McCormick School of Engineering and Applied Science

NORTHWESTERN ENGINEERING

SPRING 2026

HIDDEN TREASURE SECURING MINERALS TO POWER SOCIETY

"Creating and maintaining a world-class research and education system requires both conviction and agility. We must invest deeply in our existing strengths while also placing bold bets on what the future demands."

GREETINGS FROM NORTHWESTERN ENGINEERING

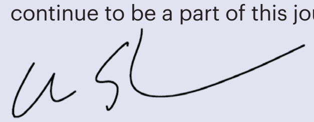
Creating and maintaining a world-class research and education system requires both conviction and agility. We must invest deeply in our existing strengths while also placing bold bets on what the future demands. This issue of the magazine highlights just a few of the ways we do that at Northwestern Engineering.

Minerals such as copper, lithium, and graphite are essential to many of the technologies we use today, but meeting demand requires innovative approaches for both acquiring and preparing them for use. From inventing new ways to recover or reuse minerals to exploring methods for quantifying and reducing the pollution that fuels local opposition to mines, our faculty are pioneering ways to build a supply to meet the needs of today and tomorrow.

In this issue, you'll also see how a once-emerging idea can, with sustained investment and vision, become a defining strength. In the early 2000s, synthetic biology was a nascent field. We saw its promise early and chose to lead—expanding our faculty and launching the Center for Synthetic Biology in 2016 to push the boundaries of how biological systems can be engineered to perform entirely new functions. Since then, the center has produced new technologies, spurred several startups, and educated hundreds of students. I hope you'll read more about our successes in this area.

This same forward-looking mindset extends to how we educate. To meet the evolving needs of students, we have undergone a comprehensive redesign of our undergraduate core curriculum. Effective for incoming first-year students this fall, the new curriculum emphasizes data and statistics, programming, and entrepreneurial thinking. We have also launched a bachelor of science in engineering degree program and an AI major. I look forward to seeing how these changes enhance the experience of our students and prepare them not just for today's challenges, but for those to come.

Throughout this academic year, I have enjoyed connecting with many alumni and friends, and I'm continually inspired by our community. Our shared spirit of innovation and problem-solving propels us forward toward new horizons, and I hope you'll continue to be a part of this journey.



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

On the Cover
Northwestern Engineering researchers are discovering new sources and innovative techniques for gathering high-value minerals to meet growing demand. Read more on page 10.

Northwestern Engineering is published by the Robert R. McCormick School of Engineering and Applied Science, Northwestern University, for its alumni and friends.

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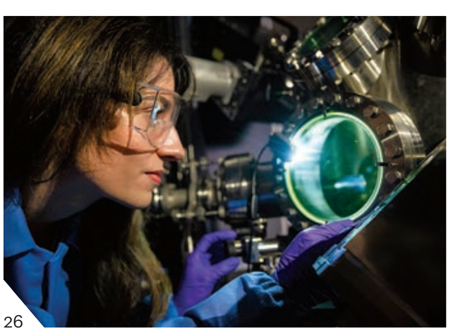
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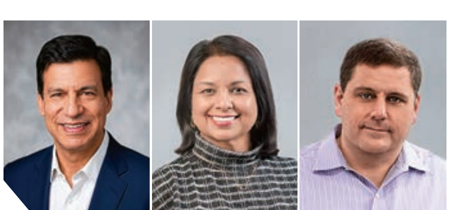
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NORTHWESTERN ENGINEERING
SPRING 2026

NEWS

LUIJTEN NAMED NEW NORTHWESTERN PROVOST

Luijten has spent more than a decade in academic leadership roles at Northwestern.

"ERIK HAS SHOWN AN ABILITY TO TRANSLATE INSTITUTIONAL PRIORITIES INTO CLEAR POLICIES THAT SUPPORT FACULTY, STAFF AND STUDENTS—A SKILL THAT IS VITAL FOR ANY PROVOST."

Henry Bienen
Northwestern University Interim President

Erik Luijten, associate dean for research and doctoral education at Northwestern Engineering, was named Northwestern University's next provost in January.

In his academic leadership roles at Northwestern over more than a decade, Luijten has managed research administration and research development, and since 2023, the McCormick School of Engineering's PhD programs. As professor of materials science and engineering, he helped strengthen scholarship across schools and disciplines, including in his work with the Center for Scientific Studies in the Arts and Northwestern's Prison Education Program.

"I'm pleased to welcome distinguished scientist and administrator Erik Luijten as our next provost," Interim Northwestern President Henry Bienen says. "During his 17 years at Northwestern, Professor Luijten has developed a reputation for academic excellence, interdisciplinary collaboration, and strong, clear leadership. His background in fundamental research, along with his efforts to bridge the physical sciences with the arts and humanities, make him uniquely qualified to lead Northwestern's academic mission now and into the future."

"I am honored to become Northwestern's next provost," Luijten says. "I plan to work hard to elevate Northwestern's national and global presence in higher education and research and strengthen the creativity and innovation that is at the heart of Northwestern's identity."

16 Faculty named in the Highly Cited Researchers 2025 List by Clarivate

'25 Graduation year of alum Ohm Vyas, who was named to Chicago Inno's 2025 "Under 25" list

10 Students selected for the Apple Next-Gen Innovators Mentorship Program

Engineering Faculty Showcase Startups

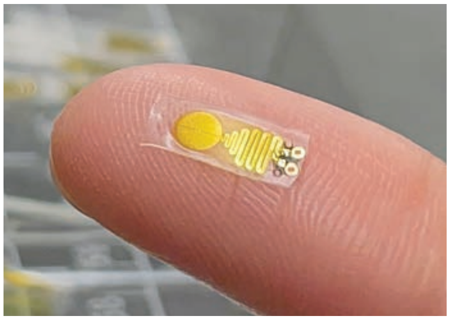
The January 2026 Midwest Biotech Startup Showcase in San Francisco brought together more than 250 founders, operators, and investors and featured more than 35 biotechnology startups from Midwest universities to highlight translated research. Startups with Northwestern Engineering connections included Syenex (Professor Joshua Leonard, founder), Sibel Health (Professor John A. Rogers, founder), Grove Biopharma (Professor Nathan Gianneschi, founder), Melanyze (Gianneschi and Feinberg School of Medicine Professor Kurt Lu, founders), and Flashpoint Therapeutics (Professor Chad Mirkin, founder).

GRADUATE STUDENTS EARN 2025 GLOBAL GOOGLE PHD FELLOWSHIPS

Northwestern Engineering graduate students Connie Chau, Ziyi Guo, and Gefei Tan earned 2025 Google PhD Fellowships. Created to recognize outstanding graduate students who are conducting exceptional and innovative research in computer science and related fields, the fellowships support candidates with up to two years of funding toward education costs.

Candidates are also matched with a Google mentor who provides feedback and helps connect students to Google's research network.

New Institute to Accelerate Adoption of Breakthrough Medical Technologies



- The Querrey Simpson Institute for Translational Engineering for Advanced Medical Systems (QSI-TEAMS) is being made possible by $29 million in philanthropic funding from University Trustee Kimberly K. Querrey ('22, '23 P).
- QSI-TEAMS aims to expedite the clinical validation, adoption, and launch of pioneering technologies at the intersections of engineering, science, and medicine.
- QSI-TEAMS will have a footprint on Northwestern's Chicago and Evanston campuses.

Northwestern launched an institute to catalyze the translation of groundbreaking university research discoveries into treatments and devices that improve patients' lives. The Querrey Simpson Institute for Translational Engineering for Advanced Medical Systems (QSI-TEAMS) is made possible by $29 million in philanthropic funding from University Trustee Kimberly K. Querrey ('22, '23 P).

QSI-TEAMS aims to expedite the clinical validation, adoption, and launch of pioneering technologies at the intersections of engineering, science, and medicine. By identifying clinical needs, performing scaled clinical studies of new technologies, and refining engineering attributes to align with clinical workflows, QSI-TEAMS can bridge academic technology advances at Northwestern with commercialization opportunities.

"Developing breakthrough medical technologies that alleviate suffering from disease is one of the noblest pursuits of human endeavor," Interim Northwestern President Henry Bienen says. "Thanks to Kimberly Querrey's visionary leadership and philanthropy, QSI-TEAMS will enhance the work of Northwestern researchers to get these new technologies to the patients' bedside, where they are most needed."

QSI-TEAMS will guide researchers in the Querrey Simpson Institute for Bioelectronics (QSIB)—and several other Northwestern centers and institutes funded by Querrey—in advancing their findings with potential to make a positive impact on patient care.

Founded in 2016 and expanded and renamed in 2019, QSIB endeavors to transform human health through technological breakthroughs and innovative startups while training future leaders in both engineering and medicine. Made up of approximately 30 medical faculty and 15 technical faculty collaborators, 300 undergraduate students and postdoctoral fellows, and 200 graduate (MS and PhD) students, QSIB has realized several accomplishments in support of this mission.

Fueled by support from Querrey, QSIB affiliates have published findings in 400 publications with 150,000 citations globally. They have disclosed 150 inventions, resulting in 120 filed patent applications and 60 issued patents, 50 of them licensed to commercial entities. Affiliates also have founded seven startups, with more than $150 million in follow-on funding, and created 200 technical jobs.

John A. Rogers, Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering, and Neurological Surgery, will lead QSI-TEAMS. Rogers also directs QSIB.

PROFESSOR JIE GU RECEIVES $3.8 MILLION DARPA ScAN PROGRAM AWARD

The Defense Advanced Research Projects Agency (DARPA) Microsystems Technology Office awarded Professor Jie Gu and coprincipal investigators Yiran Chen of Duke University and Ramesh Harjani of the University of Minnesota up to $3.8 million through the Scalable Analog Neural-networks (ScAN) program, a 4.5-year, two-phase effort launched in 2025.

The team aims to advance a disruptive in-sensor computing solution for analog-based neural network accelerators to support edge AI operation at small sensor nodes. In-sensor computing combines sensing and computing in one device and allows data to be analyzed in real time right where it's captured without conventional, costly data conversion and digital signal processing.

Christine Schyvinck Urges Graduates to Embrace Creativity, Leadership

Speaking at Northwestern Engineering's Fall 2025 PhD Hooding and Master's Recognition Ceremony held last December, Christine Schyvinck (MEM '99) told graduates that when she was younger, she did not have a career plan. Instead, she had many interests that called for exploration. Her father planted the seed that her math and science chops might be best utilized in an engineering career.

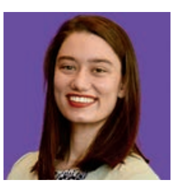
That's when she knew the direction to take. "I can confidently tell you this," said Schyvinck, president, CEO, and chairman of Shure Incorporated, "engineering is a remarkable way to help shape the world."

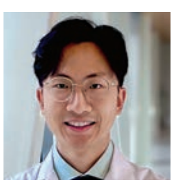
Undergraduate Taeyoung Lee Holds Guinness World Record

Computer science undergraduate Taeyoung Lee set a Guinness World Record for being the youngest male to complete an Ironman triathlon on six continents. With no running or cycling background before college, he first picked up the sport through Northwestern's Triathlon Club.

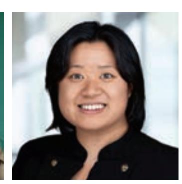
He completed his first Ironman triathlon—a 2.4-mile swim, a 112-mile bike ride, and a 26.2-mile run—in 2024 in Arizona. In 2025, he competed in Ironman triathlons in New Zealand and South Africa in March, Brazil in June, and Sweden in August. He broke the world record in his home country of South Korea in September at the age of 21. In a celebratory post on LinkedIn, he wrote, "If I never stepped out of my comfort zone, none of this would have happened."

