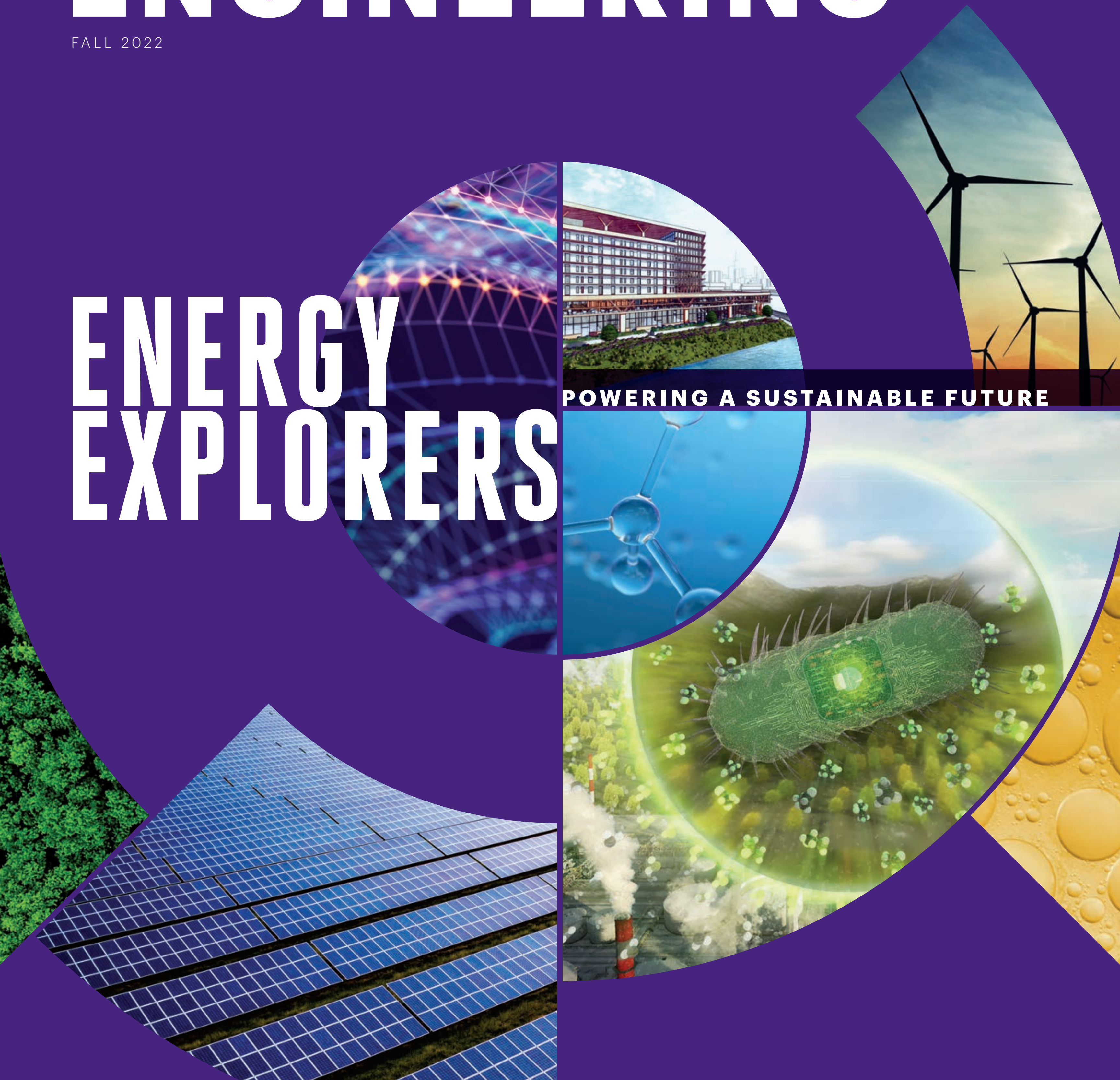
McCormick School of Engineering and Applied Science

NORTHWESTERN ENGINEERING

FALL 2022

ENERGY EXPLORERS

POWERING A SUSTAINABLE FUTURE



WELCOMING THE CLASS OF 2026

On September 14, Dean Julio M. Ottino welcomed Northwestern Engineering's class of 2026 to campus with a presentation in the Technological Institute's Ryan Family Auditorium. During his talk, Ottino discussed how first-year students will develop skills in whole-brain engineering thinking, design, and leadership as they begin their journey as engineers at Northwestern. The event was part of the University's weeklong Wildcat Welcome orientation, a series of introductory activities for new undergraduates that also included opportunities to connect with first-year academic advisers and leaders from Northwestern student groups.

Photography by Matthew Allen


Welcome to
Northwestern
Engineering!
Northwestern ENGINEERING

> "Integrating left-brain rational thinking with right-brain creative thinking, the essence of whole-brain engineering is at the center of who we are and what we do. So is the power and value of intersections and bringing together different types of thinking through cross-disciplinary teams to discover new innovations."

GREETINGS FROM NORTHWESTERN ENGINEERING

What does it mean to be an engineer? Throughout my time as dean, I have continued to ask this question as we grow our research and educational initiatives. Integrating left-brain rational thinking with right-brain creative thinking, the essence of whole-brain engineering is at the center of who we are and what we do. So is the power and value of intersections and bringing together different types of thinking through cross-disciplinary teams to discover new innovations. This mindset has been our compass as we make new investments in curriculum and forward-looking research.

This mindset gives you the toolset you need to thrive in any field. One could argue that McCormick's engineering thinking is the kind of thinking needed to thrive in the 21st century. For example, take the research we highlight in this issue. Several of our faculty members are conducting leading-edge research in energy—whether it's finding innovative ways to harness it, transmit it, or store it. Many of these faculty work in cross-disciplinary teams, using creative thinking to accomplish goals such as producing energy from new sources, like bacteria. A creative, collaborative approach will continue to be the key to solving the global challenges facing us.

We also highlight our computer science research growth, where we are investing in several areas, including data science and security. Again, we are focused on cross-disciplinary collaboration, establishing new multidisciplinary institutes that bring together researchers from across domains to work in areas that now touch nearly every aspect of modern life. We began to make a significant investment in computer science six years ago. I am enjoying watching the evolution of this department and its research.

And we continue to bring this type of creative thinking to our classrooms as well, as we explore new ways to help our students succeed. If you talk with our alumni, many of them say studying at Northwestern gave them the skills to thrive not only in traditional engineering fields, but beyond as well. To expand on this benefit, we developed a new course in the Farley Center for Entrepreneurship and Innovation that teaches students how to inspire and motivate. This is yet another aspect of right-brain thinking that will be invaluable to our students, no matter where life takes them.

As you likely know, I have announced that this year will be my last at the helm of McCormick. I look forward to celebrating our shared accomplishments over the course of the next year.

JULIO M. OTTINO
Dean, McCormick School of Engineering and Applied Science

On the Cover
Northwestern Engineering researchers and innovators are pioneering new technologies, materials, processes, and products to power a sustainable future. See story on page 12.

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Northwestern | McCORMICK SCHOOL OF ENGINEERING

Executive Director of Strategic Initiatives and Marketing: Kyle Delaney

Editorial Team: Christa Battaglia, Alex Gerage, and Emily Ayshford

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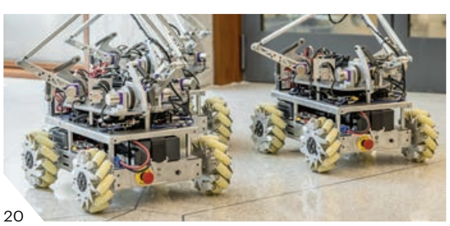
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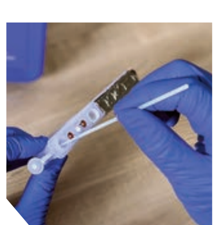
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NORTHWESTERN ENGINEERING
FALL 2022

NEWS

"There is an emerging and growing interest in being able to partner with biology to make what is needed, where and when it's needed, on a sustainable and renewable basis. This includes everything from medicines to sustainable products to materials we might use every day."

MICHAEL JEWETT
Walter P. Murphy Professor of Chemical and Biological Engineering

New Institute to Focus on Biomanufacturing

Northwestern has created a new basic science research center, the Cell-Free Biomanufacturing Institute, in partnership with the US Army. The institute aims to accelerate the development of synthetic biology technologies for creating on-demand and point-of-need products useful to both society and the Army.

With a focus on cell-free systems, the interdisciplinary institute will develop a powerful infrastructure to design, create, and manufacture molecules, materials, and sensors unattainable through traditional approaches. This offers a new production model without the constraints of working with living organisms. Instead of manufacturing in a living cell—as, for example, insulin is produced from yeast—cell-free biology activates basic cellular processes to make desired products without live, intact cells.

In addition to training the next generation of scientists and engineers, the institute can be an engine for entrepreneurial growth in Illinois in synthetic biology. A relatively young discipline, synthetic biology uses tools and concepts from physics, engineering, and computer science to build new biological systems.

ANNETTE RIPPERT ENCOURAGES GRADUATES TO USE POWER OF CHANGE

Speaking at Northwestern Engineering's 2022 Undergraduate Convocation held June 12 at Welsh-Ryan Arena, Annette Rippert ('86, KSM '94) encouraged graduates to aspire to do the work they love and let whatever transpires be a catalyst for growth.

"I know firsthand that change is powerful. It can also be unnerving," said Rippert, who recently retired from her position as group chief executive, strategy and consulting, at Accenture. "Using the power of change to shape your future, to shape our shared future—now that's a powerful idea." She also encouraged graduates to inspire others throughout their careers. "You each have a story, a journey. You are each an inspiration to others coming up behind you. You can make a difference," she said.

$10 MILLION

Funding for the transdisciplinary and multi-institution Institute for Data, Econometrics, Algorithms, and Learning to advance the theoretical foundations of data science

★★★ 40

Number of William A. Patterson Distinguished Transportation Lectures, the latest featuring Delta Air Lines CEO Edward Bastian

Student Startup Wins Pitch Competition

InfernoGuard, a wildfire detection and notification platform cocreated by Northwestern Engineering student Kevin Kaspar, won the $150,000 grand prize in the annual University-wide pitch competition, VentureCat.

Kaspar, a second-year student majoring in manufacturing and design engineering within the Segal Design Institute and minoring in entrepreneurship within the Farley Center for Entrepreneurship and Innovation, pitched the company's product, which aims to create a network of devices that continuously gather environmental data to determine and track wildfire presence on an owner's property.

In the competition—supported by the Farley Center, the Kellogg School of Management, the Donald Pritzker Entrepreneurship Law Center, and the Garage—Northwestern student-founded ventures compete across five industry tracks for a non-dilutive prize pool of more than $300,000.

STUDENT-DESIGNED TOOLS EARN TOP AWARDS

Students in Northwestern Engineering's Design, Technology, and Research program earned top honors in the undergraduate category at the Association for Computing Machinery's Computer-Human Interaction 2022 Student Research Competition.

Fardeem Munir, a third-year computer science student, and Roxanna Wilcox, a fourth-year computer science student in the Weinberg College of Arts and Sciences, won first place for their tool that trains novice web developers to build transferable and conceptual knowledge of CSS techniques.

Cindy Hu, a third-year student majoring in computer science and communication studies, earned second place for a mobile app that encourages self-disclosure between strangers by engaging users in opportunistic collective experiences with situated prompts.

