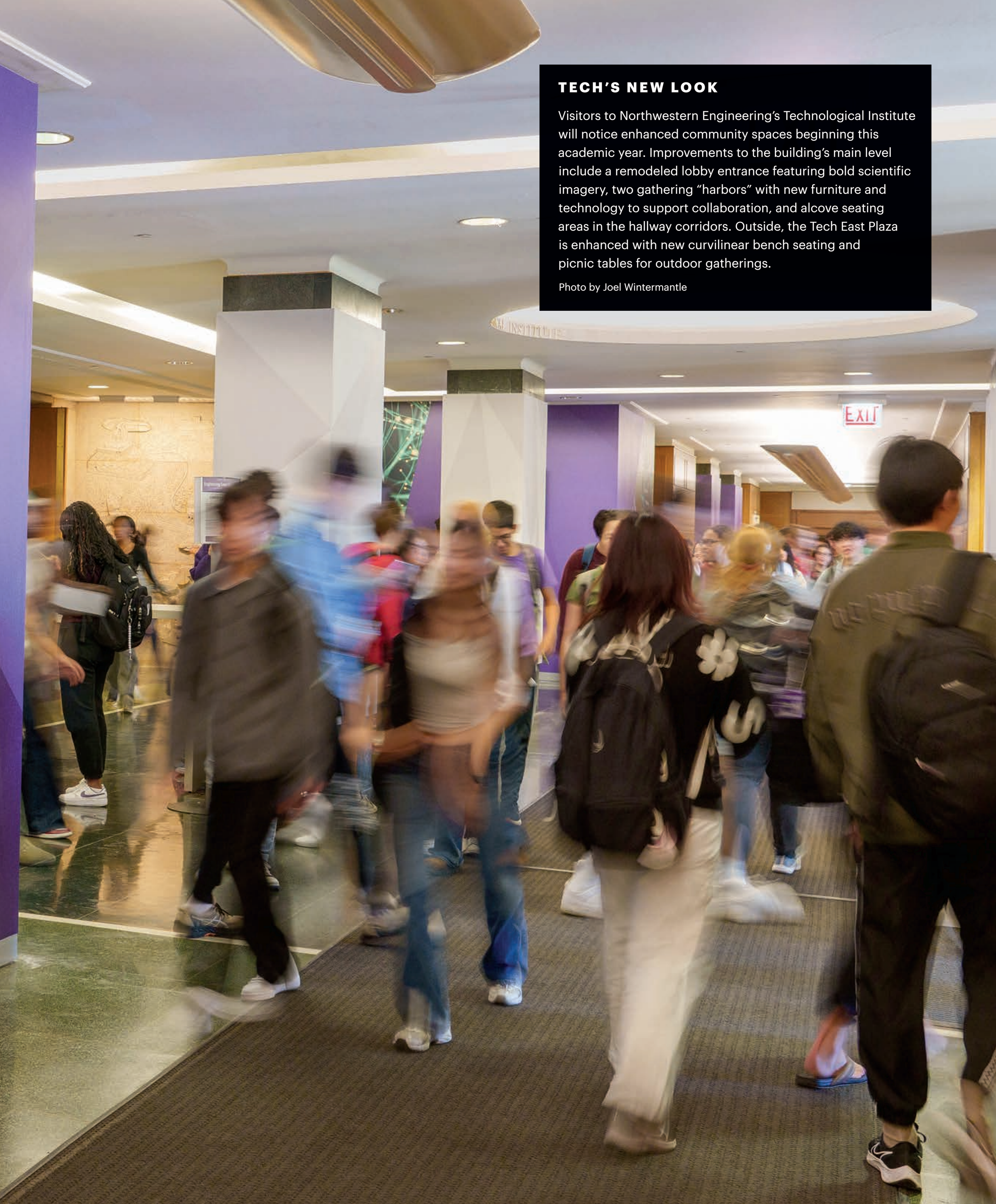
McCormick School of Engineering and Applied Science

NORTHWESTERN ENGINEERING

FALL 2024

BUILDING THE FUTURE OF NORTHWESTERN ENGINEERING

A VISION FOR LEADING ENGINEERING INTO THE NEXT ERA



TECH'S NEW LOOK

Visitors to Northwestern Engineering's Technological Institute will notice enhanced community spaces beginning this academic year. Improvements to the building's main level include a remodeled lobby entrance featuring bold scientific imagery, two gathering "harbors" with new furniture and technology to support collaboration, and alcove seating areas in the hallway corridors. Outside, the Tech East Plaza is enhanced with new curvilinear bench seating and picnic tables for outdoor gatherings.

Photo by Joel Wintermantle

"OUR STRATEGIC PLAN AIMS TO STRENGTHEN AND BUILD ON THE GROUNDBREAKING RESEARCH AND EDUCATION THAT WE DO SO WELL WHILE ALSO KEEPING THE DOOR OPEN FOR ONCE-IN-A-GENERATION IDEAS."

GREETINGS FROM NORTHWESTERN ENGINEERING

One of the best parts of my job as dean has been talking with faculty, staff, students, and alumni about the future of engineering and, of course, the future of our school. Over this last year, I have worked with our department chairs and senior leaders to analyze our strengths and growth areas to create a guiding strategic vision.

The result, which you can read about on page 16, is three strategic pillars that will guide us in pushing engineering into the next era: revolutionizing the methods of engineering, transforming engineering education, and advancing the critical applications of engineering. Within each of these pillars are individual areas of research focus, paths forward for educational initiatives, and targeted plans for how we will approach the grand challenges and opportunities of our day, including climate change, AI, and human health. In a nutshell, our strategic plan aims to strengthen and build on the groundbreaking research and education that we do so well while also keeping the door open for once-in-a-generation ideas.

This issue of the magazine features some of those trailblazing research areas. Quantum computing and devices are undergoing a new revolution. By harnessing the power of quantum mechanics, researchers could ultimately solve problems in areas ranging from information technology to drug discovery to transportation and logistics. Several of our faculty across departments are working to build and refine these technologies, and the results, both in the near and far term, are bound to change the world as we know it.

This issue also features work by faculty members Mark Hersam—a pioneer in nanoelectronics who was recently elected to the National Academy of Engineering—and Ludmilla Aristilde, a member of our Department of Civil and Environmental Engineering whose research into soil pathways could have implications in ecosystem health and agricultural productivity.

I hope you enjoy reading about this work, and I look forward to connecting with you in the coming year to tell you more about our vision for the future of McCormick.

CHRISTOPHER A. SCHUH
Dean, McCormick School of Engineering and Applied Science

On the Cover
Dean Christopher Schuh and faculty have spent the last year mapping out Northwestern Engineering's future in research and education, which has culminated in a new strategic vision. See the story on page 16.

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Northwestern | McCORMICK SCHOOL OF ENGINEERING

Executive Director of Strategic Initiatives and Marketing: Kyle Delaney

Editorial Team: Christa Battaglia, Alex Gerage, Brian Sandalow, Michelle Mohney, Emily Ayshford

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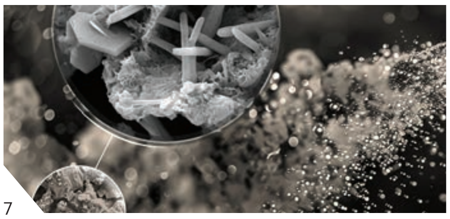
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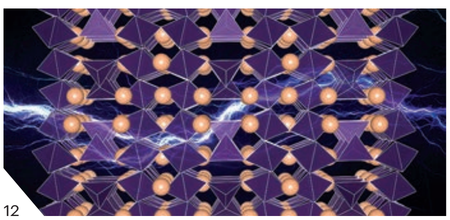
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NORTHWESTERN ENGINEERING
FALL 2024

NEWS

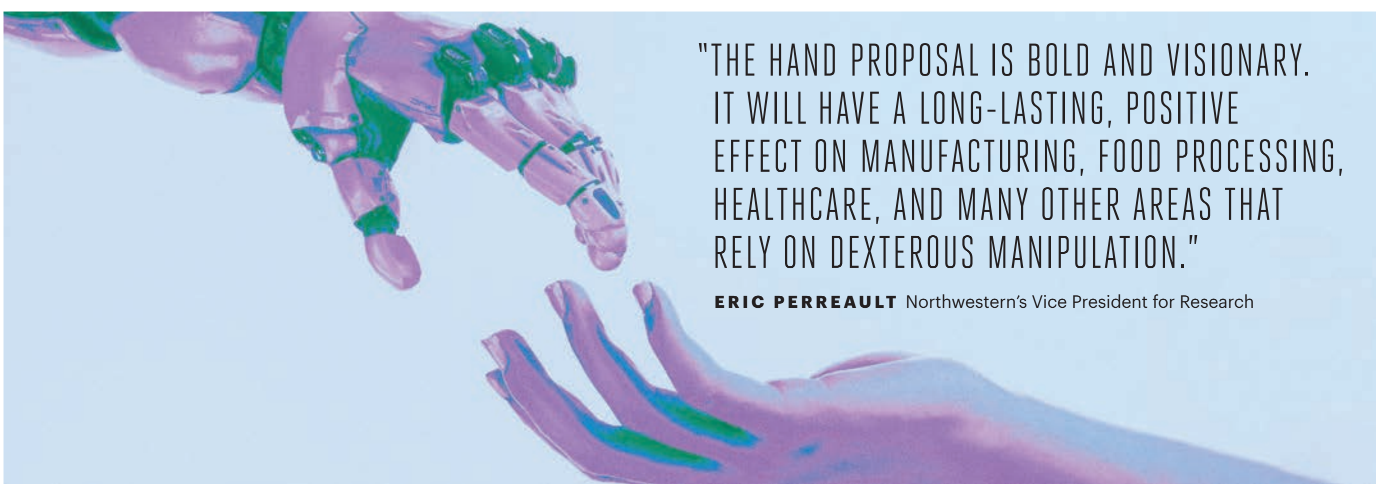
CENTER FOR ENGINEERING IN VISION AND OPHTHALMOLOGY LAUNCHES

Launched this summer, the Center for Engineering in Vision and Ophthalmology (CEVO) will work to develop new engineering tools to both improve vision loss diagnosis and management and to restore sight. Codirected by Professor Hao Zhang and Feinberg School of Medicine Professor Nicholas Volpe, the center is committed to translating engineering discoveries into ophthalmology practice with a focus on the interdisciplinary training of next-generation engineers and physicians.

"Vision loss is actually the second-most feared condition. That's why anything improving vision greatly improves the quality of life," Zhang says. "This center is focused on translating engineering research and interdisciplinary education. We want more Medical Scientist Training Program students to understand the injury aspect."

At an event to mark the launch of the center, Dean Christopher Schuh said, "As a school, Northwestern Engineering has a strong and rapidly growing effort at the intersection of engineering and the biosciences. We're also deeply committed to moving our innovations out of the lab and into the market, where they can improve lives. I'm absolutely delighted by the launch of CEVO, as it perfectly reflects both of these priorities."

New Robot Research Center to Receive up to $52 Million



"THE HAND PROPOSAL IS BOLD AND VISIONARY. IT WILL HAVE A LONG-LASTING, POSITIVE EFFECT ON MANUFACTURING, FOOD PROCESSING, HEALTHCARE, AND MANY OTHER AREAS THAT RELY ON DEXTEROUS MANIPULATION."

ERIC PERREAULT Northwestern's Vice President for Research

A large multi-institutional collaboration led by Northwestern University has received $26 million from the US National Science Foundation (NSF) to launch a new Engineering Research Center (ERC) dedicated to revolutionizing the ability of robots to amplify human labor.

Called Human AugmentatioN via Dexterity (HAND), the ERC will develop dexterous robot hands with the ability to assist humans with manufacturing, caregiving, handling precious or dangerous materials, and more. The center aims to build technological tools that are versatile and easy to integrate, creating robots capable of intelligent and versatile grasping, fine motor skills, and hand-eye coordination.

The NSF grant will fund the new center across five years, with the ability to renew for another $26 million for an additional five years. Core partners include Carnegie Mellon University, Florida A&M University, and Texas A&M University, with additional faculty support from Syracuse University, the University of Wisconsin–Madison, and the Massachusetts Institute of Technology.

Professor J. Edward Colgate, an expert in robots and haptics, will lead the center. Professor Kevin Lynch will serve as the center's research director. Other Northwestern collaborators include the McCormick School of Engineering's Brenna Argall, Jian Cao, Matthew Elwin, Elizabeth Gerber, Todd Murphey, and Ryan Truby and the School of Education and Social Policy's Lois Trautvetter.

"Northwestern has long strived to provide national leadership in areas of the greatest societal and economic importance," says Dean Christopher Schuh. "The HAND ERC does just that, delivering a broad innovation ecosystem, united in purpose and mission, to realize robot dexterity."

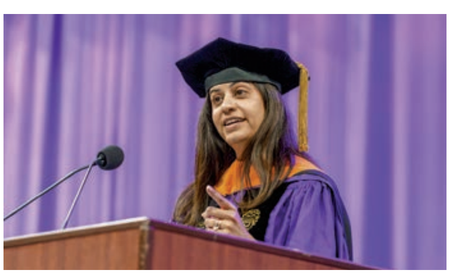
Northwestern to Lead Midwestern Carbon-Capture Hub

The US Department of Energy (DOE) has dedicated billions of dollars to explore the potential of direct air capture (DAC) technologies that can pull CO_2 out of the atmosphere. Regional DAC Hubs are a key part of DOE's strategy and are supported with $100 million in DOE investments. Northwestern University is leading one of these hubs with nearly $4 million invested by DOE and partner companies. The award will be administered through the Paula M. Trienens Institute for Sustainability and Energy.