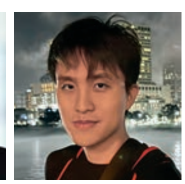
STUDENTS NAMED TO *FORBES* '30 UNDER 30' 2026


Ana Cornell


Jonathan Huang


Lauren Huttner


Claire Liu


Yuan Liu


Vishaal Mali


l–r Michael Pauleen, Benjamin Somers


Casey Qadir

Northwestern students and alumni—including nine with ties to Northwestern Engineering—earned spots on the national 2026 *Forbes* "30 Under 30" list, which recognizes leaders across technology, science, venture capital, and entrepreneurship.

"These students embody McCormick's commitment to solving real problems through rigorous thinking and bold innovation," Dean Christopher Schuh says.

The students and alumni include:

Ana Cornell | *former McCormick student, Biomedical Engineering; student at the Farley Center for Entrepreneurship and Innovation*
Cornell founded Acorn Genetics, which is building a handheld device to deliver DNA test results in under an hour, making genetic analysis faster, more affordable, and privacy preserving.

Jonathan Huang | *PhD '25, MD '27, Biomedical Engineering*
Huang developed AI tools—now used at Northwestern Medicine—to help radiologists read medical images faster and more efficiently without compromising diagnostic accuracy.

Lauren Huttner | *BSJ '24, Journalism and History; alumna of the Farley Center for Entrepreneurship and Innovation*
Huttner founded Pebble, which recruits and trains creators to produce custom content that can help brands achieve millions of downloads and views.

Claire Liu | *PhD '23, Biomedical Engineering*
Liu, a researcher at the interface of materials science and medicine, designs soft, skin-mounted devices to monitor inflammation and other physiological signals.

Yuan Liu | *PhD '24, Electrical and Computer Engineering*
Liu is advancing the stability of perovskite-based solar cells, a promising alternative to silicon photovoltaics, to improve their durability and performance.

Vishaal Mali | *BS '20, Computer Engineering*
Mali is cofounder and CEO of Salient Motion, which builds next-generation electromechanical actuation systems used in commercial and military aviation.

Michael Pauleen | *BS, MSiA '18, Industrial Engineering*
Benjamin Somers | *BA '19, Statistics and Chinese*
Pauleen and Somers, an alumnus of the Farley Center, cofounded Recess, an online homeschooling platform for students ages eight through 14.

Casey Qadir | *BA '19, Neuroscience; alumna of the Farley Center for Entrepreneurship and Innovation*
Qadir founded Hubly Surgical, which creates safer neurosurgical drilling tools, including one with a safety feature that stops the device once bone is penetrated.

LAB NOTES

BANDAGE-LIKE DEVICE BRINGS TEXTURE TO TOUCHSCREENS

Called VoxeLite, the ultra-thin, lightweight, flexible, wearable device recreates touch sensations with the same clarity, detail, and speed that skin naturally detects.

"THIS WORK REPRESENTS A MAJOR SCIENTIFIC BREAKTHROUGH IN THE FIELD OF HAPTICS BY INTRODUCING, FOR THE FIRST TIME, A TECHNOLOGY THAT ACHIEVES HUMAN RESOLUTION."

J. Edward Colgate
Walter P. Murphy Professor of Mechanical Engineering

Northwestern Engineering researchers developed the first haptic device that achieves "human resolution," meaning it accurately matches the sensing abilities of the human fingertip.

"Touch is the last major sense without a true digital interface," says Sylvia Tan, the PhD student who led the study. "We have technologies that make things look and sound real. Now, we want to make textures and tactile sensations feel real. Our device is moving the field toward that goal. We also designed it to be comfortable, so people can wear it for long periods of time without needing to remove it to perform other tasks."

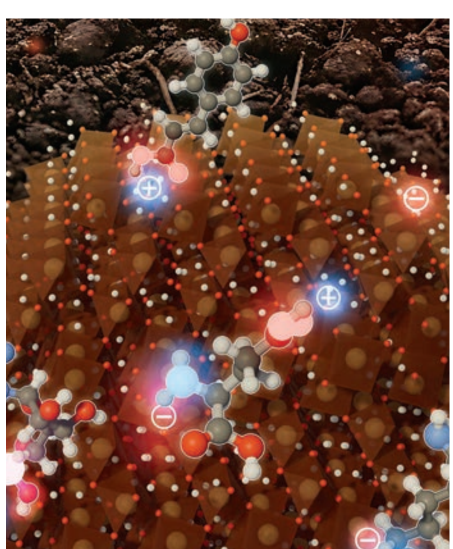
Called VoxeLite, the ultrathin, lightweight, flexible, wearable device recreates touch sensations with the same clarity, detail, and speed that skin naturally detects. Like a bandage, the device gently wraps around a fingertip to give digital touch the same realism people now expect from today's screens and speakers.

By enabling high spatial resolution in a comfortable, wearable form, VoxeLite could transform how people interact with digital environments, including more immersive virtual reality systems, assistive technologies for people with vision impairment, human-robot interfaces, and enhanced touchscreens.

The device features an array of tiny, individually controlled nodes embedded into a paper-thin, stretchable sheet of latex. These nodes function like pixels of touch, each capable of pressing into the skin at high speeds and in precise patterns. The new technology applies electrostatic forces to make each tiny node "grip" a surface and tilt to press into skin.

"This work represents a major scientific breakthrough in the field of haptics by introducing, for the first time, a technology that achieves human resolution," says Professor J. Edward Colgate, a haptics pioneer and senior author of the study. "It has the ability to present haptic information to the skin with both the spatial and temporal resolution of the sensory system."

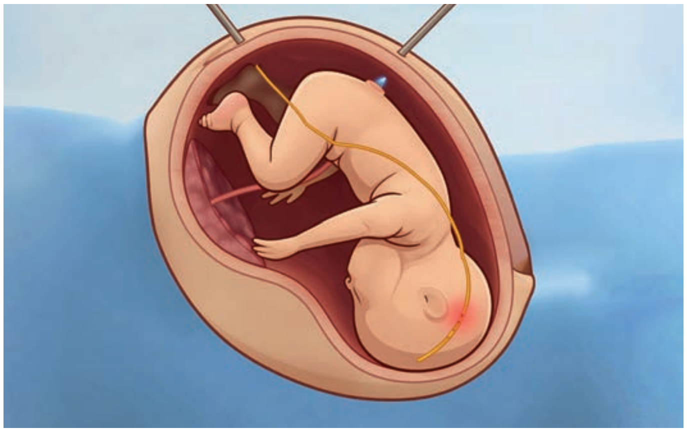
Colgate and co-senior author Professor Michael Peshkin are longtime collaborators and pioneers in the field of haptics technology.



Iron Minerals' Hidden Chemistry Explains How Soils Trap Carbon

Scientists have long known that iron oxide minerals help lock away and sequester enormous amounts of carbon from the atmosphere. Professor Ludmilla Aristilde studied ferrihydrite, a common iron oxide mineral, and discovered it employs multiple, fundamentally different chemical strategies to grab and lock carbon away.

Although ferrihydrite has an overall positive electrical charge, Aristilde found its surface is not uniformly charged. Instead, it resembles a nanoscale mosaic of positively and negatively charged patches. And ferrihydrite does not trap carbon using electrostatic attraction alone. It also uses chemical bonds and hydrogen bonding to form strong chemical links between its surface and organic materials.



FIRST-OF-ITS-KIND PROBE MONITORS FETAL HEALTH IN UTERO DURING SURGERY

- Researchers have developed the first device that can continuously track a fetus's vital signs while still in the uterus—previously an impossible feat.
- The probe can track heart rate, heart rate variability, blood oxygen levels, and temperature.
- The device could help surgeons intervene earlier or pause a procedure if a fetus shows signs of distress and give parents and caregivers greater peace of mind during surgery.

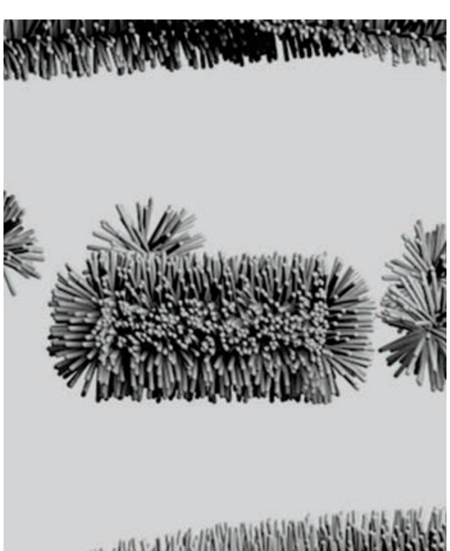
Northwestern researchers developed the first device that can continuously track a fetus's vital signs while still in the uterus—previously an impossible feat.

The soft, flexible robotic probe could dramatically improve safety during surgeries in which physicians operate on a fetus before birth. Traditionally, doctors have relied on intermittent measurements of fetal heart rate using ultrasound imaging from outside the pregnant person's body. The new device, on the other hand, is gently inserted through the same narrow port already used in fetal surgeries.

Once inside the uterus, the device maintains stable, gentle contact with the fetus to reliably track heart rate, heart rate variability, blood oxygen levels, and temperature. In studies on a large animal model, the probe provided accurate, precise, clinical-grade measurements even when the uterus and fetus moved during surgery. By tracking multiple vital signs simultaneously, surgeons gain an earlier, more complete picture of fetal distress, enabling faster interventions in case complications arise.

Northwestern bioelectronics pioneer John A. Rogers led the device's development in collaboration with Aimen Shaaban, a fetal surgeon at Ann & Robert H. Lurie Children's Hospital of Chicago. The work builds on Rogers's growing suite of soft, flexible devices designed to monitor the health of tiny, vulnerable patients, including premature infants in the neonatal intensive care unit. Professors Rogers and Shaaban co-led the study with Professor Yonggang Huang.

"Right now, clinicians only have a partial picture of how a fetus is doing throughout surgery," Rogers says. "We were presented with the challenge of designing a technology to monitor vital signs throughout the surgical process without creating an invasive access point or disturbing delicate tissues. Our flexible, hair-like probe enters a port already used in minimally invasive fetal procedures and provides continuous, comprehensive monitoring without adding risk." Similar probes could be used in the future to identify complications during the intrapartum period and for early interventions to reduce stillbirths and other adverse perinatal outcomes.

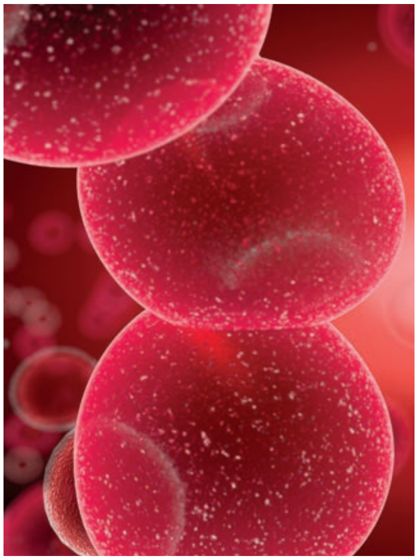


Post-Stroke Injection Protects the Brain in Preclinical Study

Northwestern scientists developed an injectable regenerative nanomaterial that helps protect the brain immediately after a stroke.