$5 MILLION

Funding from the National Science Foundation for a Northwestern-led research team to develop new methods to mitigate climate change on the Great Lakes

15

Key risk factors for stroke used by Dan Apley to design a simulation experiment to better understand false diagnoses of stroke

Latonia Harris Tells Graduates to Find Purpose and Passion

At Northwestern Engineering's PhD Hooding and Master's Degree Recognition Ceremony in June, Latonia Harris (MS '97, PhD '01) encouraged the 263 master's graduates and 106 PhD graduates to honor their support systems by finding their purpose and pursuing their passions.

"Our society needs you and your gifts," said Harris, senior director of product quality management for BioTherapeutics, Janssen Pharmaceutical Companies of Johnson & Johnson. "Embark upon the next phase of your voyage with passion and purpose. Be true to your heart's desire and know that you are destined for greatness."

"My cofounders and I put a lot of effort into developing Opera's direction over the past year. Collectively, these mentors helped me and the company transform the technology from an idea into a compelling business plan and pitch. This award is the exclamation point on that story."

DANIELLE TULLMAN-ERCEK
Professor of Chemical and Biological Engineering

Faculty Startup Wins Pitch Competition

Opera Bioscience, a biotechnology startup cofounded by Professor Danielle Tullman-Ercek, won a top prize in the Equalize 2022 Pitch Competition. The competition, presented by the Office of Technology Management at Washington University in St. Louis, is a virtual mentor program and pitch competition designed to take national action around the disparity of women academic inventors forming university startups.

Tullman-Ercek was named the overall winner in the competition's MedTech category. Opera Bioscience is developing a bacterial platform that produces high-purity proteins, reducing the cost for proteins needed to make cultivated meat, biomaterials, and cell therapies.

Created in Tullman-Ercek's laboratory, Opera Bioscience's technology provides a unique protein manufacturing platform that delivers the benefits of microbial production but also makes proteins at the highest purity levels previously inaccessible with bacterial hosts. The startup's technology transforms tools for protein manufacturing, eliminating most of the downstream processing steps by fully secreting proteins of interest.

In addition to making proteins at high purity levels, the company can pair the protein production platform with high-efficiency manufacturing techniques such as continuous fermentation. This kind of combination offers an ideal option for significantly reducing the prohibitive cost of producing proteins, enzymes, and growth factors used in cellular agriculture or therapeutics.

Pandemic Travel Lessons

Delivering the 40th Annual William A. Patterson Distinguished Transportation Lecture, Delta Air Lines CEO Edward Bastian shared lessons from the pandemic. In 2019, Delta's revenues and customer satisfaction were at record highs. Then, in late March 2020, their revenue plummeted to less than 5 percent of the previous year's earnings.

At the time, Bastian shared with the Delta board a plan to focus on what the company could control and to not stress over what they couldn't. Ultimately, Delta avoided laying off any of its 75,000 workers. Two years later, demand for flights is spiking to historic levels, businesses are back, and most of Delta's workforce was given a 4 percent pay raise in March.

$26 MILLION

Funding from the National Science Foundation to launch a multi-institutional advanced manufacturing research center

CO-OP STUDENT OF THE YEAR

Last spring, Ruiqi Pan ('22) was selected as the 2022 Walter P. Murphy Cooperative Engineering Education Student of the Year. She completed her co-op with Hollister Incorporated, a medical device developer based in Libertyville, Illinois. A computer science major at Northwestern Engineering before graduating in spring 2022, she's now in a master's program at Carnegie Mellon University. During her first four months at Hollister, Pan compiled, organized, and analyzed three years' worth of studies, an impressive feat given the complexity of the project.

"It was a good opportunity to see what my career path would look like," she says. "Being in a data analyst co-op helped me see what the role actually means and how to be responsible. Also, I connected with very amazing coworkers and supervisors. They were always really nice to me, and they always taught me to keep learning and keep innovating. I think that is an important spirit to carry on. Overall, the nine months were like a dream."

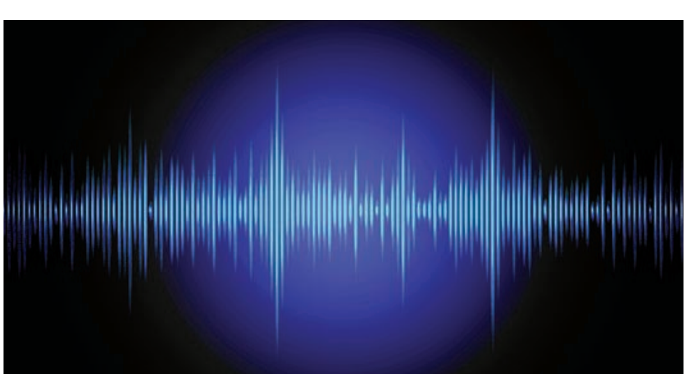
STUDENTS IDENTIFY PRACTICAL SOLUTIONS TO INDUSTRY CHALLENGES

Working with external clients is a crucial part of the Department of Industrial Engineering and Management Sciences's undergraduate curriculum. This past spring, the Client Project Challenge course paired students with industry partners to help solve issues facing companies and nonprofits. Solutions included improved scheduling for hospitals and a way to optimize UPS deliveries.

"This course was an effective synthesis of our key industrial engineering sequence courses," says student Emily Hull. "More importantly, it helped us develop critical client-facing skills. Through this course we had a chance to apply these skills in an innovative and creative way to solve a unique, real-world problem."

"WORKING WITH CLIENTS WAS SO REWARDING. GETTING TO WORK WITH REALLY INTELLIGENT PEOPLE ON A PROJECT THAT EVERYONE CARED DEEPLY ABOUT MADE ME FEEL LIKE MY TEAM'S WORK WAS IMPACTFUL."

ABBY BRANDT IEMS student



The Intersection of Art and Computer Science

The Center for Human-Computer Interaction + Design hosted a virtual panel of research scientists and artists last spring to discuss the implications of artificial intelligence for artistic creation.

"As our AI systems for artistic creation become more powerful, we need to reexamine the human role in the artistic process and our relationship to the technology we work with to realize artistic visions. This panel was a wonderful opportunity to examine what it means to be an artist working with AI in the 21st century," says Bryan Pardo, codirector of the center.

LAB NOTES

“As engineers, we are motivated by the idea of treating pain without drugs—in ways that can be turned on and off instantly, with user control over the intensity of relief.”

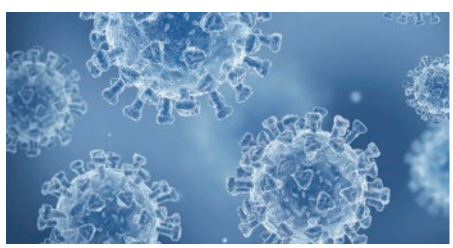
JOHN ROGERS
Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Neurological Surgery

IMPLANTABLE DEVICE RELIEVES PAIN

Researchers led by Professor John Rogers have developed a small, soft, flexible implant that relieves pain on demand and without the use of drugs. The first-of-its-kind device could provide a much-needed alternative to opioids and other highly addictive medications.

The biocompatible, water-soluble implant works by wrapping around nerves to deliver precise, targeted cooling, which numbs nerves and blocks pain signals to the brain. Similar to how evaporating sweat cools the body, the device contains a liquid coolant that is induced to evaporate at the specific location of a sensory nerve. As the nerve cools down, the signals that travel through it become slower and slower, eventually stopping completely. An external pump enables the user to activate the device remotely, increasing or decreasing its intensity. After it’s no longer needed, the device absorbs into the body naturally—bypassing the need for surgical extraction.

Researchers believe the device, which surgeons could implant during the procedure, will be most valuable for patients who undergo routine surgeries or even amputations that require post-operative pain management.



Decoy Particles Trick Coronavirus

They might look like cells and act like cells, but this potential COVID-19 treatment is a cleverly disguised trickster. Mimicking regular cells, “decoy” nanoparticles soak up viruses like a sponge, inhibiting them from infecting the rest of the body.

In their study, Northwestern Engineering synthetic biologists set out to create the design rules needed to make decoy nanoparticles effective and resistant to viral escape. After designing and testing various iterations, the researchers identified a broad set of decoys—all manufacturable using different methods—that were incredibly effective against the original virus as well as mutant variants. In fact, decoy nanoparticles were up to 50 times more effective at inhibiting naturally occurring viral mutants compared to traditional, protein-based inhibitor drugs.

2

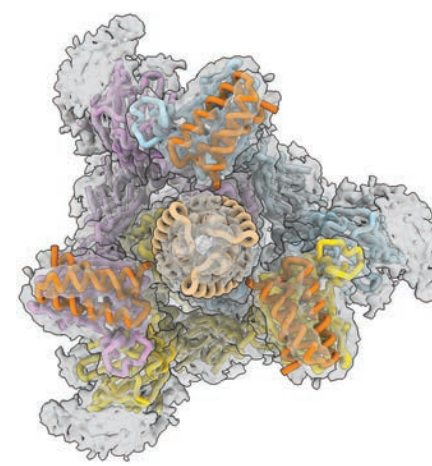
Engineering graduate students who received prestigious Presidential Fellowships

$150,000

Amount earned by McCormick student Kevin Kaspar for winning the VentureCat grand prize

2

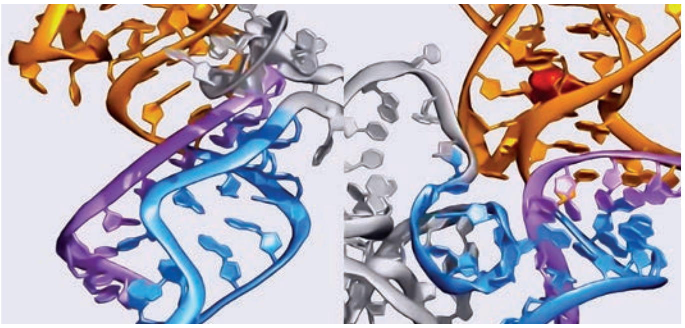
McCormick professors (Michael Jewett, Manijeh Razeghi) who presented at TEDxChicago in September



Nasal Spray Outperforms COVID-19 Antibody Treatments

A protein-based antiviral nasal spray to treat COVID-19 developed by Northwestern Engineering researchers is being advanced toward Phase I human clinical trials. The protein therapies thwarted infection by interfering with the virus’s ability to enter cells. The top protein neutralized the virus, including all tested SARS-CoV-2 variants, with similar or greater potency than current antibody treatments.

When researchers administered the treatment to mice as a nasal spray, they found the best of these antiviral proteins reduced symptoms or even prevented infection outright.



Unprecedented Videos Show RNA Switching “On” and “Off”

Similar to a light switch, RNA switches (called riboswitches) determine which genes turn “on” and “off.” Although this may seem like a simple process, the inner workings of these switches have confounded biologists for decades.

Researchers led by Professor Julius Lucks discovered one part of RNA smoothly invades and displaces another part of the same RNA, enabling the structure to rapidly and dramatically change shape. Called “strand displacement,” this mechanism appears to switch genetic expression from “on” to “off.”

Using a simulation they launched last year, the researchers made this discovery by watching a slow-motion simulation of a riboswitch up close and in action. Called R2D2 (short for reconstructing RNA dynamics from data), the simulation models RNA in three dimensions as it binds to a compound, communicates along its length, and folds to turn a gene “on” or “off.” The findings could have implications for engineering new RNA-based diagnostics and for designing successful drugs to target RNA to treat illness and disease.

1/2 mm

Size of a remote-controlled walking robot designed by John Rogers

.1 NANOMETER

Scale of structural details of chiral molecules uncovered by Monica Olvera de la Cruz and Michael Bedzyk

12

Student teams that developed optimization solutions for industry collaborators in the Client Project Challenge course

PROTECTING GOOD BACTERIA WHEN FIGHTING INFECTIONS

One medical science challenge is creating antibiotics that kill infectious diseases but leave useful bacteria alone. Northwestern Engineering researchers have now shown that the geometry and function of a bacterial organelle can be altered to inhibit the growth of harmful bacteria.

