advantages of the proposed layers include the ability to easily understand what they learn, since they are based on first principles; shallower networks with a reduction of the number of parameters that needs to be learned due to the high expressive power of the new layers; and requiring less annotated data, by providing efficient ways to transfer knowledge between domains and to synthesize realistic data.

$2.5 Million NSF CRISP Grant for Network Resilience

Critical infrastructure systems are increasingly reliant on one another for their efficient operation. The National Science Foundation awarded an interdisciplinary team at Northeastern University a $2.5 million CRISP grant, entitled, “Interdependent Network-based Quantification of Infrastructure Resilience” to develop a quantitative, predictive theory of network resilience that takes into account the interactions between built infrastructure networks, and the humans and neighborhoods that use them. The award is also in collaboration with Harvard University, and advised by MIT and the University of Texas-Austin.

The project will catalog three built infrastructures and known interdependencies (both physical and functional) into a "network of networks" representation suitable for modeling. A key part of the research will be quantifying the interplay between built infrastructure and social systems. As such, the models will incorporate community-level behavioral effects through survey-based empirical data that captures how citizens and neighborhoods utilize city services and respond during emergencies. The realistic accounting of infrastructure and its interdependencies will be complemented by realistic estimates of future hazards that it may face.

The core of the research will use network-based analytical and computational approaches to identify reduced-dimensional representations of the (high-dimensional) dynamical state of interdependent infrastructure. Examining how these resilience metrics change under stress to networks at the component level such as induced by inundation following a hurricane will allow identification of weak points in existing interdependent infrastructure. The converse scenario, where deliberate alterations to a network might improve resilience or hasten recovery of already-failed systems, will also be explored.

According to the NSF, the developed framework has the potential to guide city officials, utility operators, and public agencies in developing new strategies for infrastructure management and urban planning. More generally, the research will untangle the roles of network structure and network dynamics that enable interdependent systems to withstand, recover from, and adapt to perturbations.

Research Leads

Albert-Laszlo Barabasi, Professor, College of Science, PI

Kathryn Coronges, executive director of the Network Science Institute, Co-PI

Stephen Flynn, director of the Global Resilience Institute, Co-PI

Edmund Yeh, Professor, electrical and computer engineering, Co-PI

Auroop Ganguly, Professor, civil and environmental engineering, Co-PI

Rob Sampson of Harvard University, Co-PI

Marta Ganzalez of MIT, advisor

Lina Sela of University of Texas-Austin, advisor

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.

CAREER Award for Microbiome Research of Drinking Water

Ameet Pinto, assistant professor in the Department of Civil and Environmental Engineering, received a CAREER award from the National Science Foundation to research the microbial community of drinking water to proactively identify water contamination before it reaches the tap and is consumed by people.

Ameet Pinto, assistant professor, civil and environmental engineering

His work will advance the safety of drinking water by integrating microbial ecology into drinking water microbiome research through establishing a long-term observatory to monitor high-resolution drinking water microbiome dynamics in Boston's water distribution system, and developing models to forecast the abundance and composition of the drinking water microbiome."Humans are impacted by infectious diseases spread by pathogenic micro-organisms, several of which can be transmitted through water. With this research we will develop a modelling framework to be able to predict the microbes in drinking water reaching the tap at time points in the future," said Pinto.

Pinto and his research team at Northeastern are collecting data and water samples from several sites in Boston to determine the microbial community of drinking water in the city. Technologies like high throughput DNA sequencing are being used to quickly establish the entire community in samples. "DNA sequencing existed for a long time, but high throughput and real-time DNA sequencing is what has given this project a boost. The NSF is in support of this research as it has the potential to predict contamination in a very short period of time," explained Pinto.

The research will predict microbial contamination by developing computer models, which will be fed with data collected from the DNA sequencing. These models will be trained using the data collected and predict the contamination at the tap, which is the ultimate goal. Pinto explained, "We aim to study the spatial and temporal dynamics of the community using two different types of models. One model is a time series model, which will be calibrated to the data we collect, and the other is a classic ecological model often used to study the spatial distribution of the plants and animals, which we will apply to microorganisms."

Findings of this research have potential to revolutionize the current United States drinking water monitoring system of "detect and mitigate" toward a proactive one of "predict and correct."

$13.2M NIH Award for Environmental Influences of Child Health Outcomes in Puerto Rico

Snell Professor and Associate Dean for Research Akram Alshawabkeh, civil and environmental engineering, has been awarded $13.2M over five years from the National Institutes of Health to lead a renewal of the multi-institutional and interdisciplinary research project, entitled, "Environmental Influences of Child Health Outcomes in Puerto Rico (ECHO-PRO). ECHO co-investigators from Northeastern include College of Engineering Distinguished Professor David Kaeli, electrical and computer engineering, and Assistant Professors Justin Manjourides and Emily Zimmerman of the Bouvé College of Health Sciences. Additionally, the project is in collaboration with the University of Michigan, University of Georgia, and the University of Puerto Rico.

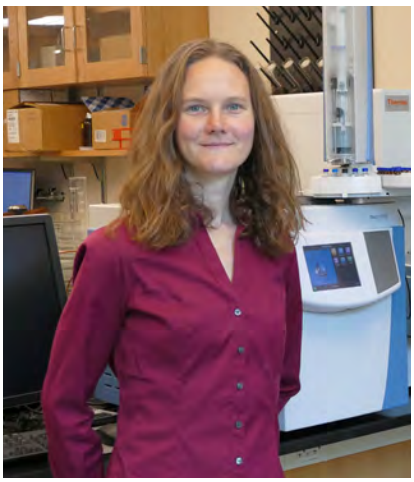
Snell Professor and Associate Dean for Research Akram Alshawabkeh, civil and environmental engineering

In collaboration with the larger ECHO Consortium, the project will contribute data, biological samples, and knowledge to allow for better understanding of how

environmental exposures affect child health outcomes in Puerto Rico and the U.S. mainland. Research from ECHO-PRO will build on the work conducted by the PROTECT (Puerto Rico Testsite for Exploring Contamination Threats) and CRECE (Center for Research on Early Childhood Exposure and Development in Puerto Rico) research centers led by Alshawabkeh, which study exposure to environmental contamination in Puerto Rico and its contribution to preterm birth, and how mixtures of environmental exposures and other factors affect the health and development of infants and children living in Puerto Rico.

$2.7 Million DARPA Award to Re-invent Wastewater Treatment

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



Amy Mueller, assistant professor, civil and environmental engineering, and marine and environmental sciences

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

Mueller remarked, “Water reclamation facilities consume approximately 2 percent of the annual U.S. energy budget, and this strategy has the potential to cut that energy demand in half, while eliminating greenhouse gas emissions. This project is an exciting example of the power of collaborative research and sharing of tools—especially data analysis strategies—across disciplinary lines.”

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

Professor Ganguly Selected as Climate Change Expert

Professor Auroop Ganguly of the Department of Civil and Environmental Engineering has been selected as a United Nations Environmental Effects Assessments Panel (UN EEAP) review member to the upcoming 2018 quadrennial assessment report. The UN EEAP was formed to assess the impacts on ozone layer depletion, and report their findings to the United Nations, and in turn to the signatories of the Montreal Protocol on Substances that Deplete the Ozone Layer, which is an international agreement to protect the ozone layer. Ganguly’s primary relevant expertise will be in the interactions with climate change, such as impacts on weather extremes and hydrological stresses, and consequences across multiple sectors. Additionally, Ganguly has been selected to author a report on climate data sciences for a major publication of the United Nations Association – United Kingdom, titled, Climate 2020.

Auroop Ganguly, professor, civil and environmental engineering

Ganguly is also the lead author of the Artificial Intelligence section in the Climate Adaptation chapter of the upcoming Sustained National Climate Assessment (NCA) report for the United States. According to the NCA, the primary goal of the U.S. National Climate Assessment “is to help the nation anticipate, mitigate, and adapt to impacts from global climate change, including changes in climate variability, in the context of other national and global change factors.”

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.