In a new preclinical study in a mouse model of ischemic stroke, the most common type, the team delivered the therapy in a single intravenous dose immediately after restoring blood flow. The therapy successfully crossed the blood-brain barrier—a major challenge for most drugs—to reach and repair brain tissue. The material significantly reduced brain damage and showed no signs of side effects or organ toxicity.

The injectable therapy is based on supramolecular therapeutic peptides, a platform developed by Professor Samuel I. Stupp previously used to reverse paralysis in mice. The findings suggest the new therapy could eventually complement existing stroke treatments by limiting secondary brain injury and supporting recovery. It could also be useful in treating traumatic brain injuries and neurodegenerative diseases such as ALS.



Building "Smart" Cell Sensors for Safer, More Precise Cancer Therapies

CAR T-cell therapy, a form of personalized medicine that engineers a patient's immune cells to find and destroy cancer, has shown remarkable success in some cancers, but its reach remains limited. A key challenge is controlling when and where these powerful therapies activate.

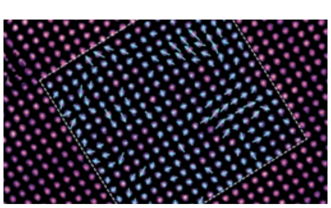
A team led by Professor Joshua Leonard developed a new class of synthetic receptors that can help cell therapies sense their surroundings more precisely. These smart sensors can detect biochemical cues that are often elevated in cancerous or diseased tissue, such as interleukin-10—a signaling molecule that regulates the immune response, and activate therapeutic functions only in diseased environments.

"Figuring out how to 'teach' cells to recognize specific molecular fingerprints that identify a site of disease is key to realizing the full potential of cell-based therapies," Leonard says. "This study could ultimately enable the development of safer and more effective treatments for cancer using 'smart' cell therapies."

AIRPLANE AND HOSPITAL AIR IS CLEANER THAN YOU MIGHT THINK

In the first study of its kind, Professor Erica Hartmann and her team sampled used face masks and an aircraft air filter to uncover the invisible world of microbes floating in shared air. Their results revealed that the same types of harmless, human-associated bacteria dominate both airplane and hospital air.

Across all samples, the team detected 407 distinct microbial species, including common skin bacteria and environmental microbes. While a few potentially pathogenic microbes appeared, they were extremely low in abundance and without signs of active infection. The study also shows that face masks and air filters can be repurposed as cost-effective tools to monitor confined, high-traffic environments.

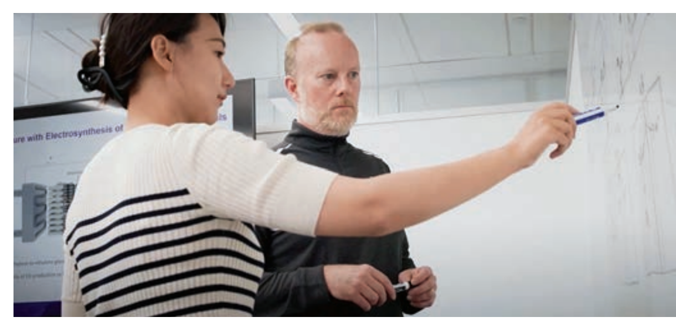


Advanced Imaging Reveals Hidden Thermoelectric Structure

A large portion of mass-produced energy dissipates as waste heat. Thermoelectric materials offer a way to capture some of that lost energy by converting heat directly into electricity.

A multidisciplinary Northwestern team developed and characterized $AgMnSbPbTe_4$, a thermoelectric semiconductor that performs well from near room temperature to over 980 degrees Fahrenheit, with hidden structural features, as revealed by advanced imaging, that help turn waste heat into electricity. By combining high efficiency with performance over a wide temperature range, this material moves thermoelectrics closer to practical applications.

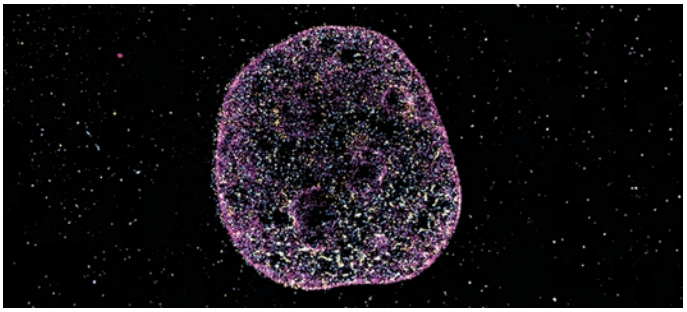
66 Enzymes that were screened by Ashty Karim and Michael Jewett to create a new artificial metabolism that transforms waste carbon dioxide into useful biological building blocks



DEVELOPING AN ENERGY-SAVING, CARBON-CAPTURING METHOD FOR MAKING ETHYLENE GLYCOL

A team led by Professor Ted Sargent developed an electrochemical system that produces ethylene glycol—best known as antifreeze but also a key building block for the polymers industry—with high selectivity, generating minimal waste, and using less energy. As electricity demand surges due to the rapid growth of AI-driven data centers, the approach could help conserve power.

This system also captures carbon dioxide for potential use or long-term storage. Traditionally, electrochemical carbon capture often has faced challenges such as low current densities and high cell voltages. In this study, researchers developed a new method that uses a special membrane with a pH difference on each side to improve carbon capture during the production of ethylene glycol.



GENOME'S 3D SHAPE FUNCTIONS AS THE LIVING COMPUTER THAT ENABLED COMPLEX LIFE

Research revealed the second language of the human genome—one not written in its chemical letters but in its physical shape. Scientists have long thought of DNA as an instruction manual written in the four chemical bases—A, C, T, and G—that make up the genetic code. Professor Vadim Backman has revealed a second "language" of life: the "geometric code" embedded in the genome's physical shape.

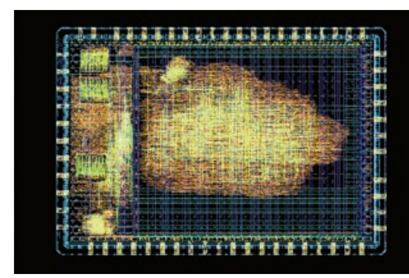
Like a blueprint for making living microprocessors, the geometric code helps cells store and process information. The code allows the genome to operate as a living computational system, adapting gene usage based on cellular history. These memory nodes are not random; geometry appears to have been selected over millions of years to optimize enzyme access, embedding biological computation directly into physical structure. The study suggests that the geometric code may have been a key adaptation that accelerated the evolution of complex body plans.

Molecular Coating Cleans Up Noisy Quantum Light

Quantum technologies demand perfection: one photon at a time, every time, all with the same energy. Even tiny deviations in the number or energy of photons can derail devices, threatening the performance of quantum computers that someday could make up a quantum internet.

While this level of precision is difficult to achieve, Northwestern researchers led by Professor Mark Hersam developed a novel strategy that makes quantum light sources, which dispense single photons, more consistent, precise, and reliable.

The team coated an atomically thin semiconductor (tungsten diselenide) with a sheetlike organic molecule called PTCDA. The coating transformed the tungsten diselenide's behavior, turning noisy signals into clean bursts of single photons. Not only did the coating increase the photons' spectral purity by 87 percent, it also shifted the color of photons in a controlled way and lowered the photon activation energy, all without altering the material's underlying semiconducting properties. The simple, scalable method could pave the way for reliable, efficient quantum technologies for secure communications and ultraprecise sensors.



A Scalable Probabilistic Computer

The Ising model in physics describes how electron spins interact and arrange themselves inside a magnetic material. Ising machines, derived from the model, exemplify the emerging field of physics-inspired computing systems that replicate physical phenomena to increase speed and improve energy efficiency of certain computations.

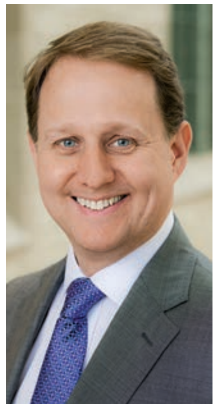
A team led by Professor Pedram Khalili demonstrated a scalable approach to building a specific type of Ising machine, called a PIM—probabilistic Ising machine or probabilistic computer. The researchers developed an integrated PIM that combines a custom-designed digital silicon chip with nanodevices based on the voltage-controlled magnetic tunnel junctions pioneered by Khalili. These computers, which operate at room temperature, can be manufactured using commercially available technology.

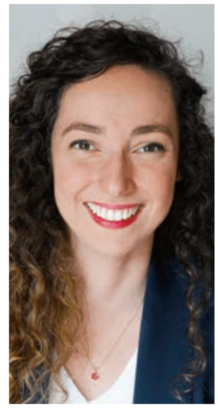
NO-SORT PLASTIC RECYCLING NEAR

The future of plastic recycling may soon get much less complicated, frustrating, and tedious. In a study led by Professor Tobin Marks, researchers introduced a new plastic upcycling process that can drastically reduce—or perhaps even fully bypass—the laborious chore of presorting mixed plastic waste.

The process harnesses a new, inexpensive nickel-based catalyst that selectively breaks down polyolefin plastics consisting of polyethylenes and polypropylenes—the single-use kinds that dominate nearly two-thirds of global plastic consumption. This means industrial users could apply the catalyst to large volumes of unsorted polyolefin waste. When the catalyst breaks down polyolefins, the low-value solid plastics transform into liquid oils and waxes, which can be upcycled into higher-value products, including lubricants, fuels, and candles.


Yonggang Huang


Christopher Schuh

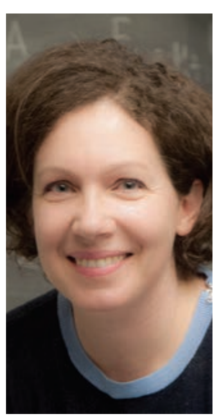

Cécile Chazot


Julio Ottino


Uri Wilensky


Chad Mirkin


Zdeněk Bažant


Petia Vlahovska


Igor Efimov


James Rondinelli


John Rogers


Chris Wolverton

Faculty Awards

Yonggang Huang Elected International Fellow of Royal Academy of Engineering
Huang was recognized for pioneering stretchable electronics and mechanics-guided deterministic 3D assembly of structures and electronics.

Julio Ottino Receives Malina, Russ Richards Memorial Awards
For his work at the interface of engineering, creativity, and art, Ottino received the Dr. Frank J. Malina '34 Renaissance Medallion Award from the Hagler Institute for Advanced Study. The Charles Russ Richards Memorial Award from the American Society of Mechanical Engineers and Pi Tau Sigma honored his achievement in mechanical engineering.

Zdeněk Bažant Named NAI Fellow
The National Academy of Inventors fellowship is the highest professional distinction accorded solely to academic inventors.

James Rondinelli and Christopher Schuh Named Fellows of Materials Research Society
Representing excellence in science and engineering and dedication to the advancement of materials research, MRS fellows exemplify the highest ideals embodied in the society's mission.

Uri Wilensky Awarded Yidan Prize for Education Research
Wilensky was recognized for his groundbreaking work in agent-based modeling.

Petia Vlahovska Earns Trailblazer Engineering Impact Award
This US National Science Foundation award will fund her research in brain-machine interfaces, neuro-prostheses, and neuromorphic engineering.

John Rogers Wins Royal Society of the United Kingdom Medal
The society's Bakerian Medal honored Rogers's contributions to the field of bioelectronics.

Cécile Chazot Receives Early Career Research Award
This US Department of Energy grant honors next-generation STEM leaders and will fund Chazot's work to develop a new class of sustainable energy materials.