The DOE-funded projects will work to demonstrate the capture, processing, delivery, and sequestration or end-use plans for captured carbon. Called the Midwest Nuclear DAC Hub (MINDAC), the Northwestern-led program will unite a diverse group of research and commercial partner institutions to test the feasibility of using a zero-emission nuclear fleet to power air handling units that remove CO_2 from the atmosphere.

MINDAC is one of only two DAC Hubs located in the Midwest as well as one of two hubs with plans to harness nuclear energy as a power source. After feasibility testing and engineering are complete, each Regional DAC Hub is expected to capture 1 million metric tonnes of CO_2 annually from the atmosphere. This is 250 times more CO_2 than the largest operating DAC facility currently removes.

"While we need to amplify efforts to reduce greenhouse gas emissions across all economic sectors, given the urgency and severity of climate change, we need all options on the table—full speed ahead." **JENNIFER DUNN** Professor of Chemical and Biological Engineering



Sheila Gujrathi Tells Her Story to Graduating Seniors

Sheila Gujrathi ('92, MD '96) was forced to deal with a significant challenge at the outset of her Northwestern journey: She lost her father. Though she went on to become a biotechnology entrepreneur and executive, she struggled at the time. After enrolling in medical school, she dropped out and moved to an ashram in India, which helped her define her purpose and values.

"Don't ignore the answers. They're pointing you to your purpose and passion: what you were put on this Earth to do," she said during her address at Northwestern Engineering's 2024 undergraduate convocation held June 10. "You can't stop at what you want to do, though—you also need to figure out who you want to be."

30

PhD engineering students who took part in the Farley Center's Entrepreneurial Scientist Bootcamp

21

Climate change observation stations in the Chicago area, including at Northwestern, for the federal Community Research on Climate and Urban Science project

BUILDING CONNECTIONS WITH BAY AREA EMPLOYERS AND ALUMNI

During spring break 2024, 23 Northwestern students traveled to the San Francisco Bay Area to build connections with employers and alumni as part of a Northwestern Computer Science (CS) career development pilot initiative. Professor Samir Khuller accompanied the cohort, which included engineering students pursuing undergraduate and master's degrees in computer science, industrial engineering, and mechanical engineering. The group also included computer science students in Northwestern's Weinberg College of Arts and Sciences.

The cohort visited companies of various sizes in different industries, including Aptos Labs, Dolby Laboratories, Adobe Research, Uber, and Liftoff Mobile. Students also met with alumni and friends of Northwestern CS at the University's San Francisco academic center.

SOCIETY OF WOMEN ENGINEERS HOSTS 2024 CAREER DAY FOR GIRLS

In February 2024, the Northwestern undergraduate student chapter of the Society of Women Engineers (SWE) hosted Career Day for Girls. Around 180 students from nearby schools signed up to attend the 53rd annual event, which featured the theme "Reach for the Stars!"

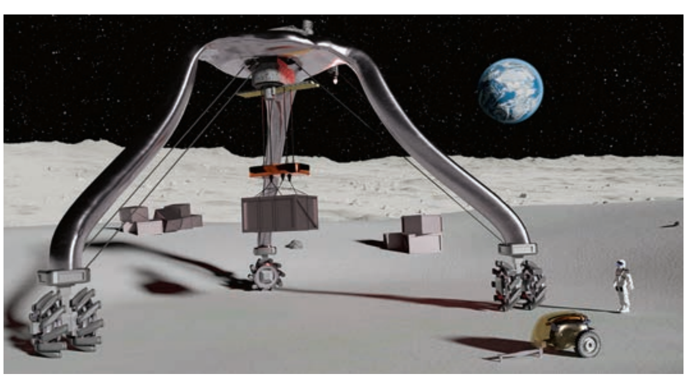
Designed for middle and high school students, the program welcomes students of any gender identity who are interested in science and mathematics.

Career Day for Girls is NU SWE's largest on-campus outreach event, hosting students from the Chicagoland area for hands-on engineering activities and competitions. The program, which was divided into separate paths for the middle school students and the high school students, included educational content and career information about opportunities in engineering and applied science.

The high school cohort visited the Querrey Simpson Institute for Bioelectronics, Subsurface Opportunities + Innovations Laboratory, and the Northwestern University Atomic and Nanoscale Characterization Experimental Center. Meanwhile, the middle school group met with members from Northwestern's Baja racing team and the AutoAquaponics project in Northwestern's chapter of Engineers for a Sustainable World. They also visited the 3D Printing and Rapid Prototyping Lab and heard a panel discussion with four engineering graduates from Northwestern and other universities.

"CAREER DAY FOR GIRLS IMPACTS YOUNG STUDENTS' LIVES BY SHOWING THEM THAT THEY DO BELONG IN ENGINEERING, AND THAT ENGINEERING IS ACCESSIBLE TO EVERYONE."

GYDA NAWARUNGRUANG Electrical Engineering/MS Computer Science '25, **TARA SAXENA** Mechanical Engineering '25, NU SWE Outreach Codirectors



STUDENT TEAM SELECTED FOR NASA BIG IDEA CHALLENGE

If or when NASA reestablishes a human presence on the moon, novel inflatable systems configured for future lunar operations could play a key role. A team that included Northwestern Engineering students was again selected to help fill that need.

The interdisciplinary group of 23 engineering students was one of six selected for funding in NASA's 2024 annual Breakthrough, Innovative, and Game-Changing (BIG) Idea Challenge. The team proposed a metal inflatable system made by laser-welding stacked layers of sheet metal along their aligned edges. On the lunar surface, pressurization would deploy gantries, solar towers, and other structures from rolled, folded, or origami-like stowed configurations.

4–12 mm

Size of stickers developed by John Rogers that can detect fluid leaks inside the body after gastrointestinal surgery

5

Years since the Center for Physical Genomics and Engineering was founded at Northwestern

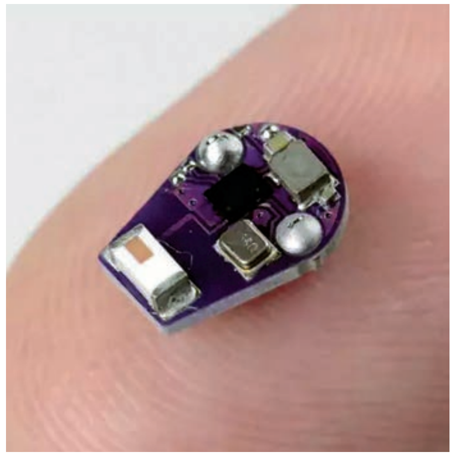
GRACE WANG URGES GRADUATES TO THINK BIG

Grace Wang (PhD '01), president of Worcester Polytechnic Institute, speaking at the 2024 PhD Hooding and Master's Degree Recognition Ceremony, held June 10, encouraged graduates to harness both their imagination and their abilities. She stressed that it's even more important to respect others.

"Regardless of what career paths we choose and what jobs we do, we all work with people. Genuinely respect and value others," she said. She recounted listening to a mentor who told her to eat and sleep well, exercise, and pace herself. "Think boldly as you pave the path forward. … Pace your own journey as you enjoy it along the way."

LAB NOTES

Sensors Monitor Inflammation, Bladder Function



Two new sensors developed by Professor John Rogers will help people with Crohn's disease and people who have compromised bladder function.

Rogers and his team developed the first wireless, implantable temperature sensor to detect inflammatory flare-ups in patients with Crohn's disease. The tiny, soft device rests within the gastrointestinal system and measures temperature. Rogers and another team also developed a new soft, flexible implant that attaches to the bladder wall to sense filling. It wirelessly transmits data to a smartphone app, so users can monitor their bladder fullness in real time. It marks the first example of a bioelectronic sensor that enables continuous monitoring of bladder function for a prolonged period.

"The cement and concrete industries significantly contribute to human-caused CO_2 emissions. We are trying to develop approaches that lower CO_2 emissions associated with those industries and, eventually, could turn cement and concrete into massive 'carbon sinks.'"

ALESSANDRO ROTTA LORIA Louis Berger Associate Professor of Civil and Environmental Engineering

Simple New Process Stores CO_2 in Concrete Without Compromising Strength

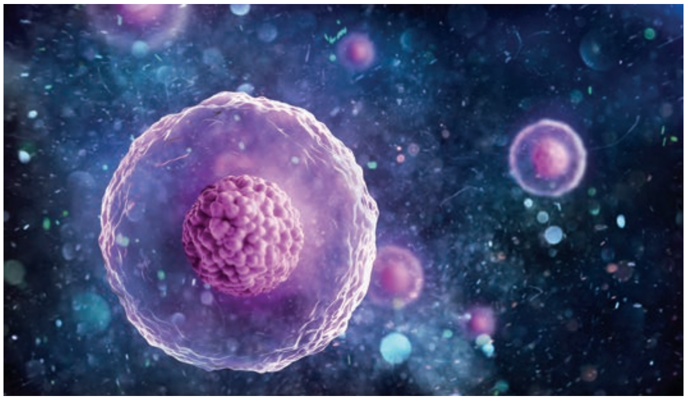
By using a solution based on carbonated rather than still water during the concrete manufacturing process, a Northwestern-led team of engineers has discovered a new way to store carbon dioxide (CO_2) in the ubiquitous construction material. Not only could the process help sequester CO_2 from the ever-warming atmosphere, it also results in concrete with uncompromised strength and durability.

In laboratory experiments, the process achieved a CO_2 sequestration efficiency of up to 45 percent, meaning that nearly half of the CO_2 injected during concrete manufacturing was captured and stored. The researchers hope their new process could help offset CO_2 emissions from the cement and concrete industries, which are responsible for 8 percent of global greenhouse gas emissions. Professor Alessandro Rotta Loria led the research in collaboration with Cemex, a global building materials company dedicated to sustainable construction.

AI Algorithm Identifies High-Performing Electrolytes for Batteries

A tool developed by Professors Wei Chen and James Rondinelli provides a new solution to an intractable problem. Electrolytes enable batteries to generate power in everything from cell phones to electric cars. Scientists have long sought to develop longer-lasting, more efficient electrolytes, but the vast number of potential molecular combinations that requires presents a challenge.

Chen and Rondinelli were part of a team that developed an artificial intelligence algorithm called MolSets, which uses machine learning to predict the properties of electrolyte mixtures. It completes in seconds a process that would take years to do in the lab.



TRANSPORTING PRECIOUS CARGO USING THE BODY'S OWN DELIVERY SYSTEM

Professors Neha Kamat and Josh Leonard sent tiny, virus-sized containers to effectively deliver an engineered protein to its target cell and trigger a change in the cell's gene expression. The success came from encouraging engineered proteins to move toward a specific cell membrane structure that increases a protein's likelihood of latching onto the container.

The keys to this "cargo loading" approach are sites on cell membranes called lipid rafts that are more structured than the rest of the membrane and reliably contain specific proteins and lipids. The study brings researchers a step closer to addressing a major bottleneck for biological medicine development: determining how to protect fragile molecules in the body and ensure they reach the correct diseased cells in a patient without impacting healthy cells.

"In this study, we discover general ways to load drug cargo into these vesicles very efficiently while preserving their function. This might enable more effective and affordable extracellular vesicle-based biological medicines."

NEHA KAMAT Associate Professor of Biomedical Engineering

RESEARCHERS MOVE CLOSER TO GREEN HYDROGEN VIA WATER ELECTROLYSIS

Water electrolysis offers an ideal process for producing hydrogen, a chemical element that could play a key role in the global energy transition. As an energy source, hydrogen has been largely untapped due to unaffordability and a lack of understanding of the catalysts used to produce it. Research from Professor Linsey Seitz on the most promising catalysts, iridium-based oxides, enabled the design of a novel catalyst that maintains higher activity, longer stability, and more efficient iridium use, which could make green hydrogen production feasible.

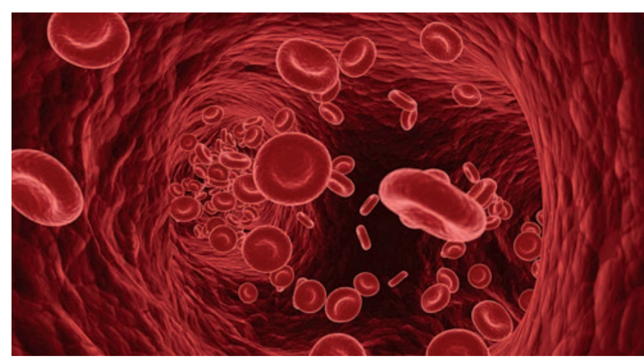
The research combined complementary electron- and x-ray-based characterization techniques to, for the first time, identify experimental evidence for how the surface of iridium oxide changes during water electrolysis.

AI Tool Quickly Assesses Self-Harm Risk

A new assessment tool that leverages powerful artificial intelligence uses a quick and simple combination of variables to predict whether participants exhibited suicidal thoughts and behaviors.

Developed by Professor Aggelos Katsaggelos and PhD student Shamal Shashi Lalvani along with an international team of researchers, the system focuses on a simple picture-ranking task along with a small set of contextual/demographic variables rather than extensive psychological data.

The tool was on average 92 percent effective at predicting four variables related to suicidal thoughts and behaviors. The study concludes that a small set of behavioral and social measures plays a key role in predicting suicidal thoughts and behaviors. The current work details how the tool could help develop an app for medical professionals, hospitals, or the military to assess those most at risk of self-harm. Data was collected from surveys completed by 4,019 participants ages 18 to 70 across the United States.



3D PRINTING AND CITRATE BIOMATERIALS COULD ALLOW DISSOLVABLE STENTS

Implanted stents have saved countless lives, but they can also develop plaque due to the systemic nature of the same cardiovascular disease they were implanted to counteract.

Recent work from Professor Guillermo Ameer could allow the restenting of an artery to restore blood flow with a dissolvable product, a process currently not possible.