Led by Professor Danielle Tullman-Ercek, the investigators studied the components that make up the shell of bacterial organelles called microcompartments. They found how the geometry of the resulting structures can be altered with small changes to the components. Given that 12 of the 14 pathogens that cause the most threatening infectious diseases have these microcompartments, the systems could be an antibiotic target.

"MANY DISEASES ARE LIKELY CAUSED BY SOMETHING GOING AWRY AT THE RNA LEVEL. THE MORE WE KNOW ABOUT THIS, THE BETTER WE CAN DESIGN RNA-TARGETING DRUGS AND RNA THERAPEUTICS."

JULIUS LUCKS Professor of Chemical and Biological Engineering

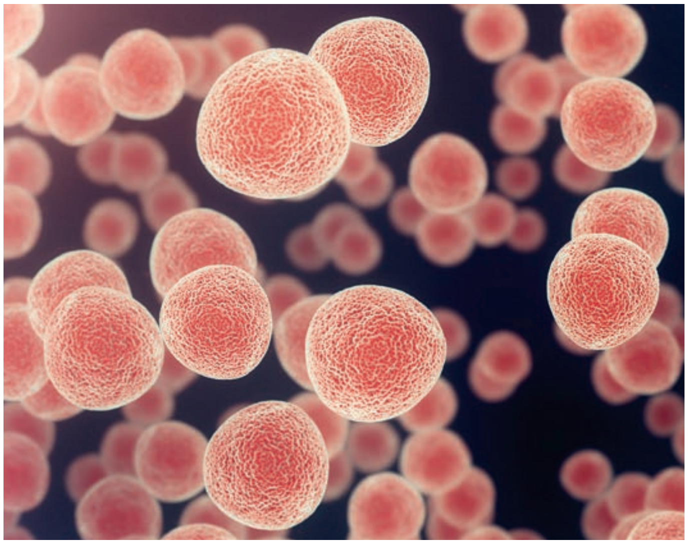
Climate Change Could Have Negative Effect on Great Lakes Travel

Climate change in the United States could be bad news for the Great Lakes region’s transportation needs. Professor Luís Amaral and his team found that a simple machine-learning approach could be successfully trained to forecast which connections in an air transportation network are most likely to be removed within a one-month timescale.

The team used the model to forecast what the US domestic air transportation network would look like in 2035 if there was a mandate to shrink it by 67 percent to reduce greenhouse gas emissions.

The forecast doesn’t bode well for the Great Lakes region—many Midwestern cities would likely lose air connections given a large reduction in the size of the US domestic air transportation network.

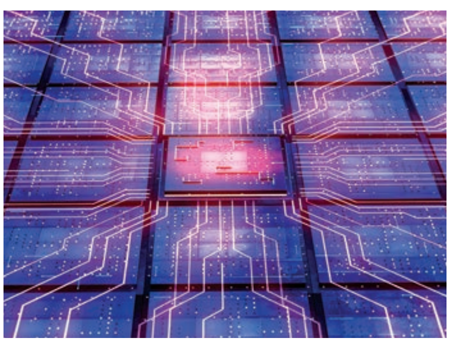
In 2021, Amtrak released an expansion plan that would add 30 new and 20 expanded routes, which the team found would likely be inadequate to serve transportation needs of the Great Lakes region. The team found that the number of driving trips lasting from three to eight hours would increase if air routes are removed and Amtrak sticks to this plan.



Boosting Effectiveness of Cancer Treatments

Using simple methods, a team of researchers led by Professor Neha Kamat devised an approach that leverages lipids' natural ability to separate to make an underperforming cancer treatment more effective.

Using the natural ability of lipids—think olive oil and butter—to separate on the surface of a lipid nanoparticle, the investigators created spatially organized regions of protein presentation that could enhance the effectiveness of TNF-related apoptosis-inducing ligand (TRAIL) treatment. TRAIL is a naturally occurring protein that immune cells express to kill cancer cells, but it has shown only limited efficacy in clinical trials. The team's approach enhances TRAIL's ability to kill certain cancer cells. "This technique could help scientists develop better nanoparticle therapeutics," Kamat says.



COLLECTING DATA FOR MACHINE LEARNING

Professor Todd Murphey and his team have demonstrated how robots can collect data in environments they may not have seen before. To reach this conclusion, the researchers developed an algorithmic method for collecting data for learning—how a robot moves determines what it learns. This work shows how robots can respond to novelty by purposefully collecting data to learn about the environment, rather than passively collecting data as they go about other tasks.

"Right now, the prevailing view in machine learning is that the data we already accumulate will be sufficient for everything we want to learn. We'd like it to be unbiased, and we'd like it whenever we encounter something novel," Murphey says. "Robots are not just going to need to collect data for their own effectiveness, they are also going to collect data for all these data centers that we use for machine learning in general."

"We created a pacemaker that simply dissolves and does not need to be removed. This avoids the dangerous step of pulling out the wire."

IGOR EFIMOV
Professor of Biomedical Engineering

$65,000

Estimated savings for farmers if they implement Shane Dolan's OptiAg sprinkler controller system

25

Years since McCormick's Design Thinking and Communication course was launched

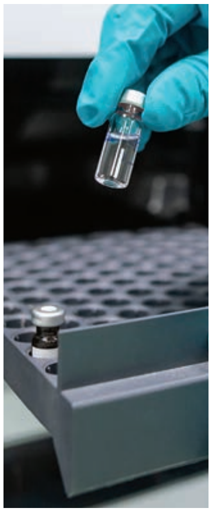
SMART PACEMAKER COMMUNICATES WITH SENSOR NETWORK

In 2021, Northwestern researchers introduced the first-ever transient pacemaker—a fully implantable, wireless device that harmlessly dissolves in the body after it's no longer needed. Now, they have unveiled a smart version that is integrated into a coordinated network of soft, flexible, wireless, wearable sensors and control units placed around the upper body.

The sensors communicate with each other to monitor the body's various physiological functions continuously, including body temperature, oxygen levels, respiration, muscle tone, physical activity, and the heart's electrical activity.

The system uses algorithms to analyze this combined activity to autonomously detect abnormal cardiac rhythms and decide when to pace the heart and at what rate. This information is streamed to a smartphone or tablet so physicians can monitor their patients remotely. The new transient pacemaker and sensor/control network can be used in patients who need temporary pacing after cardiac surgery or are waiting for a permanent pacemaker.

The pacemaker wirelessly harvests energy from a node within the network, eliminating the need for external hardware. The work was led by Northwestern professors John Rogers, Igor Efimov, and Rishi Arora.



GOVERNMENT-FUNDED RESEARCH REFLECTS PUBLIC INTEREST

Governments worldwide fund scientific research with taxpayer money for the public good. How well does science serve the public interest in practice? A study led by Northwestern professors Dashun Wang and Benjamin Jones found that public funding is well-aligned with public use, and that the public tends to value research that scientists also see as impactful within their fields.

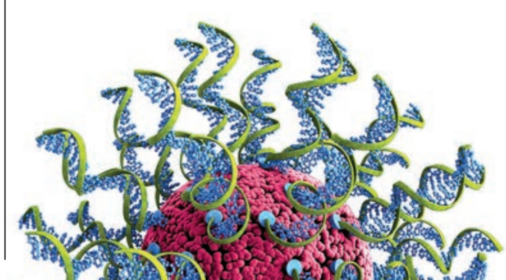
"Our findings suggest that concerns about public funding not being aligned with public uses are unfounded," Wang says. "There is alignment in key areas. In other words, funding hasn't gone to waste. I think this evidence is going to help inform discussion around this going forward."

New COVID-19 Vaccine Could Target Other Diseases

Just one dose of a new nanoparticle-based COVID-19 vaccine was enough to produce an immune response in animals that tracks with vaccines currently in clinical use. With minor changes, Northwestern researchers hope the same platform could target other infectious diseases.

In a study led by Professor Chad Mirkin, every mouse that received the protein-based immunization survived when challenged with lethal doses of the SARS-CoV-2 virus, which causes COVID-19. None of the mice experienced lung damage due to SARS-CoV-2 exposure. All mice that did not receive the nanoparticle vaccine died in a 14-day trial.

The results outline the structure-function relationships between the first spherical nucleic acid (SNA) vaccine developed to protect against viral infections. Researchers experimentally determined the ideal ratio between the SNA's shell and core density that produces the most potent response.



NEW METRIC EVALUATES PHYSICIAN PERFORMANCE

Inspired by advanced analytics used in sports, a research team led by Professor Luís Amaral has developed an approach for measuring physician adherence to best practices. The study also shows that high-performing individuals are more likely to be aware of system-level challenges.

The data-driven method takes into consideration the characteristics of patients seen by a physician—how sick a patient is, for example—to estimate an adjusted performance that more accurately captures the know-how of a set of physicians. The researchers' case study focused on patients with acute respiratory distress syndrome, a form of lung failure. The metric could help change behavior more broadly and bolster adoption of medical innovations, researchers say.

"OUR NEW METRIC COULD HELP CHANGE BEHAVIOR MORE BROADLY, BEYOND OUR CASE STUDY, AND INCREASE ADOPTION OF MEDICAL INNOVATIONS."

LUÍS AMARAL
Erastus Otis Haven Professor of Chemical and Biological Engineering

$25 MILLION

Funding from the US Department of Energy for a new multi-institution collaboration to study climate change

Boosting Patient Satisfaction

In 2019, Northwestern Memorial Hospital wanted to heighten patient satisfaction in its emergency department and tabbed wait times as one area that could enhance the patient experience. In a series of meetings with the emergency department leadership, Professor Seyed Iravani, a prominent voice in the field of queuing theory, started working to fix the department's wait times.

Using two years of hospital data and predictive analytics and factoring in elements such as staffing levels, the severity of cases, and current patient load, Iravani's team produced an institution-specific algorithm that predicted wait times for the hospital's emergency department visitors. The department has since implemented the system as part of its electronic medical record system to improve patient communication and satisfaction.

Self-reported satisfaction scores jumped nearly 20 percent when patients received a wait time; moderately overestimating the wait time produced the highest patient satisfaction scores.


Julio M. Ottino


Elizabeth Gerber

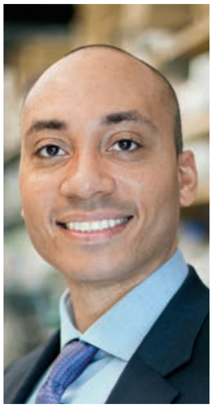

Noshir Contractor


Guillermo Ameer


Neha Kamat


Muzhou Wang


Robert Linsenmeier


Evan Scott


Michael Beltran


Karen Smilowitz


Shana Kelley


Chang-Han Rhee

Faculty Awards

Julio M. Ottino Elected to the National Academy of Sciences NAS membership is one of the highest honors given to a scientist in the United States.

Guillermo Ameer Wins Innovation Commercialization Award The award, given by the Tissue Engineering and Regenerative Medicine International Society-Americas, recognizes the application of this type of medicine to products or technologies that benefit patients.

Robert Linsenmeier Receives Biomedical Engineering Lifetime Faculty Mentor Award The American Society for Engineering Education presented the inaugural award for excellence in mentoring other faculty.

Karen Smilowitz Named 2022 INFORMS Fellow One of the highest honors in operations research, the fellowship was awarded for outstanding research, contributions to social good, and efforts to advance equity and diversity.

Elizabeth Gerber Receives Social Impact Award The Association for Computing Machinery Special Interest Group on Computer-Human Interaction gives this award to individuals who promote the application of human-computer interaction research to pressing social needs.

