Northeastern University
College of Engineering

Engineering for Society
Boldly innovating to better our world

2016 | 2017
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 2016-2017 for Northeastern University's College of Engineering, including highlights of our College's five-year report.

During the past year, our talented College of Engineering faculty have achieved many prestigious grants, awards, and recognitions. Of special note are our associate professors of electrical and computer engineering, including Kaushik Chowdhury, who received the PECASE Award from the White House, and Tommaso Melodia, who was selected to lead the National Science Foundation's Platforms for Advanced Wireless Research Project Office, responsible for $100 million in investments and a $6.1 million grant. Our numerous wins and honors showcase our research strengths in the focus application areas of health, sustainability, and security, as well as in the cross-cutting topics of robotics and the Internet of Things.

Our esteemed faculty are significant to our success. Since 2016, 33 tenured/tenure-track faculty joined our College, each bringing complementary areas of research expertise to help us boldly innovate to better our world, and develop the next generation of engineering leaders able to solve the Engineering Grand Challenges of the 21st century. Our commitment to conducting transformative, interdisciplinary research is evidenced by a 79% increase of externally funded research in five years, with total award funding of current projects at $197 million, and awards in 2017 reaching nearly $60 million. We also opened in April 2017 our new Interdisciplinary Science and Engineering Complex—a 223,000 square foot architectural marvel designed to spur state-of-the-art research and innovation, while enabling collaboration across the University and with industry, academia, and government.

Our rigorous, experiential, and interdisciplinary education with global opportunities is preparing our students to meet the increasingly complex technical challenges of our time. In just four academic years, our initiatives and program enhancements, including 39 new degrees and graduate certificates, have resulted in a 122% increase in master's degree student enrollment, a 295% increase in graduate students participating in co-op, and a 130% increase in overall student global co-op placements.

This Scholarship Report is designed to showcase 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

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

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Five-Year Report Highlights

Four-year academic period ending 2016

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

ENROLLMENT AND OUTCOMES

981
Graduate degree conferrals, up **79%**

1450
Mean 2-part SAT score up over 50 points

Student body over **6700** students, up **54%**

122%
MS enrollment growth
BS — 30% | PhD — 18%

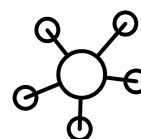## PERSONALIZED AND INTERDISCIPLINARY EDUCATION

39 New degree and graduate certificates on four campuses and online

48%
Undergraduate courses taken outside of College of Engineering

97%
Increase in non-engineering minors

EXPERIENTIAL AND GLOBAL LEARNING

295%
Graduate co-op increase

165%
Increase in global experiences

TRANSFORMATIONAL RESEARCH

$197M
Total active research funding for the College of Engineering (in millions)

74
Patents since 2012

Welcome New Faculty

SAMUEL CHUNG
Assistant Professor
Bioengineering
PhD, Harvard University, 2009

Scholarship focus: central nervous system regeneration model in C. elegans, femtosecond laser surgery, user-friendly and low-cost fluorescence microscopy

SAFA JAMALI
Assistant Professor
Mechanical and Industrial Engineering
PhD, Case Western Reserve University, 2015

Scholarship focus: microstructure-macroscopic properties relationship in complex fluids; rheology and physics of complex and structured fluids; colloidal suspensions; mesoscale computational science; computational fluid dynamics; physics of living systems; hemorheology and hemodynamics

SAMUEL MUÑOZ
Assistant Professor
Marine and Environmental Sciences; jointly appointed, Civil and Environmental Engineering
PhD, University of Wisconsin-Madison, 2015

Scholarship focus: sedimentary records of environmental change, paleoclimate and climate change, rivers and fluvial processes, hydroclimatic extremes

ARON STUBBINS
Associate Professor (joining January 2018)
Marine and Environmental Sciences; jointly appointed, Civil and Environmental Engineering, Chemistry and Chemical Biology
PhD, Newcastle University, 2002

Scholarship focus: aquatic environmental chemistry; carbon cycle; freshwater, coastal and ocean biogeochemistry; feedbacks between natural biogeochemical cycles and climate change; aquatic microplastics

HEATHER CLARK
Professor
Bioengineering; jointly appointed, College of Science; affiliated faculty, Chemical Engineering
PhD, University of Michigan, 1999

Scholarship focus: optical nanosensors for biological analysis

YANG (EMILY) LIU
Assistant Professor (joining January 2018)
Mechanical and Industrial Engineering
PhD, Columbia University, 2015

Scholarship focus: multiscale/multiphysics computational modeling of complex materials and structures; computational mechanics; large scale impact and blast simulation; high performance computing

EDUARDO SONTAG
University Distinguished Professor
(joining January 2018)
Electrical and Computer Engineering; jointly appointed, Bioengineering
PhD, University of Florida, 1977

Scholarship focus: control theory, systems biology, cancer, and biomedicine

SRINIVAS TADIGADAPA
Professor and Chair (joining January 2018)
Electrical and Computer Engineering
PhD, Cambridge University, 1994

Scholarship focus: sensor devices and smart sensor systems realized through the interdisciplinary field of microelectromechanical systems (MEMS); including the design, optimization, fabrication, testing, and networking of such transducers; fabrication of novel micro and nano-sensors and actuators by integrating non-traditional materials using silicon planar microfabrication techniques and exploring phenomenon at the micro-nano interfaces

JOSHUA GALLAWAY
DiPietro Assistant Professor
Chemical Engineering
PhD, Columbia University, 2007

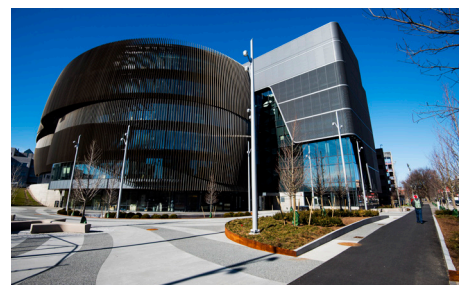**Scholarship focus:** electrochemical engineering, batteries and energy storage, energy sustainability

77

YOUNG INVESTIGATOR Awards

40

NSF CAREER Awards

Opening of the Interdisciplinary Science and Engineering Complex

The grand opening of Northeastern's state-of-the-art 223,000 square foot Interdisciplinary Science and Engineering Complex (ISEC) marks a new era of transformative research. An architectural marvel, ISEC is designed to spur innovation, collaboration, and scientific breakthroughs for years to come. Northeastern researchers will collaborate across the university and with partners from academia, industry, and government to pursue use-inspired and innovative research that solves global challenges. ISEC is located in Boston, a hub for innovation, home to the high technology, medical, and biotech industry, and numerous educational institutions.

13 MULTI-INSTITUTIONAL 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

CHOT Center for Health Organization Transformation; a National Science Foundation industry-university collaborative Healthcare Systems Research 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
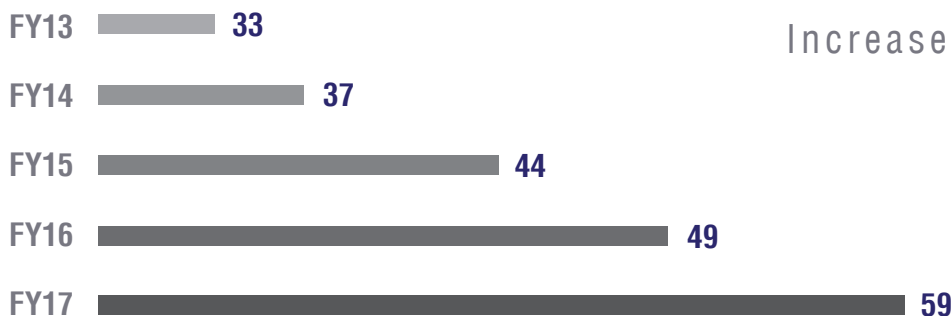
CURENT Center for Ultra-wide-area Resilient Electric Energy Transmission Networks; a National Science Foundation and Department of Energy multi-university Engineering Research Center

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

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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173 TENURED/TENURE-TRACK Faculty

Research Award Growth ($M)

FY13	33
FY14	37
FY15	44
FY16	49
FY17	59

79% Increase

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

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

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

CO-CHAIRS

Hanchen Huang
Donald W. Smith Professor and Chair,
Mechanical and Industrial Engineering

George Adams
College of Engineering Distinguished Professor,
Mechanical and Industrial Engineering

Andrew Gouldstone
Professor,
Mechanical and Industrial Engineering

Marilyn Minus
Associate Professor,
Mechanical and Industrial Engineering

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

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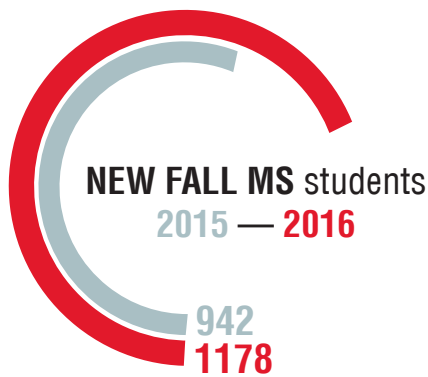

700 researchers gather at Northeastern.
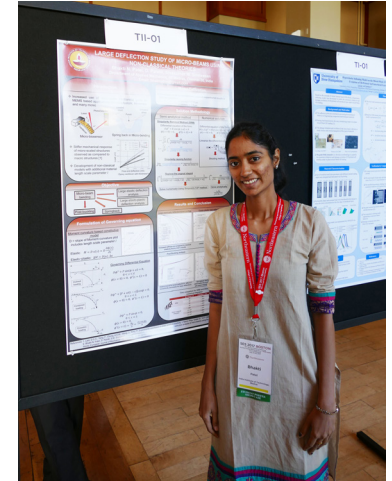
PhD students from around the world present their research during the conference's poster competition.

Nadine Aubry, dean of the College of Engineering, has been elected to the American Academy of Arts and Sciences. Her election to the prestigious organization places her among esteemed scientists, humanitarians, and researchers, including 250 Nobel laureates and 60 Pulitzer Prize winners, who constitute its influential membership. Aubry was elected President of the International Union of Theoretical and Applied Mechanics. She is also a member of the U.S. National Academy of Engineering and a Fellow of the National Academy of Inventors, American Association for the Advancement of Science, American Institute of Aeronautics and Astronautics, American Physical Society, and the American Society of Mechanical Engineers.

3177
GRADUATE
students

NEW FALL MS students
2015 — **2016**

942
1178

3566
UNDERGRADUATE
students

NEW FALL
UNDERGRADUATE students
2015 — **2016**

665
729
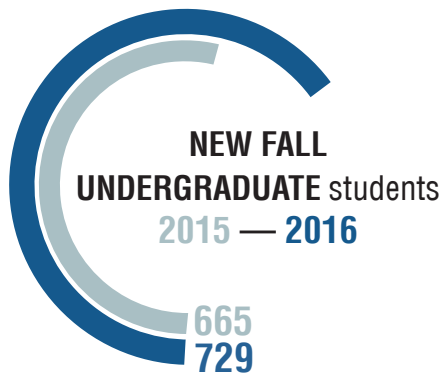
5 ENGINEERING
DEPARTMENTS

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

409
Conference
Proceedings
in 2016

564
Journal
Papers
in 2016

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 and Signal Processing
Computer Engineering and Networks
Electromagnetics and Optics
Microsystems and Devices
Power Electronics, Systems and Controls

MECHANICAL AND INDUSTRIAL ENGINEERING

Biomechanics
Energy
Healthcare Systems
Operations Research
Material Science
Mechanics
Mechatronics
Nanomanufacturing
Thermofluids

Garima Bhardwaj, PhD'17

ADVISOR: THOMAS J. WEBSTER, PROFESSOR AND CHAIR OF THE DEPARTMENT OF CHEMICAL ENGINEERING, AND ART ZAFIROPOULO CHAIR IN ENGINEERING

Garima Bhardwaj, a graduate of the chemical engineering program, developed novel nanostructured materials and coating processes to reduce orthopedic implant infections and increase bone growth without using drugs. Her project was approved by the FDA for human implantation during her PhD studies. Bhardwaj completed an internship with, and is now the managing director of, Therapeutic Innovations, a student-led startup that focuses on redesigning medical devices to make them more cost affordable for developing countries.