Using a 3D printing technology called microCLIP developed at Northwestern by Professor Cheng Sun, Ameer produced citrate-based bioresorbable vascular scaffolds (BVS) with a strut thickness of 62 micrometers, which is thinner than a human hair. Ameer's stent can also slowly release the drug Everolimus, which is used to prevent vessels from re-occluding due to scar-like tissue after angioplasty, by depositing a drug-and-citrate-based polymer coating onto the 3D printed BVS. "Blood vessels treated with our bioresorbable vascular scaffolds were able to regenerate their endothelium, the inner cell layer in contact with blood that, when healthy, prevents clots," Ameer says.

RANDOM ROBOTS ARE MORE RELIABLE

A new AI algorithm developed by Professor Todd Murphey and his team helps robots rapidly and reliably learn complex skills. Called Maximum Diffusion Reinforcement Learning (MaxDiff RL), the algorithm's success lies in its ability to encourage robots to explore their environments as randomly as possible to gain a diverse set of experiences.

This "designed randomness" improves the quality of data that robots collect regarding their surroundings. By using higher-quality data, simulated robots also demonstrated faster and more efficient learning, improving their overall reliability and performance. When tested against other AI platforms, simulated robots using MaxDiff RL consistently outperformed state-of-the-art models.

8

Number of lunar soil simulants Eric Jacobson is analyzing to develop lunar construction technology, working with McCormick alum Katie Koube ('14)

30

Degrees Fahrenheit by which Mars could warm based on a method, proposed by Hooman Mohseni, that would release engineered particles into the atmosphere

"UNDERSTANDING THE ORIGIN OF THE SUN'S MAGNETIC FIELD HAS BEEN AN OPEN QUESTION SINCE GALILEO AND IS IMPORTANT FOR PREDICTING FUTURE SOLAR ACTIVITY, LIKE FLARES THAT COULD HIT THE EARTH."

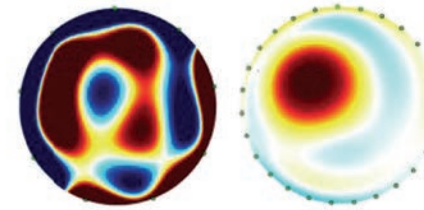
DANIEL LECOANET Assistant Professor of Engineering Sciences and Applied Mathematics

Sun's Magnetic Field Originates Surprisingly Close to the Surface

An international team of researchers including Professor Daniel Lecoanet is getting closer to solving a 400-year-old solar mystery that stumped even famed astronomer Galileo Galilei. Since first observing the sun's magnetic activity, astronomers have struggled to pinpoint where the process originates. Now, after running a series of complex calculations on a NASA supercomputer, the researchers discovered that the magnetic field is generated about 20,000 miles below the sun's surface.

The finding contradicts previous theories that suggest the phenomenon originates more than 130,000 miles below the sun's surface. Not only does the new discovery help scientists better understand the sun's dynamic processes, it also could help them more accurately forecast powerful solar storms, which can damage electricity grids, radio communications, and Earth-orbiting satellites.

To solve the puzzle, the research team developed new, state-of-the-art numerical simulations to model the sun's magnetic field. Unlike previous models, the new model accounts for torsional oscillations, a cyclical pattern of how gas and plasma flow within and around the sun. Because the sun is not solid like Earth and the moon, it doesn't rotate as one body. Instead, its rotation varies with latitude. Like the 11-year solar magnetic cycle, torsional oscillations also experience an 11-year cycle.



A SHARPENED FOCUS FOR SEEING WITH ELECTRICITY

The ability to visually represent internal electrical resistance variations within a body is called electrical impedance tomography. EIT has applications across numerous fields, including defect detection in electronic materials, medical imaging to determine organ function, or even soil quality and moisture content assessment.

But EIT uses data from all possible available measurements for a given number of electrical contacts. While this allows for a complete picture of electrical resistance, it also introduces noise from the weaker signals, resulting in suboptimal resistance maps. Professor Matthew Grayson and his team added more contacts to increase the number of measurement options without increasing the actual number of measurements. Their algorithm can then select only highest-signal measurements, resulting in higher-resolution and more accurate images.

"Interdisciplinary work like this happens at Northwestern because of intersections of expertise and because of the serendipity of proximity. As an electrical engineer, I can walk down the hall and knock on the door of a geophysicist. Who knew that our cross-disciplinary expertise would open an exciting new frontier in biomedicine, structural testing, and robotics?"

MATTHEW GRAYSON
Professor of Electrical and Computer Engineering

An AI-Driven Design Framework for Programmable Material Systems

A team with Professor Wei Chen has developed an AI framework that could enhance the design and functionality of programmable material systems (PMS).

Crafted from smart materials, these structures can respond to external stimuli and transition between multiple states or functions. The applications of PMS are diverse, ranging from surgical robots and deployable satellites to water- and energy-harvesting devices.

But PMS have posed challenges because the co-design of structure, material, and external stimuli is a nontrivial task due to the extremely vast space of possible choices, high dimensionality, and a trade-off across on-demand functions.

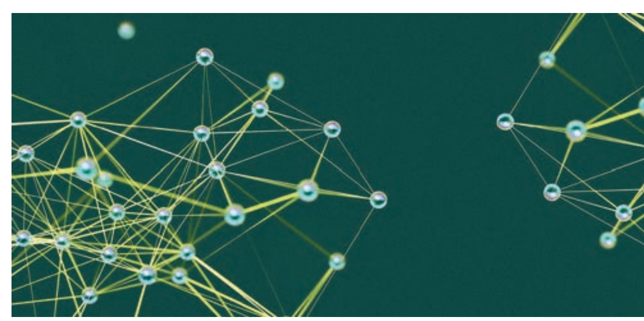
To combat those obstacles, the team developed a data-driven design approach based on a state-of-the-art machine-learning technique called "neural operator." The research team plans to extend its AI-driven design approach to additional PMS applications, further exploring the potential of this technology. The focus will also include advancing the design framework to account for uncertainties, such as those arising from manufacturing imperfections.

"WE HAVE BROADENED THE HORIZON OF AI FOR DESIGN, SPECIFICALLY FOR PMS FEATURING COMPLEX FIELDS OF INPUTS AND OUTPUTS, BEYOND THE REACH OF CONVENTIONAL DESIGN. THIS COULD HELP EXPEDITE CUSTOMIZATION AND MINIATURIZATION OF NEXT-GENERATION PRODUCTS AND DEVICES WITH BUILT-IN INTELLIGENCE." **WEI CHEN** Wilson-Cook Professor in Engineering Design

THE IMPACT OF THE VENEZUELAN CRISIS ON THE COUNTRY'S INTERNET

Over the past decade, multiple socioeconomic and political crises have profoundly impacted Venezuela's public and private sectors. Professor Fabian E. Bustamante and his team examined the ramifications of the crisis on a previously unexplored area—Venezuela's internet infrastructure. They aimed to understand better the declining connectivity landscape and the potential long-term consequences on the network to help inform mitigation strategies.

They reported findings of bandwidth stagnation, limited network infrastructure growth, and high latency compared to average service in Latin America. The team studied core infrastructure to access networks, evaluating metrics including bandwidth measurements, changes to the submarine cable network, and routes to root Domain Name System servers. The research team also found clear signs of decline in Venezuela's DNS infrastructure.

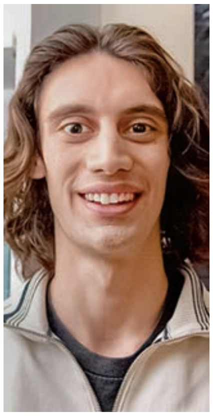


POLYMER ELECTRONICS FEEL STRAIN AND EVOLVE DURING OPERATION

Advanced plastics play a key role in a range of emerging energy, computation, and biomedical technologies. Understanding these complex materials poses a considerable challenge for conventional characterization techniques. In particular, understanding the dynamic aspects of these material systems under external stimuli is important for improving both material design and longevity.

Research from a team that included Professor Jonathan Rivnay details how strain and dynamics couple with an external electrical stimulus within a complex polymer system. Rivnay and his colleagues discovered that the deformation induced by voltage and the resulting structural changes depend on how the voltage is applied to the material, whether through a large step or a gradual change. This finding is important because the deformation and structural changes are related to the material's stability during electrochemical operation.

Jorge Nocedal

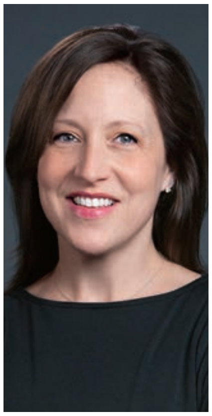


Daniel Lecoanet

G. Jeffrey Snyder

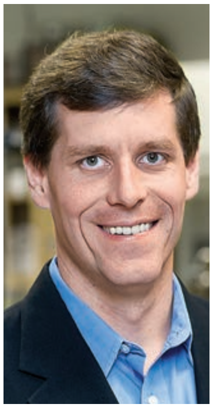
Chad Mirkin

Wei Chen



Sara Owsley Sood

Erik Luijten



Mark Hersam

Petia Vlahovska

Julio M. Ottino

Uri Wilensky

Teri Odom

Faculty Awards

Jorge Nocedal Receives John von Neumann Prize

Nocedal was recognized by the Society for Industrial and Applied Mathematics for his fundamental work in nonlinear optimization, both in the deterministic and stochastic settings.

Chad Mirkin Awarded Kavli Prize in Nanoscience

The first Northwestern scientist to receive the prestigious award from the Norwegian Academy of Science and Letters, Mirkin was recognized for his discovery of spherical nucleic acids.

Erik Luijten Named Fellow of the American Association for the Advancement of Science

Part of a 2023 class that spans 24 different disciplines, Luijten was honored for his development of highly efficient computer simulation algorithms and their application to statistical physics phenomena.

Julio M. Ottino Elected to American Institute for Medical and Biological Engineering's College of Fellows

Recognized for his outstanding contributions to the understanding of fluid mixing and biocomplexity and for his leadership in engineering education, Ottino is among 152 engineers who make up AIMBE's College of Fellows Class of 2024.

Daniel Lecoanet Named Sloan Research Fellow

The award from the Alfred P. Sloan Foundation recognizes Lecoanet as a next-generation leader with standout creativity, innovation, and research accomplishments.

Three Faculty Elected to American Academy of Arts and Sciences

Wei Chen, Mark Hersam, and Uri Wilensky are among the 250 individuals elected to the academy, one of the nation's oldest and most prestigious honorary societies.

G. Jeffrey Snyder Earns Two Awards for Thermoelectrics Research

Snyder was selected to receive a Humboldt Research Award from the Alexander von Humboldt Foundation and the Outstanding Achievement in Thermoelectrics Award from the International Thermoelectric Society.

Sara Owsley Sood Receives Alumnae of Northwestern University Award for Curriculum Innovation

The award recognizes and supports faculty who have innovative ideas for new courses, methods of instruction, and components of existing classes.

Three Faculty Appointed 2024 Guggenheim Fellows

Chad Mirkin, Petia Vlahovska, and Teri Odom are part of a diverse group of culture-creators working across 52 disciplines. As established in 1925 by founder US Senator Simon Guggenheim, each fellow receives a monetary stipend to pursue independent work at the highest level under "the freest possible conditions."

NORTHWESTERN ENGINEERING RESEARCHERS ARE COLLABORATING TO HARNESS THE EXTRAORDINARY PHENOMENA THAT UNDERLIE THE ORIGIN AND STRUCTURE OF THE UNIVERSE.

GOING **QUANTUM**

At first glance, quantum mechanics might seem strange or even impossible. That's because our everyday experiences of the laws of physics are very different from how matter and energy behave at the atomic and subatomic level.

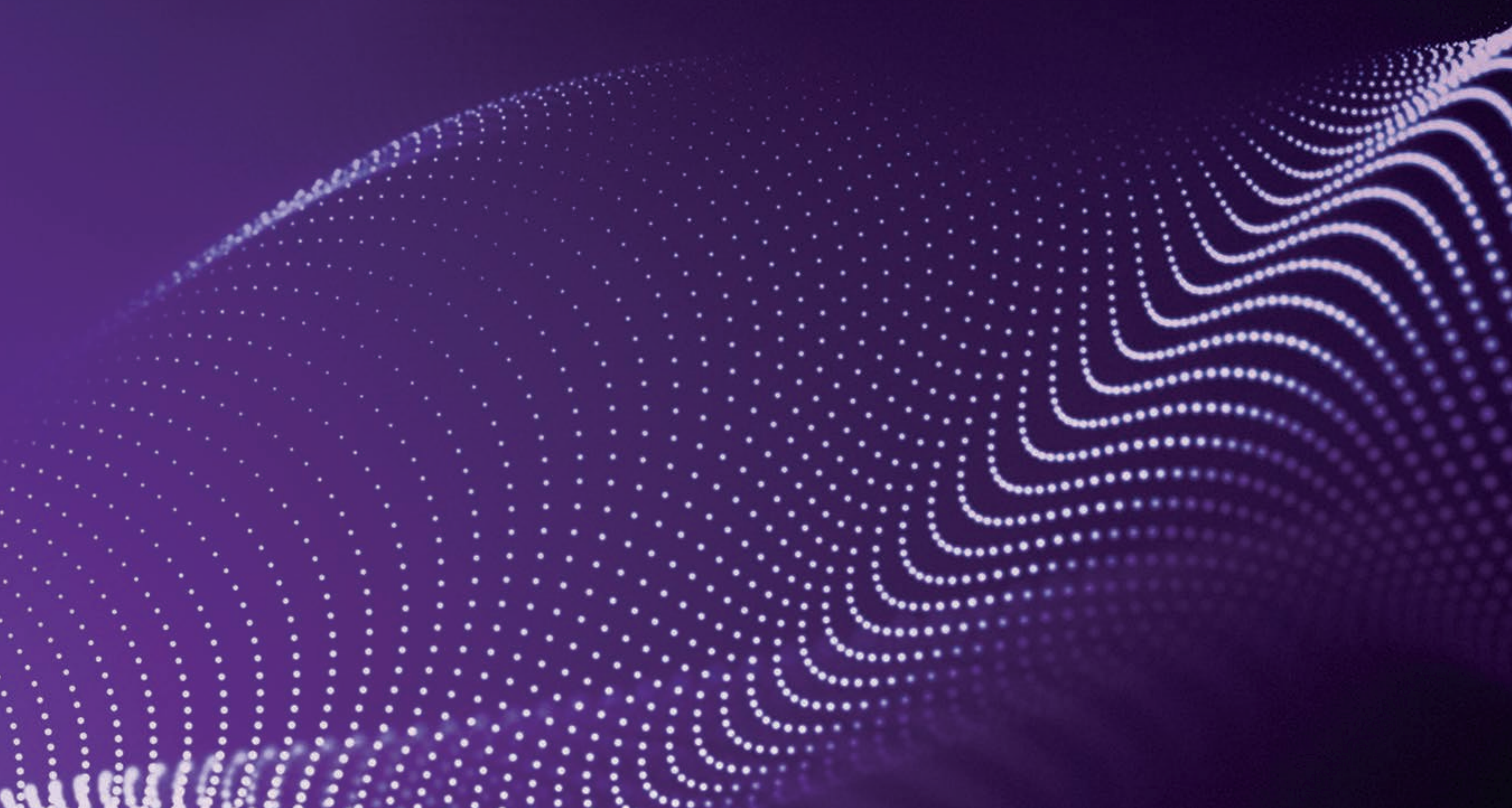
"Two things can be at the same time; things appear to jump through walls. The deeper we dig into the nature of reality, we find that it is very complicated and bizarre and far removed from our day-to-day experiences," says Prem Kumar, professor of electrical and computer engineering and director of the Center for Photonic Communication and Computing at Northwestern. "In the words of Arthur C. Clarke, 'any sufficiently advanced technology is indistinguishable from magic.'"