Chad Mirkin Awarded Harvey Prize in Science and Technology
The Technion-Israel Institute of Technology honored Mirkin's pioneering discoveries, which reshaped nanoscience and nanotechnology, nanomedicine, and drug development.

Igor Efimov Invested as Member of American Academy of Sciences and Letters
Academy membership recognizes distinguished contributions to human learning.

Chris Wolverton Receives 2025 Materials Theory Award
This Materials Research Society award recognized his outstanding contributions to the development and application of materials prediction methods to practical problems.

HIDDEN TREASURE

SECURING MINERALS TO POWER SOCIETY

What do data centers, cars, agriculture, and smart devices have in common? They all rely on minerals.

From copper to graphite to zinc, most minerals are mined directly from the earth, where reserves are available around the world. However, some minerals are abundant in surprising places such as lakes and waste streams, where they have yet to be harvested on a large scale. Northwestern engineers are unearthing new approaches, technologies, and tools to expand the availability of minerals for the future.

"Ultimately, we need raw minerals from which we're going to synthesize novel materials for next-generation technologies," explains Mark Hersam, chair and Walter P. Murphy Professor of Materials Science and Engineering. "The raw minerals are often mined, which creates supply chain challenges depending upon where the mines are located." In most cases, those mines are located overseas, which creates a dependence for the United States.

"A role of the University is to help assess, develop, and scale technologies that can expand domestic mining to meet our needs while limiting the types of emissions to water or air that would harm people's health in the vicinity of mines."

Jennifer Dunn Professor of Chemical and Biological Engineering

Mining comes with other challenges. Data has shown that confusion and concern around human health impacts can fuel community opposition and slow the development of new mines.

Jennifer Dunn, professor of chemical and biological engineering, notes that as the United States builds its domestic mineral supply chain, "a role of the University is to help assess, develop, and scale technologies that can expand domestic mining to meet our needs while limiting the types of emissions to water or air that would harm people's health in the vicinity of mines." This role requires collaboration across disciplines and geographies.

Minerals at the core of everyday technology

When it comes to harvesting graphite and the innovative materials derived from it, Hersam is writing the playbook. This critical mineral has been a focal area of his research at Northwestern for the past 20 years, and recent collaborative advancements are elevating the game.

Graphite has long been essential to the anode side of the lithium-ion batteries that power everyday technology. Thanks to Hersam's research, a coating of graphene—a high-performance electronic material derived from graphite—can now be part of the cathode side of those batteries as well.

"Graphene has superlative electronic conductivity and is very inert chemically," Hersam explains. In a caustic environment, such as a lithium-ion battery, the atomically thin carbon material facilitates both chemical stability and electrical connectivity. Plus, it improves charging speed and prolongs battery life.

The demand for graphene is skyrocketing. It's used in lithium-ion battery applications from backup power for data centers to grid-level energy storage to printed electronics including medical monitoring patches and environmental sensors. Ongoing work focuses on upcycling sustainably sourced graphene to print sensors that could then be used to monitor mining waste for residual valuable minerals and to reduce waste.

Hersam, Dunn, and Wei Chen, Wilson-Cook Professor in Engineering Design and chair of mechanical engineering, are working together to produce larger quantities of graphene from graphite. Chen leverages AI-based methods to identify the ideal processing conditions for graphene production to optimize yield, sustainability, and cost. Her approach of adaptive learning identifies the preferred technique much more quickly than conventional trial-and-error methods.

"After we do a very small amount of physical tests, we can find optimal processing conditions considering multiple criteria," Chen says.

Bringing mining data to the surface

The challenge of acquiring minerals is massive in every sense—a concept all too clear to Dunn when she visited the world's largest copper mine in Chile. It took an hour to drive from the main entrance of the mine to the heart of the operation—an underground world of ore.

Dunn is uniquely positioned to see the big picture. She is an expert in quantifying environmental impacts from mining that include water consumption and water pollution.

In two recent papers, Dunn and her team set the stage for more consistency in quantifying mining's environmental impacts. After a comprehensive review of 15 years of studies on these impacts, they found inconsistencies that made comparing results difficult.

"We realized that there is an important need for better methods and data so that it's possible to compare the environmental effects of different supply chains for these minerals," Dunn says. In response, her team published guidelines researchers can follow as they evaluate mining's environmental effects. Future studies that follow the guidelines can be more accurately compared across geographies, minerals, and other conditions. Such comparable analyses would also improve understanding of how a shifting supply chain, including the possible development of new mines or changes to existing mines, will influence sustainability and impacts.

In their second paper, Dunn's team members unpacked the global state of data on mine emissions to air, water, and land. These factors determine the emissions of pollutants like nitrates, metals, and particulate matter per metric ton of mineral produced.

The initial challenge? Wrangling data from disconnected sources. Dunn's team consolidated decentralized data for copper and nickel mines in the United States into a data compendium that experts can tap into for future analyses. Dunn and her colleagues are already working on expanding that resource to include mines in Chile, Australia, and Canada.

opposite, top to bottom Mark Hersam, Jennifer Dunn, Wei Chen, Richard Lueptow

Collaborations with members of the US National Science Foundation-funded center for a Sustainable, Resilient, and responsible global Minerals supply chain (SuReMin) that Dunn leads support impactful international research in mining sustainability, including developing the data compendium. Beyond research, SuReMin provides important educational opportunities for students. For example, SuReMin has held seminars with industrial speakers for engineering students at Northwestern and for global SuReMin partners to learn about sustainability initiatives and employment opportunities in the mining industry. SuReMin has also supported Northwestern's Global Engineering Treks (see top image on page 14) for students to learn about mining. In addition, Ally Snead, a graduate student in Dunn's research group, is a Fulbright Scholar with a SuReMin partner in Australia, the Sustainable Minerals Institute at the University of Queensland.

ENGINEERING TECHNOLOGIES TO RECOVER VALUABLE MINERALS

As the need for minerals, which are nonrenewable resources, continues to grow amid production shortages, exploring all options for acquiring them becomes imperative.

"A lot of people would prefer that we don't open new mines or expand mining to meet the critical mineral demand," Dunn says. "But the demand is so large that expanding mining is unavoidable. So, we need parallel paths."

Those parallel paths include extracting minerals from natural sources other than mines and upcycling previously used minerals. Those techniques can boost local supply, in addition to or instead of mining.

Extracting minerals from natural sources

Some minerals abound naturally in sources other than mines. In Chilean salt lakes and other salt brines, for example, magnesium and lithium can be found together. Because the lithium must meet high purity standards for industrial use, it must be separated from the magnesium before it can be used.

Northwestern Engineering's Richard Lueptow and his collaborators accomplished this by adding a coating to a nanofiltration membrane that becomes positively charged at an acidic pH, allowing lithium ions to pass through but blocking most magnesium ions. Introducing a positive charge to the membrane is a key innovation that enables the selective separation of lithium and magnesium.

Starting small is key, says Lueptow, senior associate dean and professor of mechanical engineering. His team performs atom-by-atom simulations called molecular dynamics to explore how ions interact with the charged membrane nanostructure.

"We can look inside one of the membranes that could be used for separating lithium ions from magnesium ions and see the interactions at the molecular level computationally," Lueptow says.

Dunn and Richards have separately traveled with undergraduates through Northwestern's Global Engineering Trek program to visit lithium and copper mining facilities to learn about how companies are pursuing strategies and technologies to limit water and energy consumption in mining. Here, students observe a lithium brine in an evaporation pool at a lithium extraction facility in Chile.

Photo courtesy of Jennifer Dunn

“There is broad recognition that recovering critical and rare metals is essential to creating a resilient manufacturing sector for key technologies. Identifying waste streams that contain these metals and recovering them from those waste streams is the key step to ensuring a robust domestic supply of those elements to power these technologies.”

Jeffrey Richards Associate Professor of Chemical and Biological Engineering

Collecting minerals from polluted water

A century of industrial progress has left a treasure trove of discarded minerals in the world’s waterways.

Phosphate has long been found streaming into waterways from agricultural lands as runoff from fertilizer. Copper and zinc have accumulated in the Great Lakes since the Industrial Revolution. The value of these once-discarded minerals is now recognized. Copper is vital to data centers, zinc is key to industrial manufacturing, and phosphate remains important for food production.

“The mine of the future may well be waste streams,” says Vinayak Dravid, Abraham Harris Professor of Materials Science and Engineering. His lab is developing technologies to recover minerals from polluted urban and agricultural water. Over the past several years, Dravid and his collaborators have developed a family of sponge-based materials designed to selectively capture and recover valuable minerals from contaminated water. Dravid’s Phosphate Elimination and Recovery Lightweight (PEARL) membrane provides a simple single-step capture and recovery process for phosphate.

Another of Dravid’s technologies, a magnetically recoverable sponge coated with functional nanoparticles, can collect zinc, copper, phosphate, and other valuable ions present at very dilute concentrations from what he calls “used” water, then later release them one by one when prompted. “It’s no longer purely about environmental sustainability, which is a natural outcome from this process,” Dravid says. “If you use a mineral and recover it for reuse, you effectively multiply the value of that mineral many times over.”

Finding value in industrial waste

Industrial waste is another promising source of minerals. Jeffrey Richards, associate professor of chemical and biological engineering, is working to recover copper and zinc from semiconductor manufacturing waste.

“The opportunity is to use electrochemistry to directly recover these metal ions as a solid that can be easily separated from the acidic waste stream,” he says. “These metallic solids can then be resold or reused.”

Corporate partnerships are particularly valuable to this work. They offer researchers insight into real marketplace needs, enable immediate application of their findings, and show graduate students the direct impact of their research. “We always try to sit at the interface between fundamental research and the actual application to make sure that the fundamental research we’re doing is relevant,” Richards says.

The biofuels industry has also proven to be an abundant source of a useful waste product: carbon-rich biochar. Hersam recently published a technique for sourcing graphite from biochar. This graphite, referred to as biographite, can then be transformed into graphene.

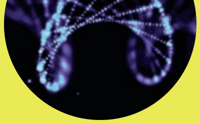
Bio-derived graphene can be made into graphene inks for high-value applications like batteries, IoT devices, and printed electronics. “Suggesting that a high-performance electronic material like graphene could be produced completely from waste biochar seemed outrageous at first—but I am happy to report that we’ve shown that it is possible,” Hersam says.

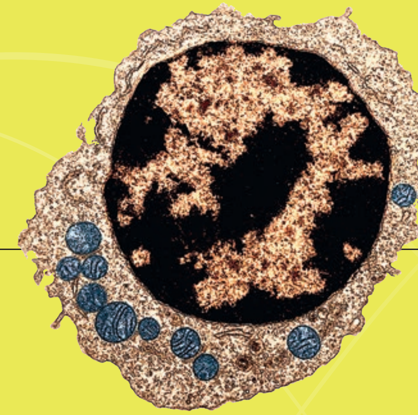
“There is broad recognition that recovering critical and rare metals is essential to creating a resilient manufacturing sector for key technologies. Identifying waste streams that contain these metals and recovering them from those waste streams is the key step to ensuring a robust domestic supply of those elements to power these technologies,” Richards says.

As mineral use soars, researchers remain grounded in their efforts to refine the ways to access, produce, and apply them to improve daily life. Recent advances at the McCormick School of Engineering have set the stage for a new decade of research that can further reduce waste, stabilize supply, and advance technological capacity in the United States for the benefit of all.