Neha Kamat Receives ACS Synthetic Biology Young Investigator Award The award recognizes one early-career scientist who has made a major impact on the field of synthetic biology.

Evan Scott Wins Biomedical Engineering Society Mid-career Award This award recognizes significant leadership and achievements in biomedical engineering.

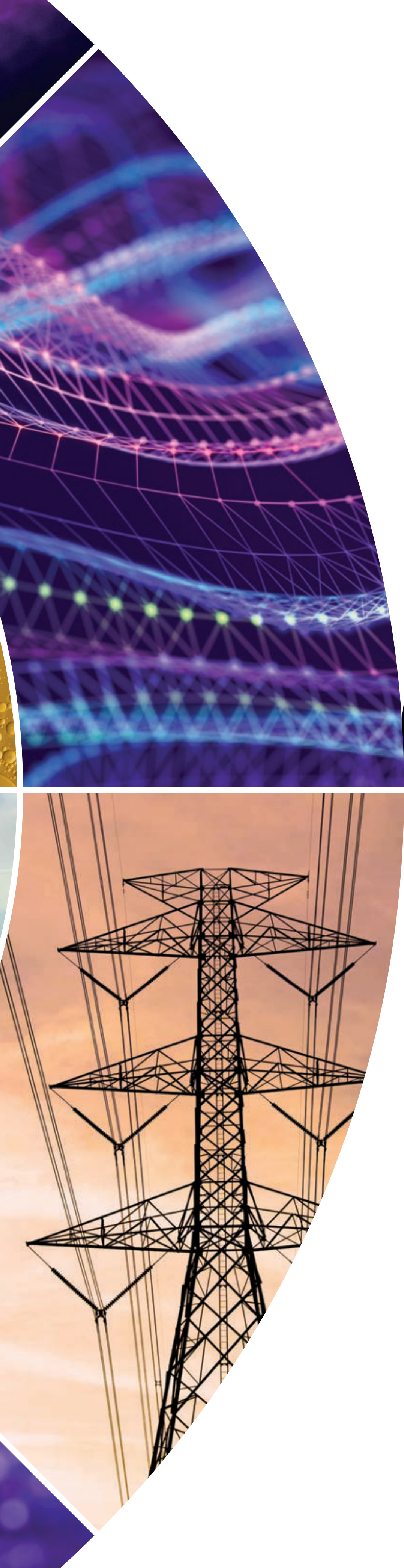
Shana Kelley Named Guggenheim Fellow With the fellowship, Kelley will develop a new class of sensors to enable continuous monitoring of biochemical markers of human health and disease.

Noshir Contractor Named Fellow of the Network Science Society The society recognizes investigators for outstanding contributions to network science research and the community of network scientists.

Muzhou Wang Paper Earns Finalist Honors for PNAS Cozzarelli Prize PNAS awards only one prize and names one finalist yearly for the best paper in each of six National Academy of Sciences classes.

Michael Beltran Honored with University Teaching Award Northwestern's Office of the Provost confers the annual recognition on professors who demonstrate excellence and innovation in undergraduate teaching.

Chang-Han Rhee Earns NSF CAREER Award The Faculty Early Career Development Program offers the National Science Foundation's most prestigious awards in support of early-career faculty.



ENERGY EXPLORERS

Northwestern Engineering researchers and innovators are pioneering new technologies, materials, processes, and products to power a sustainable future.

CREATING A FUTURE POWERED BY SUSTAINABLE ENERGY IS ONE OF SOCIETY'S BIGGEST CHALLENGES—a challenge intensified by the increasingly evident threat of climate change.

While global energy demand keeps rising—global energy demand will rise 47 percent by 2050, according to the US Energy Information Administration—much of our energy still comes from finite resources. Many of the processes that power our lives remain energy intensive.

Such complex problems inspire Northwestern Engineering faculty and students, who are approaching energy sustainability across the entire lifecycle: how we source the energy we need, how we store it, how we distribute it through the power grid, and how we use energy to produce goods and power our daily lives.

top to bottom
column 1
Sossina Haile
Michael Bedzyk
Vinayak Dravid
column 2
James Rondinelli
Chris Wolverton
Lin Chen

NEW RESEARCH CENTER TO DEVELOP HYDROGEN TECHNOLOGIES

"OUR CENTER FOCUSES ON THE SCIENCE OF HYDROGEN IN MATERIALS AS A FOUNDATIONAL STEP TOWARD CREATING A SUSTAINABLE ENERGY SOLUTION."

SOSSINA HAILE
Walter P. Murphy Professor of Materials Science and Engineering

To help combat climate change—and funded with more than $10 million from the US Department of Energy—Sossina Haile, Walter P. Murphy Professor of Materials Science and Engineering, is heading up Northwestern's new Hydrogen in Energy and Information Sciences (HEISs) Energy Frontier Research Center.

"It is now almost trite to acknowledge that climate change is an existential crisis—but the urgency of the situation can't be repeated enough," says Haile, a fuel cell pioneer whose work centers on sustainability and social good on a global scale.

Through the center, researchers will develop hydrogen-based energy technologies, working to provide a scientific foundation for practical developments in carbon-neutral energy (including nitrogen and carbon dioxide reduction) and materials for brain-inspired computing.

Hydrogen has tremendous societal importance in energy technologies and growing importance in energy-efficient computing. In both arenas, the relevant devices are limited by hydrogen kinetics, whether electrochemical reaction at an interface or diffusion through the bulk, and whether the material is an electrolyte, a semiconductor, or a metal.

HEISs will establish the governing mechanisms and physical descriptors of the transport as well as the interfacial incorporation mechanisms needed to achieve precision-guided discovery and design across these classes of materials. The research team will focus on use-inspired, ambient-to-intermediate temperatures to advance the center's goals. This includes controlling electrochemical transformations critical for carbon-neutral energy and for modulating electron transport in computing materials.

Five other Northwestern faculty members—Michael Bedzyk, Vinayak Dravid, James Rondinelli, and Chris Wolverton from engineering, and Lin Chen from chemistry—and six researchers from an additional five universities, are co-principal investigators.

"Our center focuses on the science of hydrogen in materials as a foundational step toward creating a sustainable energy solution," Haile says. "Beyond that, we will exploit the unique influence of hydrogen on material properties to create new ways of computing for information sciences. We have put together a spectacular team of experimentalists and computationalists, and I am absolutely thrilled to lead this effort."

ENHANCING MATERIALS DEVELOPMENT FOR RENEWABLE ELECTRICITY STORAGE

Jeffrey Richards

To harness the full power of renewable energy sources like wind and solar, researchers are looking for better ways to store these energies. Recent work by a Northwestern team could impact the design of next-generation grid-scale electrochemical storage.

Jeffrey Richards, assistant professor of chemical and biological engineering, and his collaborators identified a particular contribution to charge transport in flow battery technologies—energy storage technologies that pump electrically active fluids to store renewable electricity for later use. The key enabling feature of these fluids is their ability to maintain a connected and dynamic network while flowing that enhances electron transport beyond the predictions of current theories.

Richards and his team developed a new framework to design these fluids by combining experimental evidence and computer simulations, which quantified the origin of electrical transport in concentrated suspensions of semiconducting and metallic particles. This research could set the stage for advancing the design of emerging electrical energy storage systems.

> "There are exciting opportunities that arise from this research, including technologies that are used for impact sensing in soft robots and as replacements for optical encoders."
>
> **JEFFREY RICHARDS**
> Assistant Professor of Chemical and Biological Engineering

OPTIMIZING THE POWER GRID

> "OUR WORK PROVES THAT WE CAN SOLVE THESE IMPORTANT DILEMMAS AND REPRESENTS A FIRST STEP TOWARD IMPROVING THE OPERATION OF THE POWER GRID USING MORE EXACT MODELS."
>
> **ANDREAS WÄCHTER** Professor of Industrial Engineering and Management Sciences

Andreas Wächter Ermin Wei

As renewable energy sources become more prevalent, Northwestern professors are working to ensure current power systems operate more efficiently.

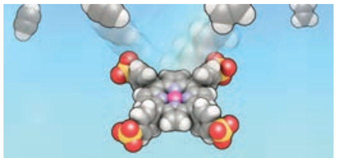
Participating in the US Department of Energy's Grid Optimization (GO) Competition, professors Andreas Wächter and Ermin Wei and their team developed new algorithms that increase the speed and efficiency of routing power across the grid.

The team's approach acts as a counter to the current simplified formulations, which ensure power systems work, yet fall short of the optimal, precise approaches needed to foster a stronger, more resilient grid. The team received $400,000 in prize money from the competition to further develop their approach.

Wächter, professor of industrial engineering and management sciences, says the GO competition empowered him to pursue his burgeoning interest in optimizing power flow—and he's now committed to finding more novel solutions to improve power grid operations.

"We need more accurate, robust solutions as renewable penetration and complexity increase," Wächter says. "Our work proves that we can solve these important dilemmas and represents a first step toward improving the operation of the power grid using more exact models."

REDUCING PLASTIC'S ENERGY FOOTPRINT



Emily Weiss

Samuel I. Stupp

"OUR STRATEGY IS A FIRST, MAJOR STEP TOWARD PRODUCING THIS IMPORTANT COMMODITY CHEMICAL WITH THE LOWEST ENERGY FOOTPRINT POSSIBLE."

EMILY WEISS Professor of Chemistry

Inspired by nature, Northwestern Engineering professors are finding new ways to create important industrial products that require much less energy.

In a first for the field, a Northwestern team has used light and water to convert acetylene into ethylene, a widely used, highly valuable chemical and a key ingredient in plastics.

Traditionally, chemists have created ethylene through steam cracking, an industrial method that employs hot steam to break down ethane into smaller molecules, which are then distilled into ethylene. Achieving the high temperatures and pressures required for a successful chemical reaction requires an incredible amount of energy.

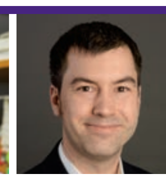
A collaboration between Northwestern faculty in the Center for Bio-Inspired Energy Science has discovered a photosynthesis-like process that is much less expensive and energy intensive. To convert acetylene into ethylene, Emily Weiss, professor of chemistry, and Samuel I. Stupp, Board of Trustees Professor of Materials Science and Engineering, Chemistry, Medicine, and Biomedical Engineering, replaced the process's traditional catalyst, palladium, with cobalt, a less expensive, more abundant alternative.

The researchers also used room-temperature and ambient pressure. In place of heat, they used visible light. And while the traditional process relies on protons from hydrogen, which is produced from fossil fuels and generates vast amounts of carbon dioxide, the team replaced hydrogen with plain water as a source for protons.

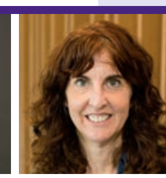
"Our strategy is a first, major step toward producing this important commodity chemical with the lowest energy footprint possible," says Weiss, who also has a courtesy appointment as a professor of materials science and engineering.

ENGINEERING BACTERIA TO CREATE FUELS

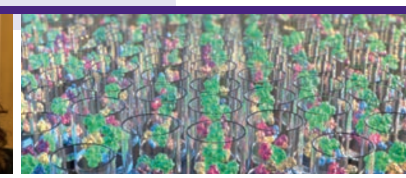
Michael Jewett



Keith Tyo



Linda Broadbelt



For years, synthetic biologists have worked to reengineer bacteria into tiny factories that produce renewable fuels and chemicals. In doing so, they hope to reduce both prices and energy use. Yet designing, building, and optimizing biosynthetic pathways in cells to produce these fuels remains complex, risky, and time consuming.