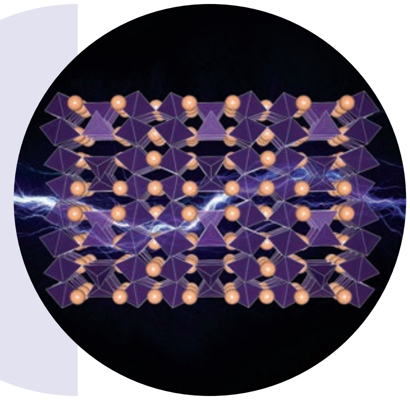
But quantum mechanics underlies the structure and origin of our universe and is even central to much of our technology. It explains nuclear fusion and governs how a solar panel converts sunlight to electricity.

When scientists began to understand the strange quantum phenomena of superposition, measurement, and entanglement, it paved the way for technologies such as lasers, MRI scanners, transistors, and semiconductor devices.

Scientists and engineers are now at the beginning of the next revolution in quantum computing, sensing, and communication. Work in quantum 2.0 could help solve currently insurmountable challenges in cryptography, drug discovery, information technology, optimization, and transportation and logistics.

Northwestern Engineering faculty in computer science, electrical engineering, computer engineering, and materials science are working alongside teams in chemistry and physics at Northwestern's Weinberg College of Arts and Sciences to leverage the unique behaviors of quantum particles to build more efficient, powerful, and sustainable technologies.





James Rondinelli discusses research ideas with materials science PhD student Megan Burrill.

The oxide compound $Ca_3Co_3O_8$, developed by Rondinelli's Materials Theory and Design Group, blurs the traditional distinctions between metals, polar materials, and magnets.

Engineering quantum communication networks

Building a large enough network

While quantum computers promise exponential processing power over classical computers, current quantum computers do not have enough quantum bits (qubits, the basic building blocks of quantum computers) to perform difficult computational tasks.

Still, researchers are looking for other ways to boost quantum computing. "It turns out that one way to improve computation and effectively increase the number of quantum transistors working together is to connect these computers via fiber networks—the same way that we now use cloud computation or distributed computing," says Mahdi Hosseini, associate professor of electrical and computer engineering.

These fiber networks are already used in classical communications, where a pulse of light carries binary information encoded as zeroes and ones, enabling the transmission of telecommunications signals through optical fibers.

Hosseini and Kumar are developing the next generation of fiber-based quantum networks, integrating quantum information into the existing classical fiber infrastructure to reap the exponential computational power and security of quantum communications.

Through the Advanced Quantum Networks for Science Discovery (AQNET) project, Kumar will demonstrate the feasibility of this classical-quantum symbiosis via Fermi National Accelerator Laboratory's Chicagoland quantum network, which connects Northwestern, Fermilab, Argonne National Laboratory, and the University of Illinois Urbana-Champaign.

Kumar will also build on his early work in quantum frequency conversion to help develop a quantum repeater demonstrator for Argonne's InterQnet project. Like an optical amplifier in classical communications, the repeater would boost quantum communication distances in fiber networks by enabling quantum interference of photons distinguishable by wavelength or color but made identical through the process of quantum frequency conversion.

Holding on to fleeting information

One advantage of quantum communication is its reliance on quantum phenomena such as superposition (where a qubit is in different states simultaneously until measured) and entanglement (where the quantum states of qubits are connected, no matter how far apart they are). Both help make quantum communications ultra secure: hacking, amplifying, or copying information is virtually impossible.

But this also makes quantum information difficult to control and store.

"Quantum information is very fragile. We cannot store it into a typical hard drive," Hosseini says. "And quantum mechanics forbids knowing what is stored. As soon as we look at quantum information and measure it, the quantum nature of information is destroyed."

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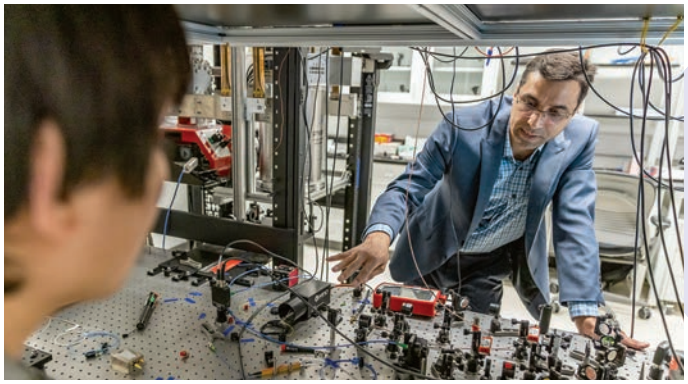
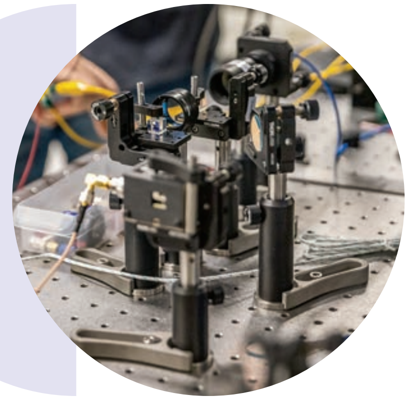
Professor of Electrical and Computer Engineering,
Director of the Center for Photonic Communication and Computing





Mahdi Hosseini works with postdoc Zongfeng Li in the Quantum Atom Optics lab.

Hosseini's team investigates light-atom interactions, harnessing the particle properties of light for applications in quantum optics, quantum materials, quantum communication, and quantum sensing.

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Associate Professor of Electrical and Computer Engineering

In collaboration with the US Department of Energy's Oak Ridge National Laboratory Quantum-Accelerated Internet Testbed project, Hosseini's research group is developing a building block for the future long-distance quantum network called quantum optical memory—a device designed to store quantum information carried by photons. Driven by practicality, the lab uses machine learning to optimize quantum storage at the telecom wavelength that can operate at temperatures achievable with tabletop refrigerators.

Atomic quantum memory technology, Hosseini explains, will enable a fundamentally secure quantum network guaranteed by the laws of quantum mechanics.

Designing quantum functionality into materials

To bring quantum technology out of the controlled research lab into a noisy world, Hosseini is leveraging the University's strength in materials science. In a study with materials scientists including Professors Michael Bedzyk and Mark Hersam, Hosseini applied a novel quantum thermoreflective imaging technique to perform a precise imaging of heat on microwires and superconductor materials.

This advancement in quantum thermal imaging can enable the study of microscopic phenomena within classical and quantum materials—an innovation of interest to James Rondinelli, who investigates structure–property relationships to design next-generation, multifunctional inorganic materials.

Applying an atom-by-atom design approach with quantum mechanical simulations and collaborative experimentation, Rondinelli's Materials Theory and Design Group recently developed a new material: $Ca_3Co_3O_8$. This oxide compound blurs the traditional distinctions between metals, polar materials, and magnets, combining intrinsically contradictory properties and paving the way for exciting functionalities in electronics and spintronics.

"This achievement opens the door to a frontier of unique quantum phenomena never before seen in classical systems and conventional metals," says Rondinelli, Walter Dill Scott Professor of Materials Science and Engineering.

Rondinelli's team is also modeling a subclass of polar metals called topological semimetals to address the interconnect bottleneck for further downscaling integrated circuits for microelectronics. Interconnects, traditionally copper, are the metal wires that connect billions of transistors in computer chips at the nanometer scale.

"As you shrink copper, it becomes so resistive that it no longer acts like a metal and consequently consumes more energy," Rondinelli says. "But in a topological semimetal, the current is carried via electronic states on the surface of the material. So thinner is better. The surface states are topologically protected and cannot be destroyed through scaling effects."

Quantum software to support hardware

Caffeine, a popular energy booster, is composed of 24 atoms. To describe all possible arrangements of the compound's subatomic particles would require 10 to the 48 (1e+48) bits, a staggeringly unfeasible amount of data to process even on today's most powerful supercomputer, says Kate Smith, assistant professor of computer science.

Smith studies quantum software and applies her work to supporting better-performing quantum computing systems. By applying quantum mechanical properties, quantum computers are theorized to enable applications in chemistry, cryptography, drug discovery, financial forecasting, machine learning, optimization, space exploration, and weather and climate modeling.

Pedram Khalili's team demonstrated that anti-ferromagnetic tunnel junctions can be grown on conventional silicon substrates using sputter deposition, an established semiconductor manufacturing technique.

from left PhD students Sevde Nur Arpaci and Jordan Athas, Khalili, postdoc Mohammad Hamdi

Smith is exploring how to build abstraction layers—interfaces that make it easier to describe and manipulate a quantum system—for quantum computation that are intuitive and would allow researchers to map their unanswered questions to implementations that reach solutions quantumly.

"This is a challenging problem," Smith says. "While there's a lot that you can borrow from classical computing to build out the quantum software stack, there's a lot of other things that have to be completely redefined."

Bridging classical and quantum

Pedram Khalili's Physical Electronics Research Laboratory integrates traditional semiconductor technologies with quantum materials to build energy-efficient computers that can solve sophisticated problems.

In one study, Khalili, AT&T Research Professor in the McCormick School of Engineering and professor of electrical and computer engineering, designed complementary metal-oxide-semiconductor probabilistic computing chips capable of solving complex optimization problems in concert with the magnetic random-access memory (MRAM) devices that Khalili pioneered. MRAM offers better speed and energy efficiency than existing semiconductor memories.

Through the US National Science Foundation's Future of Semiconductors program, Khalili leads a multi-institution team of researchers that aims to develop probabilistic computers

"OUR PROBABILISTIC COMPUTERS UTILIZE PHYSICS TO SOLVE HARD OPTIMIZATION PROBLEMS, WHICH HAS IMPORTANT SUSTAINABILITY IMPLICATIONS FOR A WIDE RANGE OF INDUSTRIES."

Pedram Khalili
AT&T Research Professor, Professor of Electrical and Computer Engineering

based on antiferromagnetic tunnel junctions. This new class of spintronic devices—resilient to magnetic fields and ionizing radiation—may provide even higher speeds and bit densities than existing MRAM devices.

Khalili's approach is to use physics—classical or quantum—in a way suited to the particular computing problem at hand, a paradigm he refers to as "unconventional computing."

"Our probabilistic computers utilize physics to solve hard optimization problems, which has important sustainability implications for a wide range of industries," Khalili says. "In the long run, we'll see a more domain-specific mix of quantum, unconventional, and classical computing technologies. This will enable the computing industry to overcome its current sustainability roadblock—which is the most important reason all of this work needs to be done—by innovating exciting new types of hardware and associated algorithms."

MICHELLE MOHNEY

"WHILE THERE'S A LOT THAT YOU CAN BORROW FROM CLASSICAL COMPUTING TO BUILD OUT THE QUANTUM SOFTWARE STACK, THERE'S A LOT OF OTHER THINGS THAT HAVE TO BE COMPLETELY REDEFINED."