JULIANNE BECK

opposite, l–r Vinayak Dravid (photo by Matthew Allen), Jeffrey Richards (photo by Jason Brown)





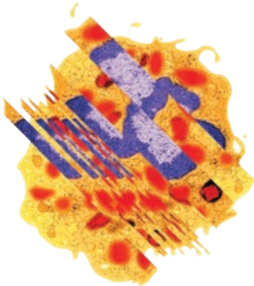
BIOLOGY, REIMAGINED:

NORTHWESTERN'S CENTER FOR SYNTHETIC BIOLOGY AT 10

TEN YEARS OF DISCOVERY— AND THE BREAKTHROUGHS STILL AHEAD.

"HERE IN CHICAGO AND EVANSTON, WE ARE THE THIRD COAST OF BIOTECH. THE CENTER IS AT THE FOREFRONT OF DEVELOPING TECHNOLOGIES THAT CAN SOLVE KEY PROBLEMS IN SUSTAINABLE AND RESPONSIBLE WAYS. IT WILL HOPEFULLY TRANSFORM THE WORLD."

Julius Lucks
Center for Synthetic Biology Codirector, Margery Claire Carlson Professor of Chemical and Biological Engineering



NOW THAT WE CAN DO ANYTHING, WHAT SHOULD WE DO?

In the world of synthetic biology—where scientists and engineers can rewire biological systems to perform remarkable new tasks, like sensing chemicals or delivering therapies—that question could hardly feel more urgent.

Even a mere 10 years ago, when Northwestern Engineering doubled down on its commitment to the field by establishing the Center for Synthetic Biology, researchers required expensive equipment, intricate algorithms, and lengthy experimentation to design and test new ideas.

Now empowered with the center's automated Foundry lab, team members can use AI tools like AlphaFold to design proteins and use powerful, high-throughput experimental equipment to create and test thousands of designs a day.

"That would have been science fiction five years ago," says Danielle Tullman-Ercek, James N. and Nancy J. Farley Professor in Manufacturing and Entrepreneurship, professor of chemical and biological engineering, and codirector of the center.

As the field accelerates and the center celebrates its 10th anniversary, faculty point to successes created by the team—new kinds of diagnostics and sensors, more effective therapies—while also looking to the future of the field.

"Here in Chicago and Evanston, we are the third coast of biotech," says Julius Lucks, Margery Claire Carlson Professor of Chemical and Biological Engineering and codirector of the center. "The center is at the forefront of developing technologies that can solve key problems in sustainable and responsible ways. It will hopefully transform the world."

"WHEN WE'RE CONSIDERING HOW TO SOLVE A PROBLEM, WE HAVE TO THINK ABOUT WHETHER IT IS ACCEPTABLE TO PURSUE AND HOW IT WILL AFFECT SOCIETY. WE WANT NORTHWESTERN TO BE THE PLACE WHERE THESE QUESTIONS ARE ASKED AND WHERE STUDENTS LEARN TO ASK THOSE QUESTIONS THROUGHOUT THEIR LIVES."

Danielle Tullman-Ercek
Center for Synthetic Biology Codirector, James N. and Nancy J. Farley Professor in Manufacturing and Entrepreneurship, Professor of Chemical and Biological Engineering

BUILDING SUCCESS THROUGH MULTIDISCIPLINARITY

Northwestern's reputation as a powerhouse in synthetic biology stems from its multidisciplinary, collaborative team, which represents some of the best minds in engineering, medicine, chemistry, law, policy, and anthropology.

"All of these perspectives are needed when technologies are developed," Lucks says. "We have one of the largest concentrations of synthetic biology researchers in the country, if not the world. When you're doing pioneering work, a collaborative team of experts is needed to go after important societal challenges."

One of those challenges is access to clean water. Over the past several years, Lucks and his collaborators have developed new synthetic biology biosensors that can detect lead and cadmium in water within minutes. The multidisciplinary project benefitted from field testing in Costa Rica, Kenya, and Chicago and involved faculty from anthropology, the Pritzker School of Law, and the Buffett Institute for Global Affairs.

Such technology-driven initiatives have also benefited from Northwestern's strengths in cell-free systems—harnessing the power of biology without being constrained by keeping the "machinery" inside the cell.

Researchers like Neha Kamat, associate professor of biomedical engineering, are taking that idea one step further and creating artificial cells. She and her team build membranes and put cellular machinery inside to perform useful functions, like synthesizing proteins. The goal is to create biosensors that can detect environmental contaminants or early biomarkers for diseases.

"With artificial cells, you can access the biological function that you get from a real cell, but in a very customizable way by building it up from scratch," she says. "And while regular cells are designed to grow and evolve, artificial cells will not do that. That makes them more controllable and safer."

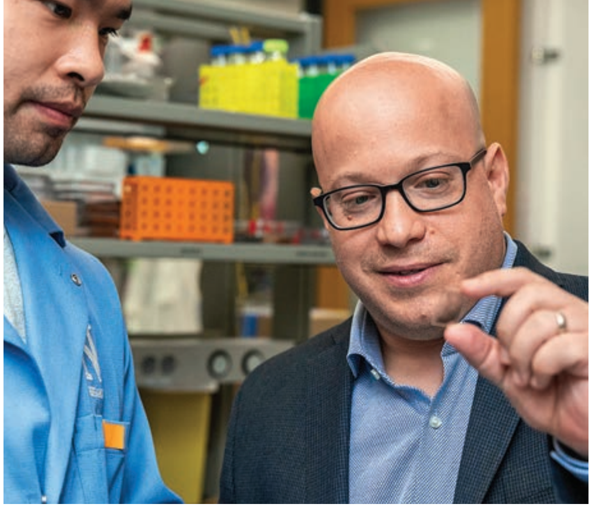
MODELING THE COMPLEXITY OF BIOLOGY

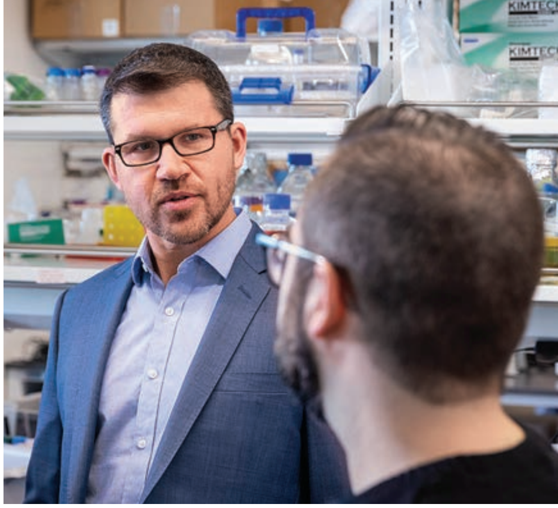
Northwestern synthetic biology researchers have made major breakthroughs in areas ranging from drug delivery to biofuels. For example:

DANIELLE TULLMAN-ERCEK, an expert in highly organized self-assembling proteins, has developed a biomanufacturing platform for proteins that could be used to create biofuels and meat alternatives.

JOSH LEONARD, professor of chemical and biological engineering, developed a platform that uses extracellular vesicles—particles released by cells—to deliver cell and gene therapy medicines.

JONATHAN RIVNAY, Jerome B. Cohen Professor of Biomedical Engineering and Materials Science and Engineering, is developing a "living pharmacy," an implantable electronic device that uses engineered cells to synthesize and release therapies.





left Danielle Tullman-Ercek and Julius Lucks, *top center* Jonathan Rivnay (photos by Heather Eidson), *bottom center* Niall Mangan, *top right* Josh Leonard, *bottom right* Neha Kamat (photos by Northwestern University)

Because biology is so complex, reengineering it to perform new tasks requires not only experimental innovation but mathematical models that describe which of the thousands of parameters that affect a cell's function are necessary for a certain task. That's where Niall Mangan, assistant professor of engineering sciences and applied mathematics, comes in.

"The art of mathematical modeling is understanding how you pick what's important," Mangan says. "We try to blend a combination of intuition with our collaborator's knowledge and the flexibility of learning new things from the data."

In one project, she worked with Tullman-Ercek to create a mathematical model of how metabolism is organized in space and time within bacteria—essential background knowledge needed to engineer bacteria to perform new tasks, like creating biofuels or pharmaceuticals.

And as in every research field, AI plays an increasingly large role. Mangan is developing AI-inspired methods, with the goal of automatically building new models for new experiments based on data from previous experiments.

With the automated equipment at the Foundry, "we could close the loop," she says. "Combining automated experiments with automatic models could help us look at the results and direct the next experiment."

EDUCATING STUDENTS TO ASK THE BIG QUESTIONS

Of course, no one is looking to take humans completely out of the loop. That's why education is such a large part of the center, which has developed a research experience for undergraduates and the first graduate training program in synthetic biology in the United States—both funded by the US National Science Foundation.

The team is even writing a textbook to serve as a foundational tool for teaching synthetic biology. As AI and automated equipment accelerate what the field can do—empowering center members to tackle new challenges, such as using synthetic biology to create fertilizers to help feed the planet—understanding the underlying concepts and their implications is critically important.

"We want to educate students to think about the big questions when dealing with synthetic biology," Tullman-Ercek says. "When we're considering how to solve a problem, we have to think about whether it is acceptable to pursue and how it will affect society. We want Northwestern to be the place where these questions are asked and where students learn to ask those questions throughout their lives."

EMILY AYSHFORD

>$53 MILLION

IN RESEARCH FUNDING

300+

UNDERGRADUATE AND GRADUATE STUDENTS AND POSTDOC TRAINEES

24

FACULTY ACROSS THE McCORMICK SCHOOL OF ENGINEERING, WEINBERG COLLEGE OF ARTS AND SCIENCES, AND FEINBERG SCHOOL OF MEDICINE

RESEARCH STRENGTHS ACROSS SCALES

Center for Synthetic Biology faculty develop solutions from molecular to societal scales to drive innovation and impact in science, technology, and ethics. Areas of strength include:

CELL-FREE BIOMANUFACTURING

A departure from traditional processes that turn cells into tiny reactors to create new products, cell-free biomanufacturing uses the power of biological machinery outside of the constraints of actual cells. This versatile approach requires less time to develop new platforms that can provide on-demand manufacturing at scale.

SYNTHETIC BIOLOGICAL MATERIALS

Faculty are creating new functional materials that could transform medicine and biotechnology. They use AI, computational modeling, and experimental data to develop tailored biomaterials that use intricate biological components, including bacterial microcompartments and artificial cells.

SYNTHETIC IMMUNOLOGY

From engineering immune cells that target specific pathogens to developing synthetic vaccines that offer rapid response to emerging diseases, synthetic immunology has the potential to reshape healthcare.

MODEL-INFORMED DESIGN

By leveraging sophisticated mathematical and computational models to simulate and predict the behavior of complex biological systems, researchers can navigate the intricate landscape of genetic circuits, cellular processes, and biomolecular interactions to gain invaluable insights into the design and optimization of synthetic biology projects.

SUSTAINABLE BIOCHEMICAL PRODUCTION

As the need for low-cost bio-products like fuels and medicine increases, synthetic biology offers a new way to engineer biological systems to produce these chemicals and materials via efficient, environmentally sustainable systems.

BIOSENSORS AND DIAGNOSTICS

Biosensors that detect chemicals in water or biomarkers in blood are breakthrough synthetic biology technologies. At the core of these platforms are genetically encoded factors that bind to chemical markers and trigger changes in reporter gene expression to generate a visible output.