Yun Raymond Fu, professor, electrical and computer engineering, jointly appointed in the College of Computer and Information Science

AI Startup Acquired by Global Cosmetics Company

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

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

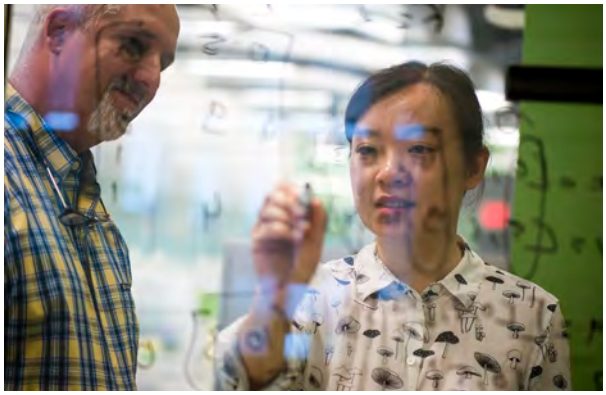
In the SMILE Lab, Fu and his team focus primarily on research with security and defense applications. Beauty, on the other hand, was hardly on his team's radar initially. "In the early stages of this research, we didn't know much about fashion, makeup, and beauty," Fu explained. But this potential application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

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

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

NSF Award for Design of an Efficient Deep Learning System

Assistant Professor Xue (Shelley) Lin, electrical and computer engineering (ECE), and College of Engineering Distinguished Professor David Kaeli, ECE, will collaborate with City University of New York researchers to design an efficient deep learning system under a three-year, $800K National Science Foundation grant. If successful, the grant to develop "A Framework of Simultaneous Acceleration and Storage Reduction on Deep Neural Networks Using Structured Matrices" will have a profound impact on a variety of deep learning applications with significant implications for autonomous systems/spaces of the future.



David Kaeli, COE distinguished professor, and Xue "Shelley" Lin, assistant professor, electrical and computer engineering

Deep learning models, a subset of traditional machine learning algorithms, use a network structure composed of multiple layers known as Deep Neural Networks or DNNs, which are designed to be able to extract features at multiple levels of abstraction. Deep learning requires training DNNs by feeding them a lot of data, which they can then use to become more intelligent and make decisions about new data such as the algorithm applied by Google for image recognition and article searches.

"DNNs require millions of parameters to perform complicated tasks," says principal investigator Lin. "That, in turn, demands a lot of computation and parameter storage resources from the computing platform, which can potentially limit the use of deep learning in many applications. Our project will provide for efficient implementation in terms of computation speed and parameter storage such that we can seat deep learning systems into computing platforms that don't have enough computing or storage resources."

Lin notes that ultimately the research project will promote wider applications of deep learning systems. Among these applications are self-driving cars, unmanned aerial vehicles, and wearable devices. "These applications may need deep learning to perform specific tasks, but they are limited by their storage and computing power," says Lin, "so we need to compress the model and accelerate computation." Given the growing trend toward autonomous systems, Lin says the project "is an important first step in the development of future autonomous systems and future 'smart spaces' such as smart homes and buildings."

NSF CAREER Award for Innovative Big Data Management

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

Stratis Ioannidis, assistant professor, electrical and computer engineering

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

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

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

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

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*

ARO Young Investigator Award to Develop Security Solutions

Marvin Onabajo, associate professor, electrical and computer engineering

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

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

Onabajo is exploring a unique solution: designing thermal sensors that can be placed within chips to detect an increase in heat within the device when a Trojan circuit is activated. The sensor circuits will provide a security alert that can potentially be used to notify users of the malicious hacking attempt before data is compromised, or automatically stop the execution of critical tasks. Much of Onabajo's research focuses on the incorporation of self-testing and correction features directly onto the chip as it is manufactured. "Although the semiconductor industry has improved in its ability to produce much smaller chips with increased functionality, reliability will always be a concern, due to unavoidable variations of the chip production processes—as well as the degradation of materials over time, as devices age," Onabajo notes. "One solution is to design chips that measure their own performance, and then self-calibrate to correct any issues. That is a continuing focus of my investigations."

ALERT Research Focused on Protecting the Nation from Terrorists

Robert D. Black Professor Michael Silevitch, Department of Electrical and Computer Engineering

The Center for Awareness and Localization of Explosives-Related Threats (ALERT) is focused on improving the detection, mitigation, and response to threats from explosives, weapons, and other contraband. This Department of Homeland Security (DHS) Center, led by Robert D. Black Professor Michael Silevitch, of the Department of Electrical and Computer Engineering, receives award funding exceeding $4 million annually.

ALERT is comprised of more than two-dozen university, private industry, and national laboratory partners. One research team at Northeastern is designing video software to track airplane passengers and their luggage as they move through airport security. The software, created in collaboration with other ALERT research teams, the DHS Science and Technology Division, TSA, the Massachusetts Port Authority, and the security screening company Rapiscan, will be able to automatically identify when passengers enter and exit a checkpoint, track passenger belongings, and spot unusual behavior such as item theft.

Another ALERT team at the University of Rhode Island has created safe training aides for bomb-sniffing dogs. ALERT partnered with DetectaChem to make them available to first responders. The aides, which contain small amounts of explosive material but cannot explode, have already been tested by the Massachusetts State Police, the Toronto Police, and the New York Metropolitan Transportation Authority. In addition, Northeastern's Assistant Professor Jose Martinez-Lorenzo is focused on designing a low-cost millimeter wave radar system to detect threats concealed under the clothing of passengers walking through an airport. The system will be capable of detecting the presence of guns, knives, and other contraband when people are walking at a speed of up to three meters per second. In the area of education and workforce development, to date, ALERT has graduated over 150 MS and PhD students of which over 100 have taken positions within organizations working in Homeland Security. "We've made significant improvements in security infrastructure," said Silevitch. "We've been able to meld academic knowledge and understanding with industrial pragmatism to enable a transition of the best ideas into practice."

NSF Award for Wide-Area Acoustic Monitoring of Marine Mammals

Purnima Ratilal-Makris, associate professor of electrical and computer engineering, received a $710K award from the National Science Foundation for the "Development of a Large-Aperture Coherent Hydrophone Array, Data Processing and Analysis Software System for Instantaneous Wide-Area Passive Acoustic Monitoring of Marine Mammals."

Purnima Ratilal-Makris, associate professor electrical and computer engineering, and her undergraduate and PhD students at sea aboard research vessel RV Endeavor. **From left:** Michael Potter, Seth Penna, Heriberto Garcia, Purnima Ratilal-Makris, Matthew Schinault, and Chenyang Zhu

This project aims to develop and provide high-resolution coherent hydrophone array hardware technology for compliance based marine mammal monitoring in support of seismic survey operations on UNOLs research vessels. A large-aperture densely-sampled hydrophone array system can provide significant enhancement in marine mammal vocalization detection by increasing signal-to-noise ratio via coherent beamforming, which eliminates noise outside of the signal beam. Whale vocalizations not detected using a single hydrophone or sparse array can be extracted out of the noise floor by coherent beamforming with the large aperture hydrophone array system. The coherent beamforming also provides high-resolution estimates of whale vocalization bearings, which are required for finding the range of the whale from the array and localizing the marine mammal in geographic space. The project will also develop a real-time array signal data acquisition, processing and analysis software to provide real-time detection, bearing-estimation, localization and tracking, and classification of marine mammal vocalizations received on the coherent hydrophone array hardware system.

The hardware and software systems together make up the passive ocean acoustic waveguide remote sensing (POAWRS) technology, a transformative approach for ocean sensing, capable of monitoring sound sources over instantaneous wide areas spanning 100 km in diameter or more. In addition to marine mammal vocalizations, the other sound sources detected by POAWRS include biology such as sounds from fish and crustaceans; geophysical processes such as hurricanes and submarine volcanoes; and man-made activities such as ships and other ocean vehicles, seismic airgun and sparker for earthquake plate tectonic studies and oil exploration, as well as offshore piling. The instantaneous continental-shelf scale environmental monitoring capability and temporal-spatial dynamics of sound sources revealed by POAWRS makes it an important technology that could become an indispensable tool in a variety of field operations.

$8 Million DARPA Award to Advance RF Materials Science

Vincent Harris, University Distinguished Professor, electrical and computer engineering

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

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

Harris notes that while most communication and sensing platforms use TRMs—for example, radar and mobile cell phone base stations—many key aspects of the technology have not changed significantly in more than 30 years. "Our work will allow us to break through the existing design paradigm—that is, discrete component TRM systems—and move to something that has never been done before: the TRM system on a GaN wafer," he says. "The TRM is at the heart of the radar as it interfaces with the antenna and [power amplification and] signal processing components," says Harris. "Incorporation of GaN allows us to put more power through the radar system. That means the radar can reach deeper into space, define threats earlier and allow for countermeasures. It will be able to identify threats more effectively, ultimately saving the lives of our troops."

Human-Centered Robotics

Aerial Drone System Leads to Discovery of Penguin Super-Colony

Penguin super-colony discovered in Antarctica. (c) WHOI, Northeastern University, Courtesy Thomas Sayre McChord, Hanumant Singh

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

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

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

The super-colony—which is comprised of 751,527 penguin pairs—includes the third and fourth largest Adélie penguin colonies in the world. Researchers believe the Danger Islands will be an important breeding location for penguins under projected climate change, and that they deserve special consideration in the negotiation and design of Marine Protected Areas in the region. The number of penguins in the Danger Islands could provide insight not just on penguin population dynamics, but also on the effects of changing temperature and sea ice on the region's ecology, according to the Woods Hole Oceanographic Institution, which collaborated on the study with researchers from Northeastern, Stony Brook University, Oxford University, Louisiana State University, and Southampton University.

