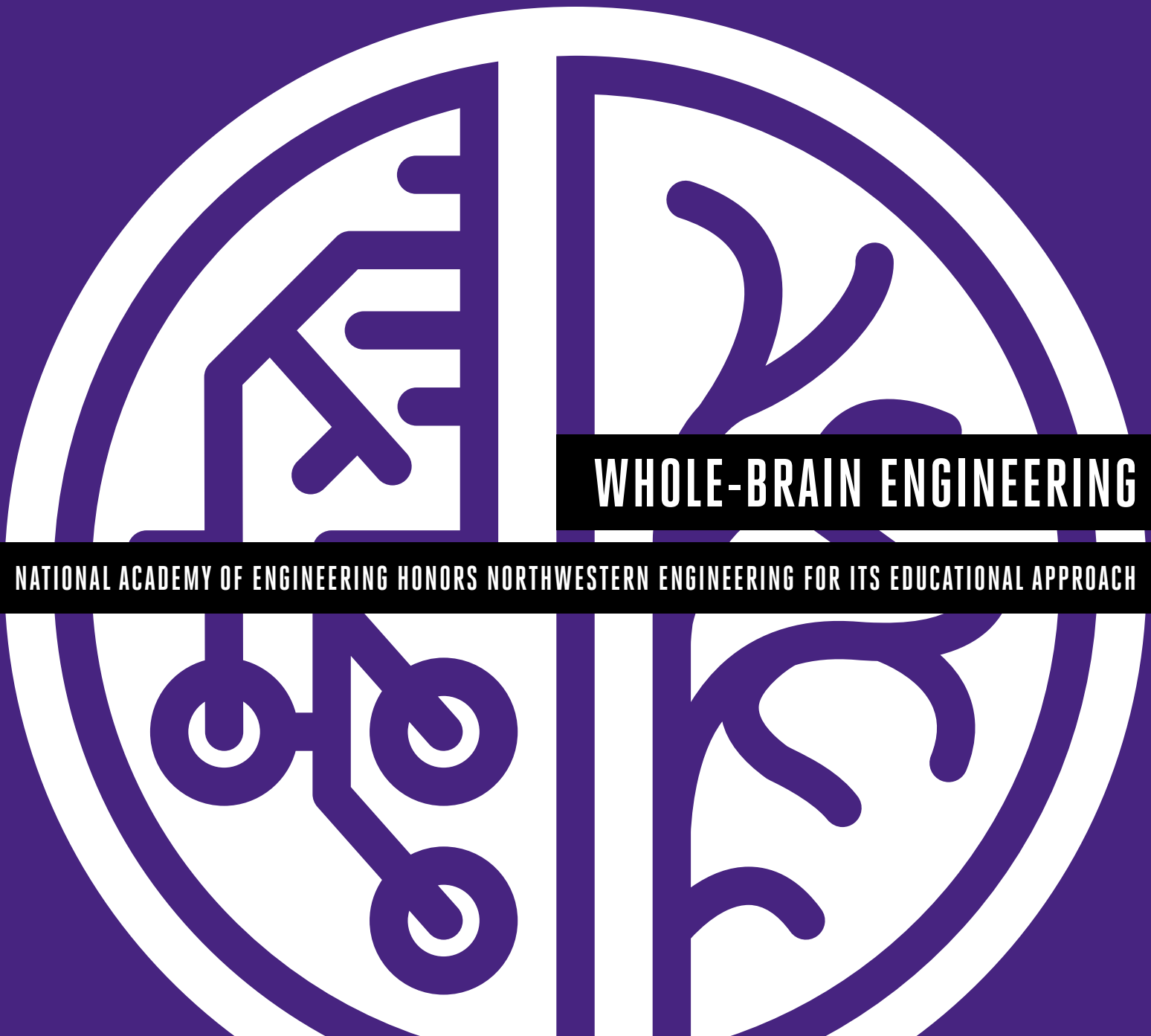
McCormick School of Engineering and Applied Science