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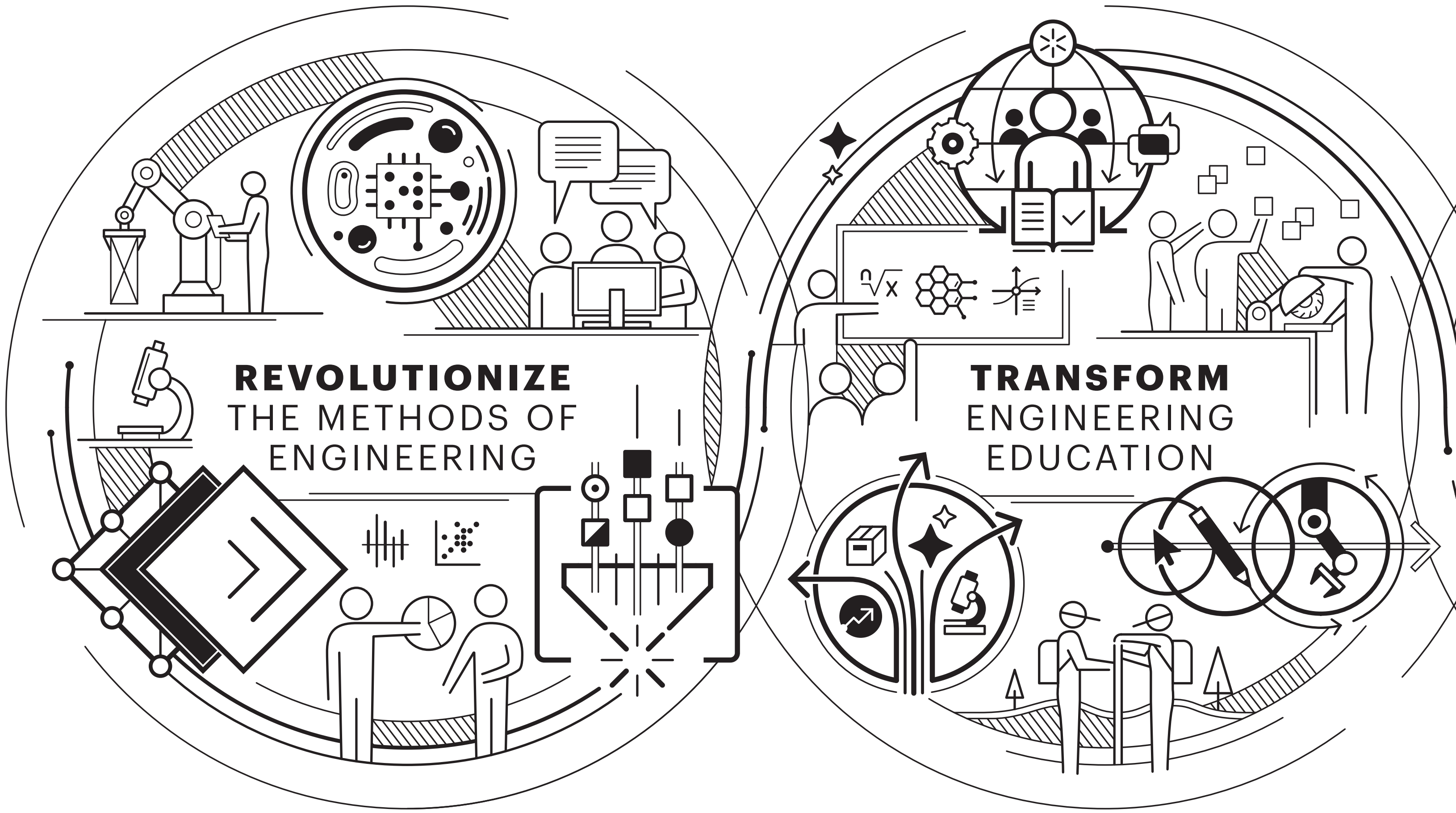


ENVISIONING ENGINEERING'S FUTURE

DEAN CHRISTOPHER SCHUH AND FACULTY LEADERS HAVE SPENT THE LAST YEAR MAPPING OUT NORTHWESTERN ENGINEERING'S FUTURE IN RESEARCH AND EDUCATION. THE SCHOOL'S NEW STRATEGIC VISION OFFERS A GLIMPSE OF WHAT IS TO COME.

Imagine McCormick's future. What will it look like?

OVER THE PAST ACADEMIC YEAR, Northwestern Engineering leadership—including Dean Christopher Schuh, the school's nine department faculty chairs, and senior administrative leaders—have worked to answer this deceptively simple prompt.

Through months of planning meetings and collaborative discussions that engaged the entire faculty, the team conducted a comprehensive **ANALYSIS OF THE SCHOOL'S STRENGTHS AND ANTICIPATED GROWTH AREAS** in **research and education, collaboration with key partners, and leadership thrusts** connected to the University's own priorities.

In late spring, the school formalized its **GUIDING STRATEGIC VISION,** one poised **to embrace the fast-changing nature of the engineering field and usher in a period of redefinition and growth.** The plan focuses on ▶ **THREE STRATEGIC PILLARS** ◀ that are key to **PUSHING ENGINEERING INTO THE NEXT ERA.**

1. REVOLUTIONIZE the Methods of Engineering

Build upon Northwestern Engineering's existing **research strengths** to define the **methods** and **tools** that engineers of tomorrow will need to know and use.

2. TRANSFORM Engineering Education

Pair these engineering methods with a curriculum steeped in **innovation, design,** and **entrepreneurial thinking** to prepare the next generation of engineers.

3. ADVANCE Critical Applications of Engineering

Apply engineering methods and a **whole-brain mindset** to positively impact the biggest challenges facing the world today—and tomorrow.

▶ **Northwestern Engineering's priorities** ◀ dovetail the school's future growth with four of the University's six research and innovation priorities over the next seven years:

- ▶ 1. **ADVANCE** the **biosciences**
- ▶ 2. **LEAD** in **decarbonization, renewable energy, and sustainability**
- 3. **FOSTER interdisciplinary innovation** among social sciences and global studies
- ▶ 4. **HARNESS** the power of **data analytics** and **artificial intelligence**
- 5. **ENHANCE** the **creative and performing arts**
- ▶ 6. **DELIVER** an **outstanding educational experience** for undergraduate and graduate students

> "I wanted us not only to think about how we can continuously improve the things we do well, but also to consider what we don't do all the time—once-in-a-generation ideas and goals—that can carry us into the future together."
>
> **CHRISTOPHER SCHUH** DEAN

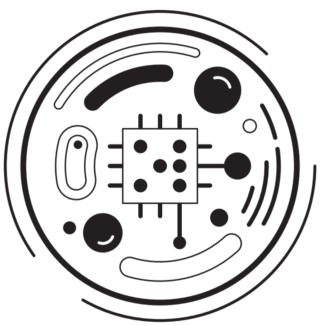
REVOLUTIONIZE THE METHODS OF ENGINEERING

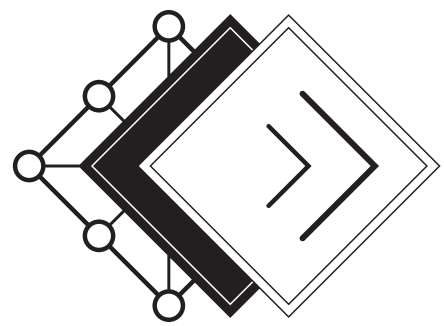
HOW ENGINEERS WORK IN THE FIELD IS CHANGING, AND IT'S CHANGING QUICKLY.

NOW IS THE TIME TO DEFINE HOW ENGINEERS WILL DRIVE THE FIELD FORWARD.

"We want to be AT THE FRONTIER OF DEFINING FUTURE METHODS that all engineers will know," Schuh says.

TO ACHIEVE THAT, Northwestern Engineering will foster new engineering tools and methodologies and focus on strengthening its research efforts in three areas.





Biohybrid Systems

Northwestern engineers will **MAXIMIZE BIOLOGY'S POTENTIAL** as a method to **create devices and technologies that SUPPORT WORK ACROSS DISCIPLINES.**

SYNTHETIC BIOLOGY

Alongside collaborators from Northwestern's Feinberg School of Medicine and Weinberg College of Arts and Sciences, Northwestern engineers are using the fundamental molecules of life—DNA, RNA, and proteins—to **DESIGN NEW TOOLS AND SYSTEMS TO TACKLE GLOBAL CHALLENGES** such as **water quality, crop health, biological drug delivery, and plastics upcycling.**

BIOELECTRONICS

Northwestern engineers are **developing the guiding mechanical, material, and biological processes** to overcome the mismatch between biological systems (soft, curvilinear, and transient) and modern semiconductor devices (rigid, planar, and long lasting), supporting platforms that **INTEGRATE SEAMLESSLY IN THE HUMAN BODY AND PROVIDE UNPRECEDENTED CLINICAL HEALTHCARE CAPABILITIES**.

BIOMATERIALS

Northwestern Engineering faculty are **CREATING SELF-ASSEMBLED, SYNTHETIC, AND NANOSCALE MATERIALS** designed to interact with the human body in new ways, supporting **innovative therapeutics and regenerative medicine.**

Concurrent Materials Design

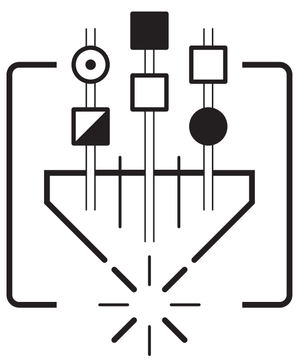
By **COMBINING STRENGTHS IN MATERIALS SCIENCE, GENERATIVE AI, AND MACHINE LEARNING TO PREDICT MATERIAL BEHAVIOR**, Northwestern engineers are **advancing methods** that allow researchers to design materials at the atomic and microstructural levels while simultaneously designing the product—such as electronics, batteries, and quantum technologies—for which they will be used.

"Concurrent materials design has become common throughout many of our research areas in materials science and an area of collaboration with other McCormick departments," says Mark Hersam, Walter P. Murphy Professor of Materials Science and Engineering and chair of the Department of Materials Science and Engineering. "By **LEVERAGING AI AND MACHINE LEARNING**, we're **DISCOVERING NEW MATERIALS** with ideal properties for our technologies **hundreds of times faster** than we would have before."

"Generative AI is revolutionizing how to design new materials that satisfy application-specific properties, significantly **reducing both research costs and time to market,"** says Samir Khuller, Peter and Adrienne Barris Chair of Computer Science. "We're **SUPPORTING A FUTURE** where researchers are no longer constrained by existing materials when developing a new device. Instead, AI is actively **HELPING TO DESIGN OPTIMAL MATERIALS AND DEVICES** concurrently in collaboration with human scientists."

"We want to be at the frontier of defining future methods that all engineers will know."

CHRISTOPHER SCHUH DEAN



Going Beyond Data: Discovery, Design, and Decision-Making

Data has undoubtedly changed how engineers think, teach, and work. **LEVERAGING STRENGTHS IN AI AND MACHINE LEARNING, OPTIMIZATION, AND APPLIED MATHEMATICS**, Northwestern engineers use data to **help guide decision-making.**

"Our ultimate goal is to leverage data to **create intelligent systems that excel at decision-making under uncertainty,"** says Simge Küçükyavuz, David A. and Karen Richards Sachs Professor of Industrial Engineering and Management Sciences and chair of the Department of Industrial Engineering and Management Sciences. "These systems will **IMPROVE EFFICIENCY, SAFETY, AND SUSTAINABILITY ACROSS SECTORS,** from healthcare to transportation to energy and more."

IMPROVING REINFORCEMENT LEARNING

Northwestern engineers are **ADVANCING REINFORCEMENT LEARNING, a form of machine learning** where models learn optimal policies through a process of trial and error, **dynamically adapting to changing environments and unforeseen challenges.** Its diverse applications range from autonomous systems—such as cars or robots—to advanced financial models making predictions in fluctuating markets.

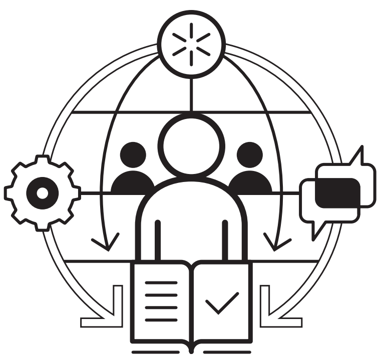
"Machine learning and artificial intelligence can make astonishingly good predictions, but they are still limited in their ability to contribute to the **understanding of complex systems in science and engineering,"** says Hermann Riecke, professor and chair of the Department of Engineering Sciences and Applied Mathematics. "Mathematical modeling can incorporate constraints within AI's deep architecture to **IMPROVE HUMAN INTERPRETABILITY.**"

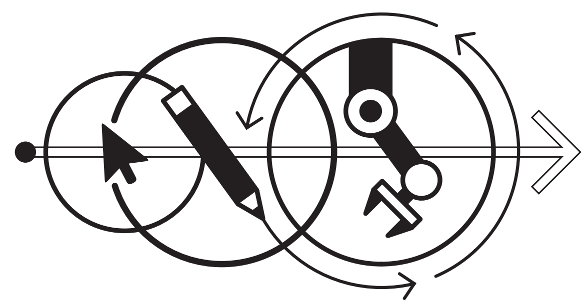
TRANSFORM ENGINEERING EDUCATION

CONCURRENT WITH NORTHWESTERN ENGINEERING'S MISSION TO REVOLUTIONIZE THE METHODS OF ENGINEERING IS ITS MISSION TO ▶ EMPOWER STUDENTS TO USE THESE METHODS AND ENVISION NEW ONES. ◀

TO DO THAT, the school will ▶ **PRIORITIZE INNOVATIVE, ADAPTABLE CURRICULUM AND PROGRAMS.** ◀

"There are plenty of forces that would have us ossify our curriculum and not change it," Schuh says. "It's not enough to define how engineering is done. We want those same methods reflected in our curriculum and taught to our students."





Innovate the First-Year Curriculum

When Northwestern Engineering unveiled its Engineering First curriculum more than 25 years ago, it introduced **design thinking** into undergraduate engineering education. Through the curriculum's flagship Design Thinking and Communication (DTC) course, first-year students collaborate with industry and nonprofit organizations to address client needs by **integrating science and mathematics with design** while also **building vital writing and communication skills.**

Now, Engineering First will **INJECT INNOVATION-BASED AND ENTREPRENEURIAL-BASED THINKING INTO THE CURRICULUM** to help future students consider how their client projects can better **CONNECT TO** **companies, the marketplace, and policy makers.** "Technical solutions—new designs, products, processes—have limited impact unless a pathway can be built for success in the marketplace," says Wes Burghardt, professor of chemical and biological engineering and associate dean of undergraduate engineering. "Whether launching a new enterprise or new directions within an established company, **entrepreneurial thinking skills are essential to gather support for any new innovation."**

Design Thinking That Permeates

Northwestern Engineering will more deeply **INCORPORATE ALL ELEMENTS OF ENGINEERING DESIGN**—including **mindset, process, and tools**—throughout the undergraduate curriculum and into senior-year capstone courses, ensuring that the school's unique approach to design innovation is leveraged alongside other engineering methods.