$1 Million NSF Grant to Develop Underwater Video Transmission for Human-Robot Interaction

Professor Tommaso Melodia and Associate Professor Matteo Rinaldi of the Department of Electrical and Computer Engineering, have been awarded a $1 million grant from the National Science Foundation for "Reliable Underwater Acoustic Video Transmission Towards Human-Robot Dynamic Interaction." This is a collaborative project with Rutgers University, led by Professor Dario Pompili at Rutgers.

While there are novel underwater monitoring applications and systems based on human-robot dynamic interaction that require real-time multimedia acquisition and classification, they are supported by Remotely Operated Vehicles (ROVs). Underwater ROVs are often tethered to the supporting ship by a fiber cable or have to rise periodically to the surface to communicate with a remote station via Radio Frequency (RF) waves, which constrains the mission.

Wireless acoustic communication is the typical physical-layer technology for underwater communication; however, video transmissions via acoustic waves are hard to accomplish as the acoustic waves suffer from attenuation, limited bandwidth, Doppler spreading, high propagation delay, high bit error rate, and time-varying channel. For these reasons, state-of-the-art acoustic communication solutions are still mostly focusing on enabling delay-tolerant, low-bandwidth/low-data-rate scalar data transmission or at best low-quality/low-resolution multimedia streaming in the order of few tens of Kbps.

The objectives of the research program are: (i) To design novel communication solutions for robust, reliable, and high-data rate underwater multimedia streaming on the order of hundreds of Kilobits per second (Kbps); (ii) To investigate the problem of integrating communication methods available in multiple environments on an innovative software-defined testbed architecture integrating Microelectromechanical (MEMS)-based Acoustic Vector Sensors (AVSs) that will enable processing-intensive physical-layer functionalities as software-defined, but executed in hardware that can be reconfigured in real time by the user based on the Quality of Experience.

Collaborative Robotics to Foster Innovation in Seafood Handling

Associate Professor of Electrical and Computer Engineering Taskin Padir was selected to lead a new project to bring collaborative robots developed at Northeastern University into processing plants. The goal: increase production and efficiency, keep workers safe, and stimulate local job growth.

The project, called Collaborative Robotics to Foster Innovation in Seafood Handling, or FISH, was selected to receive funding from Advanced Robotics for Manufacturing (ARM), a national consortium dedicated to improving the workforce with robotics. The project, said a representative from ARM, will begin when all agreements are in place. The research team working with Padir includes professors Octavia Camps, Deniz Erdogmus, Samuel Felton, Nader Jalili, Robert Platt, Dagmar Sternad, and Peter Whitney.

Seafood processing plants are inherently harsh environments for humans, Padir said. The factories are kept cold to keep fish fresh. There's often slushy water and ice coating the floors, making them slippery. And some of the tasks, such as cutting and portioning fish, are dangerous. These factors limit the number of people interested in working at processing plants.

Taskin Padir, associate professor, electrical and computer engineering

Operations can also be unpredictable. For example, Padir said seafood companies often can't recruit enough workers to handle the influx of orders they receive over the holidays. Adding a system of robots to the existing processing line in seafood plants could double or even triple the production, Padir said. This would allow both small and large plants to reduce imports and complete more processing work locally.

Padir said that the robots and humans will work collaboratively, with robots performing much of the inspection and handling and humans completing the more complicated tasks, such as trimming left-over skin patches or bones. Eventually, he said, robots could be developed to handle dangerous duties such as cutting fish."It would be very hard for a robot to do the whole process from end-to-end," Padir said. "But through meaningful collaboration, we can introduce robots and potentially double-up the volume of the seafood that will be processed. That means more revenue for the company and more jobs for U.S. workers."

Designing Robots to Detect Infrastructure Damage

Quickly following a natural disaster, it's critical to evaluate the health and strength of a city's infrastructure. Associate Professor of Electrical and Computer Engineering Taskin Padir is working with faculty colleagues Jerome Hajjar, professor and chair of civil and environmental engineering, and Peter Boynton, professor of practice of social science and humanities, to build automated aerial robots to detect infrastructure damage after extreme events. The goal of the project is to "minimize additional disasters caused by disasters," Padir said. The project is funded by the Department of Homeland Security as part of the National Infrastructure Protection Plan (NIPP) Security and Resilience Challenge program, along with seed funding from the Global Resilience Institute at Northeastern University.

These aerial robots aren't like the drones providing visual footage for news outlets, Padir said. Those images are helpful in conveying a general sense of the wreckage, but detecting infrastructure damage is different. Cracks, fractures, and other structural vulnerabilities are often inconspicuous and can appear innocent to the untrained eye.

Padir and Hajjar are developing algorithms to program the aerial robots so they will be highly specialized and discerning. One algorithm would allow the robot to automatically detect a structure, like a bridge or a building, and break it down into parts—including its foundation, bearings, and other components. Another algorithm would enable the robot to identify types of damage, such as bent steel, concrete cracks, or corrosion. A third algorithm would program the robot to perform a computational simulation predicting how the structure would respond to the disaster.

The ultimate vision, Hajjar said, is a robot swarm deployed to assist engineers in damage inspection, although that goal is still a few years away from coming to fruition. Right now, the team is refining the robot's hardware and algorithms so it knows what to look for. Eventually, Hajjar said the robot may also be able to make recommendations on what buildings are unsafe and uninhabitable. This would make relief efforts safer and more efficient after natural disasters. "We want to make the process as automated as possible without human intervention, but still anticipate that it will complement what inspectors would be doing," Hajjar said.

Automated aerial robots detect infrastructure after extreme events.

Internet of Things

Professor Miriam Leeser Selected as Fulbright Fellow

Professor of Electrical and Computer Engineering Miriam Leeser was selected for the prestigious Fulbright U.S. Scholar grant where she will spend the next academic year at Maynooth University and the CONNECT Centre, Trinity College Dublin, Ireland studying wireless and networking technology with applications to internet of things, wireless networking, cognitive radio, software-defined radio and software-defined networking.

Miriam Leeser, professor, electrical and computer engineering

The Fulbright Program, which aims to increase mutual understanding between the people of the United States and the people of other countries, is the flagship international educational exchange program sponsored by the U.S. government.

Today, internet of things devices all connect wirelessly to each other, but the devices use various protocols—Bluetooth, WiFi, LTE, to name a few. "I've seen devices that have 10 chips, one for each protocol, then a new protocol comes out and it's useless," she explained. The long-term goal of Leeser's research is designing smarter circuits that know exactly which protocol to use that will deliver the fastest and most efficient connection—and switch between them as needed. Leeser explained that the normal way to do this would be to use software, but that would be too slow. So, her research is focused on doing this using hardware but making it is as flexible as software with reconfigurable devices.

Leeser leads Northeastern's Reconfigurable and GPU Computing Laboratory, where she and her students research how to use hardware accelerators such as field programmable gate arrays and graphics processing units for a variety of applications. The purpose of their work is to speed up wireless networking, the internet of things, medical imaging, and security and privacy applications. Recent projects have been funded by Google, Mathworks, the National Science Foundation, and the Defense Advanced Research Projects Agency.

NSF PAWR Project Office Awards First Round of Funding for Groundbreaking Community-scale Wireless Experimental Platforms

Northeastern's College of Engineering research team, led by Tommaso Melodia, professor of electrical and computer engineering (ECE), together with U.S. Ignite, Inc., a nonprofit organization, was selected to direct a National Science Foundation initiative: Platforms for Advanced Wireless Research. The PAWR Project Office, or PPO, is responsible for managing $100 million in investments from the federal government and an industry consortium, and is supported through a $6.1 million NSF-funded award.

The goal of PAWR is to foster fundamental research and development of multiple community-scale platforms supporting next-generation wireless communications networks across the United States. On April 9, 2018, the NSF announced the first two PAWR research platforms selected by the PAWR Project Office, based in Salt Lake City and New York City, which will be supported by the NSF and the industry consortium of more than 28 networking companies and associations. These awarded platforms will power research motivated by real-world challenges on experimental, next-generation wireless test beds at the scale of cities and communities. Their goal is to advance the state-of-the-art for wireless technology in the areas of millimeter wave communication, massive multiple input multiple output (MIMO) antenna equipped software defined radios, IoT, and next-generation cellular access.

PAWR PPO Northeastern University Team

Tommaso Melodia, director of research, and professor of electrical and computer engineering

Kaushik Chowdhury, associate professor of electrical and computer engineering

Stefano Basagni, associate professor of electrical and computer engineering

Edmund Yeh, professor of electrical and computer engineering

Guevara Noubir, professor of computer and information science and ECE affiliated faculty

Abhimanyu Gosain, PAWR technical program director

Fiona Morgan, academic coordinator

$1.57 Million NSF Award for Underwater Communications and Networking Testbed

A Northeastern engineering team led by Electrical and Computer Engineering (ECE) Professor Tommaso Melodia will develop a first-of-its-kind underwater acoustic modem and networking testbed under a three-year, $1.57 million grant, titled "Development of a Software-Defined Networking Testbed for the Internet of Underwater Things" awarded by the National Science Foundation (NSF).