Professors Michael Jewett, Keith Tyo, and Linda Broadbelt are working with clean energy startup LanzaTech to find biosynthetic pathways within these organisms to optimize production of biofuels.

Jewett and collaborators from LanzaTech and the University of South Florida have optimized and implemented a pathway for the specific production of butanol, an alcohol biofuel, as well as butanoic acid, hexanol, and hexanoic acid across three biotechnological platforms.

"Our work forms a new blueprint for the generation and optimization of biochemical pathways for metabolic engineering and synthetic biology," says Jewett, Walter P. Murphy Professor of Chemical and Biological Engineering. "This will facilitate design-build-test cycles of biosynthetic pathways by decreasing the number of the strains to be engineered and the time required to achieve desired objectives."

Tyo, associate professor of chemical and biological engineering, is using computational design algorithms with Broadbelt, Sarah Rebecca Roland Professor of Chemical and Biological Engineering, to rapidly assess thousands of potential biosynthetic pathway designs that could optimize clostridia—bacteria that metabolize carbon—to produce butanol. To convert the carbon monoxide into butanol, enzymes spur chemical reactions. The Tyo lab simulates what the enzymes are doing in cell-free reactions to find the most efficient ways to make butanol, analyzing multiple choices to find the best options.

"Our work forms a new blueprint for the generation and optimization of biochemical pathways for metabolic engineering and synthetic biology."

MICHAEL JEWETT
Walter P. Murphy Professor of Chemical and Biological Engineering

DESIGNING LOW-CARBON BUILDINGS POWERED BY RENEWABLE ENERGY

"TREEHOUSE IS A BEACON OF THE POSSIBILITIES OF GREEN INFRASTRUCTURE, COMBINING MATERIAL AND OPERATIONAL SUSTAINABILITY WITH COMMUNITY ENHANCEMENT AND SOCIAL EQUITY."

ROBERT SZYMCZYK Civil Engineering Major

Strategies to combat climate change through lower energy usage also could tackle other issues, like affordable housing.

An interdisciplinary Northwestern Engineering student team designed a multifamily building that addresses Chicago's lack of diverse housing options and the built environment's contribution to CO_2 emissions. A 2022 Design Challenge Division Winner in the US Department of Energy Solar Decathlon, their design earned third-place honors in the competition's Multifamily Building Division.

The team's 10-floor development, called TreeHouse, includes eight floors of affordable housing units and two floors of dedicated commercial space designed to provide valuable resources such as a grocery store, daycare center, doctor's office, library, tutoring center, gym, and local retailers to residents of all income levels.

TreeHouse's holistic approach to sustainability features passive design strategies to optimize natural ventilation, daylight, and energy loads during Chicago's harsh winter and summer climates. The design leverages geothermal and solar energy, high-efficiency HVAC and graywater systems, natural and recycled materials, super-insulated and continuous envelopes, and prefabrication to reduce both the operational and embodied carbon of the building.

"TreeHouse is a beacon of the possibilities of green infrastructure, combining material and operational sustainability with community enhancement and social equity," says Robert Szymczyk, a civil engineering major and the team's project manager and design leader.

INVESTMENT IN PEOPLE POWERS CS RESEARCH GROWTH

Now in the sixth year of an ambitious University initiative to catalyze computer science as a foundational discipline, the research enterprise of Northwestern CS continues to grow strategically in depth and breadth.

Computers and computational thinking permeate practically every aspect of human endeavor—from the purely social to the highest levels of enterprise worldwide. Their impact is perhaps most obvious in technology-driven disciplines where they have inspired groundbreaking innovation.

Behind these innovations are computer science researchers who pave the way for new and better systems both within the field and beyond it. As demand for such research has grown, so have computer science departments across the country.

Northwestern Engineering's Department of Computer Science—Northwestern CS—exemplifies that growth, having become in its short history a hub of interdisciplinary research across the University and a magnet for some of the brightest minds in the field. Samir Khuller, inaugural Peter and Adrienne Barris Chair of Computer Science, attributes the department's rapid expansion to the University's "investment in the growth of people."

Since 2016, Northwestern CS has hired 16 new tenure-track faculty members and 10 fully integrated teaching-track faculty and plans to hire nine additional faculty in the coming years. The department's faculty hiring strategy has centered around pinpointing and strengthening existing core research areas—including data science and network security—with a relatively small footprint.

"We're not going to be able to do everything," Khuller says. "We have to be strategic about what we do, and we also have to be strategic about what we decide not to do."

The department's expansion has also led to the launch of new institutes and research collaborations that aim to accelerate transformative advances in the field. "We seek to leverage the power of data and computation to address the grand challenges of this century," Khuller says. "These innovative partnerships advance our research and help train our students in creative problem-solving."

ADVANCING THE THEORETICAL FOUNDATIONS OF DATA SCIENCE

In 2019, Northwestern faculty helped launch the multidisciplinary Institute for Data, Econometrics, Algorithms, and Learning (IDEAL). There, faculty, students, and researchers study machine learning and optimization, high-dimensional data analysis and inference, and emerging topics including reliability, interpretability, privacy, and fairness.

Through its research, training, and outreach activities, IDEAL aims to broaden local and national participation in data science and bridge the theoretical foundations of data science and the practice of data science in industry and applied science.

"You see data science used in every walk of life, but there are so many fundamental data science questions that we don't understand," says institute site director Aravindan Vijayaraghavan, associate professor of computer science. "There's a lot that theory can contribute, and we hope these collaborations will spark new areas of research."

Underscoring the institute's success, the National Science Foundation has awarded IDEAL a $10 million grant as part of the foundation's Harnessing the Data Revolution: Transdisciplinary Research in Principles of Data Science Phase II program. With the new funding, more than 60 investigators in computer science and across fields will collaborate with Google Research, the Illinois Institute of Technology, the Toyota Technological Institute at Chicago, the University of Illinois Chicago, and the University of Chicago.

STRENGTHENING CORE RESEARCH AREAS

As network security becomes paramount across a wide range of industries, Northwestern CS has continued to expand its footprint. The Northwestern Security and Privacy Group recently appointed four faculty members who have considerably expanded the group's work in software and system security, network security, artificial intelligence (AI) security, cryptography, and data privacy.

One of them, V. S. Subrahmanian, Walter P. Murphy Professor of Computer Science and a faculty fellow at the University's Roberta Buffett Institute for Global Affairs, is building global early warning systems for both terrorist attacks and cyberattacks. Another, Xinyu Xing, associate professor of computer science, and his team recently uncovered an eight-year-old security vulnerability in the Linux kernel and participated in two prestigious security contests: Pwn2Own and DEF CON.

"The synergies we gain by boosting a research group are significant," Khuller says. "Now we're able to offer a variety of very strong advanced-level courses, which makes Northwestern an attractive place for top students."

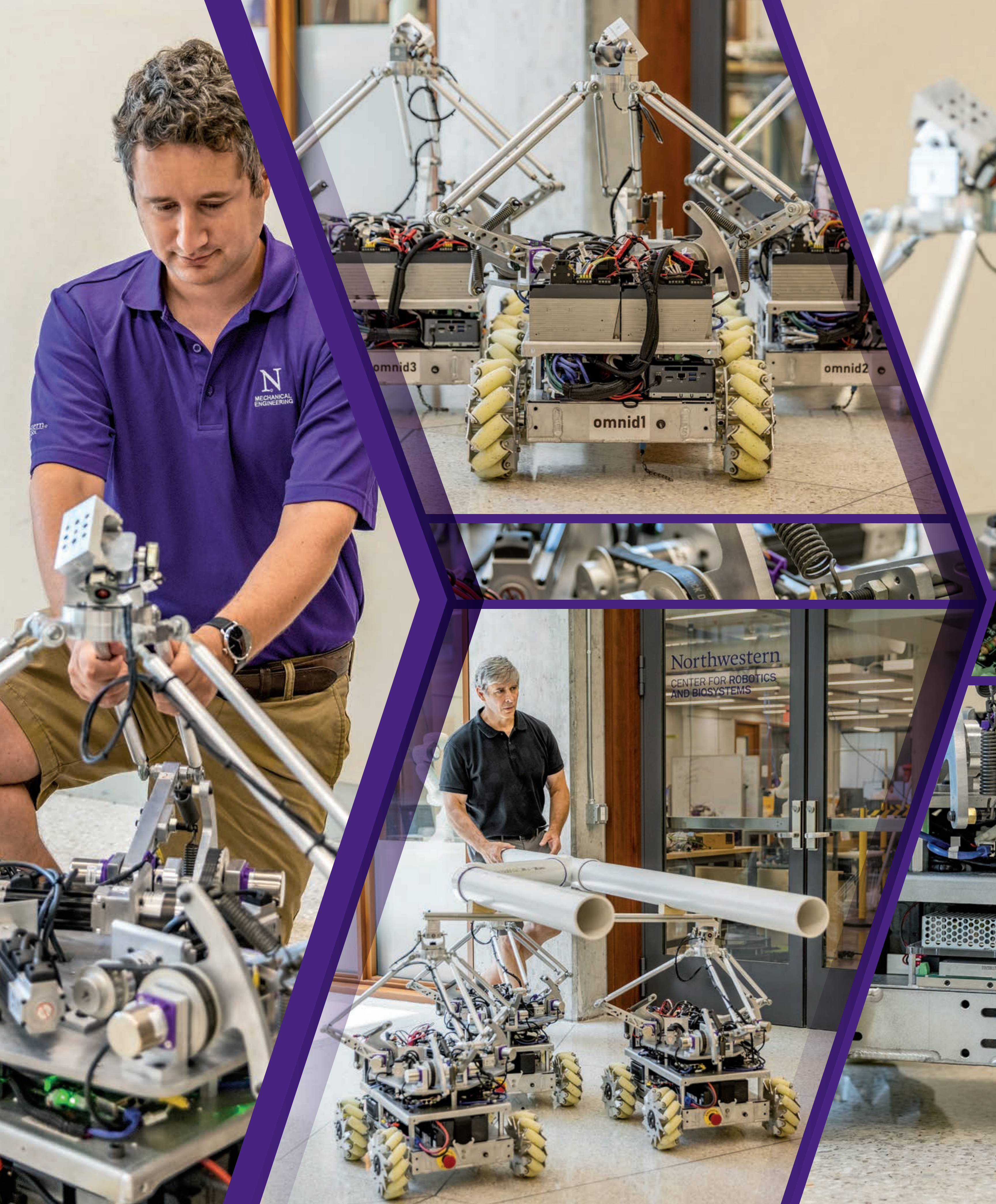
TRAINING INDEPENDENT RESEARCHERS

The number of computer science graduate students at Northwestern continues to grow. From a previous average of 10 to 15 incoming students per year, this year's 35 new PhD students join the more than 120 current CS PhD students and additional students pursuing interdisciplinary or electrical and computer engineering degrees who are advised by CS faculty.

Northwestern CS's postdoctoral program is also thriving, in part due to startup packages for early-career faculty that allow them to hire postdocs to accelerate their research productivity soon after they join. Some postdoctoral teaching fellows launch and instruct courses while also conducting research.

Khuller credits the increased interest and enrollment to the department's people-first approach. "Our growth in postdocs is a product of our investment in faculty, the new and core research areas we've strengthened, and grant funding we've received as a result," he says. "Those postdocs help co-mentor graduate and undergraduate students. Our research groups and labs accelerate projects, which present interdisciplinary collaboration opportunities, advance the field, and further fortify research excellence. It's a cycle we're excited to continue."