Sarah Brown, PhD'17

**ADVISOR: JENNIFER DY, PROFESSOR, ELECTRICAL AND COMPUTER ENGINEERING**

Sarah Brown is a triple husky, earning her BS, MS, and PhD at Northeastern. She conducted research in the Biomedical Signal Processing, Imaging, Reasoning, and Learning (B-SPIRAL) Group under her PhD advisor, Professor Dy, in the Department of Electrical and Computer Engineering. Her graduate studies were supported by a National Science Foundation Graduate Research Fellowship and a Draper Laboratory Fellowship. Following completion of her PhD in January 2017, Brown was the recipient of the Berkeley Chancellor's Postdoctoral Fellowship from UC Berkeley, which provides scholars with faculty mentoring and eligibility for a hiring incentive at the University of California.

Joshua Martin, PhD'18

ADVISOR, RANDALL ERB, ASSISTANT PROFESSOR, MECHANICAL AND INDUSTRIAL ENGINEERING

Joshua Martin is a PhD candidate in the Department of Mechanical and Industrial Engineering on a National Science Foundation fellowship. He is part of the Directed Assembly of Particles and Suspensions Lab under Assistant Professor Erb, which specializes in soft matter physics. Martin's work is focused on enabling 3D printing of composite materials with magnetically controlled alignment. His work has led to patented technology and him being CEO and co-founder of a spin-out, 3DFortify, which won gold prize with a $50,000 award at the 2016 MassChallenge Accelerator Program. He also won first prize in the Young Stress Analyst Competition after giving his invited lecture on Magnetic 3D Printing in front of the British Society for Strain Measurement in Exeter, England. Additionally, in 2016, Martin was a winner at Northeastern's annual Research, Innovation, and Scholarship Expo for Developing Hierarchically Reinforced Composites via 3D Printing and Magnetic Assembly. Industry leaders judged some 400 projects, which detailed the work of more than 900 Northeastern students and faculty. After graduation, Martin plans to focus on growing his business, and applying what he has learned during his Northeastern studies to industrial applications.
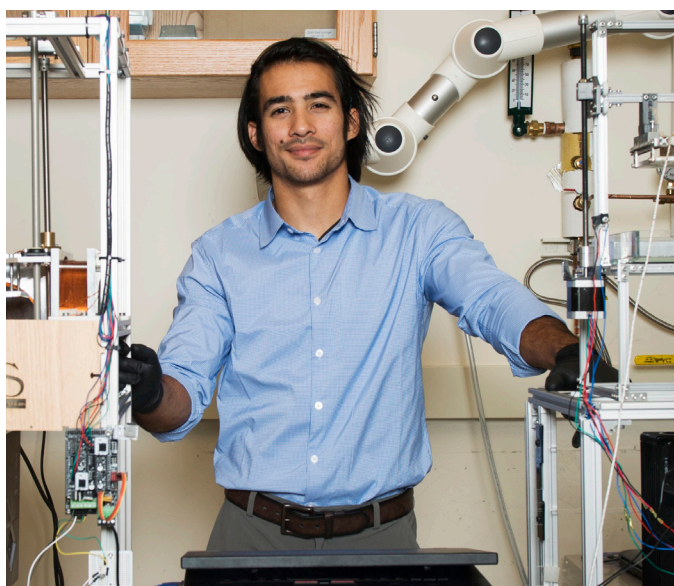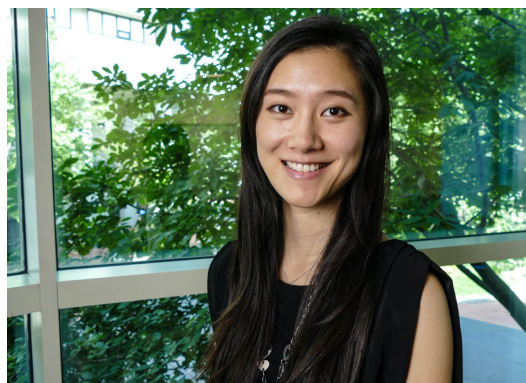
David Walsh, PhD'16

ADVISOR: SHASHI MURTHY, PROFESSOR, CHEMICAL ENGINEERING

While in the Department of Bioengineering at Northeastern University, David Walsh developed point-of-care diagnostic tools for ocular disease on a graduate research fellowship funded by the National Science Foundation. He performed research abroad for nine months in Stockholm in a joint grant between the Swedish Research Council and National Science Foundation, and he had a summer internship at MIT Lincoln Laboratory. After completing his PhD, Walsh joined MIT Lincoln Laboratory fulltime as a member of the technical staff in the Bioengineering Systems & Technologies group.

Yiwen Zhu, PhD'17

ADVISOR: HARIS KOUTSOPOULOS, PROFESSOR AND ASSOCIATE CHAIR OF GRADUATE STUDIES, CIVIL AND ENVIRONMENTAL ENGINEERING

While pursuing her PhD in civil engineering at Northeastern, Yiwen Zhu, who also holds a master's degree from M.I.T., developed data-driven approaches working on a research project funded by Mass Transit Railway in Hong Kong. She completed internships at BNP Paribas in New York City, Microsoft in Seattle, and Barclays Bank in New York. After graduating with her PhD, Zhu joined Microsoft as a data scientist in the Information Management and Machine Learning team. After gaining further experience in machine learning and data analysis, Zhu plans to return to her home country of China to work in the general area of artificial intelligence.

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

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*

$3 Million Grant Establishes Advanced Nanomanufacturing Cluster for Smart Centers and Materials

The Massachusetts Technology Collaborative Research and Development Matching Grant Program awarded a $3 million grant to Northeastern to establish the Advanced Nanomanufacturing Cluster for Smart Sensors and Materials, or CSSM, which comprises research universities and private manufacturing companies.

Advanced nanomanufacturing has vast potential to advance connected technologies, known as the internet of things, and revolutionize the sensing industry. This includes potential commercial applications such as high-precision miniature wireless sensors used to monitor premature babies in hospital neonatal units, wearable sensors for health and fitness that tracks biomarkers such as glucose, lactate or other biometrics, and sensors that track water quality.

The initiative will leverage Northeastern's innovative Nanoscale Offset Printing System, or NanoOPS, a manufacturing technology pioneered by the College's NSF Center for High-Rate Nanomanufacturing (CHN), led by Ahmed Busnaina, University Distinguished Professor and the William Lincoln Smith Chair in the College of Engineering. NanoOPS can print nanoscale sensors and devices as small as 20 nanometers—more than 10,000 times thinner than a human hair—on a variety of surfaces, and 100 to 1,000 times faster than current inkjet-based electronic and 3-D printing.

Part of the new funding will be used to establish infrastructure for printed materials characterization and testing smart sensor prototypes, and to build generation 2 and generation 3 NanoOPS with enhanced capabilities, including the ability to print on any surface. The grant is being matched by nearly $11 million in outside funds through this partnership between academia, industry, and government.

NSF CAREER Award for Development of Optical Control Over Magnetic Memory at Unprecedented Speed and Density

Assistant Professor Yongmin Liu, jointly appointed in the Department of Mechanical and Industrial Engineering and the Department of Electrical and Computer Engineering, has received a $500K National Science Foundation CAREER award. He received the award for his research developing new ways to control the magnetic properties of recording media such as hard disk drives in computers to dramatically increase the speed at which data can be stored.

Instead of using the traditional magnetic head to activate the magnetic recording materials, Liu will use light—optical laser pulses—combined with metallic nanostructures to generate the necessary magnetic field to store the data, transforming data storage for the Big Data era. Enterprises that will benefit from this ultrafast nanoscale optical-magnetism approach include web search engines, online retailers, and social media platforms.

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*

$5M NIH Award for In Vitro Model of the Human Gut

Rebecca Carrier

Recent research has linked conditions inside the intestine not only to obviously related problems like inflammatory bowel disease—but, more surprisingly, to Alzheimers, depression, heart disease, and other long-term health issues. Professor Rebecca Carrier (PI) and Assistant Professor Abigail Koppes (Co-I), of the Department of Chemical Engineering at Northeastern, were awarded a $5 million National Institutes of Health Bioengineering Research Partnership grant to develop an in vitro model of the human gut that can be utilized for laboratory study. This is a collaborative project between Northeastern University, MIT, and Boston Children's Hospital.

While the gut microbiome is known to have tremendous impact on human health, these effects are complex and generally not well understood, limiting translation of observed microbiome impact to effective therapies. Currently, studies of the intestinal tract are done using animal subjects, but there are many differences between humans and animals. The in vitro model will be the first to include human tissue, immune cells, and microbes to provide a more accurate view. The approach combines the development of hardware components, culture techniques, model microbial communities, novel biomaterials, and computational modeling frameworks.

Abigail Koppes

$1.9M NSF Grant to Build a Tool to Detect Retinopathy of Prematurity in Infants

Assistant Professor Stratis Ioannidis, Professor Deniz Erdogmus, and Professor Jennifer Dy of the Department of Electrical and Computer Engineering, in collaboration with the MGH/HST Athinoula A. Martinos Center and Oregon Health & Science University, were awarded a $1.9 million National Science Foundation grant to create an "Assistive Integrative Support Tool for Retinopathy of Prematurity." The research team will use machine learning techniques to build an assistive tool to detect retinopathy of prematurity in infants with multimodal clinical data.

Retinopathy of prematurity (ROP) is a leading cause of childhood visual loss worldwide, and the social burdens of infancy-acquired blindness are enormous. Early diagnosis is critically important for successful treatment, and can prevent most cases of blindness. The joint NU, MGH and OHSU team will develop a prototype assistive integrative support tool for ROP, comprising image analysis; information fusion of clinical, imaging, and diagnostic data; and generative probabilistic and regression models with associated computationally efficient machine learning algorithms.

Nikolai Slavov, Assistant Professor of Bioengineering

$2.35M NIH Director's New Innovator Award

The National Institutes of Health recognized Nikolai Slavov, assistant professor in the Department of Bioengineering, for his groundbreaking research with its Director's New Innovator Award. The five-year, $2.35 million award is part of the NIH Common Fund's High-Risk, High-Reward Research program, which supports highly creative early-career researchers taking out-of-the-box approaches to major challenges in biomedical research.

Slavov's work contradicted scientists' decades-long assumption that all ribosomes were the same. Slavov and his colleagues' research findings were published in the journal *Cell Reports*. The concept of "specialized ribosomes"—that not all ribosomes house the same standard 80 core proteins but rather varieties of them—had finally been validated. Before Slavov's discovery, scientists believed that ribosomes in unperturbed cells had a passive role in the expression of genetic information. A molecule called messenger RNA, or mRNA, picked up protein-assembly instructions—which amino acids to link in a chain and in what order they should link—from genes and delivered them to the ribosome to follow. Slavov's findings, however, indicated that ribosomes not only assembled proteins, they also appeared to regulate that production.