"We have a unique opportunity to **BUILD ON THE SKILLS** acquired in DTC—**creativity, teamwork, tackling poorly defined problems, appreciation of human factors**—by integrating those skills with **discipline-specific technical content** as students mature within their individual degree programs," Burghardt says.

"Technical solutions—new designs, products, processes—have limited impact unless a pathway can be built for success in the marketplace. Whether launching a new enterprise or new directions within an established company, entrepreneurial thinking skills are essential to gather support for any new innovation."

WES BURGHARDT
ASSOCIATE DEAN OF UNDERGRADUATE ENGINEERING

Flexibility and Innovation in Degree Programs

At all academic levels, Northwestern Engineering will continue to **PROVIDE A CURRICULUM THAT'S AS NIMBLE AS IT IS RIGOROUS** by **creating new degree programs and specializations and expanding existing offerings.**

"Rapid technological advancements and complex engineering challenges are reshaping the professional landscape," says Shelley Finnigan, associate dean for master's and professional education at Northwestern Engineering. "We regularly evaluate and **ENHANCE OUR DEGREE PORTFOLIO** **using insights from our faculty, groundbreaking research, and industry partners** to **ENSURE OUR STUDENTS GRADUATE** with the **specialized competencies** needed to **MEET THE DEMANDS** of both emerging and current leaders."

"We regularly evaluate and enhance our degree portfolio using insights from our faculty, groundbreaking research, and industry partners to ensure our students graduate with the specialized competencies needed."

SHELLEY FINNIGAN
ASSOCIATE DEAN FOR MASTER'S AND PROFESSIONAL EDUCATION

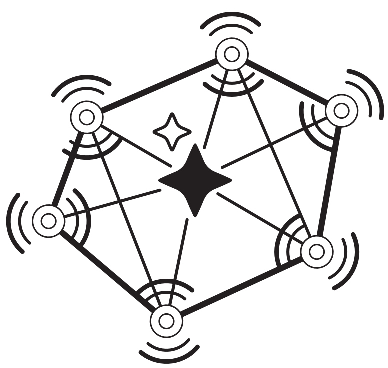
ADVANCE CRITICAL APPLICATIONS OF ENGINEERING

THE GRAND CHALLENGES THE WORLD FACES TODAY ARE IMPOSSIBLE TO LOOK PAST:

- TACKLING CLIMATE CHANGE.
- EXPLORING SPACE TRAVEL.
- MAXIMIZING ARTIFICIAL INTELLIGENCE.
- ERADICATING DISEASE.

Equipped with **future methods of engineering** and an educational skill set rooted in **whole-brain thinking,** Northwestern engineers will ▶ **APPLY THEIR EXPERTISE** in unique ways **TO MAKE THE GREATEST POSSIBLE IMPACT.** ◀

HOW? With a distinctly Northwestern mindset. "The problems and opportunities facing the world today are obvious, but we thought, 'Can we explore these challenges and put a Northwestern spin on it?'" Schuh says. "We're going to ▶ FOCUS OUR ENERGY IN SLIGHTLY DIFFERENT WAYS." ◀



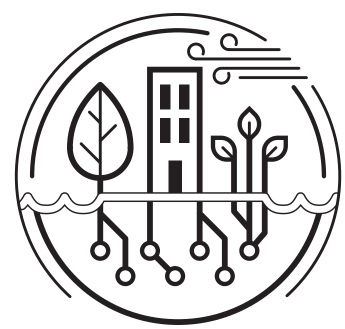
Embodied AI

Leveraging strengths in robotics, AI and machine learning, and sensor networks, Northwestern engineers **MAXIMIZE AI'S IMPACT IN THE PHYSICAL WORLD** by designing sensor-actuator and mechanical systems embedded within complex networks—from the power grid to autonomous vehicles to smart factories. "Embedding intelligence into physical systems will require more advanced sensors, communication tools, and embedded computation," says Randall Berry, John A. Dever Chair of Electrical and Computer Engineering. "Our goal is to design AI-equipped systems **better able to autonomously adapt to societal needs."**

EXPANDING EMBODIED INTELLIGENCE IN ROBOTICS

Mechanical engineering, computer science, industrial engineering, and electrical and computer engineering researchers are **using AI to develop intelligent robot shepherds that could help direct people stranded in disaster areas to safer locations during emergencies. Another team is developing the first intelligent assistance system for power wheelchairs.**

"Our **leadership in robotics LAYS THE GROUNDWORK** for **future breakthroughs in embodied intelligence,"** says Wei Chen, Wilson-Cook Professor in Engineering Design and chair of the Department of Mechanical Engineering. "Integrating sensors, actuators, and mechanical computation into the physical design and interaction of these dynamic environments is complex, but Northwestern Engineering is strategically positioned to spearhead these advances because of our expertise across core research areas and significant partnerships within and outside the University."



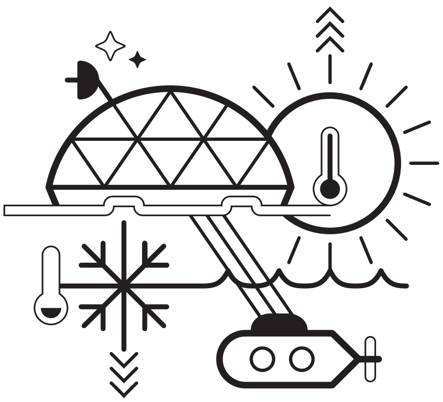
Climate-Resilient Communities

By connecting sustainability, urban environments, and equitable climate technologies, Northwestern engineers will not only **HELP DECARBONIZE THE EARTH** but also **HELP MITIGATE THE EFFECTS OF CLIMATE CHANGE** on people and communities.

WHAT IS RESILIENCE?

In the twentieth century, engineers made cities livable. Now, in the twenty-first century, they must make them sustainable and adaptable to extreme weather. From **concrete that stores CO_2** to new chemical catalysts that degrade plastic pollution, Northwestern engineers are **BUILDING, PRESERVING, AND RESTORING SYSTEMS** to support human activities and **MINIMIZE OUR FOOTPRINT ON NATURE.**

"To live a **healthy life,** one must also live on a **healthy planet,"** says Justin Notestein, professor and chair of the Department of Chemical and Biological Engineering. "We're **TAKING A MULTI-FRONT APPROACH TO SUSTAINABILITY.** That means improving battery materials and performance or developing intrinsically recyclable materials with better properties. It also means forging new tools to quantify our impact on the world, not just in tons of CO_2 emitted, but **also on societal health, prosperity, and wellbeing."**



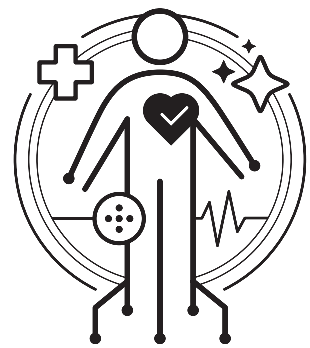
Remote Environments

Surviving and thriving in the harshest environments—on Earth or elsewhere in the solar system—will require specialized devices, infrastructure, and communication systems optimized for these unique conditions. Northwestern **LEADS IN DEVELOPING THE MATERIALS AND TECHNOLOGY** to support these endeavors.

Collaborations among chemists, materials scientists, and civil, environmental, mechanical, and chemical engineers are focused on **DEVELOPING FOUNDATIONAL COMPONENTS TO SUPPORT HUMAN SETTLEMENTS** in the most severe environments. Their work is dual-purposed: The same materials and methods used to build habitats on Mars, for example, could also help rapidly produce housing in areas hit by natural disasters on Earth.

"We're exploring every dimension of what determines a habitable planet—be it on Earth or another planet," says Kimberly Gray, Roxelyn and Richard Pepper Family Chair in Civil and Environmental Engineering. "We are deeply involved in **CREATING CLOSED-LOOP SYSTEMS** for materials, food, water, energy, and waste that can **SUPPORT LIFE ANYWHERE**."

Our work doesn't stop there. Researchers are also studying computational data to determine how to **FORM OPTIMAL TEAMS IN REMOTE ENVIRONMENTS**—such as deep space—so they can perform at their best.



Optimize the Human Health Span

Engineering and technology can do more than simply cure disease or extend life. Technologies that interact with the human body and optimize health will **ADVANCE AND TRANSLATE BIOMEDICAL RESEARCH TO MAXIMIZE HUMAN WELL-BEING AND IMPROVE QUALITY OF LIFE.**

Northwestern engineers are developing **innovative technologies** that could change how the human body responds to disease and heals from injury as well as improve short- and long-term health outcomes.

- A **synthetic cream** that heals skin injuries from sunburn and chemical burns
- **Biomaterials** that regrow damaged cartilage in joints and support soft tissue grafts to bone in reconstructive surgeries
- An **implant** that senses inflammatory markers associated with cancer and then delivers immunotherapy to the body

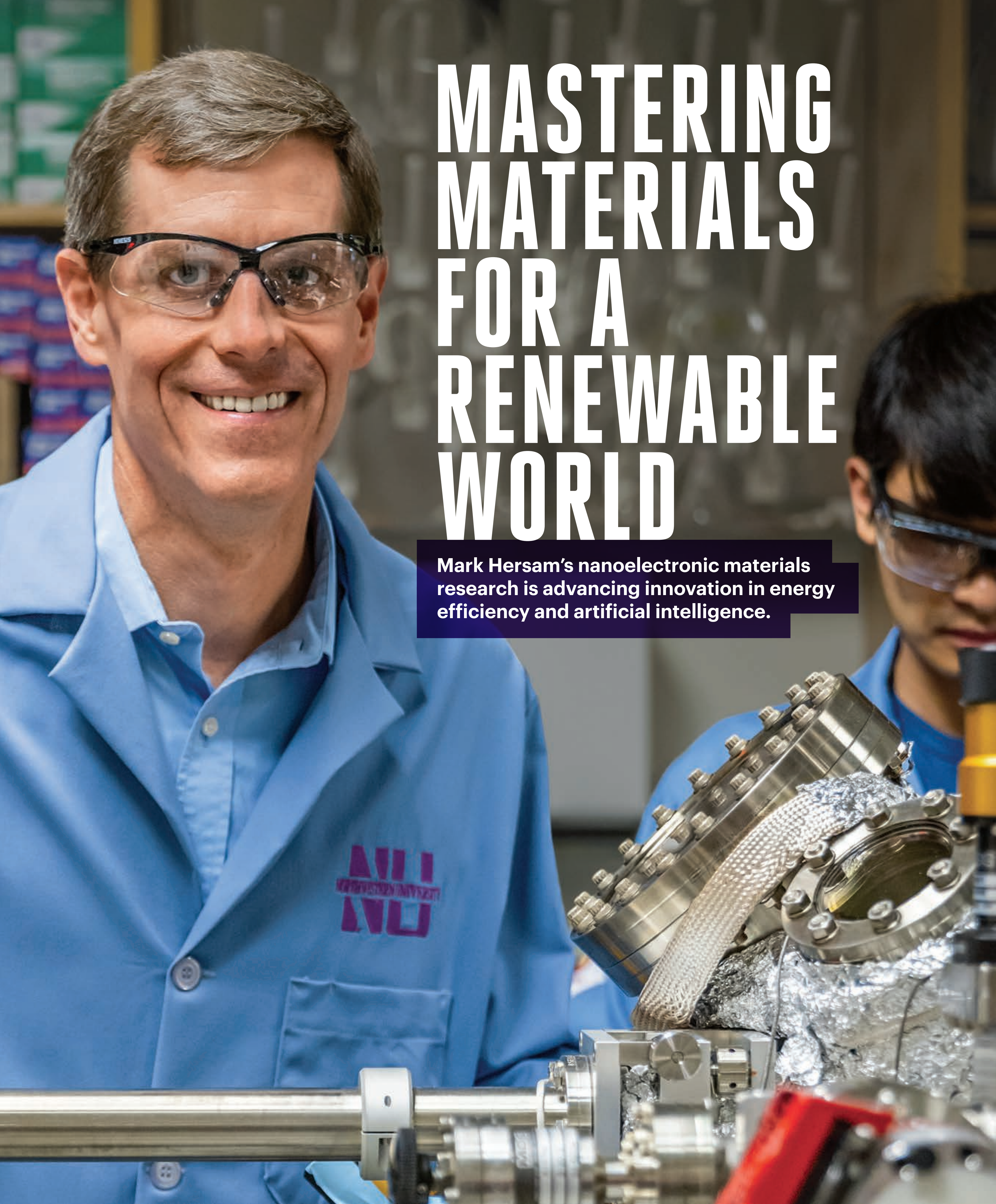
"Our work demonstrates the **collaborative and translational research** led by Northwestern Engineering and biomedical engineering faculty working with partners from the Feinberg School of Medicine and Northwestern Medicine," says Matthew Tresch, professor and chair of the Department of Biomedical Engineering. "We're facing hard challenges, but there's an opportunity to greatly **IMPACT THE QUALITY OF PEOPLES' LIVES**."

ALEX GERAGE

Illustrations by Kyle Nelson, Stoltze Design Group

MASTERING MATERIALS FOR A RENEWABLE WORLD

Mark Hersam's nanoelectronic materials research is advancing innovation in energy efficiency and artificial intelligence.



