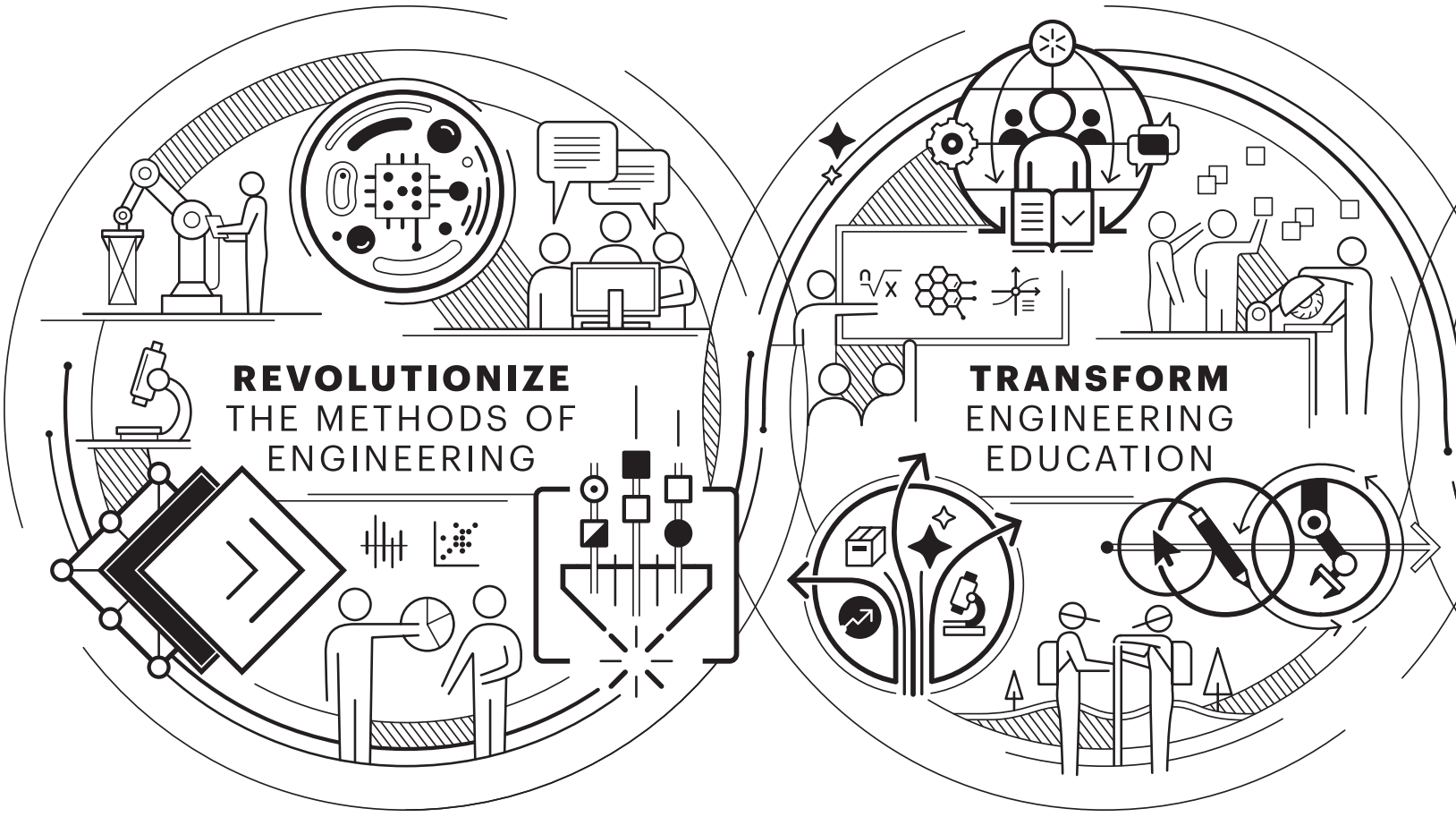


ENVISIONING ENGINEERING'S FUTURE

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

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

CHRISTOPHER SCHUH DEAN

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

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

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

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

1. REVOLUTIONIZE the Methods of Engineering

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

2. TRANSFORM Engineering Education

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

3. ADVANCE Critical Applications of Engineering

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

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

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

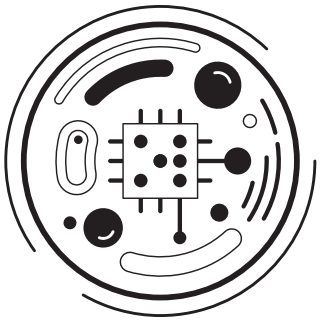
REVOLUTIONIZE THE METHODS OF ENGINEERING