The findings could have implications for new directions in fields from cancer therapeutics to regenerative medicine, and the potential applications of the research findings are broad. In tissue engineering, for example, if researchers want to program, for instance, an embryonic stem cell to make a heart cell, they may now have to take into account how to influence the ribosome. If a genetic mutation has led to a core-protein malfunction that contributes to the growth of cancer, researchers may now consider developing drugs that target that ribosomal core protein to restore its function, inhibiting cancer growth.

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*

Loretta A. Fernandez, Assistant Professor & Mark Patterson, Professor

NSF Award to Develop Best Practices for Tide Gate Operations

The National Science Foundation (NSF) recently awarded a three-year research grant to Northeastern University to develop best practices for tide gate operations in coastal marshes. Professor Mark Patterson, interdisciplinary faculty between the College of Science (COS) and civil and environmental engineering (CEE), is leading the project with Assistant Professor Loretta A. Fernandez, CEE/COS and Brian Helmuth, affiliated faculty, CEE.

"Wetlands are critical to protection of coastal infrastructure," says Patterson. "Our research will establish engineering best practices to help communities effectively manage tide gate operations and reduce risk of storm surges and fire, while protecting ecosystem health."

Under the NSF grant, the Northeastern team will work with local Massachusetts communities to investigate three diverse salt marsh environments, including a large urban coastal marsh, a smaller urban marsh and a "pristine" marsh that will serve as a control site.

Based on its data gathering and modeling—along with input collected in workshops with stakeholders—the team will develop decision-support tools for operators, including a smartphone app to provide guidance on when and how much to open tide gates under various scenarios, and a companion website to serve as a resource for managers, the public, and K-12 school programs. Because the marshes selected for the study are different in size and behavior, the decision support tools will be suitable for use in a variety of locations across the country.

As part of the focus on protecting ecosystem health, the study will examine the effects of human-made pollutants. "Industrial toxins now present in almost all aquatic environments can accumulate and stick to the sediment moving in and out of the marsh, which has an impact on both plant life and fish species—and can potentially affect people when they consume the fish," explains Fernandez.

Using engineering tools known as "passive samplers" will allow for measuring low concentrations of these toxins in the environment and enable researchers to learn more about how tide gate operations affect the transport of toxic chemicals in salt marshes and predict how bioavailable these chemicals are to resident fish species. Collected data will be fed into the smartphone app developed for operators to help manage both nutrient and toxin transport, and decisions to open or close tide gates.

Developing a National Agenda for Research on Offshore Wind Resiliency

The Massachusetts Clean Energy Center (MassCEC) recently awarded funding to Civil and Environmental Engineering (CEE) Professor and Chair Jerome Hajjar and CEE Associate Professor Andrew Myers to develop a national research agenda for offshore wind energy infrastructure. A draft agenda will be presented at a workshop hosted by Northeastern University in December 2017.

As part of MassCEC's Massachusetts Research Partnership in offshore wind, six institutions—Northeastern, Tufts University, University of Massachusetts at Amherst, Lowell and Dartmouth, and the Woods Hole Oceanographic Institution—are working collaboratively with government and industry to develop a framework for offshore wind research. "We're looking at creating research to scale up industry and at workforce development to create opportunities," says Hajjar. "This includes everything from wind turbine towers to supply chain, public policy and regulatory policy."

Each of the participating universities is hosting a workshop focusing on various aspects of the research agenda, with the final culminating workshop to be hosted by Northeastern in December. The Northeastern team's primary focus is on the structural engineering part of the research agenda, specifically large-scale testing of wind turbine towers. "We're looking at manufacturing imperfections and how that affects performance of wind turbine towers," explains Myers, who is leading testing at Northeastern's structural testing lab in Burlington, Mass. "We're baselining new methods [of manufacturing], identifying what parts of the manufacturing process could be improved to lead to a better, stronger tower."

Ultimately, according to Myers, Northeastern's work underscores the benefits of large-scale testing to advance research in developing this new energy industry. "This is an example of what large-scale testing can do," says Myers. "It demonstrates there is a need for testing—for investment in testing facilities—and how it can support the research agenda."

RESEARCH INITIATIVES

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*

Sara Wadia-Fascetti   Haris N. Koutsopoulos   Matthias Ruth

Northeastern Designated Beyond Traffic Innovation Center

The U.S. Department of Transportation designated Northeastern University a Beyond Traffic Innovation Center; one of 18 "forward thinking and influential institutions" to lead research aimed at solving transportation challenges such as population growth, climate change, and driverless cars over the next three decades. The Northeastern team will focus specifically on the Northeast, one of 11 megaregions throughout the country, consisting of 11 states and the District of Columbia, and the Atlantic seaboard spanning 450 miles with a host of airports, ports, rail, and urban transportation systems.

Civil and Environmental Engineering Professor Sara Wadia-Fascetti is leading the Center's efforts with Professors Haris N. Koutsopoulos and Matthias Ruth. The Center will leverage the expertise of a host of faculty across disciplines in areas such as network science, public policy, resilience, and sensors and monitoring systems, as well as work closely with partners in industry, government, and academia. Additionally, the Center will build upon Northeastern's College of Engineering Versatile Onboard Traffic Embedded Roaming Sensors (VOTERS) center, led by Ming Wang, distinguished professor of Civil and Environmental Engineering.

Through research and outreach, the Center will harness Big Data to improve decision-making as it particularly relates to traffic, transit, and related infrastructure systems. The project specifically builds upon and combines Northeastern's research expertise in physical infrastructure and sensing, streamlined services using data analytics, and governance and policy.
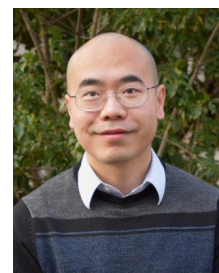
In 2016, Assistant Professor of Civil and Environmental Engineering Qi Wang's paper, titled "Patterns and Limitations of Urban Human Mobility Resilience Under the Influence of Multiple Types of Natural Disaster" was published in the journal *PLoS One*, Volume 11, No. 1, e0147299.

$2.5M NSF Award for Designing a Framework for Resilient Emergency Health Response

Mario Sznaier (PI)

The National Science Foundation awarded a $2.5 million Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) Type 2 grant for "Identification and Control of Uncertain, Highly Interdependent Processes Involving Humans with Applications to Resilient Emergency Health Response," to pioneer a new approach to enable communities to withstand and bounce back quickly from hazards.

A new paradigm of proactive resiliency through "prediction, intervention and adaptation," is used as opposed to the current reactive cycle of discovery, recovery and redesign. The research also uniquely integrates engineering (electrical, industrial, civil), computer science, and social science strategies for achieving resilience over the short and long term.

The multidisciplinary research, according to the NSF, seeks to develop a comprehensive framework for designing and operating resilient communities by modeling them as partially engineered networked cyber-physical-human systems. The goal of the project is to develop a synthesis framework for such systems, capable of guaranteeing minimum levels of performance and rapid recovery of functionality in the face of disruptions. The resulting framework will be tested using a scenario involving four systems critical to maintaining minimum levels of emergency medicine: power, communications, critical goods supply chain, and built environment.

RESEARCH LEADS

Mario Sznaier (PI), Dennis Picard Trustee Professor, Electrical and Computer Engineering

Octavia Camps (co-PI), Professor, Electrical and Computer Engineering

Lisa Feldman Barrett (co-PI), University Distinguished Professor, Psychology

Jacqueline Griffin (co-PI), Assistant Professor, Mechanical and Industrial Engineering

Stacy Marsella (co-PI), Professor, Computer and Information Sciences

Ali Abur, Professor, Electrical and Computer Engineering

Peter Boynton, Director, George J. Kostas Institute for Homeland Security

Jerome Hajjar, CDM Smith Professor and Chair of the Department of Civil and Environmental Engineering

Edmund Yeh, Professor, Electrical and Computer Engineering

NSF Award to Develop Multi-agent Modeling Framework to Mitigate Distributed Disruptions

Jacqueline Griffin (PI)

The National Science Foundation awarded a $500K Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) Type 1 grant to develop new mathematical models and analysis methods for improving resiliency in complex human-managed systems, which involve cascades of multiple smaller-size distributed events, such as the drug shortage crisis in the U.S., rather than the traditional focus of resiliency for single, large disruptive events.

The interdisciplinary research, led by Jacqueline Griffin, assistant professor of mechanical and industrial engineering, seeks to drive a paradigm shift with regard to infrastructure resiliency and supply chain risk management, accounting for the critical inclusion of realistic human decision-making components with information sharing and bounded rationality. To achieve this, the researchers will develop a unique and transformative multi-agent modeling framework that combines mathematical modeling, realistic human behavior modeling, and game design to more appropriately consider human behavior and dynamics of the underlying physical, information, and social systems in critical infrastructures.

Research findings will define new resiliency measures and classifications incorporating a robust characterization of stable systems and agent behavior in undisrupted multilayered networked systems with multiple realistic agent-based models of human decision makers, and contrast these to system performance and agent behaviors after distributed and single extreme events.

RESEARCH LEADS

Jacqueline Griffin (PI), Assistant Professor, Mechanical and Industrial Engineering

Ozlem Ergun (co-PI), Professor, Mechanical and Industrial Engineering

David Kaeli (co-PI), College of Engineering Distinguished Professor, Electrical and Computer Engineering

Casper Harteveld (co-PI), Assistant Professor, College of Arts, Media, and Design

Stacy Marsella (co-PI), Professor, College of Computer and Information Science

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.

$5M NSF Grant Creates STEM Pathways and New Generation of Energy Experts

Northeastern was awarded a $5 million grant from the National Science Foundation to establish the Student Pathways Opening World Energy Resources (S-POWER) program. A five-year innovative scholarship and mentoring program, S-POWER seeks to increase the number of underrepresented minority, as well as first-generation college transfer students from two- and four-year institutions that do not offer degrees in STEM to institutions that do grant degrees in STEM. It also seeks to address the need for fundamental research and training in energy-related fields in order to prepare a new generation of energy experts.

From left: Brad Lehman (PI), professor of electrical and computer engineering; Marilyn Minus, associate professor of mechanical and industrial engineering; Claire Dugan, director of the Center for STEM Education; Richard Harris, assistant dean and director of the Northeastern University Program in Multicultural Engineering.

Northeastern is partnering with two historically black colleges and universities—Clark Atlanta University and Hampton University—as well as Mass Bay, Middlesex, and Northern Essex community colleges in Massachusetts. Undergraduates from these institutions will transfer into Northeastern's College of Engineering beginning fall 2017, while graduated students from Hampton University will begin graduate studies this fall. The program will provide scholarships for up to 160 undergraduate and graduate students; participating students will each be eligible for up to $30,000 in direct financial aid. Northeastern will also build a collaborative education, administrative, and mentoring ecosystem that uniquely supports students throughout the transfer process, including helping partner colleges and universities implement S-POWER back at their institutions.

Edward Beighley,
Associate Professor

$651K Grant from NASA for Surface Water and Ocean Topography Satellite Mission

Edward Beighley, associate professor of civil and environmental engineering, received a $651K grant from NASA for research supporting the Surface Water and Ocean Topography (SWOT) satellite mission. SWOT will make the first global survey of Earth's surface water, providing understanding of how water bodies change over time. Insights gained from SWOT will help quantify the potential impacts of climate and land cover change on surface water dynamics with a sufficient resolution for community scale planning and management. Beighley's research will focus on understanding how hydrologic processes are integrated along SWOT measurement boundaries, new methods for improving SWOT data products such as river discharge, and quantifying the potential benefits of SWOT data products in hydrologic applications. As part of his research, he will work with the global insurance industry to develop new methods for integrating SWOT measurements into flood hazard applications.