Tommaso Melodia, professor, electrical and computer engineering

According to Melodia, while companies have been building underwater modems for many years, most of those available on the market are inflexible. The project's research team will build a new modem that features completely reprogrammable software and hardware—capabilities not available today. In addition, the platform will have the ability to generate acoustic waves at frequencies that are not typically used by current technology.

One of the research team's key goals is to experiment with high data rate communications underwater: transmitting video over distances of 100-200 meters, similar to today's radio frequency Wi-Fi networks. "If we're successful with our research, we should be able to achieve these results with the new platform," he said.

Work on the underwater modem and network testbed will be performed at Northeastern University's Marine Science Center in Nahant, Mass. While Melodia serves as project lead with responsibility for overall system integration, ECE Associate Professor Matteo Rinaldi will build the new acoustic front end, the device that generates acoustic waves with bandwidth larger than is available today; ECE Associate Professor Stefano Basagni, an underwater networking expert, will work on integrating the new network; and ECE Professor Milica Stojanovic, an expert in signal processing and underwater communications, will focus on finding innovations in the communications layer. They will be joined by Postdoctoral Research Associate Emrecan Demirors in a leading role, and four PhD and undergraduate students.

Results achieved under the NSF grant are primarily intended to benefit the U.S. academic research community, providing an experimental platform to advance research activities in underwater networking and data collection. Melodia notes that some of these capabilities may ultimately appeal to the U.S. Navy and to commercial entities such as the oil and gas industry. "If we're successful, there should be a lot of interest from the commercial and DoD world."

FACULTY HONORS AND AWARDS

Select Highlights

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

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

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

Associate Professor **Raymond Fu**, electrical and computer engineering,

interdisciplinary with the College of Computer and Information Science, was selected as a fellow of SPIE, the International Society for Optics and Photonics.

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

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

Laura Lewis, chemical engineering and mechanical and industrial engineering, was appointed to the rank of University Distinguished Professor in 2018, which is the highest honor the university can bestow upon a faculty member. Also, the University of Texas at Austin selected

her as one of the "2018 Mechanical Engineering Academy of Distinguished Alumni Honorees" by virtue of her superior professional achievement, community service, and service to the University. In 2017, Lewis received a Fulbright U.S. Scholar Program grant for a research project in Spain where she conducted research at the Instituto de Ciencia de Materiales de Madrid as part of a project to tailor magnetic microwires for advanced applications.

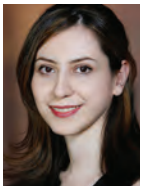
Assistant Professor **Ameet Pinto**, civil and environmental engineering, was selected as the recipient of the 2018 International Symposium on Microbial Ecology/International Water Association Bio Cluster Award in the Rising Star Category. He was also awarded a National Science Foundation CAREER award for "Developing a Spatial-Temporal Predictive Framework for the Drinking Water Microbiome" (see page 17).

Assistant Professor **Adam Ekenseair**, chemical engineering, was one of 21 winners of the American Chemistry Society's Polymer Science and Engineering Young Investigator Award. Recipients of the award are recognized as emerging leaders in the fields of synthesis, processing, characterization, and physics of soft materials and their applications. Ekenseair was also recognized with the 2018 Nano Research Young Innovator Award (NR45) in nanobiotech from the journal *Nano Research* for his notable accomplishments and potential to make significant contributions to the field of nanobiotechnology.

Assistant Professor **Stratis Ioannidis**, electrical and computer engineering,

received a $2 million BIGDATA grant from the NSF and a donation from Google to lead a collaborative research effort for the "Design and Computation of Scalable Graph Distances in Metric Spaces: A Unified Multiscale Interpretable Perspective." He was also awarded a National Science Foundation CAREER grant for "Leveraging Sparsity in Massively Distributed Optimization" (see page 20).

Assistant Professor **Mahshid Amirabadi** and Professor **Brad Lehman**, of the Department of Electrical and Computer



Engineering, were awarded $660K in funding from the U.S. Department of Energy's Advanced Research Projects Agency-Energy and the Massachusetts Clean Energy Center to develop a new class of universal power converters for DC, single-phase AC, and multi-phase AC systems.

Professor of Mechanical and Industrial Engineering **Ahmed Busnaina**, director of the Center for High-Rate Nanomanufacturing, unveiled NanoOPS Gen 2, the university's second-generation-nanoscale offset printing system; a

pioneering technology that can print 1,000 times faster and 1,000 smaller circuits—down to a 20 nanometer—than inkjet printing systems on the market today.

Professor **Eduardo Sontag**, electrical and computer engineering, and bioengineering, in collaboration with MIT and the University of Minnesota-Twin Cities, was awarded a $1.5 million grant jointly funded by the National Science Foundation and Semiconductor Research Corporation for "Very Large-Scale Genetic Circuit Design

Automation." Also, Sontag's research on a novel synthetic biology technique that would give researchers the ability to control the behavior of engineered cells, leading to breakthroughs in disease treatment was recently published in *Nature Biotechnology.*

Assistant Professor **Ambika Bajpayee**, bioengineering, was awarded a National Institutes of Health grant for "Charge driven contrast enhanced computed tomography for imaging negatively charged tissues." The grant which will develop charge based probes for CT imaging of cartilage is a two-year R03 award with the NIH National Institute of Biomedical Imaging and Bioengineering.

Assistant Professor of Civil and Environmental Engineering **Loretta Fernandez's** pilot study on using polyethylene passive samplers to monitor potential PCB transport across the engineered cap at the Grasse River Superfund site has received a grant in collaboration with the U.S. Army Engineer Research and Development Center from the Environmental Protection Agency.

Associate Professor **Richard West**, chemical engineering, in collaboration with Columbia University, was awarded a grant from the National Science Foundation for creating "Autonomous Systems for Experimental and Computational Data Generation and Data-Driven Modeling of Combustion Kinetics." West also received a CAREER Award from the NSF for Predictive Kinetic Modeling of Halogenated Hydrocarbon Combustion (see page 10).

Associate Teaching Professor **Lucas Landherr**, chemical engineering, was awarded the AIChE Education Division's Award for Innovation in Chemical Engineering Education, which recognizes an individual who has, according to the AIChE, "implemented a pedagogical innovation into a class or course that has made a significant and documented positive impact on teaching effectiveness and has enhanced student learning."

Debra Auguste, professor of chemical engineering, has been selected as a fellow of the Biomedical Engineering Society (BMES) for her exceptional achievements and significant contributions within the biomedical engineering field. She has also been appointed a member of the Board of Directors.

Associate Professor **Marilyn Minus**, mechanical and industrial engineering, received an Outstanding Young Engineering Alumni Award from Georgia Tech's College of Engineering Council for her research contributions and service as a faculty member at Northeastern University. The award recognizes alumni who have distinguished themselves through professional practice and/or service to the Institute, profession, or society at large, and they are on the "fast track" having made rapid advancement within their organizations. They have also been recognized for early professional achievements by others within their profession, field, or organization.

Assistant Professor of Mechanical and Industrial Engineering **Hongli Zhu's** research on "Batteries: Freestanding Metallic 1T MoS2 with Dual Ion Diffusion Paths as High Rate Anode for Sodium-Ion Batteries" was featured on the cover of *Advanced Functional Materials.*

Professor of Chemical Engineering **Ming Su's** article on "Three-dimensional Microtissues as an In Vitro Model for Personalized Radiation Therapy" was selected to be featured on the cover of the journal, *Analyst*.

Northeastern was selected as a host site for the Louis Stokes Alliance for Minority Participation 2018-2020 Bridge to the Doctorate program, under a $1 million National Science Foundation grant, entitled, "Strategic Advancement of Rising Scholars (STARS)" led by Provost **James Bean** (PI), Professor of Mechanical and Industrial Engineering **Hameed Metghalchi** (co-PI) and other co-PIs across the university, and collaborators **Richard Harris**, director of NUPRIME, and Vice Provost of the PhD Network and Professor of Civil and Environmental Engineering **Sara Wadia-Fascetti**.

Professor **Sinan Muftu**, mechanical and industrial engineering, in collaboration with UMass Amherst, was awarded a $500K National Science Foundation grant for determining the "High-Strain-Rate Dynamics of Copolymer Microparticles for Advanced Additive Manufacturing."