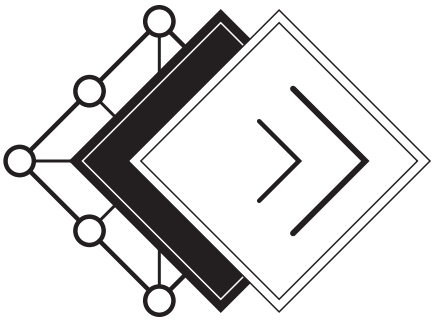
HOW ENGINEERS WORK IN THE FIELD IS CHANGING, AND IT'S CHANGING QUICKLY.

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

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

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





Biohybrid Systems

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

SYNTHETIC BIOLOGY

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

BIOELECTRONICS

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

BIOMATERIALS

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

Concurrent Materials Design

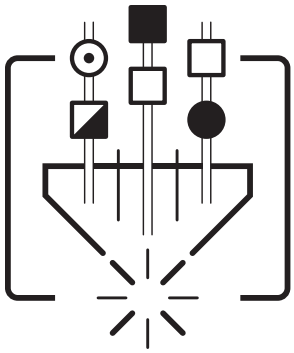
By **COMBINING STRENGTHS IN MATERIALS SCIENCE, GENERATIVE AI, AND MACHINE LEARNING TO PREDICT MATERIAL BEHAVIOR,** Northwestern engineers are **advancing methods** that allow researchers to design materials at the atomic and microstructural levels while simultaneously designing the product—such as electronics,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

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

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

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

CHRISTOPHER SCHUH DEAN



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

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

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

IMPROVING REINFORCEMENT LEARNING

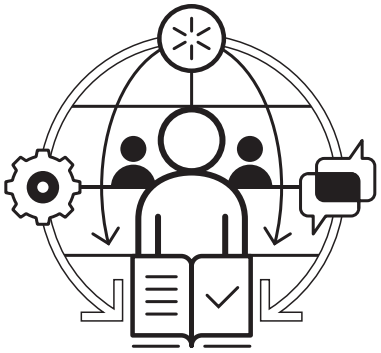
Northwestern engineers are **ADVANCING REINFORCEMENT LEARNING, a form of machine learning** where models learn optimal policies through a process of trial and error, **dynamically adapting to changing environments and unforeseen challenges.** Its diverse applications range from autonomous systems—such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

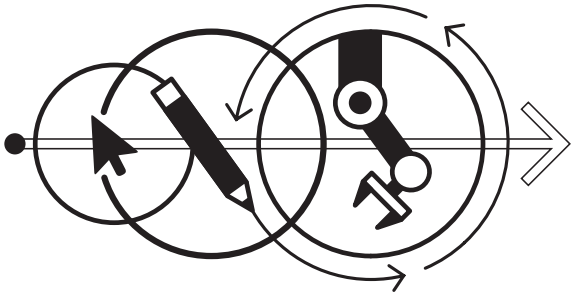
"Machine learning and artificial intelligence can make astonishingly good predictions, but they are still limited in their ability to contribute to the **understanding of complex systems in science and engineering,"** says Hermann Riecke, professor and chair of the Department of Engineering Sciences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