HUMAN THERAPEUTICS

Harnessing the power of genetic engineering and synthetic biology techniques, researchers are pioneering novel, tailored treatments—including gene therapies, vaccines, and protein-based drugs—for a wide range of human diseases.

HIGH-THROUGHPUT DISCOVERY

With automated technology, scientists can evaluate thousands of genetic variations, cellular responses, or biomolecular interactions simultaneously, unlocking the potential to discover novel solutions and optimize biological systems at an unprecedented pace.

EDUCATIONAL TOOLS

Educating students about the science and ethics underpinning synthetic biology technologies is critical to empowering them to make informed decisions. Faculty have adapted synthetic biology lab activities into two portable, low-cost, user-friendly educational kits: BioBits Bright and BioBits Explorer.

WHERE SYNTHETIC BIOLOGY ACCELERATES

In synthetic biology, progress can often be hindered by the sheer complexity of biological systems. The more efficiently researchers can design, build, and test these new systems, the faster they can make medicines, produce sustainable chemicals, capture carbon, and pioneer other remarkable new tasks while taking into account any ethical considerations.

Opened in 2025, the SynBio Foundry at the Center for Synthetic Biology offers robotics, automation, and advanced data analysis to streamline engineering biology.

There, scientists use automated platforms to assemble DNA, construct engineered microbes, and run large numbers of experiments simultaneously. Automated workflows can shorten experimental cycles from months to weeks, enabling researchers to test far more designs.

The facility supports the core workflow of synthetic biology: the "design–build–test–learn" cycle. Researchers begin by using computational tools to design biological components for their technologies. The Foundry then builds those designs by assembling DNA and introducing it into cell or cell-free systems. Automated platforms test how the engineered systems perform, generating large datasets that researchers analyze to improve the next round of designs.

At the technical level, the Foundry integrates liquid-handling robots, automated DNA assembly platforms, high-throughput microbial culturing and cell-free gene expression systems, and advanced analytical instruments. Robotic systems can precisely transfer microscopic volumes of liquids, allowing thousands of biological reactions to be prepared in parallel. High-throughput screening platforms then use plate readers, fluorescence detection, or automated imaging to monitor how engineered cells grow or cell-free systems operate, produce chemicals, or respond to environmental signals.

These instruments are run by specialized software that manages experimental design, tracks samples, and captures data from each step of the workflow. The result is a highly standardized and traceable process that makes experiments easier to reproduce and allows researchers to compare results across large numbers of genetic designs.

BRIAN SANDALOW

FROM LAB TO STARTUP

Synthetic biology researchers have launched several startups to translate their innovations:

MOONLIGHT BIO

Founded by adjunct professor Jaehyuk Choi, this startup aims to harness evolutionary forces that reveal unparalleled advances in T cell potency to create therapies that achieve unrivaled outcomes for cancer patients.

SAMDI TECH

SAMDI Tech was founded by Professor Milan Mrksich in 2011 to help researchers benefit from SAMDI (Self-Assembled Monolayer Desorption Ionization) technology for diverse drug discovery applications.

DESIGN PHARMACEUTICALS

Founded by adjunct professor Michael Jewett, Design Pharmaceuticals applies robust ultra-high throughput bioscience technologies in a novel approach to accelerate drug discovery and outpace current industry capabilities.

PEARL BIO

Cofounded by Michael Jewett, Pearl Bio's proprietary technology couples genome and ribosome engineering to produce novel biologics with diverse chemistries previously inaccessible.

SWIFTSCALE BIOLOGICS

Cofounded by Michael Jewett, this company's technology eliminates the constraints of using living cells in the drug manufacturing process, resulting in faster production times, less variability across batches, and greater scalability with hard-to-produce proteins. In 2021, the company was acquired by Resilience.

SYENEX

Syenex, cofounded by Professor Josh Leonard, is developing a synthetic biology discovery platform to harness the therapeutic potential of extracellular vesicles to accelerate the development of cell and gene therapy medicines.

OPERA BIOSCIENCE

Founded by Professor Danielle Tullman-Ercek, Opera offers a platform that allows scientists to source the proteins, growth factors, and reagents they need quickly and inexpensively.

THE NEXT ERA OF ENGINEERING EDUCATION

A NEW CORE CURRICULUM AND DEGREE PROGRAM WILL PROVIDE STUDENTS WITH A FOUNDATION TAILORED FOR THEIR GOALS.

Technology continues to accelerate at an unprecedented pace. Artificial intelligence is reshaping commerce and industry. Complex, interconnected global challenges demand new ways of thinking and working. To meet this moment, engineering education must evolve.

AT NORTHWESTERN ENGINEERING, such evolution is not new—it's foundational. For decades, the McCormick School of Engineering has embraced an adaptable curriculum, regularly introducing innovative courses, minors, and certificates designed to prepare students to have a meaningful impact across disciplines and industries.

This coming fall will mark the most significant advancement in the undergraduate experience since the school's Engineering First program debuted more than 25 years ago. Northwestern Engineering will unveil a comprehensive redesign of its undergraduate core curriculum and launch a new bachelor of science in engineering (BSE) degree program and an AI major.

"The core curriculum changes, the BSE program, and the AI major will vastly enhance the experience of our students," says Wesley Burghardt, associate dean for undergraduate engineering. "This is important and exciting work."

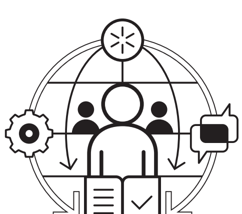
> "The core curriculum changes, the BSE program, and the AI major will vastly enhance the experience of our students. This is important and exciting work."
>
> **Wesley Burghardt** Associate Dean for Undergraduate Engineering

REFINING THE CORE CURRICULUM

Northwestern Engineering's redesigned core curriculum—effective for incoming first-year students this fall—reflects engineering's shifting center of gravity by emphasizing data and statistics, programming, and entrepreneurial thinking as essential foundations for modern practice.

Today's engineers power innovation with data. The ability to interpret and harness it is the methodological backbone, decision-making engine, and discovery accelerator behind breakthroughs from AI and advanced manufacturing to biohybrid systems, concurrent materials design, and risk modeling.

To meet an evolving landscape, the new first-year technical requirements will include three Engineering Foundations courses—one in Python-based programming, one in probability and statistics, and one in linear algebra. This new model shifts the focus from engineering mechanics to data analytics and probabilistic reasoning, equipping students to build discipline-specific applications, reason under uncertainty, and model complex systems.



STRATEGIC VISION: TRANSFORM ENGINEERING EDUCATION

Northwestern Engineering prioritizes innovative, adaptable curriculum and programs to prepare the next generation of engineers to address challenges in an ever-changing landscape.

ELEVATING ENTREPRENEURIAL THINKING

The updated core curriculum also aims to broaden students' opportunities to cultivate crucial skills in entrepreneurship with a reimagined Design, Communication, and Innovation requirement (formerly Design and Communication).

Beginning in fall 2026, two Farley Center for Entrepreneurship and Innovation introductory courses—Principles of Entrepreneurship (ENTREP 225) and Engineering Entrepreneurship (ENTREP 325)—will be included as options for fulfilling the core requirement. Previously, these courses were offered only as unrestricted electives.

Burghardt notes that the expanded fulfillment options build on the interdisciplinary, innovation focus of the existing design, writing, and oral communication options.

"A hallmark of engineering practice is effective storytelling—thinking critically, pitching ideas, and communicating effectively," Burghardt says. "Transformative technologies succeed not only because they work but because engineers can compellingly communicate why they matter."

BUILDING MORE FLEXIBLE PATHWAYS

Not every incoming undergraduate student arrives with the same goals, academic background, or pre-engineering experiences. The new core curriculum is designed to meet the needs of individual students.

"We're recalibrating the fundamental engineering skills that each of our degree programs will build upon with discipline-specific training," says Burghardt, who chairs the working group leading the curriculum changes.

Mechanics-centric programs—including mechanical engineering, biomedical engineering, and civil and environmental engineering—will continue to require a rigorous two-quarter engineering mechanics sequence to align depth with disciplinary imperatives in those subject areas. Students in programs outside these mechanics-intensive disciplines will gain a solid grounding through a foundational physics mechanics course.

"Also, while the former model was built on the premise that every student should jump in and progress through the same sequence at the same pace, the new core curriculum creates more entry points and flexibility," Burghardt says.

All core technical requirements will be offered every quarter, enabling students to chart the course most appropriate for them.

LAUNCHING THE BACHELOR OF SCIENCE IN ENGINEERING DEGREE

Also in fall 2026, Northwestern Engineering will launch a new bachelor of science in engineering degree. The BSE structure creates one degree program that will house majors and facilitate a flexible pathway for creating new and interdisciplinary majors in the future. The school's 13 existing standalone bachelor of science degree programs will remain to preserve accreditation and continuity.

"Our goal is simple but ambitious: create a degree structure that ignites the creativity and ingenuity of McCormick faculty to develop ideas for exciting, forward-looking areas of study," Burghardt says.

The benefit isn't simply administrative. Students enrolled in other Northwestern schools can pursue second BSE majors as seamlessly as they currently can add complementary Northwestern Engineering certificates and minors.

"We aim to prepare students for the future of a quickly changing and expanding field. The AI industry demands specific technical skills that differ from the existing core computer science curriculum, including computer vision, knowledge representation and reasoning, natural language processing, machine learning, and robotics."

Sara Owsley Sood Chookaszian Family Teaching Professor of Instruction, Associate Chair for Undergraduate Education

LEARNING TO BUILD, DEPLOY, AND USE AI RESPONSIBLY

The first major to debut under the new BSE degree is AI, a domain that underpins innovation across industries, drives discovery at the frontiers of research, and shapes how technology affects people and communities. Graduates with AI expertise are in high demand in advanced degree programs and across a broad spectrum of employers including tech companies, startups, healthcare, government, and nonprofits.

Designed to prepare students to become versatile builders and critical thinkers amid constant technological advances, the AI major curriculum will equip students with a deep, practical understanding of how to build, deploy, and use intelligent systems responsibly.

"We aim to prepare students for the future of a quickly changing and expanding field," says Sara Owsley Sood, Chookaszian Family Teaching Professor of Instruction and associate chair for undergraduate education. "The AI industry demands specific technical skills that differ from the existing core computer science curriculum, including computer vision, knowledge representation and reasoning, natural language processing, machine learning, and robotics."

Through rigorous training in machine learning, natural language processing, AI systems and infrastructure, data structures and algorithms, and the mathematical foundations that underpin modern AI, students will learn to design efficient, reliable, and scalable solutions to complex problems.

Equally important, the program emphasizes the human and societal dimensions of AI, training students to apply user-centered design principles and critically evaluate the impacts of AI on privacy, sustainability, and intellectual property.

The new major builds on McCormick's popular AI minor and AI concentration in the Department of Computer Science. Beginning this fall, Northwestern students may choose to declare the AI major as a new major, a change in major, or a second major. More BSE majors and potential joint major programs will launch in the coming years.

MEASURING IMPACT, ENSURING SUCCESS

As with any new change, faculty and staff will assess the new core curriculum. They will employ an evaluation plan developed by curriculum working group member Jennifer Cole in collaboration with Northwestern's Searle Center for Advancing Learning and Teaching. Cole, associate professor of instruction and assistant chair of chemical and biological engineering, brings expertise as the director of the Northwestern Center for Engineering Education Research to the assessment planning process.