STUDENTS

PhD student **Solomon Mensah**, bioengineering, who is also co-founder and CEO of Therapeutic Innovations, was selected through a competitive process to present his Social Impact Pitch on "Re-Examining the Design of the Neonatal Bubble-CPA P for Application in the Developing World" at the 15th annual Global Health & Innovation Conference in April 2018, the world's largest and leading global health and social entrepreneurship conference. Social Impact Pitch abstracts are required to identify high quality outcomes that support the innovation's important long-term goals and to prove effectiveness.

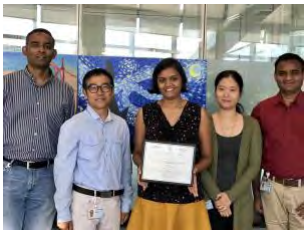
MS Information Systems students **Swathi Kommaghattachandr** and **Vivek Madhusudanbadrina** won the second place prize at the MIT Blockchain Hackathon. The Hackathon had over

250 hackers organized into 30 teams participating in the competition. They built an end-to-end smart contract application leveraging Blockchain technologies to protect the drug supply chain from counterfeit crimes and have been approached by investors to market their solution.

Northeastern's undergraduate engineering team, advised by Associate Professor **Taskin Padir**, won first place at the 2018 NASA RASC-AL Mars Ice Challenge, which is a competition sponsored by NASA to

invent a way to access water far beneath the ground on Mars. The team competed at the NASA Langley Research Center against eight other finalist university teams. They won by a landslide, collecting 3,209 milliliters of water. The second-place team collected around 800 milliliters of water.

Anas Abou Allaban, E'20, **Tarik Kelestemur**, ME'18, and **Naoki Yokoyama**, E/ME'18, under the direction of Associate Professor **Taskin Padir**, placed fourth overall (the best of any U.S. team) at the RoboCup@Home competition, landing them a spot to participate in the World Robot Summit in Tokyo.



Associate Professor of Electrical and Computer Engineering **Ningfang Mi** and two of her PhD students, **Janki Bhimani** and **Zhengyu Yang**, were awarded the 2018 IEEE International Conference on Cloud Computing Best Paper, “FIOS: Feature Based I/O Stream Identification for Improving Endurance of Multi-Stream SSDs.”

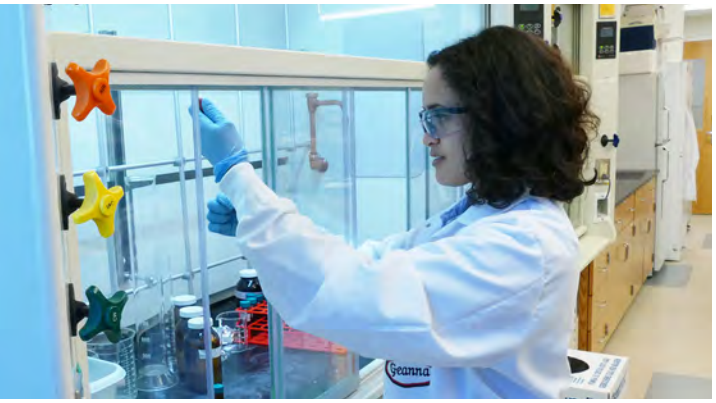
Interdisciplinary Engineering PhD student **Lizzy Warner** was part of a two-person team that won the top prize at the Department of Homeland Security Center of Excellence Summit for their interactive map that illustrates how critical infrastructure in Boston—including the MBTA, the energy grid, and the water and sewer system—are connected to each other. They also created a software program that simulates disasters to show how the connections between these major systems respond to catastrophic events such as earthquakes, floods, and terrorist attacks.

Master’s student **Timothy Aduralere**, ME'18, mechanical and industrial engineering, won the 48th St. Gallen Symposium essay competition for his submission "Reinventing for the Unknown: A Pivotal Approach to Maximize the Constantly Evolving Future of Work." He was selected from almost 1,300 submissions, representing 350 universities and more than 100 nationalities.

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

The **Paradigm Hyperloop** team, an international team of students from Northeastern University and Memorial University of Newfoundland & Labrador, placed second out of 25 teams globally at the SpaceX Hyperloop Pod Competition in California. They were also the only North American team qualifying for the finals.

Northeastern's **INFORMS student chapter**, advised by **Ozlem Ergun**, professor, mechanical and industrial engineering, has received the prestigious INFORMS 2018 Student Chapter Annual Award at the Cum laude level.



Departments

Bioengineering

Chemical Engineering

Civil and Environmental Engineering

Electrical and Computer Engineering

Mechanical and Industrial Engineering

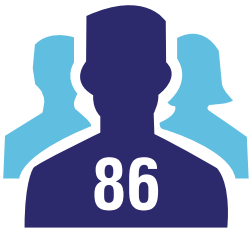
DEPARTMENT CHAIR MESSAGE

The Department of Bioengineering is the newest department in Northeastern's College of Engineering. Building on the success of its PhD program, BioE added BS and MS degree programs in the 2017 – 2018 academic year. We are now in an era of rapid growth with plans to double our faculty over the next three years and continue to increase as our student body expands.

Our research into the fundamentals of cell and tissue engineering, biomedical imaging and signal processing, biomechanics and biocomputing is providing a foundation on which a vibrant bioengineering community is developing—a community that spans the entire University. With over 80 affiliated faculty, the bioengineering department offers research opportunities that encompass the entire breadth of biological and biomedical engineering. Our co-op program is working with companies across the sector to provide BioE students with the broad range of opportunities within the Boston biotech industry and beyond. Through the co-op program, we identify opportunities that make it possible for our students to work in areas that most excite them.

I invite you to learn more about our new and fast-growing Department of Bioengineering. Our Scholarship Report provides a window into the many activities of our faculty and the energy and breadth of their applications.

Lee Makowski
Professor and Chair of Bioengineering
l.makowski@northeastern.edu



AFFILIATED AND T/TT FACULTY MEMBERS

STUDENTS

See Bioengineering's full scholarship report at **coe.neu.edu/bioe/sr**

FACULTY BY RESEARCH AREAS

BIOIMAGING AND SIGNAL PROCESSING

Dana Brooks
Octavia Camps
Samuel Chung
Charles DiMarzio
Jennifer Dy
Deniz Erdogmus
Qianqian Fang
Lee Makowski
Edwin Marengo
Mark Niedre
Jessica Oakes
Rupal Patel
Carey Rappaport
Purnima Ratilal-Makris
Bahram Shafai
Milica Stojanovic
Gilead Tadmor
Vladmir Torchilin

BIOMEMS/BIONANO

Mansoor Amiji
Ahmed Busnaina
Heather Clark
Jack Dennerlein
Adam Ekenseair
Robert Hanson
Nicol McGruer
Hossein Mosallaei
Sanjeev Mukerjee
Shashi Murthy
Mary Jo Ondrechen
Matteo Rinaldi
Jeffrey Ruberti
Srinivas Sridhar
Nian Sun
Thomas Webster
Mark Williams

BIOMECHANICS AND MECHANOBIOLOGY

Anand Asthagiri
Ambika Bajpayee
Chiara Bellini
Guohao Dai
Eno Ebong
Andrew Gouldstone
Yingzi Lin
Sinan Müftü
Uichiro Narusawa
Hamid Nayeb-Hashemi
Jessica Oakes
Hari Parameswaran
Jeffrey Ruberti
Carmen Sceppa
Sandra Shefelbine
Ashkan Vaziri
Kai-Tak Wan

BIOCHEMICAL AND BIOENVIRONMENTAL ENGINEERING

Akram N. Alshawabkeh
Ambika Bajpayee
Rebecca Carrier
Edgar Goluch
Robert Hanson
Barry Karger
Carolyn W.T. Lee-Parsons
Kim Lewis
Shashi Murthy
Mary Jo Ondrechen

CELL AND TISSUE ENGINEERING

Anand Asthagiri
Penny Beuning
Rebecca Carrier
Erin Cram
Guohao Dai
Andrew Gouldstone
Carol Livermore
Donald O'Malley
Hari Parameswaran
Jeffrey Ruberti
Nikolai Slavov
Eduardo Sontag
Kai-Tak Wan

MOTOR CONTROL

Joseph Ayers
Nader Jalili
Bahram Shafai
Rifat Sipahi
Dagmar Sternad
Mario Sznaier
Gilead Tadmor

BIOCOMPUTING

Stefano Basagni
David Kaeli
Miriam Leeser
Waleed Meleis
Jessica Oakes
Hari Parameswaran

DEPARTMENT CHAIR MESSAGE

The Department of Chemical Engineering has been on fire over the past six years. For example, our undergraduate student body has tripled, our graduate student body has tripled, there has been over a 200% increase in research funding, and our faculty size has more than doubled. This has all culminated into our recognition by the *U.S. News and World Report* that over this six year period, we have experienced the greatest increase in graduate school rankings for any department ever on record. It is clear that our impact in chemical engineering education and research is at a record level and is poised for continual unprecedented growth in the years ahead.