Northeastern Takes Part in $157M NIH Study:

Environmental Influences on Child Health Outcomes Program

Northeastern's College of Engineering is participating in a National Institutes of Health (NIH) study, called Environmental Influences on Child Health Outcomes (ECHO) program, to investigate the ways that early exposure to a range of environmental factors influence the short- and long-term health of children.

The NIH awarded $157 million in its fiscal year 2016 to launch the seven-year initiative. Top research institutions will examine the effects of a variety of environmental factors—from air pollution and chemicals to stress and diet—on the health of children and adolescents. The Puerto Rico Testsite for Exploring Contamination Threats (PROTECT) Center and the Center for Research on Early Childhood Exposure and Development in Puerto Rico (CRECE), both led by Akram Alshawabkeh, George E. Snell Professor of Engineering, in the Department of Civil and Environmental Engineering, and Associate Dean of Engineering for Research at Northeastern, are taking part in the study.

Akram Alshawabkeh, George E. Snell Professor of Engineering, and Associate Dean of Research

PROTECT, which launched in 2010 with funding from the NIH's National Institute of Environmental Health Sciences (NIEHS), explores the role contaminants such as phthalates play in Puerto Rico's high rate of preterm birth. CRECE, which launched in 2015 with funding from the NIH and the U.S. Environmental Protection Agency (EPA), uses a subset of the children participants born in the PROTECT cohort to evaluate the impact of environmental exposures, including particulate matter and phenols, on children's neurodevelopment. Both centers encompass multi-institution collaboration.

ECHO will build on the work PROTECT and CRECE have been carrying out in Puerto Rico. The teams plan on collecting data and biospecimens for 570 pairs of mothers and children who are already in the PROTECT-CRECE cohort and to recruit an additional 1100 pregnant women. Over the seven-year span of the program, PROTECT and CRECE expect to study a total of 1,560 mother-child pairs.

First ROUTES Scholar Completes Co-op at PROTECT Center

David Berroa, E'18, was selected as Northeastern's first ROUTES scholar and he completed the program in 2016. ROUTES—Research Opportunities for Undergraduates: Training in Environmental Health Sciences—aims to increase the number of minority undergraduates studying the effects of environmental contaminants on people and communities. As part of the program, Berroa had the opportunity to conduct research into a health hazard that affected his family when they lived in the Dominican Republic, and plagues much of the developing world: contaminated drinking water.

David Berroa, E'18

His ROUTES scholarship paid for a research co-op with Northeastern's PROTECT Center's Project 5, which is developing sustainable electrochemical technologies to clean up contaminated groundwater in Puerto Rico. He worked on the "Green Remediation by Solar Energy Conversion into Electrolysis in Groundwater" project. In explaining his experience joining the PROTECT team, Berroa specifically emphasized how much he valued the instruction of one of his co-op mentors, Dr. Ljiljana Rajic. It was "her persistence and guidance" that prepared him to present his new-found knowledge at conferences all around the Boston area and even in Puerto Rico.

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.

Kaushik Chowdhury, Associate Professor

Professor Chowdhury Named Presidential Early Career Award Winner

Kaushik Chowdhury, associate professor in the Department of Electrical and Computer Engineering, was named a winner of the White House Presidential Early Career Award for Scientists and Engineers, or PECASE, in 2017. It is the highest honor bestowed by the U.S. government on science and engineering professionals in the early stages of their independent research careers.

Chowdhury was nominated for the honor by the Department of Defense, whose Office for Naval Research is funding his research on the use of intelligent, autonomous radios in wireless communications with a $1 million Director of Research Early Career Grant over the next five years. Chowdhury's radio technology has wireless bidirectional transmitter-receivers that not only detect congestion and interference along the information highway, but also autonomously respond, switching pathways, or "spectrums," for instance, or changing transmission parameters to ferry data quickly and accurately to the appropriate destination.

"I was excited to receive this recognition and at the same time humbled to be counted among some very accomplished colleagues," says Chowdhury. "Receiving the PECASE for my research serves as a reminder that the Department of Defense and the nation rely on wireless communications and networking in advancing our country's technological edge and underscores the responsibility inherent in pursuing this work."

The goal of Chowdhury's research is to make radios not just intelligent but 'cognitive,' that is, to go beyond recognizing interference to acting on it. Integral to the research is ensuring that each radio can connect to many other radios, establishing a "distributed network" so that the radios will be able to discover one another and configure themselves, forming multi-hop forwarding paths. The applications of such networks range from defense operations, in which military forces need to communicate efficiently with one another, to emergency services, where personnel from fire departments, hospitals, and law enforcement must converge, to next-generation consumer networks.

Edmund Yeh, Professor

$10M Multi-university, Industry Collaborative DARPA Award

The Defense Advanced Research Projects Agency (DARPA) recently awarded a $10 million, four-year research project to Raytheon BBN, Northeastern's College of Engineering, and the Massachusetts Institute of Technology as part of the Dispersed Computing Program. According to DARPA, the research to advance wireless communication technology will build "software instantiations of algorithms and protocol stacks that leverage pervasive, physically dispersed computing platforms to boost application and network performance by orders of magnitude." Professor Edmund Yeh, of the Department of Electrical and Computer Engineering, is leading the effort at Northeastern.

As part of this multi-university and industry collaborative award, Northeastern and MIT engineering researchers will develop a set of optimized communication and computation algorithms and protocols to support multiple-sender multiple-receiver applications with highly demanding latency constraints over heterogeneous, congested, and error-prone network environments. BBN will use the algorithms and protocols in software to develop new wireless communication technology solutions to create a new system architecture from the ground up. The technology will enable seamless wireless communication in the field, regardless of channel conditions and computing platforms, thus enabling real-time intelligence for critical decision making.

Stratis Ioannidis

Miriam Leeser

NSF Grant to Advance Large- Scale and Secure Data Mining

Assistant Professor Stratis Ioannidis and Interim Chair and Professor Miriam Leeser of the Department of Electrical and Computer Engineering have been awarded a $500K grant from the National Science Foundation to develop a "Massively Scalable Secure Computation Infrastructure Using FPGAs" to advance large-scale and secure data mining.

Every day, the collection of behavioral data takes place on a massive scale, from clinical trials performed by medical and scientific experts, to shopping conduct and economic trends by retail sales corporations. While mining this data can offer tremendous societal benefits resulting from sharing data among researchers and practitioners, it also gives rise to significant personal privacy concerns—an Engineering Grand Challenge facing society today. Ioannidis and Leeser's research seeks to not only guarantee the safety of the personal data collected, but also to speed up the process by which it is encrypted.

"There are solutions to safeguard personal information, including behavioral data, through a technique called Secure Function Evaluation (SFE); the end user can access the output of a computation performed on the data, but not the original records," said Ioannidis. "The problem with SFE is that it is computationally intensive; computations performed securely can be up to 700,000 times slower, which is prohibitive for large datasets."

Leeser and Ioannidis propose a solution to this slow-down in the form of field-programmable gate arrays, or FPGAs, which are specialized hardware that accelerate the SFE application. "By using FPGAs, we can work to apply SFE over large and changing data using parallel computing practically in real-time, while still preserving personal privacy," said Leeser. "This has worldwide applications throughout industries, as well as toward the whole notion of the importance of protecting one's data, from medical records to geolocation. If there is no chance that an individual's personal data can be compromised, then we as a society are much more likely to become comfortable with prudent data collection. This can work for the betterment of everything from homeland security to the curing of diseases," explained Leeser.

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*
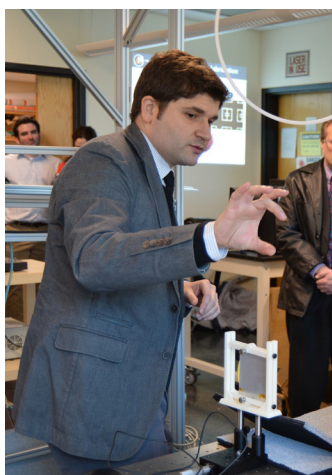
Jose Martinez-Lorenzo,
Assistant Professor

NSF CAREER Award to Advance Security Monitoring

Jose Martinez-Lorenzo, assistant professor of mechanical and industrial engineering, jointly appointed in the Department of Electrical and Computer Engineering, of Northeastern University's College of Engineering, was recently awarded a $500K National Science Foundation (NSF) CAREER Award for his work developing a method for "4D mm-Wave Compressive Sensing and Imaging at One Thousand Volumetric Frames per Second."

Millimeter-wave sensing and imaging systems are generally used for a wide range of applications, such as security monitoring to detect potential threats at the airport and biological imaging for wound diagnosis and healing. The four-dimensional millimeter-wave imaging system can operate in quick-changing scenarios. One of the main applications of this system is finding security threats hidden under clothing, inside backpacks, or in public spaces, such as sports arenas. The system can scan multiple people within 26 cubic meters and produce 1000 3D image frames per second, far surpassing existing millimeter-wave sensing and imaging systems.

Martinez-Lorenzo also collaborates with College of Engineering (COE) Distinguished Professor, Electrical and Computer Engineering Carey Rappaport through the support provided by the Awareness and Localization of Explosives-Related Threats (ALERT) research center at Northeastern, which is a multi-university, interdisciplinary Department of Homeland Security center of excellence led by Robert D. Black Professor, COE Distinguished Professor Michael Silevitch of electrical and computer engineering at Northeastern.

ALERT and Gordon-CenSSIS Scholars Deliver Final Presentations

The ALERT and Gordon-CenSSIS research centers hosted 15 freshmen engineering students as participants in the ALERT and Gordon-CenSSIS Scholars Program, which is designed to provide freshmen engineers with the opportunity to get involved in research and STEM outreach. It also focuses on building their professional development. Throughout the year, Scholars attend seminars on public speaking skills, research ethics, lab safety and research poster building skills.