As an electrical engineering undergraduate student in the 1990s, Mark Hersam knew the future of electronics was tied to the future of materials.

At the time, the field was focused on making the transistor ever smaller. Before nanotechnology became a popular area of research, Hersam understood there were going to be significant challenges to scaling below one micron.

"Many fundamental limits would be reached, some of which would be related to the fact that the physics would change at the nanometer scale," says Hersam, Walter P. Murphy Professor of Materials Science and Engineering. "The underlying principles would transition from classical physics to quantum mechanics, and consequently, there would need to be new materials to get past those barriers."

This realization prompted Hersam to shift toward materials science, where he became a pioneer in the field of low-dimensional nanoelectronic materials. His groundbreaking research helped drive Northwestern's leadership in materials science while contributing to advances in renewable energy and computing.

His work includes the synthesis of borophene. Stronger, lighter, and more flexible than graphene, borophene has the potential to revolutionize batteries, electronics, sensors, solar cells, and quantum computing.

Today, Hersam is an elected member of the National Academy of Engineering and chairs Northwestern Engineering's Department of Materials Science and Engineering. He also serves as professor (by courtesy) of electrical and computer engineering and chemistry. In addition to leading high-impact research, he trains the next generation of graduate and undergraduate students, who are pushing the boundaries of materials science.

A BROAD VIEW OF NANOELECTRONIC MATERIALS

Hersam joined Northwestern in 2000 after earning his PhD from the University of Illinois Urbana-Champaign. He says Northwestern's interdisciplinary culture was a major draw, but the fact that the school was ahead of the curve on nanotechnology made the decision easy.

It didn't take long for Hersam's research group to make waves in the materials science field. One of the lab's specialties is understanding and controlling the surface chemistry of nanoelectronic materials, which can have a decisive impact on properties.

"We work on multiple next-generation technologies, including neuromorphic computing and quantum computing," Hersam says. "But what you realize is that surfaces and interfaces are critical in other areas, like energy technologies such as solar cells and batteries. Once you have mastered the surface chemistry of nanoelectronic materials, you can apply that knowledge to many other technologies."

A FOCUS ON ENERGY

With energy consumption growing worldwide, minimizing energy use and finding sources of energy are important areas of focus for Hersam.

"I think energy is the most significant challenge facing humanity," he says. "We would like to produce and use energy in a way that does not have collateral damage, and it is fair to say that renewable forms of energy have the least amount of collateral damage. Solar cells are about as renewable and clean as you can get, so making a more efficient solar cell is a high priority for us."

But even the world's best solar cell can't take over the energy grid without storage for use in darkness or cloudy conditions. "Another target for us is batteries as an enabler for renewable energy," Hersam says. "We already use batteries for other applications, including portable electronics and electric vehicles, but the dream would be to do it at the grid level. Once you solve that problem, then you can imagine a world where all energy is renewable."

One particularly problematic area for energy consumption is artificial intelligence. AI requires a tremendous amount of energy to handle large volumes of data and uses huge quantities of water for cooling. Hersam's lab is working on projects to address this issue, including developing a new transistor modeled on the brain, which mimics human intelligence by simultaneously processing and storing information to perform energy-efficient associative learning at room temperature.

"In neuromorphic computing, you no longer have a separate memory and microprocessor," he explains. "Instead, memory and data processing are colocated, which minimizes the need to move data, thus giving you massive reductions in power consumption for data-intensive tasks like artificial intelligence."

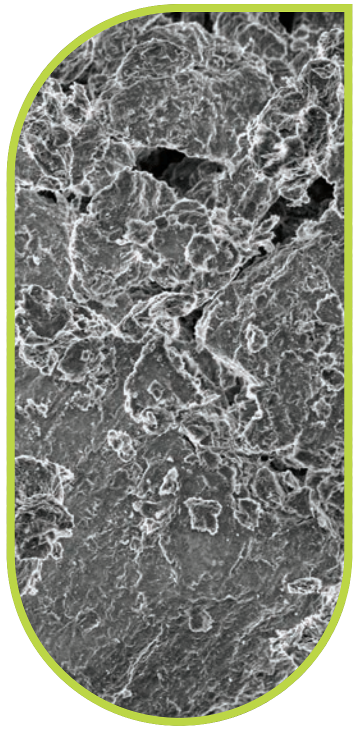
MULTIPLYING IMPACT BY TRAINING THE NEXT GENERATION

The Department of Materials Science and Engineering is undergoing a generational change, Hersam says. He sees this as a moment to improve the experience of students, postdoctoral fellows, faculty, and staff. As he works to hire the next generation of faculty, Hersam "wants to create an environment where junior faculty can thrive. They will each be leading their own research groups, where the next generation of students will be trained to maximize their impact on society."

Educating students is what Hersam enjoys most about his role. "All professors believe that their research is important and can result in impactful technologies," he says. "But at the end of the day, research is a means of training students, and watching what they accomplish in their careers is where I get the most joy from this job. I know that the accumulated impact of the alumni from my laboratory will easily exceed what I will ever achieve myself."

SARA LANGEN

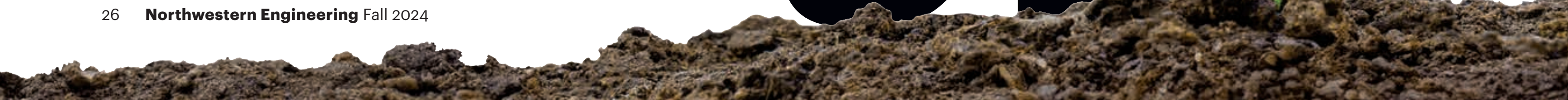
Photo by Matthew Allen



SOIL SECRETS

PROFESSOR LUDMILLA ARISTILDE COLLABORATES WORLDWIDE TO GAIN A BETTER UNDERSTANDING OF THE SOIL THAT SUSTAINS LIFE ON EARTH.

Combining experimental techniques with computational simulations, Professor Ludmilla Aristilde and her lab work to understand the environmental behavior of organic materials with implications for nutrient cycling, ecosystem health, agricultural productivity, and environmental biotechnology. "We cannot have food security without soil," Aristilde says. "That's literally what sustains us."



"I have collaborators all over the world, and these colleagues have really enriched my research. I get to work with a mosaic of researchers with different expertise and we can put our knowledge together to create a picture with a better understanding of soil processes."

Ludmilla Aristilde Associate Professor of Civil and Environmental Engineering

Growing up in Haiti, Northwestern Engineering's Ludmilla Aristilde looked critically at the land and thought about how soil sustains plants. This came naturally; her father was both an educator and farmer, and her mother was also an educator, instilling in Aristilde intellectual curiosity and a respect for the environment.

"Now I study soil microbes and soil minerals," Aristilde says. "It all stemmed from my childhood."

Aristilde, associate professor of civil and environmental engineering at the McCormick School of Engineering, works to understand the environmental behavior of organic materials with implications for nutrient cycling, ecosystem health, agricultural productivity, and environmental biotechnology.

Her driving motivation is simple but crucial. "We cannot have food security without soil," she says. "That's literally what sustains us. We need soil for agricultural productivity and for food security."

Understanding soil pathways and cycles

It's one thing to respect the soil and its importance. It's another to understand how the many different systems within the soil work. "We need to understand what's happening and why it's happening, and then by what mechanism," Aristilde says.

Phosphorus, a critical nutrient for plant growth, is a nonnegotiable component of fertilizers. Without it, farmers cannot ensure plant health and boost crop yields. Understanding Earth's phosphorus cycle, therefore, is important for protecting the global food supply.

Aristilde and her team have discovered a new way that nature cycles phosphorus, a finding that uncovers a missing piece of Earth's phosphorus cycle, which continues to puzzle scientists. Her study showed that iron oxide, a naturally occurring mineral in soils and sediments, can perform the reaction that transforms organic phosphorus to generate the inorganic form.

In another study earlier this year, Aristilde tracked the pathways of a plant waste mixture as it moves through bacteria's metabolism and contributes to atmospheric CO_2. These findings help disentangle the role of microbes in soil carbon cycling—information that could help improve predictions of how carbon in soil will affect climate change.

In a separate study, she found the factors that could determine whether plant-based organic matter gets trapped in the soil or feeds microbes that then respire CO_2 into the environment. That breakthrough could help researchers predict which soil chemistries are most favorable for trapping carbon—potentially leading to soil-based solutions for slowing human-caused climate change.

"The majority of carbon storage is in soil, and we want to mitigate or limit the amount of greenhouse gases that go into the environment," Aristilde says. "Since the majority of our carbon reservoir is in soil, any perturbation in that reservoir has a huge impact."

Better understanding of soil, Aristilde says, helps scientists predict how it will react to atmospheric changes. "Understanding environmental resilience requires prediction," she says. "It's important to be able to forecast how nature is going to respond. It's through this forecasting that we know to what extent the soil is resilient."

Collaborating across disciplines worldwide

A core faculty member of Northwestern's Center for Synthetic Biology and a faculty affiliate of both the Paula M. Trienens Institute for Sustainability and Energy and the International Institute for Nanotechnology, Aristilde's expertise is in both molecular environmental chemistry and molecular biochemistry. Therefore, the bedrock of her research is collaborating across disciplines.

"I tell the members of my group that the beauty of academia is that you have colleagues with different levels of expertise," she says. "I don't want to reinvent the wheel. If I know colleagues with a specific expertise in something I am interested in, I just want to collaborate with them."

By working with others, Aristilde hopes to move the world closer to a full understanding of the biology and chemistry of soils. In addition to her collaborations across the US with colleagues in Georgia, Indiana, Delaware, New York, and California, Aristide has fostered research exchanges across the globe with collaborators in Czechia, Denmark, France, Germany, and Thailand. Closer to home, Aristilde has found Northwestern collaborators at luncheons, taking notes on their specialties and circling back if there's an opportunity to conduct research together.

"I have collaborators all over the world, and these colleagues have really enriched my research," Aristilde says. "I get to work with a mosaic of researchers with different expertise and we can put our knowledge together to create a picture with a better understanding of soil processes."

BRIAN SANDALOW

Photos by Jason Brown

COMPLETING THE CIRCUIT

AAMIR PAUL STEERS EFFORTS TO COMBAT CLIMATE CHANGE AND BOOST SUSTAINABILITY.

"We are the first generation to fully understand the impacts of climate change and the last generation that can effect change. It's our responsibility to do something about it."

As president of Schneider Electric North America Operations, Aamir Paul ('00) leads all operations from strategy to execution in Canada, Central America, Mexico, and the US—delivering best-in-class solutions for customers across the company's Energy Management and Industrial Automation businesses. And his journey to become the leader of the company's largest and fastest-growing region has roots at Northwestern.

Paul jokes about his foremost objective upon arriving at Northwestern Engineering in fall 1995.

"Make the most of this," says Paul, an immigrant from Pakistan who commuted to campus from his home on Chicago's North Side.

For Paul, Northwestern delivered a strange juxtaposition—an environment simultaneously intimidating and accessible. While the challenging nature of early chemical engineering courses and the campus's intellectual horsepower occasionally pushed him out of his comfort zone, Paul also felt encouraged to be inquisitive.

Everything blended beautifully for him when he joined the Walter P. Murphy Cooperative Engineering Education (Co-op) Program. An educational initiative combining alternating periods of academic study with full-time stints of paid work experience, the Co-op Program pushed him to connect his classroom work to industry, crystallizing his strengths and helping him evaluate career possibilities, including opportunities beyond traditional chemical engineering routes in industrial plants, refineries, and laboratories.

After graduating from the McCormick School of Engineering in 2000 with a degree in chemical engineering, Paul packed up his Nissan Sentra and drove to Austin, Texas, to work for Dell—"the hot technology company of the time."

Rotating through different units at Dell, he thrived in a world largely dominated by electrical engineers and computer scientists. By his 30th birthday, he was in London, leading a $1 billion, 300-person team of sales professionals focused on small and mid-sized businesses across the United Kingdom and Ireland.

Itching for a change and ready to return to Chicago, he moved back to the area in 2013 and joined Schneider Electric, a global leader in energy management and automation with a strong presence in the US. Nearly half of American homes feature Schneider circuit breakers, he says, and it's statistically impossible to avoid a data center powered by Schneider when online for more than six hours. Most enticing for him, however, was that Schneider held a clear and compelling purpose: to drive progress and sustainability for all.

Now president of Schneider North America Operations, which includes 46 factories and more than 35,000 employees, Paul and his team are enabling more efficient, resilient, sustainable energy and automation for data centers, buildings, homes, industries, and critical infrastructure in the US and around the world. Earlier this year, *TIME* placed Schneider atop its list of the world's most sustainable companies.

"We are the first generation to fully understand the impacts of climate change and the last generation that can effect change," Paul says. "It's our responsibility to do something about it."

Paul's work with Schneider has also reconnected him with Northwestern. The company has long been involved with the Master of Science in Energy and Sustainability program, including joint development of technologies with faculty and students, and continues helping the University pursue its ambitious sustainability targets.

"It's a wonderful full-circle moment for me," Paul says.

DANIEL P. SMITH

AS ONE OF THE PHARMA INDUSTRY'S MOST REPUTED GLOBAL SUPPLY CHAIN LEADERS, **KIMBERLY LOUNDS FOSTER** THRIVES ON OPPORTUNITIES TO HELP PATIENTS WORLDWIDE.

PASSION & PERSEVERANCE

A lifelong passion for science began in the childhood home of Kimberly Lounds Foster ('94), where her two STEM-oriented parents—her father an electrical engineer and her mother a nurse—encouraged her innate curiosity and inquisitive spirit. As early as her elementary school years, Lounds Foster became active in the science fair circuit, devoured copies of *Nature* magazine, and exchanged handwritten letters with an Ivy League professor working on tactile illusions in the body.