We offer degrees at all levels (Bachelor of Science, Master of Science and Doctor of Philosophy) and are internationally renowned for high quality classroom-based education in conjunction with industrial work experience. Our top-rated (and one of the nation's largest) Cooperative (Co-op) Education program was one of the first in the country and the Chemical Engineering Co-op placed students in 179 companies in 2017; spanning the areas of consumer products, plastics, biotechnology, nanotechnology, alternative energy, and petrochemicals, to name a few. We even placed students in international co-op locations in Germany, Chile, France, Singapore, China, United Arab Emirates, Madagascar, India, Italy, Costa Rica, Spain, and Belgium in this year alone. In addition, our Graduate Co-op program has grown tremendously. We have placed students in top companies such as Glaxosmithkline, CONTINUUS Pharmaceuticals, Kaleido Biosciences, Inc., and NBD Nanotechnologies. It is not hard to see why we have been ranked five times as the Best School for Internships by the *Princeton Review.*

Our undergraduate program is accredited by the Engineering Accreditation Commission (EAC) of ABET, Inc. ensuring that our program meets the quality standards established by the profession of Chemical Engineering. Our award-winning undergraduate student chapter of the American Institute of Chemical Engineers (AIChE) is very active in many outreach programs, such as the ChemE Car competition and hosting regional AIChE annual conferences. Our graduate program is very interdisciplinary and offers students opportunities to work with outstanding faculty to attain research experience and achieve their career goals in a variety of subfields of chemical engineering. In 2017 alone, our faculty gave a total number of 322 presentations (including invited talks at conferences, professional societies, workshops, and more) and we now have international research centers in China, Columbia, and other countries around the world, demonstrating our leadership across the chemical engineering community.

I invite you to explore our Department of Chemical Engineering through this Scholarship Report and find out why we have been listed among the most innovative and best-valued schools by the *U.S. News & World Report.*

Thomas J. Webster
Art Zafiropoulo Chair and Professor
Department Chair, Chemical Engineering
th.webster@northeastern.edu

See Chemical Engineering's full scholarship report at **coe.neu.edu/che/sr**

FACULTY BY RESEARCH AREAS

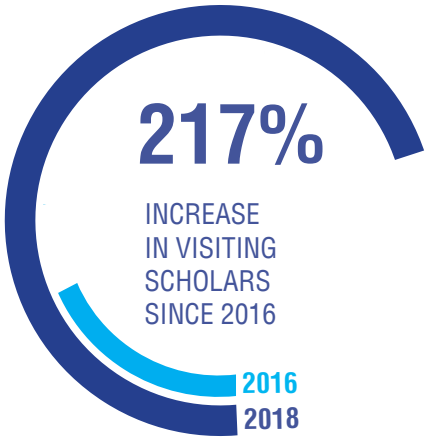
ADVANCED MATERIALS RESEARCH

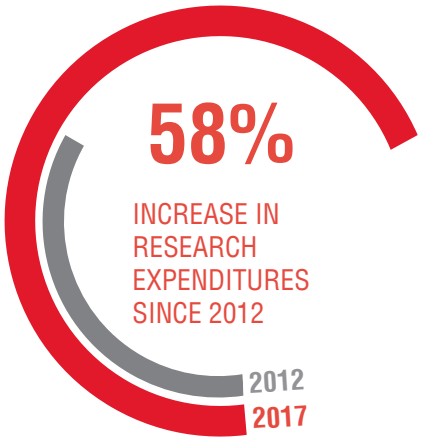
Debra Auguste
Sidi A. Bencherif
Sunho Choi
Arthur Coury
Matthew Eckelman
Adam Ekenseair
Hicham Fenniri
Joshua Gallaway
Andrew Gouldstone
Vincent G. Harris
Francisco Hung
Laura H. Lewis
Steve Lustig
Mrityunjay Singh
Ming Su
Thomas Webster
Richard West
Ronald Willey
Katherine Ziemer

BIOLOGICAL ENGINEERING

Mansoor Amiji
Anand Asthagiri
Debra Auguste
Sidi A. Bencherif
Rebecca L. Carrier
Heather Clark
Arthur Coury
Eno Ebong
Adam Ekenseair
Hicham Fenniri
Edgar Goluch
Abigail Koppes
Ryan Koppes
Carolyn Lee-Parsons
Shashi Murthy
Mrityunjay Singh
Nikolai Slavov
Srinivas Sridhar
Ming Su
Thomas Webster

GRADUATE students





TENURED/ TENURE-TRACK Faculty

34 **Countries represented across both undergraduate and graduate levels**

DEPARTMENT CHAIR MESSAGE

Our department is on the move. As new opportunities impact our discipline, Northeastern University's Department of Civil and Environmental Engineering is meeting them with timely innovation, vital research, and experiential education for our students.

Our department is strategically focused on urban engineering, preparing students for the great challenges of our time by exploring the unique ways in which the built and natural environment interact. Utilizing the latest advances in simulation, smart sensing, data and network science, and urban informatics, our faculty are conducting critical research in civil infrastructure security, environmental health, and sustainable resource engineering.

The department is expanding its research presence across all fields, and is currently leading the PROTECT Center, funded by the National Institute of Environmental Sciences (NIEHS) of the National Institutes of Health, and the CRECE Center, funded by the NIEHS and the Environmental Protection Agency, to study the relationship between environmental contamination and preterm births.

Over the last eight years, we have seen dramatic growth. The department's faculty and graduate populations have both more than doubled, and we continue to expand our degree offerings at both the undergraduate and graduate levels. Our newly opened 220,000 square-foot Interdisciplinary Science and Engineering Complex advances our commitment as a top tier research institution to providing faculty and students with access to the highest quality, state-of-the-art laboratories.

Our scholars are engineering a resilient and sustainable future through leading-edge research. This fifth annual scholarship report details the exceptional academic and professional accomplishments of our faculty and Ph.D. candidates for the 2017-2018 year. For the latest highlights, please visit us at northeasten.edu/tomorrow. We look forward to building a better world together.

Jerome F. Hajjar
Professor and Chair of Civil and Environmental Engineering
jf.hajjar@northeastern.edu

See Civil and Environmental Engineering's full scholarship report at **coe.neu.edu/civ/sr**

3
FEDERALLY FUNDED RESEARCH CENTERS

8
NATIONAL SCIENCE FOUNDATION CAREER Awards

45
TENURED/ TENURE-TRACK
Including Affiliated Faculty

179 **masters** students
28% female

67 **doctoral** students
40% female

FACULTY BY RESEARCH THRUSTS

CIVIL INFRASTRUCTURE SECURITY
George Adams
Joseph Ayers
Dionisio Bernal
Luca Caracoglia
Qin Jim Chen
Steven Cranford
Daniel Dulaski
Stephen Flynn
Peter Furth
Auroop Ganguly
Jerome Hajjar
Michael Kane
Haris Koutsopoulos
Yiannis Levendis
Sinan Müftü
Andrew Myers
Mark Patterson
Mehrdad Sasani
Thomas Sheahan
Craig Shillaber
Michael B. Silevitch
Hao Sun
Ali Touran
Sara Wadia-Fascetti
Ming Wang
Qi Ryan Wang
Mishac Yegian

SUSTAINABLE RESOURCE ENGINEERING
Luca Caracoglia
Daniel Dulaski
Matthew Eckelman
David Fannon
Peter Furth
Auroop Ganguly
Tarik Gouhier
Jonathan Grabowski
Jerome Hajjar
Brian Helmuth
A. Randall Hughes
Michael Kane
Haris Koutsopoulos
Michelle Laboy
Mark Patterson
Craig Shillaber
Jennie C. Stephens
Ali Touran
Geoffrey Trussell
Ming Wang
Qi Ryan Wang

ENVIRONMENTAL HEALTH
Akram Alshawabkeh
R. Edward Beighley
Qin Jim Chen
Matthew Eckelman
Loretta Fernandez
Auroop Ganguly
Edgar Goluch
Tarik Gouhier
Jonathan Grabowski
Brian Helmuth
A. Randall Hughes
Philip Larese-Casanova
Amy Mueller
Samuel Muñoz
Annalisa Onnis-Hayden
Mark Patterson
Ameet Pinto
Thomas Sheahan
Aron Stubbins
Geoffrey Trussell
Kai-Tak Wan

DEPARTMENT CHAIR MESSAGE

We in the Department of Electrical and Computer Engineering (ECE) are happy to provide you with our Annual Scholarship Report, describing the research and accomplishments of our esteemed faculty over the past year. This report serves as a reminder of the profound work being done here at Northeastern University.