MICHELLE MOHNEY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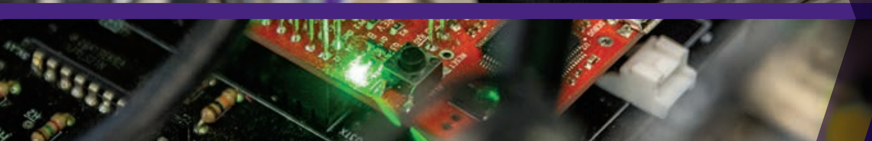
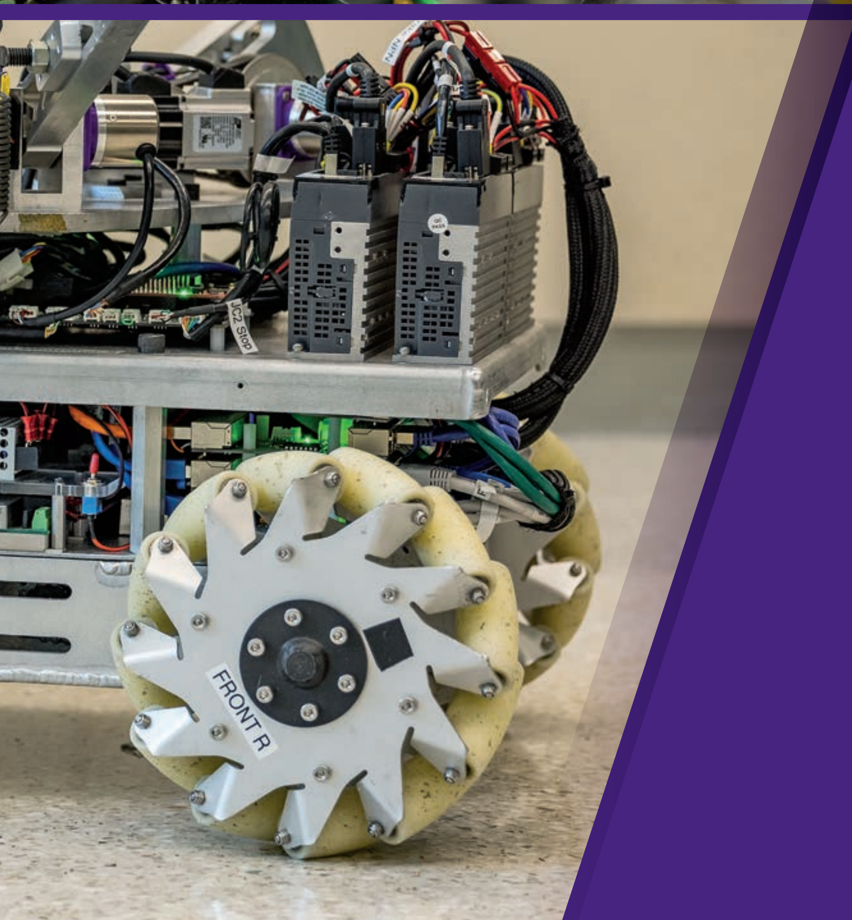




The Future of Human-Robot Interaction is Mobile

More than 25 years after Northwestern Engineering researchers advanced the concept of collaborative robotics, researchers in the Center for Robotics and Biosystems have designed team-based, mobile "mocobots" that could signal a new era of human-robot interaction in construction, manufacturing, and space exploration.

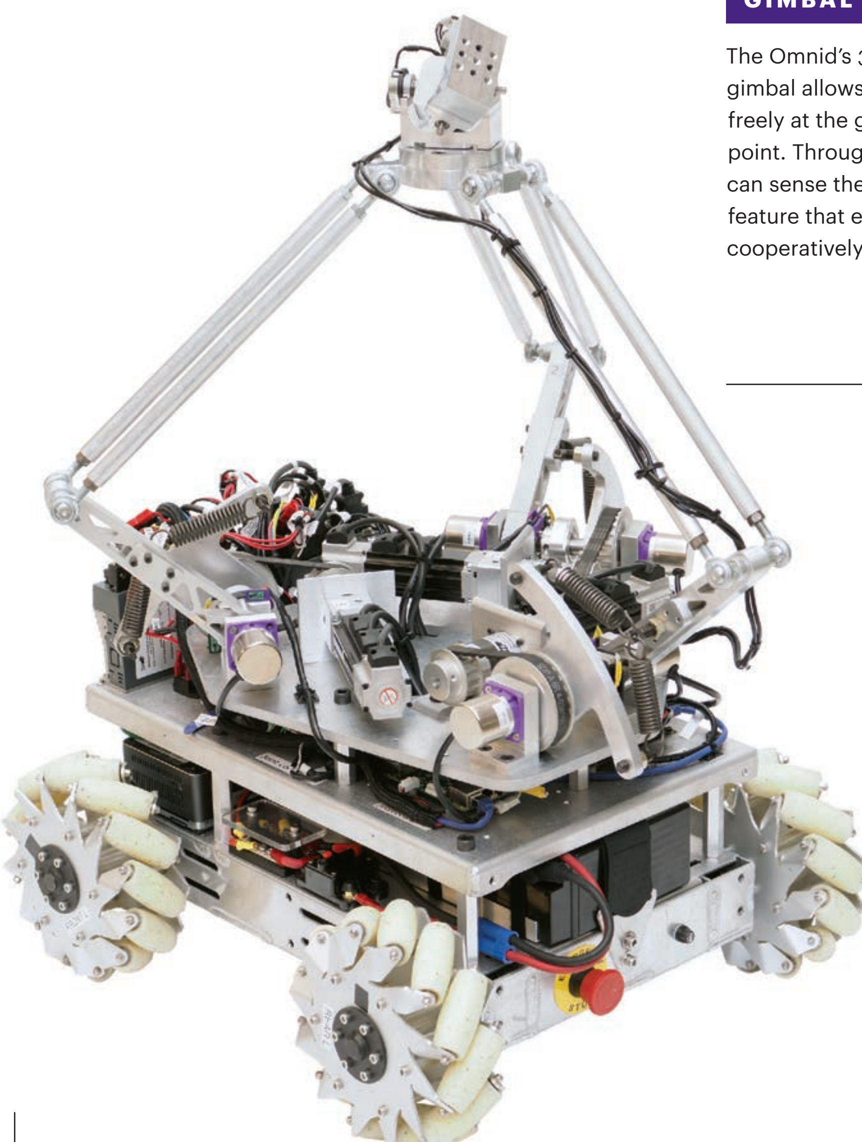
Standing alone in the atrium outside Northwestern's Center for Robotics and Biosystems, research engineer Billie Strong single-handedly performs, in a matter of seconds, a task that under other circumstances would require at least two people considerably longer to complete.

Positioned several feet from the action and using only one hand, Strong effortlessly and precisely inserts a 15-kilogram, two-pronged PVC pipe assembly into two circular openings in a wooden structure with just two millimeters of spatial tolerance in each hole. Strong then removes the eight-foot-long pipe from the structure, rotates it 180 degrees, and reinserts it from the opposite end.

Strong makes no claim of great personal strength or extraordinary precision. Three omnidirectional mobile robots perform the heavy lifting and stabilization while Strong gently guides the pipe assembly into place.

Kevin Lynch, professor of mechanical engineering at the McCormick School of Engineering, explains. "Physical collaboration with these robots is completely intuitive and requires no training for the human operator or reprogramming of the robots for this specific payload," he says. "That means the human can handle that 15-kilogram object with the feeling that it's floating in space."

The Omnid Mocobot



GIMBAL WRIST

The Omnid's 3-degree-of-freedom passive gimbal allows a human to rotate an object freely at the gimbal wrist's attachment point. Through this gimbal wrist, the Omnid can sense the angle of the payload, a key feature that enables multiple robots to cooperatively manipulate an object.

DELTA MANIPULATOR

The Omnid's Delta manipulator is a parallel mechanism that includes three identical arms that meet at the gimbal wrist. Each arm is driven by a series-elastic actuator. These springy actuators provide mechanical compliance that ensures the safety of the payload and collaborating humans. The actuators also enable high-fidelity force control—when multiple Omnids are used together, their manipulators nullify the payload's gravitational force, allowing users to manipulate heavy objects as if they are weightless.

MOBILE BASE

Four mecanum wheels—composed of small rollers around each wheel's circumference—allow the Omnids to travel omnidirectionally, including forward-backward motion, side-to-side motion, and rotation. This capability affords the human user complete freedom to transport a payload in tight spaces and perform precise assembly.

Watch the mocobots in action.

A legacy of human-robot collaboration

When Northwestern Engineering professors Ed Colgate and Michael Peshkin advanced the concept of collaborative robots, or "cobots," in the mid-1990s, they designed a single machine that could help automobile assembly line workers attach cumbersome parts, such as dashboards or side doors. The robot assumed the physical toil; the human maintained control and independence over the work.

Advancing the earlier concept, Lynch, director of the Center for Robotics and Biosystems, and a team of more than a dozen Northwestern Engineering faculty, master's, and undergraduate students have now introduced teams of "mocobots," mobile cobots that collaborate with each other and one or more human operators. Five years in the making, the new system expands opportunities for human-robot interaction in physically demanding environments—manufacturing plants, warehouses, construction zones, and the like—where teams of robots could help workers manipulate a variety of large, articulated, or flexible objects without placing physical demands on the human body.

Lynch reasons, "Instead of having a single, large robot that could manipulate anything you could ever want, why not have more, smaller robots that could easily adapt to the task at hand and possibly be less costly or space prohibitive? This is also particularly important if the payload is fragile, articulated, or flexible, and you need many distributed points of contact between the robots and the payload."

"Given Northwestern's leadership and history in the field," Lynch adds, "it felt natural for us to consider how to make humans and multiple robots work better together."

Built from scratch to be our partners

With robot manipulators and omnidirectional, mecanum-wheel mobile bases, the mocobot prototypes, dubbed Omnids, resemble other mobile robotic manipulators on the market today. Yet, these machines are custom designed for safe and effective collaboration within a team of robots and humans.

"Many existing mobile manipulators are designed to operate independently—a single robot manipulates a single object," says Matthew Elwin, assistant professor of instruction in mechanical engineering. "Some researchers have even experimented with small teams of such robots manipulating a common object. The problem is that these robots are not designed for safe human interaction, nor for safe cooperative manipulation of fragile objects. The robots overconstrain the object, and any errors in the robots' motion can result in large internal forces on the object."

The mocobot's differentiator is its built-in passive elasticity. Spring-loaded actuators within its 3-degree-of-freedom manipulator produce a springy response to different levels of force caused by the object's weight, forces from a human, or the robot's own movements. When coupled with the mobile base and a 3-degree-of-freedom passive gimbal wrist, the manipulator allows multiple mocobots to work cooperatively to render large objects weightless to the human collaborator.

"Given Northwestern's leadership and history in the field, it felt natural for us to consider how to make humans and multiple robots work better together."

KEVIN LYNCH Professor of Mechanical Engineering

"Where most robots are good at controlling their positions, our robots are good at controlling applied forces with passive elasticity for safety," Lynch says. "That passive elasticity kicks in right away to prevent objects from breaking, humans from getting hurt, or robots from being damaged."

Scaling up for the Red Planet

As described earlier, the team's first tests featured three mocobots collaborating with one or two human operators to install a PVC pipe and to transport and manipulate an articulated object—a 12-foot-long wooden assembly with a hinge joint. In the future, more mocobots could support more complex objectives and manipulation of flexible or articulated payloads with many degrees of freedom.

"We envision larger teams of even more powerful mocobots helping one or a few humans assemble large structures—a blade on a wind turbine, for example—in manufacturing and construction settings," Lynch says. "The system is designed to be scaled."

These robots' potential applications are not limited to Earth. As space travel could take humans to the moon and Mars in the coming decades, Lynch says mobile collaborative robots will play an important role.