After two semesters of active involvement in the program—which includes participation in an ALERT or Gordon-CenSSIS research project, K-12 STEM outreach, and Scholar meetings, seminars and activities—the students completed the program by presenting their final research presentations to their faculty advisors and other members of the Scholars community.
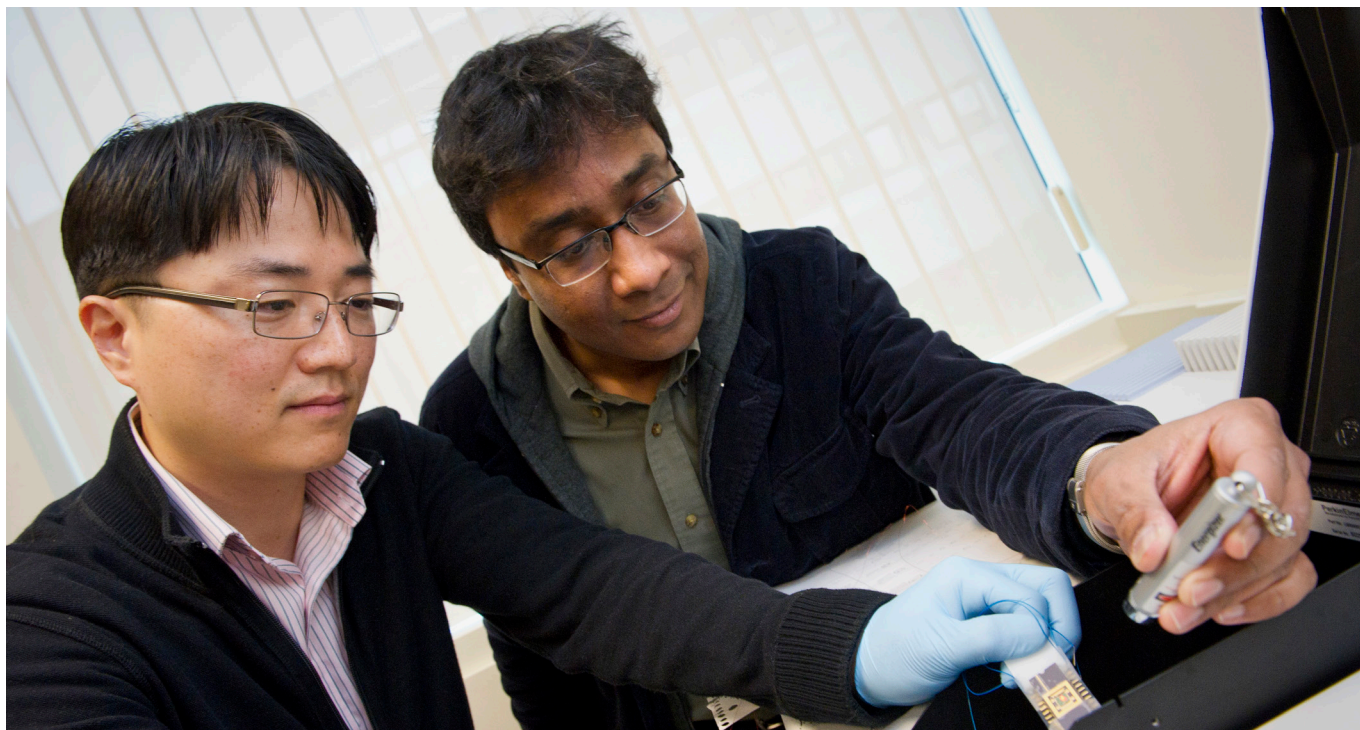
Left to right: Yung Joon Jung, Professor, Mechanical and Industrial Engineering, and Swastik Kar, Associate Professor, College of Science

Jung and Kar to Develop Rapid/Early Radiation Detection

Mechanical and Industrial Engineering (MIE) Professor Yung Joon Jung (principal investigator), and Associate Professor Swastik Kar (co-principal investigator) of the Department of Physics, have been awarded a research grant from the National Science Foundation to develop rapid/early radiation detection.

According to the NSF, the research will translate a novel nanotechnology-based charged-particle (ion) detection method for a range of radioactivity and nuclear radiation sensing and monitoring applications, resulting in the development of prototype radiation detectors that will be ultrasensitive with significantly reduced size, weight, cost and power-consumption compared to current technologies.

While Jung and Kar were developing an ion sensor using carbon nanotubes, they discovered it was extremely sensitive to iron particles and so they began to explore the ion sensor's viability in detecting radiation for potential consumer and government applications. Their efforts and the support of an NSF I-Corps grant led to a startup that is currently being formed, called Guardion, with the goal to commercialize the technology with applications in three markets, including:

• At-home radon detection for consumers
• Personal radiation dosimeters for employees at high risk of exposure, such as in hospitals and nuclear power plants
• Homeland security through large-scale deployment in the event of a nuclear emergency

Guardion, founded by Jung, Kar and mechanical and industrial engineering alumnus Dan Esposito, E'08, was selected as a 2017 MassChallenge Finalist. Additionally, the team was invited to apply for a $200K Technology in Space prize proffered by the Center for the Advancement of Science in Space (CASIS) and Boeing to fund research onboard the International Space Station (ISS) U.S. National Laboratory.

This recent NSF award enables further advancements in the technology for early/rapid nuclear threat detection for homeland security, safety applications such as border security and control, city-scale networkable monitoring, domestic nuclear power plant and medical facilities monitoring, and remote sensing via unmanned vehicles for military operations.

"Associate Professor Kar and I have been collaborating together for more than a decade," says Jung. "This is a great example of how engineering and science work together to create innovations that can help everyone, from a single individual to an entire community, stay safe from harm."

Human-Centered Robotics
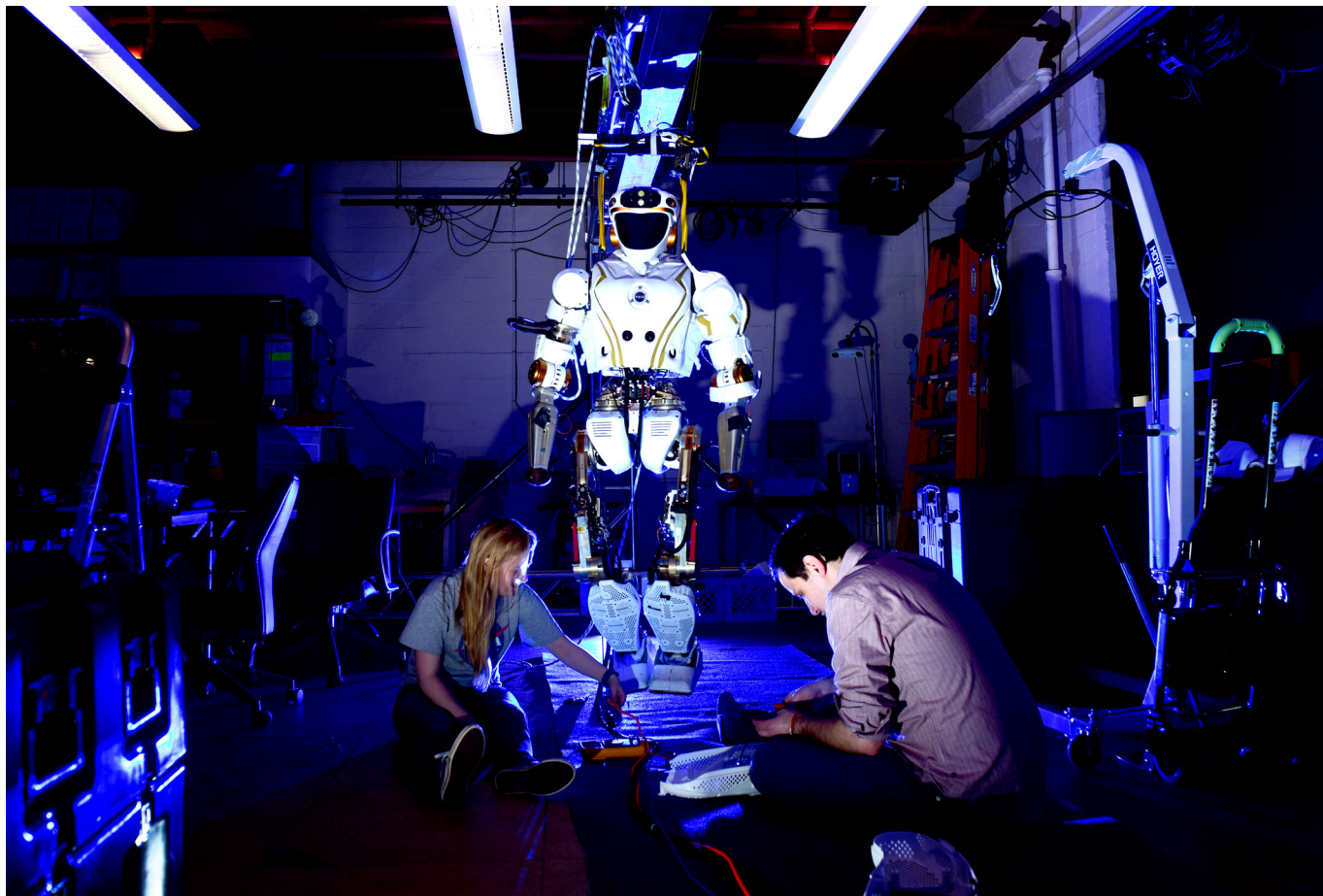
NASA Humanoid Robot Destined for Mars

Northeastern's College of Engineering is one of two university teams nationwide awarded a humanoid robot, named Valkyrie, from NASA as part of its vision for sending humanoid robots to Mars to conduct field studies and exploration. Associate Professor Taskin Padir, of the Department of Electrical and Computer Engineering, is leveraging NASA funding to develop advanced technologies that allow robots to complete specific tasks such as exiting an airlock, using a ladder to reach Mars' surface, collecting rocks, and repairing equipment; tasks which require interdisciplinary expertise including control, perception, locomotion, manipulation, and software engineering.

Northeastern was chosen to lead the NASA project after a rigorous selection process. Padir, the project's principal investigator (PI), is supported by Assistant Professor Robert Platt of the College of Computer and Information Science at Northeastern, as well as Holly Yanco, a professor of computer science at the University of Massachusetts Lowell. Student researchers are integral members of the team.

Establishing a New Institute to Advance Robotics in Manufacturing

Taskin Padir, Associate Professor

Northeastern University researchers, led by robotics expert Taskin Padir, associate professor of electrical and computer engineering, have been selected to partner with a consortium of universities, nonprofit institutions, local governments, and industry to launch a new independent robotics institute as part of the U.S. Department of Defense's Manufacturing USA, a national network for bringing innovation to manufacturing.

Called the Advanced Robotics Manufacturing Institute, or ARM, the project will bring together manufacturing companies and researchers to expand the companies' robotics capabilities, including the development of next-generation robots, educational opportunities, and workforce training. Northeastern is one of just 40 academic institutions selected to be founding members of the institute.

"Our goal is to expand the applicability of robots in manufacturing in companies of all sizes," says Padir. "A primary question we want to answer is: How can we provide robotics and automation in a novel way so that these businesses can thrive?"

Nadine Aubry, dean of the College of Engineering, commented, "I am confident the team will develop innovative robotics systems with humanlike dexterity and adaptability, as well as safe and intuitive human-robot interaction capability for the next generation of U.S. manufacturing operations."

ARM will be based in Pittsburgh and led by an independent nonprofit founded by Carnegie Mellon University called American Robotics. In addition to the academic partners, the consortium includes 123 industrial and 64 government entities. The funding, which comes from the various parties as well as the DOD, totals more than $250 million.
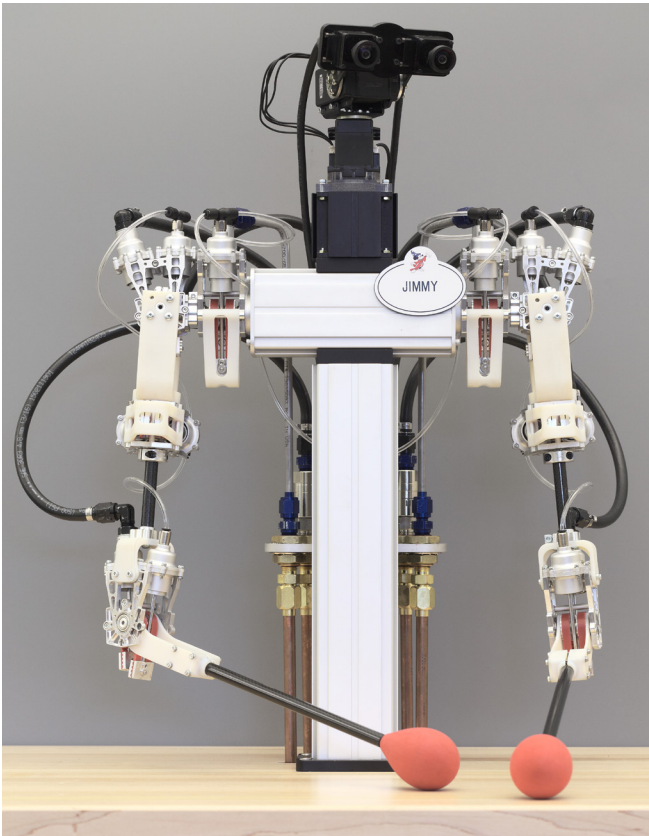
Human-Safe and Interactive Robotics

John (Peter) Whitney, assistant professor, mechanical and industrial engineering, led the Disney Research Pittsburgh team that designed and built Jimmy, a robot that moves with lifelike speed and grace, and can perform such tasks as threading a needle or closely interacting with humans. A research platform for technology innovation in human-safe and interactive robotics, *IEEE Spectrum* magazine featured the robot in the article, "Disney Robot with Air-Water Actuators Shows Off 'Very Fluid' Motions." Research in lightweight and ultra-low friction hydraulic transmissions that began with Jimmy continue at Northeastern, with applications in surgical and MRI-compatible robotics and advanced autonomous manipulation.