Faculty will compare how students meet objectives under the new and old structures to ensure changes have the desired effect. Beyond assessing measurable outcomes, the working group is also developing a survey instrument to capture more holistic insights: how students experience their first year and how that experience shapes their emerging identity as engineers.

"Our goal is to assess not only what students can demonstrate technically, but how they perceive their growth, confidence, and sense of belonging in the Northwestern Engineering community," Burghardt says.

MICHELLE MOHNEY

LAB TOUR QUANTUM OXIDE LAYERS LAB

Opened in the winter of 2025, the Quantum Oxide Layers Lab is where Jennifer Fowlie studies transition metal oxides, advanced materials that show unusual quantum behaviors.

Fowlie, assistant professor of materials science and engineering, and her research team work to create these special materials in precise ways at nanoscale. By combining careful materials design with advanced tools that measure magnetic, electronic, nuclear, and optical properties, they gather insights into how quantum materials behave in electronic applications from touchscreens to quantum information processing platforms.

1. FURNACE

A tube furnace plays a quiet but essential role in shaping transition metal oxides before and after they are grown as thin films. The long, horizontal chamber heats samples to high temperatures under carefully controlled conditions. Whether preparing targets for pulsed laser deposition or refining newly grown films, the furnace ensures the precise crystal structure and chemistry that experiments demand.

What distinguishes this tube furnace is not only its control of atmosphere and temperature, but its ability to measure electrical properties in real time as reactions occur. By flowing oxygen or other gases through the heated chamber, the team fine-tunes oxygen content while tracking changes in conductivity. For transition metal oxides, even small shifts in oxygen stoichiometry can dramatically alter magnetic and electronic behavior, making this in situ measurement critical.

2. PULSED LASER DEPOSITION CHAMBER

The pulsed laser deposition chamber is the starting point for every sample of transition metal oxides. Oxygen-metal compounds with unusual electronic and magnetic behavior, these materials naturally form ceramic crystals—hard, brittle solids with a regular, repeating 3D arrangement of atoms that gives a crystal its structure and properties.

In a highly controlled process, the system grows thin layers of these crystals, one sample at a time, with each run taking a few hours.

A high-powered laser strikes a solid target containing the exact chemical composition. The material vaporizes into a plume and deposits onto a carefully selected crystalline substrate, where it reforms as a precisely structured atomic layer.

The target must match the desired chemical composition precisely, and the substrate determines how the crystal will align as it grows. By changing the target or the substrate, the team can systematically engineer different structures while keeping the rest of the environment constant. That level of control is essential when working with transition metal oxides, the magnetic and electronic properties of which are extremely sensitive to small structural changes.

3. CLEAN ROOM

In the clean room, designed to keep dust and airborne particles away from transition metal oxide samples, the delicate films, which may be only a few nanometers thick, are handled under tightly controlled conditions.

In the lab's workflow, the clean room serves as the bridge between growth and measurement. After being created in the pulsed laser deposition chamber, the films often pass through this controlled environment for final preparation before low temperature studies.

4. CRYOGENIC MEASUREMENT SYSTEM

This is where metal oxides are put to the test. After the samples are fabricated in the pulsed laser deposition chamber, the thin films come to this system where they are cooled to extremely low temperatures and quantum effects become apparent. Many of the exotic properties Fowlie's group studies only emerge in the cold, when thermal noise is reduced and quantum interactions dominate.

The large, vacuum-insulated vessel creates a tightly controlled environment that allows researchers to observe subtle changes in a material's behavior. Inside the system, samples can be subjected to precise temperature control and electrical and magnetic measurement.

5. WIRE BONDER

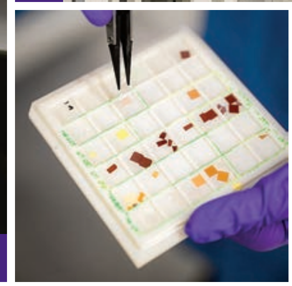
Here, the team makes first electrical contact with their transition metal oxide devices. Under the microscope, researchers guide hair-thin metal probes onto microscopic contact pads, a delicate process that requires steady hands and careful alignment.

The setup allows the team to test tiny samples without permanently wiring them, ideal for rapid checks of newly prepared films. Before moving on to more specialized low temperature studies, the researchers also measure properties like electrical resistance and current flow to see how a material behaves.

BRIAN SANDALOW

Photos by Jason Brown

1



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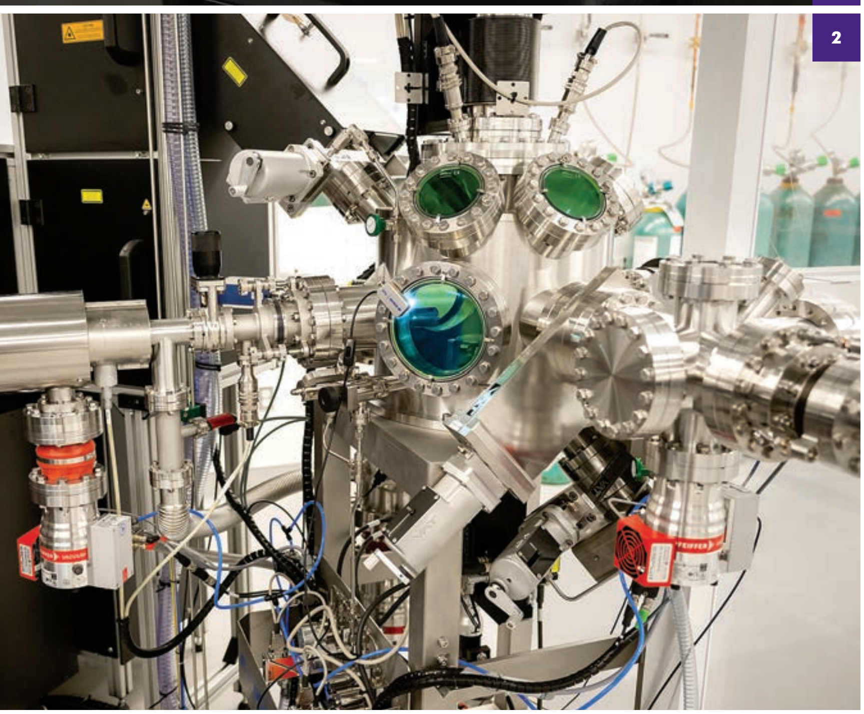

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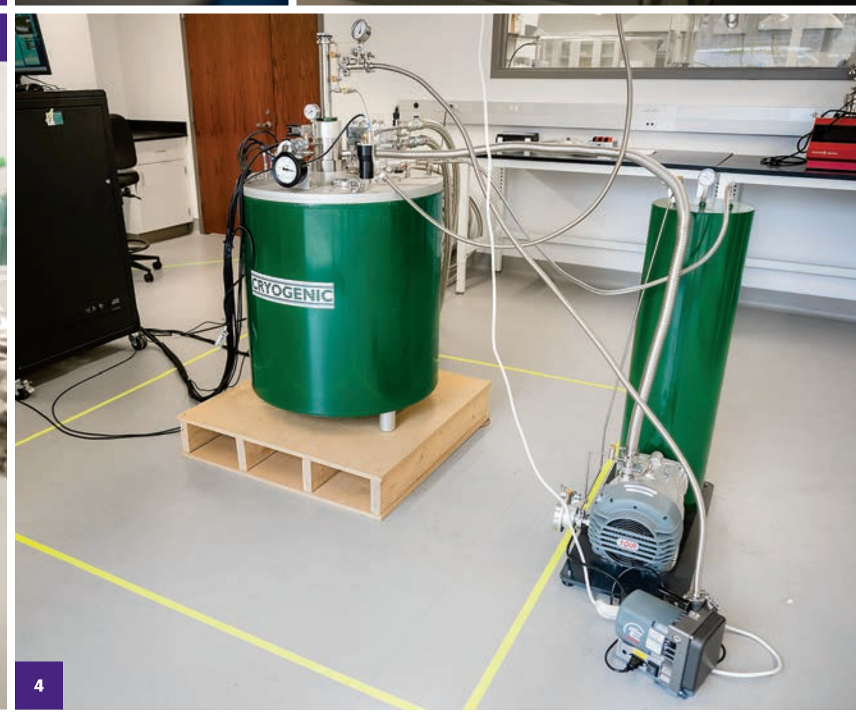
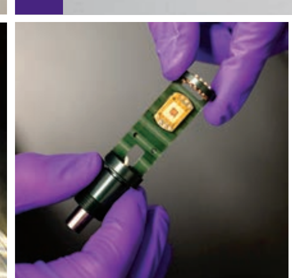
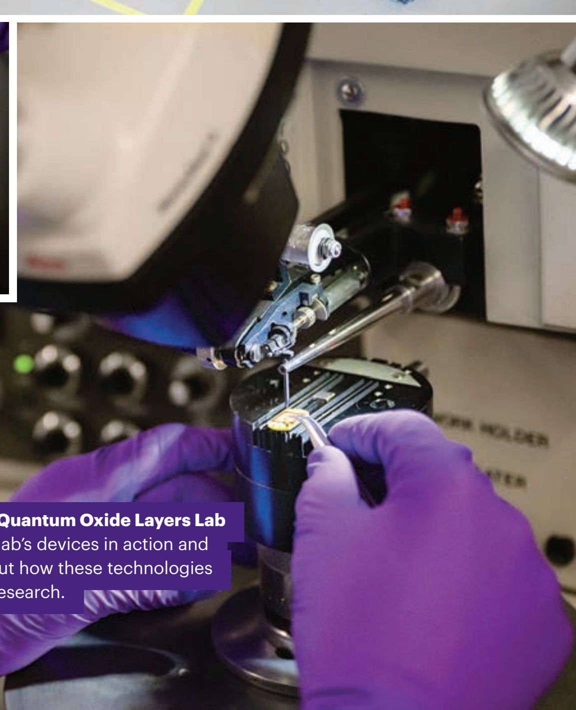


4

Jennifer Fowlie
Assistant Professor of Materials Science and Engineering





5

Tour the Quantum Oxide Layers Lab
View the lab's devices in action and learn about how these technologies support research.

At the Intersection of AI, Innovation, and Business

AT GOOGLE, NELSON GONZALEZ LEADS ARTIFICIAL INTELLIGENCE PRODUCTS THAT SIMPLIFY BUSINESS AND HELP PEOPLE SUCCEED

Nelson Gonzalez ('90, MBA '95) is driven by a simple goal: helping people and businesses succeed. As head of products, enterprise generative AI, and agents at Google, he collaborates with leading experts to advance the frontier of artificial intelligence.

With his team and his customers, he pushes the boundaries of AI to help organizations become more innovative, efficient, and competitive.

Problem-solving and team leadership are central to his approach. These are skills he honed at Northwestern, where he earned a bachelor's degree in electrical engineering and later an MBA from the Kellogg School of Management.

Gonzalez has built a career working at the intersection of AI, product innovation, and business transformation for influential technology companies, including Amazon Web Services and Microsoft. At Google, he leads enterprise generative AI initiatives that help global organizations migrate mission-critical workloads to the cloud and scale agentic AI solutions.

He has helped launch major platforms, including Vertex AI Vision and Document AI, and spearheaded the development of Google Cloud's first generative AI media models. His work has driven significant revenue growth, secured strategic enterprise customers, and strengthened Google's position as a leader in enterprise-grade AI.

"Teamwork is critical. As an engineering undergraduate and at Kellogg, I enjoyed being able to work well as a team, lead teams, contribute to teams, and problem-solve, and it has been completely applicable to what I do today."