"We'll need those robots to be able to work with humans on Mars right away, since we won't have automated factories there for a long time," Lynch says. "Mobile collaborative robots could help install solar panels on Martian habitats or build structures. While our prototypes are designed for indoor use, the principles of force control and passive elasticity in our mocobots could be applied to treaded or legged robots on rocky Martian terrain."

While mocobots are capable of autonomous manipulation using either preprogrammed controllers or strategies learned from their human collaborators, Lynch believes their flexibility to collaborate physically with people will be an enduring advantage.

"It's difficult to achieve complete robotic autonomy, and humans offer sensing, adaptability, situational awareness, and task understanding—qualities that are difficult to replicate," Lynch says. "The goal of our research is to take advantage of what the human does well while allowing the robots to do most of the work. The Omnids achieve that goal, allowing for mobile robot teams to collaborate safely and effectively with humans for the first time."

ALEX GERAGE

Photography by Matthew Allen

BECOMING 'BACKABLE'

THE ART & SCIENCE OF INSPIRING BELIEF

IN THE FARLEY CENTER'S NEW COURSE, BACKABLE: BUILDING AN INNOVATION PRACTICE, STUDENTS LEARN HOW TO INSPIRE AND MOTIVATE FROM AUTHOR SUNEEL GUPTA AND CHICAGO'S FAMED SECOND CITY.

Ask Suneel Gupta how his recently introduced course at the Farley Center for Entrepreneurship and Innovation came to be, and he responds with a line extracted not from his own best-selling book, *Backable* (Little, Brown and Company, 2021), but from Paulo Coelho's *The Alchemist*: "When you want something, all the universe conspires in helping you to achieve it."

Gupta never had visions of teaching at Northwestern University, the institution where he earned JD and MBA degrees. But a serendipitous discussion between the Farley Center and leaders at the Second City, Chicago's famed home of improvisational comedy, sparked the creation and launch of a new course called Backable: Building an Innovation Practice.

The course, held last spring, paired lessons from *Backable*, Gupta's tutorial for how people can generate support for their ideas, with research-backed improvisation exercises led by Anne Libera (SOC '86), director of comedy studies at Second City who also holds a theater degree from Northwestern.

The collaborative effort taught students the subtle art and behavioral science of expressing new ideas in persuasive, encouraging ways to spur action.

"What Anne and I dove into was not only the mindset, but just the humanness of what it means to share your idea and try to really inspire other people to believe in it," Gupta says.

Over the 10-week course, students created and practiced pitches incorporating lessons on self-disclosure, inclusion, and personal storytelling. Gupta says many people who pitch their ideas only speak about the business aspects and ignore the soul-connecting humanity that most resonates.

"As a result, you end up giving a very forgettable pitch," he says. "If you want to be that disruptor . . . you have to show them who you are."

Libera, for her part, integrated battle-tested improv exercises applying many of Gupta's *Backable* insights through activities that taught students how to remain in the moment, monitor others, and build through collaboration.

“You can use these exercises to practice being better at communicating and convincing, and at being a better human in general.”

ANNE LIBERA Second City Director of Comedy Studies and Northwestern Graduate

“You can use these exercises to practice being better at communicating and convincing, and at being a better human in general,” Libera says.

During the course, students maintained a practice journal to reflect on skills they tested and heard from guest speakers like Ai-jen Poo, president of the National Domestic Workers Alliance, who discussed the importance of deep listening and persuasion in her advocacy work.

Senior journalism major Dan Hu says Backable was unlike any other class he has taken while pursuing his entrepreneurship minor at Farley. While Hu recognized the power of storytelling and appealing to people’s emotions from his journalism studies, he found himself immediately applying lessons from Backable to his leadership roles at EPIC, Northwestern’s entrepreneurship student group, and the Yappie, a nonprofit newsroom reporting on Asian American politics. At both evolving organizations, Hu is now employing strategies learned in Backable to drive buy-in and foster deeper collaboration.

“My job is to convince other people to actually join in and want to help,” Hu says.

For Stephanie Shields, a junior studying political science and entrepreneurship, Backable delivered a powerful lesson about separating generation and analysis. Rather than staring at blank paper and contemplating the perfect opening line for a term paper, for instance, Shields now understands the benefit of releasing idea after idea.

“You’re removing that piece of your brain automatically fighting your creative juices, and you just flow,” Shields says.

While the course is perhaps most connected to the startup world, Gupta champions the idea as one that extends beyond the workplace and into family and community life as well—another lesson he hopes the students embraced.

“We’re always coming up with new visions, new ideas of how we want to live our lives, and how we want the people we love to be a part of that,” he says.

DANIEL P. SMITH

Photography by Jason Brown

Understanding Microbes on a Macro Scale

Professor Erica Hartmann's research on microbial communities opens up new possibilities for solving global health and environmental challenges.

“THERE’S AN AMAZING AMOUNT OF DIVERSITY AND POSSIBILITY IN MICROBIOLOGY.”

ERICA HARTMANN Associate Professor of Civil and Environmental Engineering

As a first-year undergraduate at Johns Hopkins University, Erica Hartmann listened intently as one of her professors delivered a lecture on bioremediation. She recalls being captivated by the idea that microbes could be used to clean up a polluted site by breaking down its environmental contaminants.

“I thought it was just wild that microbes can exist in environments where there’s no oxygen,” she says. “That they can grow in deep-sea thermal vents or by just using the energy from sunlight . . . that they can take chemicals that didn’t exist 50 years ago—chemicals that humans created, which have no place in nature—and given enough time, figure out how to eat them.”

Now an associate professor of civil and environmental engineering at the McCormick School of Engineering and an expert on indoor microbiomes, Hartmann remains captivated. “There’s an amazing amount of diversity and possibility in microbiology,” she says.

Today, she’s dedicated to exploring those possibilities, focusing her research on understanding, at the molecular level, how microbial communities respond to man-made chemicals. She then uses that new knowledge to influence practical outcomes, especially for controlling the spread of diseases and pathogens.

Monitoring and minimizing pathogens in the air

Recently, Hartmann has applied her research to the COVID-19 pandemic, examining air filters on airplanes to see whether they have captured the SARS-CoV-2 virus—information that would be valuable in both tracking the spread of the coronavirus and perhaps slowing its progress.

Teaming with a partner airline, Hartmann has learned about the practical constraints of the air sampling process. Air filters are massive. To take one out of a plane for testing, the aircraft must be pulled out of service. To overcome that limitation, Hartmann and the air carrier are seeking alternative methods of air sampling, possibly by using a device that’s easily removed so the airline can avoid the hassle of temporarily grounding the craft.

Because this work has implications beyond COVID-19, Hartmann and her collaborators are investigating how to track a handful of other viruses and bacteria. “COVID-19 is an issue right now,” says Hartmann, “but there are other respiratory pathogens in circulation all the time, and it would be really valuable if we could track lots of other pathogens as well. That would help us know when things are moving around and allow us to prepare.”

One of the end goals of the air filters project, Hartmann says, is to have monitoring data that’s accessible for public officials. This could lead to better decisions to protect our health. Another potential outcome is redesigning ventilation systems in schools, offices, and other enclosed spaces to be more like air filters in airplanes, which are intentionally designed to minimize the threat of airborne illness.

Understanding microbes in context

This current work is just one example of what’s happening in Hartmann’s lab. She has applied her passion to such diverse projects as investigating why medicine intended for fish at Shedd Aquarium in Chicago was disappearing in the water (answer: a family of microbes was consuming it) and understanding antimicrobials and the development of antibiotic resistance.

Hartmann notes that sometimes, when microbes face off with an antimicrobial agent, they die. Other times, they evolve and become immune to antimicrobials and subsequently antibiotics.

“It’s very interesting from an environmental perspective,” she says. “We know a lot about the microbes in our bodies and what happens within microbes when we take antibiotics. But what we don’t know a lot about is when we use antimicrobials in our environments, expose those microbes to antimicrobials, and then interact with both the antimicrobials and the microbes around us.”

Thanks to previous interdisciplinary projects with faculty from the Feinberg School of Medicine and the Weinberg College of Arts and Sciences, Hartmann brings a greatly expanded knowledge base to her work. Now, she is using methods such as collecting samples in the field, sequencing DNA, and developing model organisms and bacterial communities to decipher how microbes live and what they’re doing that could impact human beings.

“Instead of medicine thinking about a person in a vacuum,” Hartmann says, “we’re thinking about a person in an environment and everything they’re interacting with.”

BRIAN SANDALOW

Photography by Matthew Allen

FROM ADVISER TO LEADER

After a successful career in consulting, **Katrina Helmkamp** switched to operational roles and now drives innovation at Cartus.

When Katrina Helmkamp ('87, KSM '92) was a Boston Consulting Group partner and vice president, she thought she had the best strategy job in the world. She liked the variety and global nature of the work. She enjoyed teaming with high-caliber colleagues to solve problems for impressive clients. But after 12 years, she realized something was missing.

"I was getting tired of being the adviser, versus the owner of the results," she says. "I would ask long-term clients how they applied our strategy, because I was interested in how it gets implemented and how that turns into results."

One of those clients was residential and commercial services company ServiceMaster, which offered Helmkamp ownership over her strategy work as president of their Terminix pest control business in 2005. Helmkamp jumped at the chance to move into a leadership role and never regretted it.

Over the past 17 years, Helmkamp has led numerous global companies to launch new products and services and drive innovation and growth. Today, she's CEO of relocation services company Cartus and has served in operating roles longer than she was a consultant.

"It's about understanding customer needs well enough to find a problem that needs to be solved and understanding the economics to figure out if the solution will work in the marketplace and be profitable," she says.

TRANSFORMATIONAL LEADERSHIP

After working her way to group president at ServiceMaster, Helmkamp moved to Whirlpool in 2007, where she became vice president of global refrigeration. In 2010, she accepted her first CEO role with consumer sewing machine company SVP Worldwide.

In 2015, IDEX Corporation, a global manufacturer of specialty, mission-critical components, noticed Helmkamp's successful management of global businesses and asked her to serve on its board of directors, a role she still holds. In 2016, she became CEO of Lenox Corporation, where she served until 2018, when Cartus recruited her to lead a technology and process transformation to improve digital delivery and capture both efficiencies and market share in its relocation services.

Driving growth through innovative technology requires agile product development and design, notes Helmkamp. Her team focuses on providing a single source of information for everything relating to a client's relocation process. Building and testing a software product quickly and adapting it to customers' needs is crucial.

"You need to get it into the hands of the people who will use it and then get their feedback," she explains. "That way you keep iterating and making it better."

A FORMATIVE EXPERIENCE

Helmkamp draws from her engineering education every day, whether she's collaborating in teams, breaking down problems to find solutions, or determining how to optimize within constraints.

"What I've enjoyed most in my operating roles is finding opportunities to improve both efficiency and innovation," she says. "With that industrial engineering background, I almost can't help it."

In fact, Helmkamp's Northwestern experience—from working with the late professor Gilbert Krulee to meeting her husband, James Zydiak (PhD '89)—shaped her life and positioned her for success.

"Industrial engineering is great grounding for a career in business, whether it's working in a manufacturing plant or an office," she says. "Those skills you develop are applicable to many roles."

SARA LANGEN

"WHAT I'VE ENJOYED MOST IN MY OPERATING ROLES IS FINDING OPPORTUNITIES TO IMPROVE BOTH EFFICIENCY AND INNOVATION. WITH THAT INDUSTRIAL ENGINEERING BACKGROUND, I ALMOST CAN'T HELP IT."