ECE faculty are at the forefront of spurring the next-generation of wireless communication networks. In 2017, Northeastern's College of Engineering research team, led by Professor Tommaso Melodia of ECE together with U.S. Ignite, Inc., a nonprofit organization, was selected to co-direct the Project Office of the National Science Foundation (NSF) initiative: Platforms for Advanced Wireless Research (PAWR). The PAWR Project Office, or PPO, is responsible for managing $100 million in investments from the federal government and an industry consortium, and a $6.1 million NSF-funded award. This year, the PAWR PPO awarded the first round of funding. The awarded platforms will power research motivated by real-world challenges on experimental, next-generation wireless test beds at the scale of cities and communities.

Other research highlights include a $1.5 million multi-institutional grant received by University Distinguished Professor Eduardo Sontag, jointly appointed in ECE and in bioengineering, from the NSF and Semiconductor Research Corporation for "Very Large-Scale Genetic Circuit Design Automation," and a $1 million collaborative grant from the NSF awarded to Professor Melodia and Associate Professor Matteo Rinaldi for "Reliable Underwater Acoustic Video Transmission Towards Human-Robot Dynamic Interaction."

We are also recognized as a leader in the area of robotics and artificial intelligence. Associate Professor Yun Raymond Fu's spinout from his lab here at Northeastern, which specializes in artificial intelligence, was acquired by a large global cosmetics company, Shiseido Americas Corporation. Recently, our students, advised by Associate Professor Taskin Padir, won first place at the NASA RASC-AL Mars Ice Challenge, and qualified at the RoboCup@Home competition for the World Robot Summit in Tokyo. Additionally, we have opened a new interdisciplinary Robotics Research Center led by Professor Hanumant Singh, and Professor Padir's project, Collaborative Robotics to Foster Innovation in Seafood Handling, was selected to receive funding from Advanced Robotics for Manufacturing, a national consortium dedicated to improving the workforce with robotics.

Several of our faculty have also received prestigious recognitions, including professors Fu and Melodia selected as Fellows to SPIE—the international society for optics and photonics—and IEEE, respectively. Assistant Professor Stratis Ioannidis was awarded a CAREER grant from the NSF for a project, "Leveraging Sparsity in Massively Distributed Optimization"; and was also awarded a $2 million BIGDATA award from the NSF and Google, while Associate Professor Marvin Onabajo received a Young Investigator Award from the Army Research Office to develop "An On-Chip Thermal Sensing Method to Detect Malicious Integrated Circuits." Additionally, Professor Miriam Leeser was selected for a Fulbright Award to study wireless networking technology in Ireland.

These are just a few of the many research efforts and accomplishments in ECE. We hope you can come see for yourself all of the exciting work being done in our wonderful department and college.

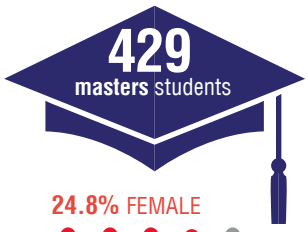
Srinivas Tadigadapa
Chair of Electrical and Computer Engineering
s.tadigadapa@northeastern.edu

YOUNG INVESTIGATOR Awards

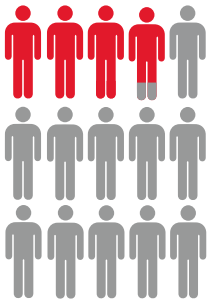
TENURED/ TENURE-TRACK Faculty

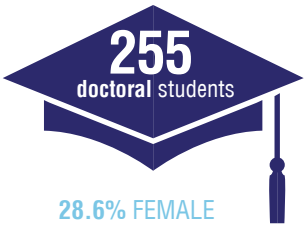
NATIONAL SCIENCE FOUNDATION CAREER Awards

See Electrical and Computer Engineering's full scholarship report at **coe.neu.edu/ece/sr**

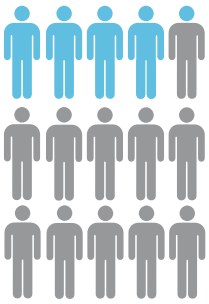


24.8% FEMALE





28.6% FEMALE



11 IEEE **FELLOWS**

$53 MILLION IN ACTIVE **RESEARCH GRANTS**

FACULTY BY RESEARCH AREAS

COMPUTER NETWORKS AND SECURITY
Stefano Basagni
Kaushik Chowdhury
Engin Kirda
Tommaso Melodia
Wil Robertson

COMMUNICATIONS CONTROL AND SIGNAL PROCESSING
Dana Brooks
Pau Closas
Vinay Ingle
Hanoch Lev-Ari
Purnima Ratilal-Makris
Masoud Salehi
Dagmar Sternad
Milica Stojanovic

ELECTROMAGNETICS AND OPTICS
Charles DiMarzio
Vincent Harris
Yongmin Liu
Edwin Marengo
Jose Martinez Lorenzo
Hossein Mosallaei
Carey Rappaport
Michael B. Silevitch

POWER ELECTRONICS, SYSTEMS AND CONTROL
Ali Abur
Mahshid Amirabadi
Bradley Lehman
Bahram Shafai
Eduardo Sontag
Mario Sznaier
Gilead Tadmor

COMPUTER VISION, MACHINE LEARNING AND ALGORITHMS
Octavia Camps
Jennifer Dy
Deniz Erdogmus
Yun Raymond Fu
Stratis Ioannidis
Waleed Meleis
Sarah Ostadabbas

ROBOTICS
Hanumant Singh
Taskin Padir
Alireza Ramezani

COMPUTER SYSTEMS AND SOFTWARE
Yunsi Fei
David Kaeli
Mieczyslaw Kokar
Miriam Leeser
Xue Lin
Fabrizio Lombardi
Ningfang Mi
Gunar Schirner
Devesh Tiwari
Yanzhi Wang
Edmund Yeh

MICROSYSTEMS, MATERIALS AND DEVICES
Cristian Cassella
Hui Fang
Yong-Bin Kim
Nicol McGruer
Marvin Onabajo
Matteo Rinaldi
Aatmesh Shrivastava
Nian Sun
Srinivas Tadigadapa

$23M ANNUAL FACULTY RESEARCH EXPENDITURES

NSF 21%
DOD/DARPA 18%
DHS 27%
NIH 7%
DOE 4%
CORPORATE 12%
FEDERAL/OTHER 11%

The department offers seven research concentrations and is either the lead or partner of seven federally-funded research centers.

DEPARTMENT CHAIR MESSAGE

The Department of Mechanical and Industrial Engineering has been on the rise through strategic hiring. As the department rises, a conducive environment has provided a platform for people to work hard and work happily. The addition of 24 new tenured/tenure-track faculty members over five years, with no attrition to other universities, has propelled multiple research clusters in the department toward excellence. In parallel with the tenured/tenure-track faculty hires, the addition of 11 teaching faculty members over four years has enabled educational excellence to advance even further.

Supporting the fast rise is the growing financial resource. The department has started large-scale collaborations with major industrial companies including General Electric, Raytheon, and Northrop. The industrial collaborations augment multiple governmental supports secured by our faculty, such as the $20M contract order from the US Army Research Office and $125M contract order from the US Veterans Health Administration.

On the solid foundation of financial resource, people are the center of focus at this department. We work hard and work happily, and take ownership of the department. As an example, Emeritus Professor and former Department Chair John W. Cipolla has given the department $100K to establish the John and Katharine Cipolla Graduate Student Support Fund. As another example, Emeritus Professor Alexander Gorlov is the namesake of the Gorlov Innovation Prize. This prize is endowed with $100K from friends and former students of Professor Gorlov, in recognition of his innovations including the invention of the Gorlov Turbine that operates on top of the Eiffel Tower in Paris and all around the world.

Strategic hiring, people focus, and preservation of a conducive environment have enabled people to work hard, happily, and productively. Productive people naturally bring successes. Rising awareness of our successes is also a trend we note and appreciate. According to the *US News and World Report*, our mechanical engineering graduate program moved up 14 places to No. 43 in five years, while our industrial engineering graduate program has moved up four places to No. 32 during the same period.

Hanchen Huang
Donald W. Smith Professor and Chair of Mechanical and Industrial Engineering
h.huang@northeastern.edu

This momentum will continue through strategic growth. I invite alums and other stakeholders to join us in propelling this department even further, and also invite all to consider this department for your education or for research and development projects. I look forward to hearing from you!