Internet of Things

$100M in Investments, $6.1M NSF Award, to Advance Wireless Technology

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

PAWR will foster fundamental research and development of multiple community-scale platforms supporting next-generation wireless communications networks across the U.S. Melodia will oversee, as director of research, the vetting, selection, management, and construction of projects aimed at developing city-scale wireless platforms and proposed by research teams drawn from the U.S. academic and industrial wireless research community. Over the next seven years, the PPO will disburse to winning teams nearly $100 million in investments from the NSF and more than 25 companies and industry associations.

In addition, Northeastern researcher Kaushik Chowdhury, associate professor of ECE, will take a leading role as director of academic outreach, while ECE Associate Professor Stefano Basagni will be responsible for platform implementation. ECE Professor Edmund Yeh and Guevara Noubir, professor of computer and information science and ECE affiliated faculty, will contribute their academic expertise in communication theory and network security, respectively. Finally, Abhimanyu Gosain was hired in the College of Engineering from BBN/Raytheon to take the role of PAWR technical program director.

"By bringing together leaders in the field from academia, industry, government, and communities, PAWR will significantly advance society by creating the platforms necessary to build the next-generation wireless infrastructure, which will spur the Internet of Things revolution and enable the smart cities of the future," remarked Nadine Aubry, dean of the College of Engineering at Northeastern.

Tommaso Melodia, Associate Professor

NSF I-Corps Grant for Continuous Operation of Consumer Devices

Kaushik Chowhury, associate professor, electrical and computer engineering, was awarded an NSF I-Corps grant for "Software-Defined Distributed Wireless Charging." The research will facilitate the continuous operation of consumer devices as well as enable uninterrupted safety-critical applications such as elderly care, and patient and structural health monitoring.

According to the NSF, the research defines a new network architecture that is capable of distributed wireless RF-based charging by combining both hardware and software platforms. The technology enables an exponential increase in wireless charging rates due to constructive interference and real-time adaptation of energy signals using minimal receiver feedback. A software-defined distributed energy beamforming plane is leveraged to ensure continuous feedback, which is used for selecting various parameters at the energy transmitters that give high charging rates. The technology also assesses energy needs over the network and is able to schedule energy broadcasts proactively.

Another benefit of this research project is its potential to improve the quality of life in society by eliminating concerns of frequent charging of low-power electronic devices. Also, by enabling wireless charging of small form factor sensors, the expenses and environmental concerns associated with battery-replacements are mitigated.

Novel Research on Ultra Compact Antennas Published in Nature Communications

The next generation of antennas could be up to 100 times smaller than current compact antennas if fabricated using a novel design approach developed by Nian Xiang Sun, professor of electrical and computer engineering. The technology could have potential applications for portable wireless communications systems, including wearable electronics, smartphones, bio-implantable and bio-injectable antennas, and the Internet of Things. Sun's research paper, entitled "Acoustically Actuated Ultra-compact NEMS Magnetoelectric Antennas," was recently published in *Nature Communications*.

Traditional antennas are rigid metal structures that are sized to be resonant with a specific wavelength of radiation, which puts limits on miniaturization. The new antenna is a membrane that is resonant not with a specific wavelength, but instead a specific frequency, which allows for a vast reduction in the physical size of the antenna. The membrane is composed of a thin film magnetoelectric material that changes its magnetization as it vibrates, coupling the acoustic vibration with both transmitting and receiving radiation. The membrane resonant frequency can be controlled by different geometric designs, and the technology has been demonstrated with two different designs spanning the UHF and VHF radio frequencies. The new antennas perform better than similarly sized traditional antennas, and they are completely passive requiring simple electronics and no battery.
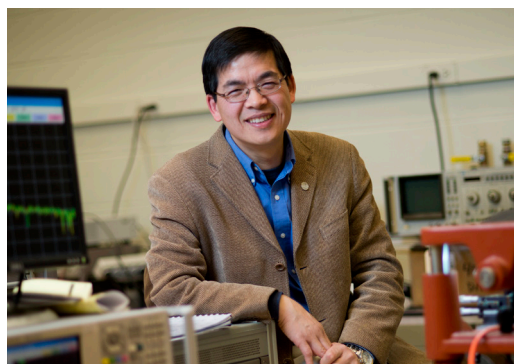
Nian Xiang Sun, Professor

$1.2M NSF Award to Protect Against Side-Channel Attacks

Professor Yunsi Fei, electrical and computer engineering, is leading a $1.2M three-year National Science Foundation

Yunsi Fei, Professor

Secure and Trustworthy Cyberspace award, titled "Automating Countermeasures and Security Evaluation Against Software Side-Channel Attacks." Fei and her interdisciplinary research team are building an automation framework, and associated software tools, metrics, and methodologies for information leakage analysis, multi-level countermeasure application, and formal security evaluation against software side-channel attacks.

The research project addresses the threat to various cryptographic implementations that do not feature dedicated protection, as well as overcomes the labor-intensive, application-specific, and security vulnerability limitations of current manually implemented countermeasures. According to the NSF, the automated framework approach unifies two most common side-channel attacks, power analysis and cache-based timing attack, into one framework. It defines new metrics of information leakage and uses them to automatically identify possible leakage of a given cryptosystem at an early stage with no implementation details. The conventional compilation process is extended along the new dimension of optimizing for security, to generate side-channel resilient code and ensure its secure execution at run-time. Side-channel security is guaranteed to be at a certain confidence level with formal methods.

With certain level of side-channel security guaranteed, the framework will enable security system architects and software developers to build verifiable security into a broad range of applications, including Internet-of-Things where pervasive embedded systems on the network edges can be easily captured by an adversary to inflict security breaches.

FACULTY HONORS AND AWARDS

Select Highlights

Vincent Harris, University Distinguished Professor and William Lincoln Smith Chair Professor, electrical and computer engineering, affiliated chemical engineering, received in collaboration with Quorvo an $8M grant (2017-2019) from the Defense Advanced Research Projects Agency for a project, "MAgnetics on GaN for Next GEneration T/R Systems (MAGNETS)," which involves the Integration of active and passive elements in GaN-based Transmit and receive modules.

David Kaeli, College of Engineering Distinguished Professor, electrical and computer engineering, and Agnes Chan of the College of Computer and Information Science, have received a $4.6M four-year renewal award from the National Science Foundation to continue and expand its participation in the CyberCorps® Scholarship for Service (SFS) program, which prepares highly-qualified cybersecurity professionals for entry into the government workforce.

Associate Professor **Sandra Shefelbine**, jointly appointed in bioengineering and mechanical and industrial engineering, was awarded a $650K National Science Foundation grant for her project, titled "Mechanobiology of Joint Morphogenesis: Manipulating Salamander Limbs." This project will examine the regenerating limbs of salamanders.

Bioengineering Assistant Professor **Ambika Bajpayee** was awarded a $310K DoD Peer Reviewed Medical Research Program Discovery Award. Collaborators on the grant include Sunny Zhou, professor of chemistry, and **Sandra Shefelbine**, associate professor of bioengineering and mechanical and industrial engineering. Bajpayee will design cartilage targeting therapies for the treatment of osteoarthritis (OA). The work promises to enable clinical translation of potential disease modifying OA drugs, which are currently limited by a lack of tissue targeting drug delivery systems.

Associate Professor **Mehrdad Sasani** of civil and environmental engineering won the 2016 Clemens Herschel Award from the Boston Society of Civil Engineers Section of the American Society of Civil Engineers in recognition of his paper "Analytical and Experimental Evaluation of Progressive Collapse Resistance of a Flat-Slab Posttensioned Parking Garage."

Professor **Laura Lewis**, jointly appointed in chemical engineering and mechanical and industrial engineering, won a Fulbright U.S. Scholar Program grant for a research project in Spain to advance her research in magnetic materials. The Fulbright program is the flagship international educational exchange program sponsored by the U.S. government. Additionally, Lewis was selected as an American Physical Society fellow. The criterion for election is exceptional contributions to the physics enterprise.

Assistant Professor of Chemical Engineering **Nasim Annabi's** research to solve the problem of chronic non-healing wounds has led to the development of the first elastic and adhesive wound dressing with adhesive, antimicrobial, and regenerative properties. The research findings were published in the journal, *Biomaterials*.
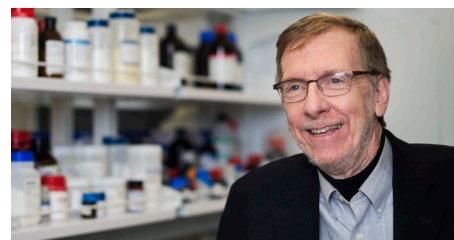
Bioengineering Professor and Chair **Lee Makowski's** new research findings on Alzheimer's progression were published in the journal *Scientific Reports*. The findings may mean that some strains of fibrils are associated with disease whereas others are not, and distinguishing between them may provide critical insights for developing therapies to show, halt, or reverse the neurodegeneration associated with Alzheimer's disease.

Richard Harris, assistant dean and director, and **Hameed Metghalchi**, professor of mechanical and industrial engineering, are co-leading a $3.5 million five-year National Science Foundation grant, in collaboration with five other U.S. universities, from the Louis Stokes Alliances for Minority Participation. As part of the international Research Experiences for Undergraduates program funded by the NSF grant, seven Northeastern engineering rising sophomores participated for the first time in international research experiences in Shanghai China at Shanghai Jiao Tong University in summer 2017.

Associate Professor **Kaushik Chowdhury**, electrical and computer engineering, received a $500K DARPA Young Faculty Award for "Reconfigurable and Application

Independent Design for Radios." RAIDER seeks to create a true "cognitive" software defined radio platform that will enable resilient communication, and increased RF environmental awareness, and intentionally protect or degrade reception capability at distant locations. Chowdhury also received the prestigious Presidential Early Career Award for Scientists and Engineers. See page 19.

Assistant Professor **Stratis Ioannidis** and Professor **Edmund Yeh** of electrical and computer engineering were awarded a $500K National Science Foundation grant for "Caching Networks with Optimality Guarantees." The project provides distributed, adaptive, stochastic optimization protocols with optimality guarantees over arbitrary network topologies.
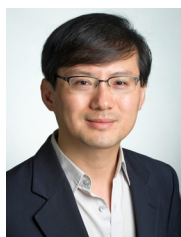
Professor **Edmund Yeh**, electrical and computer engineering, received a $1M, two-year National Science Foundation award for his project, entitled "Software Defined Network-Assisted Named Data Network for Data Intensive Experiments." The project team will redesign the Large Hadron Collider (LHC) high energy physics program network. Northeastern is the lead on this multi-university initiative, working with the California Institute of Technology and Colorado State University.