A Change of Tune Defines a Career

THROUGH AN UNEXPECTED UNDERGRADUATE RESEARCH OPPORTUNITY, ADC THERAPEUTICS CEO **AMEET MALLIK** DISCOVERED A CAREER-DEFINING INTEREST IN BIOTECH AND PHARMA.

"Northwestern is where I grew up. I became a much better problem solver and a more confident, focused individual."

With his sophomore year as a chemical engineering undergraduate winding down, Ameet Mallik ('94, MS '95) found himself searching for ways to remain in Chicago for the summer. At first, his primary motivation was to continue performing with his Northwestern-based rock-and-roll band, Delusions of Grandeur. Then an unexpected opportunity came from E. T. Papoutsakis, a professor of chemical and biological engineering at Northwestern at the time, who invited Mallik to work in his lab.

Working in Papoutsakis's lab throughout the rest of his undergraduate years proved transformative for Mallik. It exposed him to biotechnology and research in such areas as recombinant DNA technology and cell culture scale-up and optimization in bioreactors. It clarified his purpose and propelled him toward becoming an innovative pharmaceutical and biotechnology industry leader.

"Northwestern is where I grew up," Mallik says. "I became a much better problem solver and a more confident, focused individual."

Discovering another interest: business

Five years later, having earned a bachelor's degree in chemical engineering and a master's degree in biotechnology from Northwestern in the inaugural year of the degree program, Mallik joined Abbott's Engineering Professional Development Program. He rotated through different areas of Abbott's multifaceted corporation before helping launch a contract manufacturing business—an experience that convinced Mallik he enjoyed negotiating contracts as much as working on technical solutions.

To further his pursuit of becoming a business-savvy leader in science and medicine, Mallik earned an MBA at the Wharton School of the University of Pennsylvania. He then spent five years as a consultant at McKinsey & Company applying classroom lessons about supply chains, product launches, and acquisitions to real-world scenarios.

The allure of biotech, and the passion ignited in Papoutsakis's lab, remained strong. In 2005, Mallik began a 16-year run with Novartis, one of the world's largest pharmaceutical companies. There, he finally married his dual interests in biotechnology and business. He sold and marketed cardiovascular products, directed global oncology marketing, as well as led global, regional, and country business operations. In 2017, he assumed responsibility for the company's $6 billion oncology operations in the United States.

Taking on the challenge of cancer therapies

In the spring of 2022, Mallik accepted the CEO position at ADC Therapeutics, drawn by the opportunity to lead this innovative biotech company with its promising platform for attacking cancerous cells in the body.

On any given day, Mallik finds himself collaborating with his leadership team on core issues like commercialization strategies and capital allocation as well as interacting with customers, investors, industry colleagues, and board members. In many ways, it reminds Mallik of his time at Northwestern, where encounters with students and faculty from other academic disciplines and around the world awakened his curiosity and sharpened his worldview.

"I don't like monotony. I enjoy dealing with lots of different topics," Mallik says. "I thrive when uniting functional leaders from across the business around a common purpose."

If ADC is successful in accomplishing its central mission—to bring targeted cancer therapies to market for patients with unmet medical needs—Mallik will help combat a disease responsible for an estimated 10 million deaths globally each year. He considers it an energizing and motivating goal.

"There is meaningful opportunity here," Mallik says, "to make a difference in the lives of patients and their families."

DANIEL P. SMITH

Inspired to Give Back

ERNST & YOUNG'S **DAVID NICHOLS** USES HIS EXPERIENCE AT NORTHWESTERN AND CONSIDERABLE PROFESSIONAL SUCCESS TO OPEN UP OPPORTUNITIES FOR OTHERS.

Looking back, David Nichols ('91, KSM '00) can pinpoint the exact moment that changed the trajectory of his life—the last-minute decision to attend a session with two Northwestern alumni speaking to high school students in his hometown of St. Louis.

The compelling and authentic way they discussed their experiences impressed Nichols. He liked what he heard about Northwestern's interdisciplinary approach and how the University excelled on many fronts. By the time they finished speaking, Nichols knew Northwestern was the only school for him.

He spoke with the alumni afterward, and they told him applications were due at the end of the week. They offered to interview him the next morning if he was serious about applying. That night, he rushed to fill out his application by hand. He met them the next day, and the rest is history.

Now a senior principal at Ernst & Young Consulting Services (EY), Nichols traces his successful career to that life-changing interaction with two Northwestern graduates. "I hope my involvement helps students down the road," Nichols says of his engagement since 2007 as a member of the McCormick Advisory Council. "If I share my experience, and it helps them on their journey, or if I can make their experience better, that's my way of giving back."

Enduring impact

When Nichols arrived on campus to study electrical engineering and computer science, he was awed by how talented and smart the students were. He met people from all over the world, including his roommate, Emile Kfouri ('91), who had come from Lebanon and became a lifelong friend.

Another who made a lasting impression on Nichols was Janet Rutledge, one of the first Black female engineering professors

“There have been many times when the path was unclear, and I had to figure it out myself. Drawing on my Northwestern experience allowed me to succeed.”

at Northwestern. Nichols was interested in Rutledge's research on signal processing using neural networks and worked with her on an independent study project.

“She was the most pivotal professor I had at Northwestern,” he says. “The outstanding impact that she had on me gave me confidence personally and professionally.”

He credits Northwestern with teaching him to be analytical while encouraging him to develop other parts of his brain. “We weren't just engineers—we were thinkers,” he says. “That's one of the unique aspects of Northwestern. It showed us we could do anything with our degrees.”

Developing expertise

After graduating, Nichols joined Andersen Consulting, now Accenture, because it allowed him to build business acumen while leveraging his technical experience. Within 10 years, he became a partner and continued to develop his skills through the Kellogg School of Management's advanced business management program. He became global managing partner of the firm's service-oriented architecture practice and grew its revenue from $62 million in 2004 to $1.7 billion in 2007.

Nichols loved the fast pace, variety, and collaborative culture of professional services, but after 18 years, he wanted a new challenge. Beginning in 2009, he served as president and COO of PPM Global Corporation, where he worked in the world of leveraged buyouts, until he sold his interest in the company.

In 2011, Nichols returned to professional services when EY asked him to be their Americas technology and digital transformation leader. He used his computer science and digital expertise to help senior executive clients bridge the gap between business and technology. He went on to serve as EY's inorganic growth leader, where he was responsible for acquisitions as well as innovation and alliances.

Each successive position helped prepare Nichols for his role today as senior principal, where he leads EY's services team for major clients and steers growth opportunities through innovation with key external companies.

Driving digital transformation and creating an innovation culture are his areas of expertise. “It's a fantastic role because you're having strategic discussions with some of the most senior business executives about how to grow and optimize their businesses,” he says.

Channeling gratitude

Throughout his career, Nichols has relied on lessons he learned as an engineering student. “Northwestern has a culture of teaching people how to think to solve problems,” he says. “There have been many times when the path was unclear, and I had to figure it out myself. Drawing on my Northwestern experience allowed me to succeed.”

Nichols uses his success to help others by serving on Chicago-area nonprofit boards and working to increase diversity and inclusion at EY and in the broader community. He channels his gratitude for his good fortune into giving back.

“The professional opportunities I've had are beyond what I ever thought possible,” he says. “Those pivotal moments that changed the trajectory of my life were all personal interactions that I had with people because they made themselves available. I hope I can do that for someone else.”

SARA LANGEN

IN MEMORIAM

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William S. Dougherty '46, '48
Terry Glenn '46
Norton N. Nielsen '46
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Gordon Johnson '48
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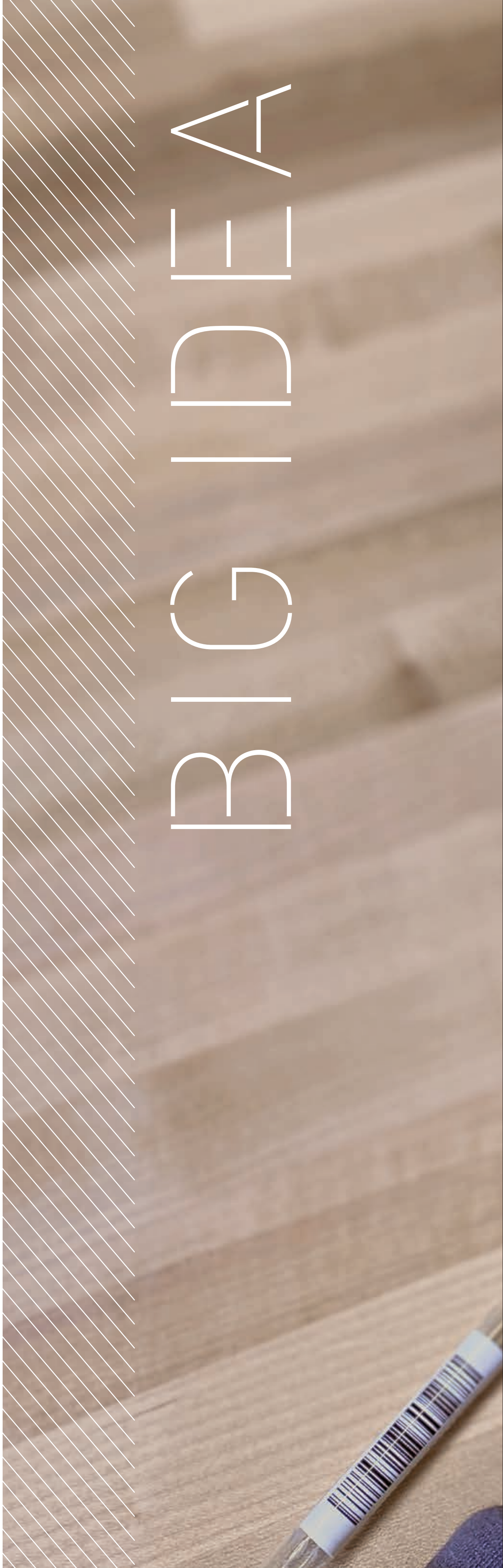
Scott Stoney '83
Martha J. White '86
Rhonda Smith Ferguson '91
Edward J. Czepiel '92
Richard A. Martinez '92
Robert S. McNeil '01
John C. Peterson '01
Michael Thomas Grover '05
Charles Vinci '05



MONKEYPOX RAPID PCR TEST IN DEVELOPMENT

Last spring, a rapid polymerase chain reaction (PCR) test for COVID-19—developed by Northwestern University spinoff company Minute Molecular Diagnostics—received emergency use authorization (EUA) status from the US Food and Drug Administration (FDA).

Now, the team behind this revolutionary test is adapting its platform to detect monkeypox. The researchers have a working prototype of the monkeypox test, with plans to submit an EUA application to the FDA early next year. Investigators are using Minute Molecular's DASH Analyzer, a compact, portable system that provides easy-to-read results in approximately 15 minutes.

Sally McFall, cofounder and chief scientific officer of Minute Molecular and a research professor of biomedical engineering at Northwestern's Center for Innovation in Global Health Technologies, is co-leading the test's development with David Kelso, cofounder, president, and CEO of Minute Molecular and clinical professor of biomedical engineering. Infectious disease specialists at the Feinberg School of Medicine will lead clinical testing.

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Robert R. McCormick School of
Engineering and Applied Science

Northwestern University

Technological Institute
2145 Sheridan Road
Evanston, Illinois 60208–3100

A NEW VIEW

Seven current and seven former students in Northwestern Engineering's Architectural Engineering and Design minor program traveled to Madrid, Spain, in September to see firsthand how classic old-world architecture meshes with contemporary designs. The students visited architectural sites and heard lectures from local architects and engineers. Students also worked in teams to develop plans to take an existing Madrid high-rise and reclad it with wood using modern technology while also making sure the new design was sustainable.