TRANSFORM ENGINEERING EDUCATION

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

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





Innovate the First-Year Curriculum

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

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

Design Thinking That Permeates

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

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

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

WES BURGHARDT
ASSOCIATE DEAN OF UNDERGRADUATE ENGINEERING

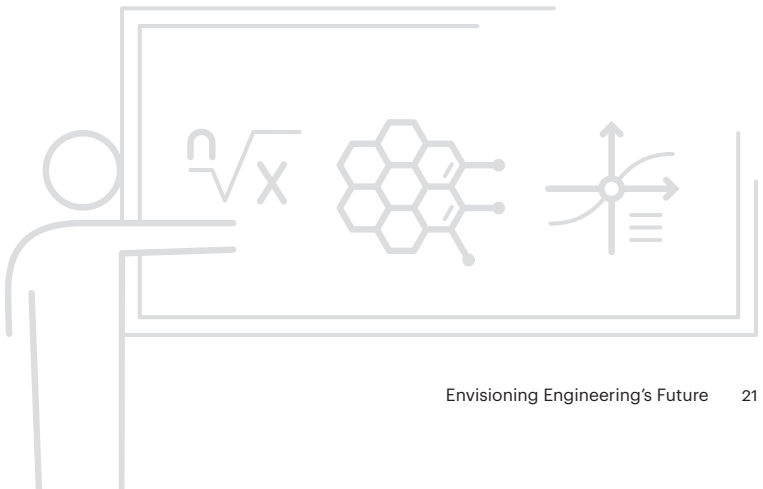
"We regularly evaluate and enhance our degree portfolio using insights from our faculty, groundbreaking research, and industry partners to ensure our students graduate with the specialized competencies needed."

SHELLEY FINNIGAN
ASSOCIATE DEAN FOR MASTER'S AND PROFESSIONAL EDUCATION

Flexibility and Innovation in Degree Programs

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

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



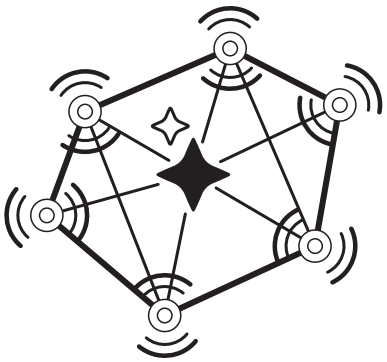
ADVANCE CRITICAL APPLICATIONS OF ENGINEERING

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

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

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

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



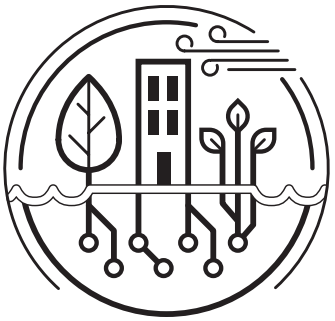
Embodied AI

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

EXPANDING EMBODIED INTELLIGENCE IN ROBOTICS

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

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



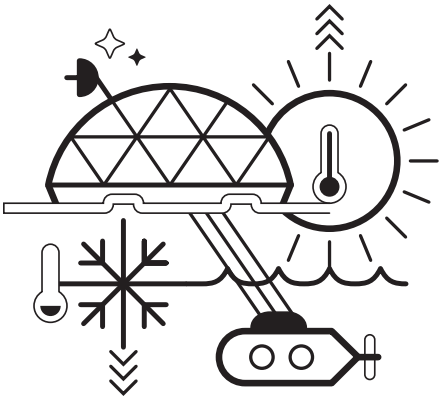
Climate-Resilient Communities

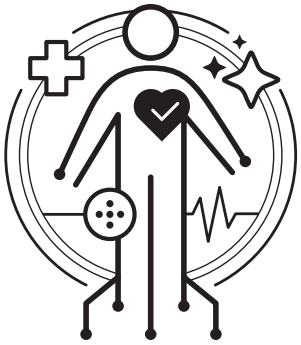
By connecting sustainability, urban environments, and equitable climate technologies, Northwestern engineers will not only **HELP DECARBONIZE THE EARTH** but also **HELP MITIGATE THE EFFECTS OF CLIMATE CHANGE** on people and communities.

WHAT IS RESILIENCE?

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

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





Remote Environments

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

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

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

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

Optimize the Human Health Span

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

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

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

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

ALEX GERAGE

Illustrations by Kyle Nelson, Stoltze Design Group