"Teamwork is critical," Gonzalez says. "As an engineering undergraduate and at Kellogg, I enjoyed being able to work well as a team, lead teams, contribute to teams, and problem-solve, and it has been completely applicable to what I do today."

"Day in, day out, I work with smart people who are changing the status quo," he says. "They're building new products, new services, and innovating. Even for existing businesses and processes, they're working really hard to make them better."

He focuses on making that transformation easier. "My role is to bring new products that simplify that journey for our customers," he says. "What I enjoy most is seeing people becoming successful and just being part of their success in some minor or major way."

Gonzalez has fond memories of Northwestern, from swimming in Lake Michigan with his Polar Bear Club to conducting biomedical engineering research with a visiting professor. An active alumnus, Gonzalez is encouraged by the University's commitment to preparing students for an AI-driven future and was proud when his daughter Ashley chose to follow in his footsteps at Northwestern. She's now a second-year materials science and engineering major.

"Not only for students who choose an AI major, but for any student, it is critical to understand basic AI capabilities," he says. "Every task will be enhanced with AI, so it's important to understand at a top level the various types of AI. It's also helpful to be hands-on and have those favorite AI tools that are going to help you be more productive in whatever you do."

SARA LANGEN

ENGINEERING BETTER MEDICINES

AT KBI BIOPHARMA, SIGMA MOSTAFA WORKS TO TRANSFORM BREAKTHROUGH DRUG CONCEPTS INTO SAFE, MANUFACTURABLE TREATMENTS FOR PATIENTS WORLDWIDE.

Knowing her work has the potential to improve lives inspires Sigma Mostafa (PhD ’00) every day in her role as chief scientific officer (CSO) at KBI Biopharma.

A global contract development and manufacturing organization (CDMO), KBI provides accelerated drug development and biologics manufacturing services to life science companies. In a rapidly evolving field, the company helps partners discover, develop, and commercialize innovative medicines and vaccines.

“Truly lifesaving drugs are being developed. We work to make them manufacturable to produce in a large-scale, compliant way so they can safely go into humans and be effective. It’s a fascinating field,” Mostafa says. “Watching drugs being developed and shaping the future of those drugs, then hearing about the impact they have on patients is absolutely amazing. It’s a very rewarding experience.”

Mostafa began her career as a research scientist at Eli Lilly and Company and later honed her expertise at Organon/Diosynth Biotechnology, a Merck & Co. subsidiary. She joined KBI in 2010 as director of upstream process development, later serving as vice president of upstream and downstream process development and senior vice president and site head. She became CSO in 2023.

In the 16 years since Mostafa joined KBI, she has helped transform the Durham, North Carolina-based company from a fledgling startup to a top 10 global CDMO. She grew the mammalian process development department from five to 50 programs per year and is responsible for 40 percent of KBI’s revenue.

She credits her Northwestern chemical and biological engineering PhD experience with giving her the technical expertise and initiative to lead KBI’s exponential growth.

“The knowledge I gained through my research was important,” she says. “What a PhD education does, especially when you work with leading researchers, is give you a methodology for working with very complex problems and sticking with them until you become an expert and can solve critical issues. It also offers a core level of confidence that you can solve pretty much any problem.”

She cites two of her professors at Northwestern, Terry Papoutsakis and William M. Miller, as major influences, noting how their pioneering research resonated with her and their guidance helped her thrive. Today, she honors those relationships by mentoring members of her own team.

“The mentors I had were world class,” she says. “I believe in the mentor relationship and try to do the same with my mentees. We have dedicated folks who are passionate about what they do. I really enjoy going into the office and working with these brilliant people.”

SARA LANGEN

“What a PhD education does, especially when you work with leading researchers, is give you a methodology for working with very complex problems and sticking with them until you become an expert and can solve critical issues. It also offers a core level of confidence that you can solve pretty much any problem.”

Attracting Materials Success

ALAN LUND COMBINES EXPERTISE IN MATERIALS AND BUSINESS TO FUEL INNOVATION IN MAGNET MANUFACTURING AND SUPPLY CHAIN MANAGEMENT.

"You can't be afraid to just go at a problem. Solving challenging problems requires working your tail off, and that's something critical I learned at Northwestern."

AS A GRADUATE STUDENT IN MATERIALS SCIENCE AT NORTHWESTERN ENGINEERING, Alan Lund (PhD '02) spent countless hours on the scanning electron microscope, imaging nickel-based superalloys to better understand them at the smallest scales.

He found the work interesting—metals, with their "friendly" molecular bonds, were his favorite material. But after a long day of preparing and imaging samples, he would stand back from his computer and walk out to his favorite spot on the Evanston campus: the lakefront. There, on the concrete blocks so familiar to Northwestern students, he would gaze out at the beauty of Lake Michigan and decompress. "It was always very calming for me," he says.

Yet research kept calling him back to his lab, and nearly 25 years later, he has built a solid and successful career based on materials. Having founded three companies, he now leads a team at MP Materials, a company that mines and processes rare-earth elements in the United States and turns them into high-performance magnets used in transportation, energy, robotics, defense, and aerospace.

Lund's success can be credited to his technical and business skills, his underlying vision—to create a supply chain in the United States that doesn't rely on shifting geopolitical relationships—and plain old hard work.

"You can't be afraid to just go at a problem," he says. "Solving challenging problems requires working your tail off, and that's something critical I learned at Northwestern."

Commercializing materials research

After earning his PhD studying with Professor Peter Voorhees and before joining the Massachusetts Institute of Technology as a postdoc, Lund spent a summer at the National Academies of Sciences working on science policy. At MIT, he joined a research group led by Christopher Schuh, then a young professor building up his portfolio and now dean of Northwestern Engineering.

It was an exciting time—the collaborative lab had good energy and produced many impactful scientific publications. As things turned out, the research also had a key commercial application. The nanocrystalline alloys produced through an electrochemical method were ideal for creating surface coatings. This led Lund and Schuh to found Xtalic, which develops and sells specialized coatings for high-performance electronics.

Lund had considered a career in academia, but the move into the marketplace set him on the path he knew was right for him. "I wanted to be able to drive innovation while having a direct and measurable impact on the real world," he says.

After 10 successful years with Xtalic, Lund and Schuh founded another company, Veloxint, which manufactures nanocrystalline powders. Through Veloxint, Lund met another entrepreneur with whom he cofounded Braidy Industries, an aluminum alloy manufacturer, which led to the first new aluminum rolling mill being built in the United States in more than 40 years. "I'm very proud to have started this multi-billion-dollar project to transform how aluminum is supplied within the United States," he says.

Drawn to magnets

When the COVID-19 pandemic hit and Veloxint was purchased, Lund found himself thinking about the failures in the supply chain the pandemic had revealed. Seeking his next opportunity, he reached out to MP Materials, which owned and had just brought back online the only rare-earth mine and processing facility in the United States.

Lund envisioned his own role at the company. MP Materials was looking to turn rare earths into high-performance magnets for leading-edge technologies, including wind turbines, electric vehicles, robotics, and autonomous flight systems. Creating such magnets requires electrochemical processes and powder metallurgy—two of Lund's areas of technical expertise. He pitched himself to the company and was hired in 2021.

As executive vice president of magnetics, Lund has signed foundational customers—including GM and Apple—and has overseen the construction of a 250,000-square-foot magnet manufacturing facility in Fort Worth, Texas.

When the United States had trade friction with China, which mines most of the world's rare-earth elements and produces most of the magnets made from them, the US Department of War invested in MP Materials to construct an even larger manufacturing facility, set to break ground in the near future.

With production from MP Materials's mine, which now supplies up to 15 percent of the world's rare-earth elements, Lund and his team are working to realize the company's mission—creating a robust, end-to-end magnet supply chain in the United States, insulated from geopolitical disruptions.

"MP is part of a broader reshoring of manufacturing to the United States," Lund says. "And I think that is a lofty and worthy goal."

Though Lund no longer can retreat to the Evanston lakefront to recenter himself at the end of a busy day, he remains connected to Northwestern. He has served on the Department of Materials Science Advisory Board, kept in touch with professors, and sent his 14-year-old son to campus for the Center for Talent Development's summer programs.

"My son was gushing about campus, and I was excited because Evanston is a place I love," Lund says. "It's a unique place in the world, and I've always had in the back of my mind that it would be a great place to end up, too."

EMILY AYSHFORD

IN MEMORIAM

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David L. Shanks '51
Robert H. Smith '53
David W. Cameron '54
James D. Dorn '54
Stanley J. Polcyn '54, '58
Leo Bademian '55, '57
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Jonathan Alexander Bockelman '05
Latoya Katrise Dean '05, '06

TURN DATA INTO INSIGHT, *INSIGHT INTO ACTION*

Professor Simge Küçükyavuz shares five tips on how to "translate" data and empirical information to fuel better decision-making and improve understanding.

At first glance, using data to drive decision-making might seem straightforward. Punch in a few numbers, look at the result, and act accordingly.

SIMGE KÜÇÜKYAVUZ warns it's not quite that simple.

Küçükyavuz, Chair and David A. and Karen Richards Sachs Professor of Industrial Engineering and Management Sciences, offers five insights on how to use data science to make robust decisions and help stakeholders understand them more readily.

1

Embrace the Messiness and Visualize Early

Real-world data are rarely "plug-and-play." Often, they are incomplete or noisy. Before beginning to analyze such data, visualize using charts or maps to identify outliers and missing entries. This ensures that data make sense and provide a solid foundation for any decision.

2

Remember, a Mathematical Model Isn't a Complete Representation

Avoid using data tools blindly. Understand and interrogate the underlying assumptions of any tool, whether it's a simple regression model or a complex mathematical model. The adage that "all models are wrong, but some are useful" helps explain the specific contexts where a model can be applied and where its outputs might be practical enough to work.

3

Quantify Risk and Map Uncertainty

Every data-based decision involves some level of risk. Instead of a single "best" number, use data to define a range of possibilities and quantify the risks of different paths. Incorporating confidence and predictive intervals, or "error bars," ensures decision-makers can choose a level of risk they're willing to tolerate.

4

Master the "What-If" through Scenarios

The best decisions are robust: they remain sound even if the future plays out differently. Use "what-if" scenarios to test how much circumstances must change before a different solution is required. If a small change in a data point flips the recommended action, the decision requires more scrutiny.

5

Translate Data into Human Context for Stakeholders

Most problems involve complex human behaviors that data and mathematical models alone cannot capture. Using specific examples, translate technical methods into clear language that decision-makers can understand. Visualizing and explaining the "why" behind an output helps stakeholders understand the model and make fully informed decisions.

BRIAN SANDALOW

"Avoid using data tools blindly. Understand and interrogate the underlying assumptions of any tool, whether it's a simple regression model or a complex mathematical model."

Simge Küçükyavuz
David A. and Karen Richards Sachs Professor of Industrial Engineering and Management Sciences

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BORN TO RUN—AND NEVER DIE

By combining physical modularity with AI-driven design, researchers have opened the door to a new class of robots that don't just survive the real world—they also adapt to it. Made from autonomous Lego-like modules that snap together into an endless number of configurations, these "legged metamachines" can adapt their structure and behavior—and easily recover from major damage—in real time. This work points toward a future where robots become less like fragile, predesigned tools and more like resilient, evolving lifeforms.

Image courtesy of Sam Kriegman, Assistant Professor of Computer Science, Mechanical Engineering, and Chemical and Biological Engineering

Watch the robots make their way across varied terrain.