2
FEDERALLY FUNDED RESEARCH CENTERS

NSF/DHHS Healthcare Systems Engineering Institute

NSF CENTER for High-rate Nanomanufacturing

$145M
CONTRACT VEHICLE

$125M: five years from Veterans Health Administration

$20M: three years from Army Research Labs

See Mechanical and Industrial Engineering's full scholarship report at **coe.neu.edu/mie/sr**

GRADUATE STUDENTS

YOUNG INVESTIGATOR AWARDS

TENURED/ TENURE-TRACK FACULTY

NATIONAL ACADEMY MEMBERS

FACULTY BY RESEARCH AREAS

ENERGY SYSTEMS
Muhammad Noor E Alam
Ahmed Busnaina
Hanchen Huang
Yung Joon Jung
Gregory Kowalski
Yiannis Levendis
Yongmin Liu
Carol Livermore
Bala Maheswaran
Hameed Metghalchi
Mohammad E. Taslim
Wei Xie
Hongli (Julie) Zhu

IMPACT MECHANICS
George G. Adams
Michael Allshouse
Nadine Aubry
Andrew Gouldstone
Carlos Hidrovo
Nader Jalili
Abhishek Kumar
Yang Liu
Carol Livermore
Craig Maloney
Jose Martinez Lorenzo
Sinan Müftü
Hamid Nayeb-Hashemi
Sandra Shefelbine
Ashkan Vaziri
Kai-Tak Wan
John (Peter) Whitney
Ibrahim Zeid

MULTIFUNCTIONAL COMPOSITES
Teiichi Ando
Ahmed Busnaina
Randall Erb
Andrew Gouldstone
Hanchen Huang
Jacqueline Isaacs
Yung Joon Jung
Abhishek Kumar
Yongmin Liu
Marilyn Minus
Sandra Shefelbine
Moneesh Upmanyu
Ashkan Vaziri
Wei Xie
Hongli (Julie) Zhu

BIOMECHANICS & SOFT MATTERS – SOLIDS AND FLUIDS
Ambika Bajpayee
Chiara Bellini
Samuel Felton
Andrew Gouldstone
Carlos Hidrovo
Beverly Kris Jaeger-Helton
Safa Jamali
Yingzi Lin
Carol Livermore
Bala Maheswaran
Sinan Muftu
Hamid Nayeb-Hashemi
Jessica Oakes
Sandra Shefelbine
Mohammad E. Taslim
Ashkan Vaziri
Kai-Tak Wan
John (Peter) Whitney

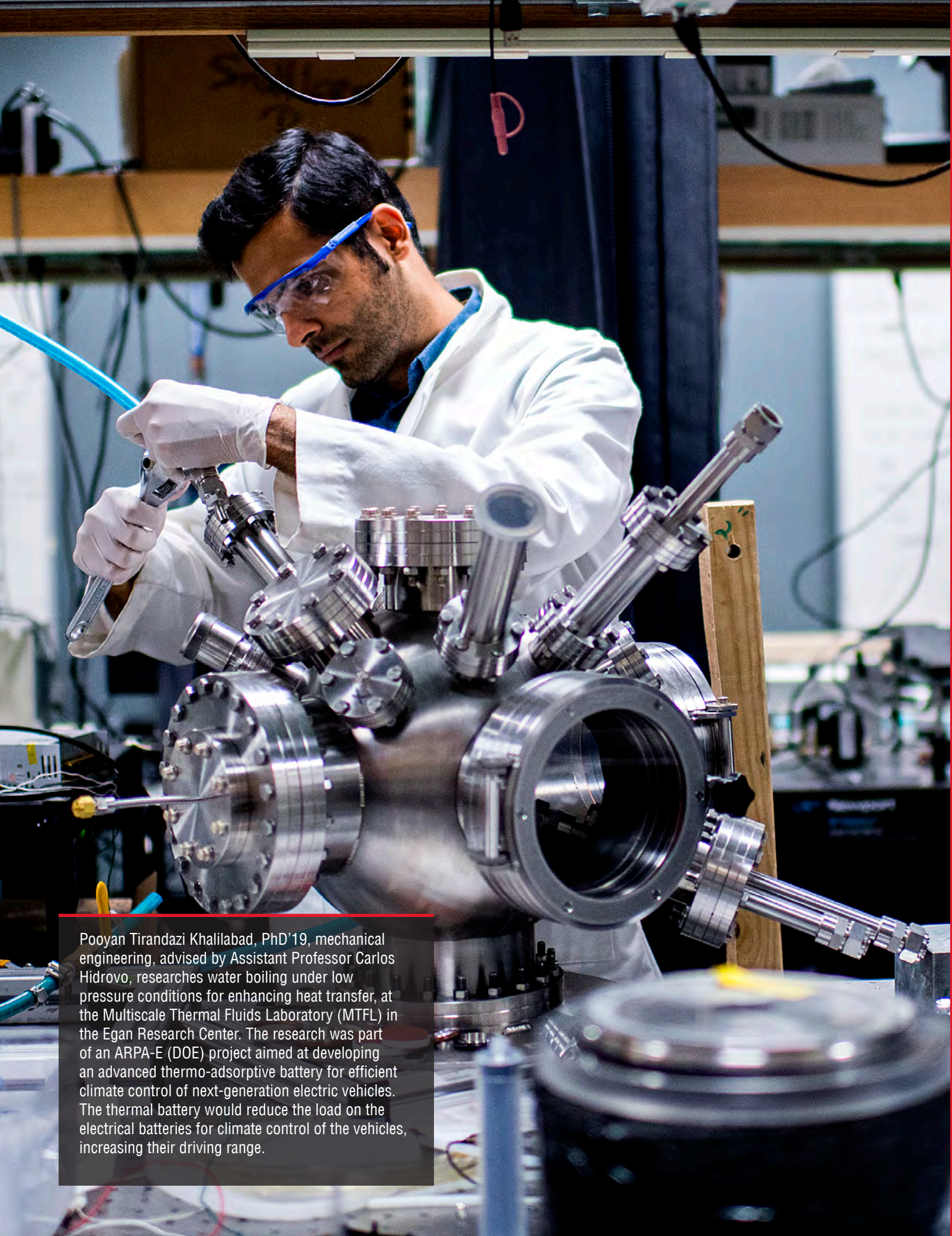
SMART AND SUSTAINABLE MANUFACTURING
Muhammad Noor E Alam
Ahmed Busnaina
Randall Erb
Jacqueline Isaacs
Nader Jalili
Yung Joon Jung
Abhishek Kumar
Yongmin Liu
Carol Livermore
Marilyn Minus
Mohsen Moghaddam
Moneesh Upmanyu
Wei Xie
Hongli (Julie) Zhu

MECHATRONICS AND SYSTEMS – CONTROL, ROBOTICS, & HUMAN MACHINES
Samuel Felton
Babak Heydari
Nader Jalili
Yingzi Lin
Rifat Sipahi
John (Peter) Whitney

MULTI-PHASE STRUCTURED MATTER
Michael Allshouse
Teiichi Ando
Randall Erb
Carlos Hidrovo
Hanchen Huang
Safa Jamali
Yung Joon Jung
Yang Liu
Yongmin Liu
Carol Livermore
Craig Maloney
Mohammad E. Taslim
Moneesh Upmanyu
Ashkan Vaziri
Kai-Tak Wan

RESILIENT SYSTEMS
Muhammad Noor E Alam
James Bean
Mehdi Behroozi
James Benneyan
Thomas Cullinane
Ozlem Ergun
Nasser Fard
Jacqueline Griffin
Surendra M. Gupta
Babak Heydari
Jacqueline Isaacs
Beverly Kris Jaeger-Helton
Xiaoning (Sarah) Jin
Sagar Kamarthi
Yingzi Lin
Kayse Lee Maass
Hugh McManus
Emanuel Melachrinoudis
Mohsen Moghaddam
Vinod Sahney
Wei Xie

HEALTHCARE SYSTEMS
Muhammad Noor E Alam
James Benneyan
Chun-An (Joe) Chou
Jacqueline Griffin
Babak Heydari
Beverly Kris Jaeger-Helton
Sagar Kamarthi
Yingzi Lin
Kayse Lee Maass
Vinod Sahney
Rifat Sipahi
Wei Xie



Pooyan Tirandazi Khalilabad, PhD'19, mechanical engineering, advised by Assistant Professor Carlos Hidrovo, researches water boiling under low pressure conditions for enhancing heat transfer, at the Multiscale Thermal Fluids Laboratory (MTFL) in the Egan Research Center. The research was part of an ARPA-E (DOE) project aimed at developing an advanced thermo-adsorptive battery for efficient climate control of next-generation electric vehicles. The thermal battery would reduce the load on the electrical batteries for climate control of the vehicles, increasing their driving range.

Northeastern University
College of Engineering

coe.neu.edu

COLLEGE OF ENGINEERING

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Northeastern University
360 Huntington Avenue
Boston, MA 02115

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COVER IMAGE

Xin Sun, PhD'20, bioengineering, advised by Qianqian Fang, assistant professor, bioengineering, uses a 3D printer to develop an anatomically accurate multi-layered full-head optical phantom for fNIRS (functional near-Infrared spectroscopy) in the Computational Optics & Translational Imaging (COTI) Lab in the Interdisciplinary Science and Engineering Complex. The COTI Lab develops innovative optical imaging techniques and computational methods that can help diagnose and fight diseases.