Professor of Chemical Engineering **Shashi Murthy** was awarded a $300K National Science Foundation grant to create a "Bioreactor System for Autologous T-Cell Stimulation." The cell type that is most commonly used to target cancers is the T cell, a type of white blood cell. The project addresses the manufacturing challenge associated with T cell stimulation with an interdisciplinary approach to design disposable stimulation systems that can accept dendritic cell and T cell samples, accomplish the desired stimulation in a timely and efficient manner, and generate enough T cells for a therapeutic dose.

Assistant Professor **Qianqian Fang**, bioengineering, was awarded a five-year $1.7M National Institutes of Health grant for "A Versatile High-Performance Optical Mammography Co-Imager." The research will fundamentally address the current clinical limitations in x-ray mammography by developing a vendor-independent high-performance optical mammography co-imager with which optical measurements can be jointly reconstructed using the structural guidance from a separately acquired 2D or 3D digital x-ray mammogram.

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." 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.
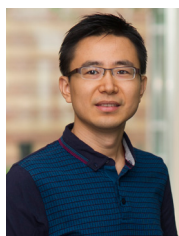
Associate Professor **Yun Raymond Fu**, electrical and computer engineering, has been selected as a fellow of the International Association for Pattern Recognition. Fu was selected for his contributions to pattern recognition, data mining, and visual intelligence.
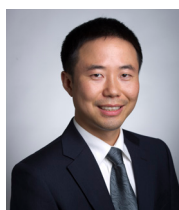
Assistant Professor **Yongmin Liu**, mechanical and industrial engineering, and electrical and computer engineering, was selected as part of the inaugural cohort of SPIE Defense and Commercial Sensing Rising Researchers

by the International Society of Optics and Photonics.

QSM Diagnostics, founded by Associate Professor **Edgar Goluch**, chemical engineering, was awarded an "In-Kind Silver Winner" prize at the 2016 MassChallenge. QSM Diagnostics uses a proprietary instrument sensor to identify common infectious bacteria in bodily fluids within one minute at the point-of-care.

Associate Professor **Ming Su**, chemical engineering, received a $300K grant from the National Institute of Justice to work on new nanoparticle barcodes, which would have an astronomically large coding space as compared to those of printed barcodes, but completely invisible to the naked eye. Additionally, Su's research on cancer biomarker detection using phase change nanoparticles was highlighted in the recent annual report of Lung Cancer Research Program of Congressionally Directed Medical Research Program of the Department of Defense.
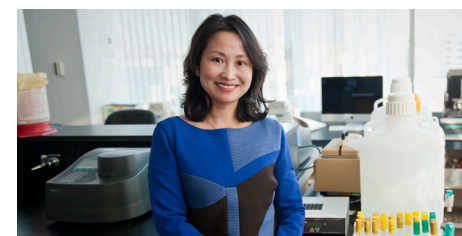
Professor **April Gu**, civil and environmental engineering, has been elected to the Association of Environmental Engineering and Science Professors (AEESP) Board of Directors. The AEESP is made up of professors in academic programs throughout the world who provide education in the sciences and technologies of environmental protection. Gu has also been selected as a Water Environment Federation fellow for her professional achievement, stature and contributions to the preservation and enhancement of the global water environment.

Chair and Professor of Chemical Engineering and Art Zafiropoulo Chair in Engineering **Thomas Webster** developed a novel self-assembling nanomolecule that is being exclusively licensed by Audax Medical, Inc. for use in tissue regeneration. Additionally, at the 13th IASTED International Conference on Biomedical Engineering in Innsbruck, Austria, Webster was awarded the Plenary Award for his lab's contributions to commercializing nanomedicine. Webster also received the International Society for Ceramics in Medicine Excellence Award for outstanding service in the field of biomaterials.

Professor **Peter Furth**, civil and environmental engineering, received an Innovation in Education Award from the Institute of Transportation Engineers' Transportation Education Council in recognition of his highly regarded Dialogue of Civilizations course, which other transportation engineering educators around the country have learned about, envied, and in some cases, emulated.

College of Engineering Distinguished Professor **Ming Wang**, civil and environmental engineering, PhD graduate **Nicole Martino**, **Ken Maser** of the VOTERS research center, and former research faculty member Ralf Birken won the 2017 Outstanding Paper in Research Award from the American Society for Nondestructive Testing for an article published in the May 2016 issue of *Research in Nondestructive Evaluation*. The article, titled "Quantifying Bridge Deck Corrosion using Ground Penetrating Radar," highlights some of the key work produced in the VOTERS center related to automated detection of damage in roadways and bridge decks using sensors mounted on vehicles driving through traffic.

Associate Professor **Rifat Sipahi**, mechanical and industrial engineering, achieved the rank of senior member of the IEEE, an honor bestowed only to those who have made significant contributions to the profession. Only about 8% of over 400,000 members attain this membership grade.

An article, titled "Improving Security Screening: A Comparison of Multistatic Radar Configurations for Human Body Imaging," by College of Engineering Distinguished Professor **Carey Rappaport**, electrical and computer engineering (ECE), and Assistant Professor **Jose Martinez-Lorenzo**, mechanical and industrial engineering, jointly appointed in ECE, was one of four featured articles on the cover of *IEEE Antennas & Propagation*.

Associate Professor **Carol Livermore**, mechanical and industrial engineering, and doctoral student **Chenye Yang** were awarded a patent for a "Sealable Microvalve that can be Repeatedly Opened and Sealed" and can be used for miniature vacuum and analysis systems.

Assistant Professor **Pau Closas**, electrical and computer engineering, has been given an Early Achievement Award by the Institute of Navigation (ION), the world's premier non-profit professional society dedicated to the advancement of the art and science of positioning, navigation, and timing. The award is given "for mathematically profound contributions to the design of advanced navigation receivers and for efforts in disseminating GNSS technology."

STUDENTS

PhD student **Maria Sevillano**, civil and environmental engineering, won the "Best Student Presentation" award at the Association of Science Engineering & Science Professors (AEESP) research and education conference in Michigan for her presentation, titled "Incidence of Antimicrobial Resistance Genes in

Municipal Drinking Water Samples from the United Kingdom." Sevillano was one of four winners chosen from more than 200 student presenters.

PhD student **Emrecan Demirors** and Associate Professor **Tommaso Melodia**, electrical and computer engineering, received the Best Student Paper Award at the 11th ACM International Conference on Underwater Networks and Systems (WUWNet'16) for their paper "Chirp-Based LPD/LPI Underwater Acoustic Communications with Code-Time-Frequency Multidimensional Spreading." It is the second year in a row that Demirors and Melodia won the Best Paper Award at this conference.

Jaclyn Lock, PhD candidate in the Department of Bioengineering, advised by Chemical Engineering Professor Rebecca Carrier, was awarded first place in the Materials Engineering & Sciences Division (MESD) poster competition at the annual American Chemical Institute for Chemical Engineers (AIChE) meeting in San Francisco. Lock's poster "Dextran Sodium Sulfate Exposure Affects Intestinal Mucus Integrity" was selected out of 50 posters in the competition.

Mechanical and Industrial Engineering Professor **Hameed Metghalchi's** Energy Systems master's students, **Keyur Jigyasu** and **Emilda Totozani**, were selected as one of only twelve finalists globally in the Go Green in the City competition by Schneider Electric focusing on innovative energy solutions for smart cities. In October 2017 the students will travel to Paris to compete for a job offer from Schneider Electric.

PhD student **Jing Xu**, mechanical and industrial engineering, won the "Volpe Best Presentation Award" at the 2017 New England Chapter Human Factors and Ergonomics Society student research conference.

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.
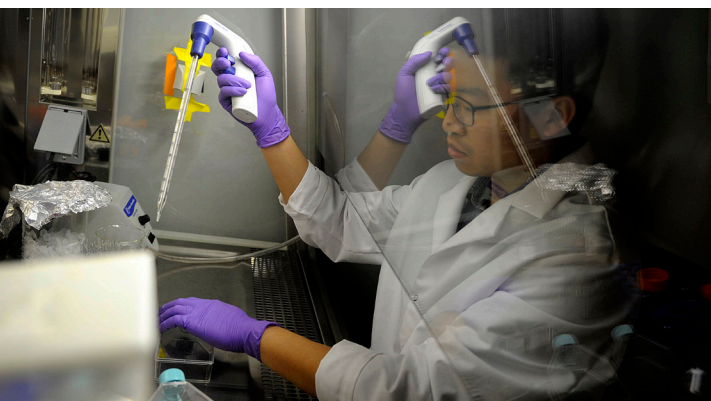
Departments

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 2015 – 2016 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.

83

AFFILIATED AND T/TT FACULTY MEMBERS

331

STUDENTS

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

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
Ying-Yee Kong
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
April Gu
Robert Hanson
Ferdi Hellweger
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 five 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 doubled. This has all culminated into our recognition by the *U.S. News and World Report* that over this five 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 program currently places students in over 55 companies spanning the areas of consumer products, plastics, biotechnology, nanotechnology, alternative energy, and petrochemicals, to name a few. We even place students in international co-op locations in the UK, France, Switzerland, China, and Vietnam. It is not hard to see why we have been ranked four times as the Best Internship/Career Service University 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 sub-fields of chemical engineering. Collectively, our graduate students and faculty have organized over 24 conferences in the past five years demonstrating our leadership across chemical engineering.

I invite you to explore our Department of Chemical Engineering through this Scholarship Report and find out why we have been listed among the top "up-and-coming national universities" by the *U.S. News and 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
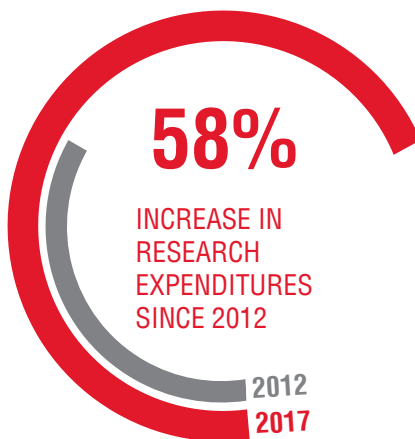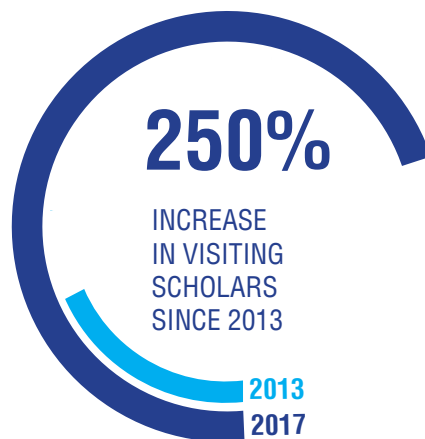
ADVANCED MATERIALS RESEARCH

Nasim Annabi
Debra Auguste
Sidi Bencherif
Sunho Choi
Arthur Coury
Matthew Eckelman
Adam Ekenseair
Hicham Fenniri
Joshua Gallaway
Andrew Gouldstone
Vincent Harris
Francisco Hung
Barry Karger
Lucas Landherr
Laura Lewis
Courtney Pfluger
Ming Su
Thomas Webster
Richard West
Ronald Willey
Katherine Ziemer

BIOLOGICAL ENGINEERING

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

100+
GRADUATE students

250%
INCREASE IN VISITING SCHOLARS SINCE 2013
2013
2017

58%
INCREASE IN RESEARCH EXPENDITURES SINCE 2012
2012
2017

23
TENURED/ TENURE-TRACK Faculty

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

DEPARTMENT CHAIR MESSAGE

The Department of Civil and Environmental Engineering has more than doubled in size of the faculty over the last seven years, with 46 faculty in civil and environmental engineering, and has more than doubled in size of the graduate program over the last seven years, with over 230 graduate students. Building out the research infrastructure of the university, this past spring the university opened the new 220,000 square foot Interdisciplinary Science and Engineering Complex that provides state-of-the art laboratories in engineering and science.