In high school, two science teachers inspired Lounds Foster's interest in discovery and were instrumental in her decision to pursue a scientific career, perhaps one that could make a difference in people's lives. At Northwestern Engineering, Lounds Foster paired a chemical engineering major with an environmental engineering minor and built a level of resilience that has helped her throughout her career.

"The whole engineering program was intensely rigorous and required an enormous amount of grit," Lounds Foster says. "I was motivated to succeed despite assumptions of doubt, which was great training for the real world."

Her career highlights include steering the launch of the generic version of the best-selling hospital medicine in the US (enoxaparin), building the supply chain for the first-ever Food and Drug Administration-approved cell therapy, and landing a spot on *Fierce Pharma*'s "2020's Fiercest Women in Life Sciences" list. Today, she serves as the global head of the advanced therapies supply chain at Johnson & Johnson (J&J), one of the world's leading healthcare companies.

At J&J, Lounds Foster leads a team responsible for planning, sourcing, and manufacturing advanced therapies and delivering them to patients in a controlled and consistent way. In an era of supply chain headwinds, geopolitical tensions, and ever-accelerating costs, those are no small tasks. Yet, Lounds Foster deftly ensures that the company's global supply chain remains interconnected and agile, a necessity for propelling new product development and industrializing nascent technology platforms to deliver their innovative treatments faster to patients around the world.

"We navigate new and interesting technical and business challenges every day, and people consistently lead with their passion for patients and the science," says Lounds Foster, whose daily work includes interacting with colleagues from research scientists to commercial leaders across the J&J enterprise.

"WE NEED DIVERSE ROLE MODELS TO ENCOURAGE TOMORROW'S WORKFORCE TO PURSUE STEM FIELDS, SO I ENJOY CARVING OUT TIME TO HELP WOMEN AND OTHER UNDERREPRESENTED GROUPS WHO ARE PURSUING STEM DEGREES IMAGINE WHAT THEY CANNOT IMAGINE FOR THEMSELVES."

Along the way, Lounds Foster has remained committed to serving as a voice for young women and students of color so they can experience more inclusive environments as they pursue degrees in chemical engineering and other STEM fields. She serves on the advisory board of Northwestern Engineering's Department of Chemical and Biological Engineering and is a member of the Council of One Hundred, an accomplished group of Northwestern alumnae helping a new generation of women launch their professional careers.

"We need diverse role models to encourage tomorrow's workforce to pursue STEM fields, so I enjoy carving out time to help women and other underrepresented groups who are pursuing STEM degrees imagine what they cannot imagine for themselves," Lounds Foster says.

DANIEL P. SMITH

DESIGNING SOLUTIONS WITH the Patient in Mind

BOSTON UNIVERSITY PROFESSOR **CATHERINE KLAPPERICH** USES BIOMATERIALS AND DIAGNOSTICS TO IMPROVE HEALTHCARE FOR WOMEN.

When Catherine Klapperich ('94) chose to attend Northwestern, her future seemed clear. As editor of her high school newspaper, she felt journalism was the right path—until she happened upon an engineering lab during a visit for prospective students.

"I went into Tech on a lark and saw a group of people looking at an environmental scanning electron microscope," she remembers. "They were literally watching cement dry, but the room was dark, and the pictures were really clear. The ability to see the contrast in the images attracted me. I became interested in engineering after just 10 minutes in a materials science lab."

Today, Klapperich is a professor of biomedical engineering and scientific director of the Design, Automation, Manufacturing, and Processes (DAMP) Laboratory at Boston University. Her innovative research focuses on developing medical devices for women's health, including diagnostic devices that can be used in low-resource settings and at the point of care.

MAKING AN IMPACT

After Northwestern, Klapperich earned a master's degree in engineering sciences from Harvard University and a PhD in mechanical engineering from University of California, Berkeley. As a PhD candidate, she became interested in how cells respond to different biomaterials and returned to UC Berkeley for postdoctoral research on the topic after working for a microfluidics company.

"At that time, the biomaterials field was the only place I could see where materials were being applied to human health," she says. "I liked being able to see the immediate impact of an engineered device that was designed for people to use."

Klapperich joined the Boston University faculty in 2003, attracted by the opportunity to work with clinical collaborators at the many hospitals in the Boston area. She distinguished herself in the area of diagnostics by creating portable devices for use in underserved communities. She also helped establish Boston University's COVID-19 Clinical Testing Laboratory through the BU DAMP Lab and currently serves as scientific director.

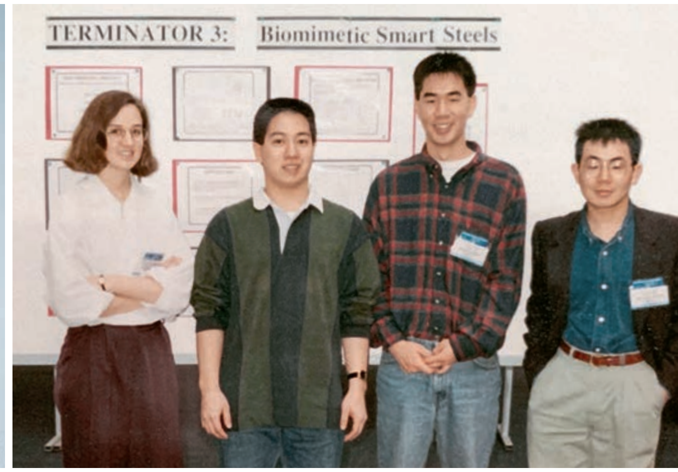
EMPOWERING WOMEN

As her research progressed, Klapperich observed that many medical devices for women were either originally designed for something else, not designed by women, or not designed with the specifics of the female anatomy in mind.

"These sex differences were not taken into account," she explains. "Often, women weren't involved in the design process. Bringing different viewpoints into design and creating diverse teams is central to my teaching on women's health."

She began making portable devices to detect sexually transmitted infections, which can cause fertility issues and future pathologies in women. "By making a portable device that can test in low-resource areas, you're putting something into the hands of people who need it," she says. "If it goes to the end of development, it should be in the drugstore, and you should be able to buy it and test yourself so that you have the power to make a decision about what to do next."

Designing products that empower women to make informed healthcare decisions motivates Klapperich. It has also educated her about many intersecting issues, including transgender women's health.



Klapperich, Edison Chu, Tom Yeh, and Dillon Fong (all '94) presenting their undergraduate project at the TMS Conference in San Francisco.

"MEETING PEOPLE FROM DIFFERENT COUNTRIES REALLY OPENED UP MY DESIRE AND ABILITY TO GET OUT OF MY LAB AND SHARE IDEAS WITH LOTS OF PEOPLE."

"With menopause and perimenopause, we know a lot about adding hormones when hormones are decreasing, but what we don't know as much about is how those hormones affect a person's health in a global sense outside of menopause," she says. "When you replace hormones for someone who's transitioning, it's the same kind of therapies, but there's much less information available, so I have a number of projects in the space of monitoring hormones."

Another area of Klapperich's research focuses on using engineering automation to do large-scale cell culture of female reproductive tissues to facilitate research on female-specific health issues.

SHARING IDEAS

None of this would have been possible if Klapperich hadn't wandered into the Northwestern Engineering lab. "I knew it was going to be hard for me," she says. "I didn't have the same preparation as those who took advanced math and science in high school, but I stuck with it."

That experience laid the foundation for her research, where she applies what she learned at Northwestern every day. One of her favorite memories is living in the International Studies Residential College. "Meeting people from different countries really opened up my desire and ability to get out of my lab and share ideas with lots of people," she says.

Her gratitude inspires her to stay active in the University. She recently joined the McCormick Advisory Council, which she considers an honor. "Sparking collaborations and getting people to work together is important, so I'm glad to add my voice."

SARA LANGEN

IN MEMORIAM

PROFESSOR EMERITUS BRUCE WESSELS

Bruce Wessels, Walter P. Murphy Professor Emeritus of Materials Science and Engineering and former chair of the Department of Electrical Engineering and Computer Science, passed away on April 7 at age 77. He will be remembered for his notable contributions to the study of thin films and nanostructures for electronic, magnetic, and photonic materials applications and his passion for professional service and scholarship at Northwestern Engineering and beyond.

During his almost 47 years at the McCormick School of Engineering, Wessels was a leader in the development of electronic materials. He developed the transient current spectroscopy technique for semiconductor defect detection at the part-per-billion level.

He also discovered a technique for preparing high conductivity, epitaxial II-VI compounds suitable for optoelectronic devices through defect control and a method of preparing rare-earth-doped epitaxial III-V compounds, and advanced epitaxial ferroelectric thin films for integrated optical applications. In addition, he was a founder of the electronic materials effort within the Department of Materials Science and Engineering.

Along with those achievements, Wessels mentored more than 50 doctoral students and post-docs who have succeeded in academia and in industry worldwide.

"Bruce Wessels was a towering figure in materials science in both research and education," says Christopher Schuh, dean and John G. Searle Professor of Materials Science and Engineering. "He played a significant role in building materials science at Northwestern into a pillar of excellence and was a respected colleague to collaborators around the world."

In 1968, Wessels earned his BS in metallurgy and materials science from the University of Pennsylvania. He received his PhD in materials science from the Massachusetts Institute of Technology in 1972. He began his professional career at General Electric, where he developed a practical process for light-emitting diode fabrication. In 1977, he joined the Northwestern Engineering faculty as an assistant professor before becoming an associate professor three years later.

Author of 405 articles and holder of 21 US patents, Wessels enjoyed a career distinguished by service to the profession and his many honors. He served as president of The Minerals, Metals & Materials Society (TMS) and its foundation and was named a fellow of the Optical Society of America, the American Physical Society, the American Society for Metals, and TMS.

"Professor Wessels played a pivotal role in the development of Northwestern Materials Science and Engineering by expanding the scope of the department to include electronic materials," says Mark Hersam, Walter P. Murphy Professor and chair of the Department of Materials Science and Engineering. "His commitment to excellence set an exceptionally high standard that not only impacted his own research but also served as an example that permeated throughout the department."

Artabandhu Mohanty '47
Maclyn R. Peat '47
Robert D. Bessier '48
Edward C. Look Jr. '49
Edward D. Henze '50
Donald G. Hudson '50
Mark Edmond Kelly '50
Walter H. Hickel '52
James W. Kirchhoff '52
Warren W. Rasmussen '53
Ronald E. Ring '54
Arthur Frank Campbell Jr. '55
William F. Connell '55
Jack A. Hoff '55
H. Herbert Rudolph '56
Edward M. Schmidt '56
Ronald J. Vodicka '56
Donald E. Manhard '57
John T. Peavey '57
Kenton E. Williams '57
William H. Perloff Jr. '58, '62
Neil L. Lehmann '59
William S. Repp '59
Gopal P. Agarwal '60
Frank N. Dimeo '60
Larry L. Anderson '61
John P. Borden '61
Norman H. Bouton Jr. '61
Frank G. Collins '61
Robert E. Beck '62
David W. Olson '62
Eugene J. Beckman '63
John C. Brown '63
William J. Readdy '63
R. Craig Kammerer '65
Richard H. Pratt '65
Adam L. Shepela '65
Tony N. Zaugh '65
James R. Keiser '66
Kenneth W. Lay '66
Taras A. Bursztynsky '67, '69
Harold Goldstein '67
William Wood Mann '67
Harvey M. Heckman Jr. '68
Nolan T. Adelman '69, '71
William C. Moor '69
Roger H. Beggs '71
Alfred C. Eckert III '71
Ted L. Hoffman '71
John B. Vander Sande '71
Michael E. Kassner '72
Manuel Yglesias Jr. '74
John Thomas Linton '76
Janet Nordin '76
Mimi Hanlon '79
Susan Jean Kuhr Tripp '80
William C. Mills '81
Michelle P. O'Connor '88
Kamal Gandhi '94
Mark D. Price '94
Chandra Sekhar Movva '94
Kelly M. Weller '95
Mark Douglas Ruark '96
Thomas Skidmore '99
Tracy Airrion Pruitt '01
Patrick John Bell '08

BIG IDEA

A SOFTER ROBOT, INSPIRED BY MUSCLES

To create a safer, more practical robot, Professor Ryan Truby and his team developed a soft, flexible actuator that enables robots to move by expanding and contracting—just like a human muscle.

To demonstrate how the actuator works, the researchers used it to create a worm-like soft robot and an artificial bicep. In experiments, the soft robot navigated the tight, hairpin curves of a narrow, pipe-like environment. The bicep was able to lift a 500-gram weight 5,000 times in a row without failing.

Because the researchers 3D printed the body of the soft actuator using a common rubber, the robots cost about $3 in materials, excluding the small motor that drives the actuator's shape change. That contrasts sharply with the cost of the typical rigid actuators, which can range from hundreds to thousands of dollars. The new actuator could be used to develop inexpensive, flexible robots that would be softer, safer, and more practical for many applications.

Truby is a member of Human AugmentatioN via Dexterity (HAND), a new US National Science Foundation Engineering Research Center led by Northwestern and dedicated to revolutionizing the ability of robots to amplify human labor.

Photos by Ryan Truby/Taekyoung Kim/Northwestern University

Northwestern | McCORMICK SCHOOL OF ENGINEERING

Robert R. McCormick School of
Engineering and Applied Science

Northwestern University

Technological Institute
2145 Sheridan Road
Evanston, Illinois 60208–3100

SYNTHETIC BIOLOGY EMPOWERS FARMERS

Last spring, Professor Julius Lucks led an expedition of scientists to Kenya to test his PLANT-Dx platform. The CRISPR-based technology, which leverages advances in in vitro synthetic biology, could allow farmers in low-resource settings to diagnose disease in crops before symptoms even appear. During the trip, Lucks's team used the technology to test for the cucumber mosaic virus and the sweet potato feathery mottle virus.