This year the department launches a new BS in Environmental Engineering, with plans for it to be ABET accredited for our first graduates. This degree program reflects our significant growth and expansion of scope in environmental engineering and water resources engineering and includes several new courses. Last year we also launched two new graduate degrees, including an MS in Environmental Engineering (MSEnvE) and an MS in Engineering and Public Policy (MSEPP) with two concentrations, including Energy and Environment, and Infrastructure Resilience. These degrees focus on topics of significant national need, with the MSEnvE integrating environmental engineering and science with public health, water sustainability, and water-energy-nexus, and the MSEPP degree providing students with the core skills needed to address engineering solutions while recognizing the impact of public policy and societal constraints on these solutions.

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

Our scholars strive to use today's discovery and research to make tomorrow happen. You can see some highlights of our civil and environmental engineering faculty members at northeastern.edu/tomorrow. We hope you enjoy this report, and we look forward to sharing our future accomplishments in our annual scholarship reports.

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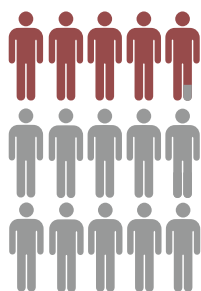**jf.hajjar@northeastern.edu**

See Civil and Environmental Engineering's full scholarship report at **coe.neu.edu/civ/sr**
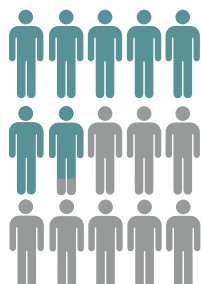
3
FEDERALLY **FUNDED** RESEARCH CENTERS

8
NATIONAL SCIENCE FOUNDATION CAREER Awards

46
TENURED/ TENURE-TRACK
Including Affiliated Faculty

166
masters students

33% female

70
doctoral students

46% female

FACULTY BY RESEARCH THRUSTS

CIVIL INFRASTRUCTURE SECURITY

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

ENVIRONMENTAL HEALTH

Akram Alshawabkeh
Edward Beighley
Matthew Eckelman
Loretta Fernandez
Auroop Ganguly
Edgar Goluch
Tarik Gouhier
Jonathan Grabowski
April Gu
Ferdi Hellweger
Brian Helmuth
A. Randall Hughes
Philip Larese-Casanova
Amy Mueller
Samuel Muñoz
Annalisa Onnis-Hayden
Mark Patterson
Ameet Pinto
Matthias Ruth
Thomas Sheahan
Aron Stubbins
Geoffrey Trussell
Kai-Tak Wan

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
Mark Patterson
Matthias Ruth
Craig Shillaber
Ali Touran
Geoffrey Trussell
Ming Wang
Qi Ryan Wang

DEPARTMENT CHAIR MESSAGE

We in the Department of Electrical and Computer Engineering are happy to provide you with our Annual Scholarship Report. This report highlights the research and accomplishments of our esteemed faculty in the past year, serving as a reminder of the real-world implications of the work being done here at Northeastern.

There are a couple of exciting initiatives we would like to bring to your attention. In particular, the National Science Foundation named Associate Professor Tommaso Melodia director of research of the Project Office for the Platforms for Advanced Wireless Research initiative, also known as PAWR. PAWR will fund the research and development of multiple community-scale platforms supporting next-generation wireless communications networks across the U.S. Over the next seven years, the PAWR Project Office will oversee close to $100 million in investments from the National Science Foundation.

Professor Edmund Yeh will lead Northeastern as a member of a group that was given a four-year, $10 million research project from the Defense Advanced Research Projects Agency. This group, Northeastern, MIT, and Raytheon BBN, will work hand-in-hand to research advance wireless communication technology.

Lastly, COE Distinguished Professor David Kaeli received a $4.6 million, four-year award from the National Science Foundation to continue and expand the CyberCorps® Scholarship for Service program. The renewal of this 2012 grant will allow the program to continue to prepare highly-qualified cybersecurity professionals for entry in the government workforce.

We hope you can come see for yourself the exciting work being done in our wonderful department and college.

22
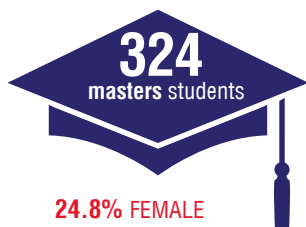**YOUNG INVESTIGATOR**
Awards

18
NATIONAL SCIENCE FOUNDATION CAREER Awards

53
TENURED/ TENURE-TRACK
Faculty

Miriam Leeser
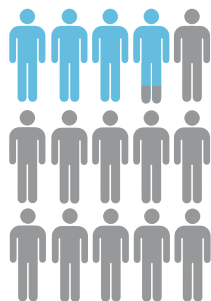**Professor and Interim Chair of Electrical and Computer Engineering**
m.leeser@northeastern.edu

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

324 masters students

24.8% FEMALE

240 doctoral students
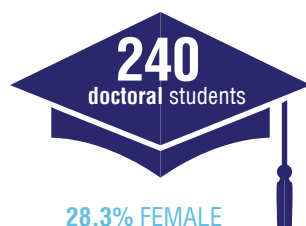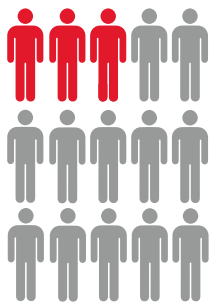
28.3% FEMALE

13 IEEE **FELLOWS**

$53 MILLION IN ACTIVE **RESEARCH GRANTS**

FACULTY BY RESEARCH AREAS

COMMUNICATIONS AND SIGNAL PROCESSING

Dana Brooks
Pau Closas
Jennifer Dy
Deniz Erdogmus
Vinay Ingle
Hanoch Lev-Ari
Sarah Ostadabbas
Purnima Ratilal-Makris
Masoud Salehi
Dagmar Sternad
Milica Stojanovic

COMPUTER ENGINEERING, NETWORKS, AND ROBOTICS

Stefano Basagni
Octavia Camps
Kaushik Chowdhury
Yunsi Fei
Yun Raymond Fu
Stratis Ioannidis
David Kaeli
Engin Kirda

Mieczyslaw Kokar
Miriam Leeser
Xue Lin
Fabrizio Lombardi
Waleed Meleis
Tommaso Melodia
Ningfang Mi
Taskin Padir
Wil Robertson
Gunar Schirner
Hanumant Singh
Devesh Tiwari
Edmund Yeh

MICROSYSTEMS AND DEVICES

Hui Fang
Yong-Bin Kim
Nicol McGruer
Marvin Onabajo
Matteo Rinaldi
Aatmesh Shrivastava
Nian Sun
Srinivas Tadigadapa

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

$17M ANNUAL FACULTY RESEARCH EXPENDITURES

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

$17M
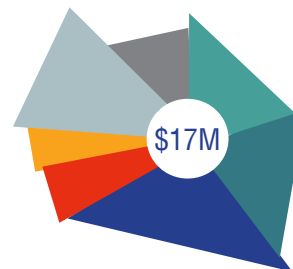
The department offers seven research concentrations and is either the lead or partner of seven federally-funded research centers.

DEPARTMENT CHAIR MESSAGE

The Department of Mechanial 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 20 new tenured/tenure-track faculty members over four years, with no attrition to other universities, has propelled eight research clusters in the department toward excellence.

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, while continuing the strong working relationship with federal and state agencies. The annual research award has gone up by 35% over four years.

In parallel with the tenured/tenure-track faculty hires, the addition of nine teaching faculty members over four years has enabled educational excellence to advance even further. Undergraduate admissions has become ever more competitive, and the average SAT has reached 1450. The graduate student population has more than doubled over the same period. Some of our recent doctoral and post-doctoral graduates have started their tenure-track careers at Arizona State University, Mississippi State University, North Carolina State University, and University of Central Florida, to name a few.

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.

Strategic hiring, people focus, and preservation of a conducive environment have enabled people to work hard and work happily, and thereby work 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 18 places to No. 39 in four years, while our industrial engineering graduate program has moved up four places to No. 32 during the same period.

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!

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

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**

1047

GRADUATE STUDENTS

17

YOUNG INVESTIGATOR AWARDS

55

TENURED/ TENURE-TRACK FACULTY

2

NATIONAL ACADEMY MEMBERS

FACULTY BY RESEARCH AREAS

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Ahmed Busnaina
Hanchen Huang
Yung Joon Jung
Gregory Kowalski
Yiannis Levendis
Yongmin Liu
Carol Livermore
Hameed Metghalchi
Reza Sheikhi
Mohammad Taslim
Hongli (Julie) Zhu

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George Adams
Andrew Gouldstone
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Yang Liu
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Sinan Müftü
Hamid Nayeb-Hashemi
Sandra Shefelbine
Rifat Sipahi
Ashkan Vaziri
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John Whitney
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MECHATRONICS

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Nader Jalili
Yingzi Lin
Carol Livermore
Jose Martinez Lorenzo
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Robert Platt
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BIOMECHANICS

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Andrew Gouldstone
Sinan Muftu
Shashi Murthy
Hamid Nayeb-Hashemi
Sandra Shefelbine
Ashkan Vaziri
Kai-Tak Wan

NANOMANUFACTURING

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Randall Erb
Jacqueline Isaacs
Nader Jalili
Yung Joon Jung
Yongmin Liu
Carol Livermore
Marilyn Minus
Moneesh Upmanyu
Hongli (Julie) Zhu

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Hameed Metghalchi
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Reza Sheikhi
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Ahmed Busnaina
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Andrew Gouldstone
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Jacqueline Isaacs
Yung Joon Jung
Laura H. Lewis
Yongmin Liu
Marilyn Minus
Sandra Shefelbine
Moneesh Upmanyu
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Hongli (Julie) Zhu

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James Bean
Mehdi Behroozi
James Benneyan
Thomas Cullinane
Ozlem Ergun
Nasser Fard
Jackie Griffin
Surendra Gupta
Xiaoning Jin
Sagar Kamarthi
Yingzi Lin
Emanuel Melachrinoudis
Vinod Sahney

HEALTHCARE SYSTEMS

James Benneyan
Chun-An (Joe) Chou
Jackie Griffin
Sagar Kamarthi
Yingzi Lin
Vinod Sahney

MECHANICAL AND INDUSTRIAL ENGINEERING

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Courtesy H. Singh (c) WHOI

COVER IMAGE

Electrical and Computer Engineering Professor Hanumant Singh and PhD candidate Pushyami Kaveti work on the electronic housing end caps of the Seabed hover-capable autonomous underwater vehicle at Northeastern University's new Interdisciplinary Science and Engineering Complex. Seabed was developed at the Woods Hole Oceanographic Institution as part of the Northeastern-led NSF Engineering Research Center for Subsurface Sensing and Imaging Systems (CenSSIS). Twelve Seabeds have been built to date and are used by researchers around the world for underwater imaging in the areas of fisheries and coral reef mapping, marine geological and geophysical mapping, marine archaeology, and polar studies.