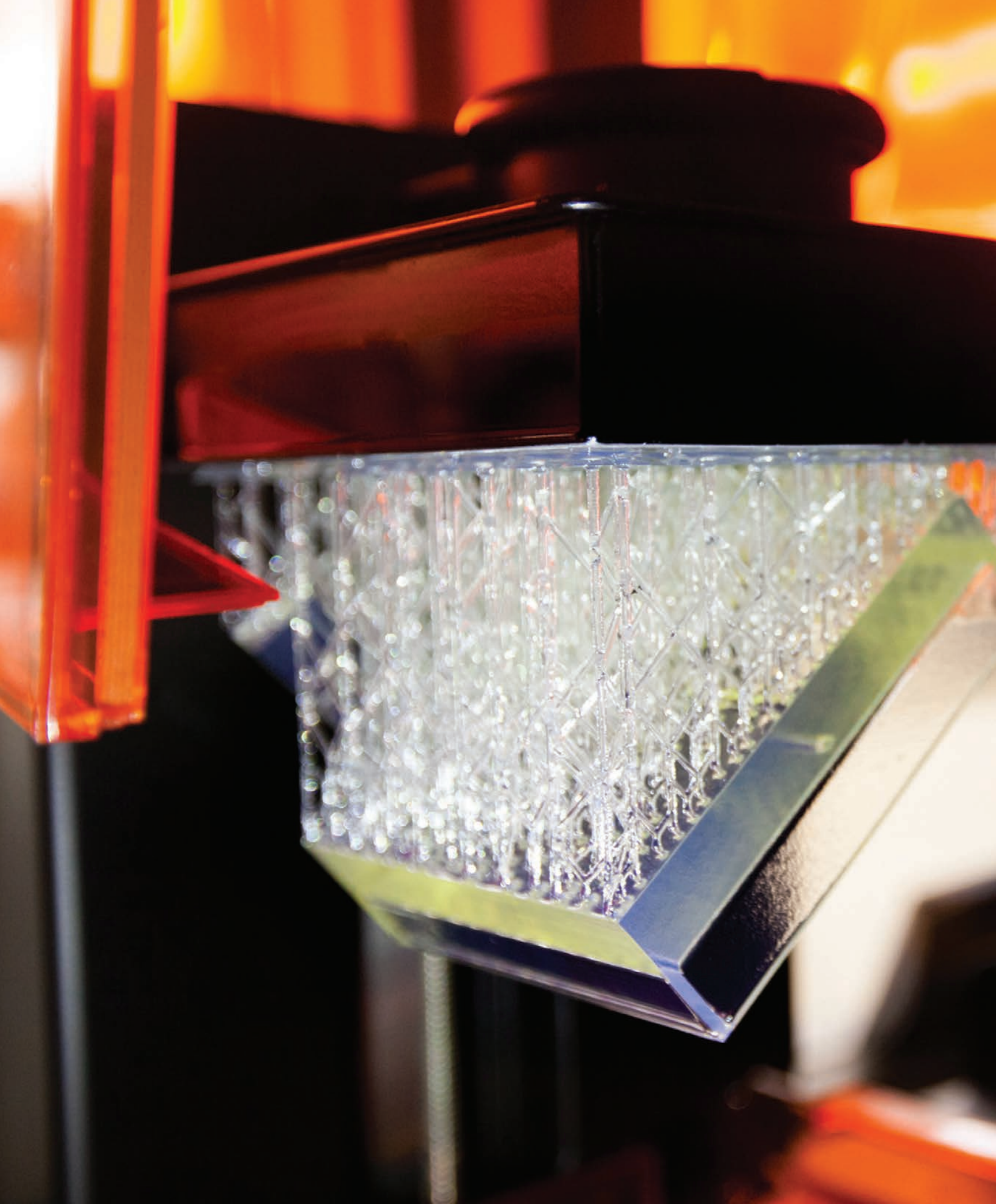
NORTHWESTERN ENGINEERING

SPRING 2017



WHOLE-BRAIN ENGINEERING

NATIONAL ACADEMY OF ENGINEERING HONORS NORTHWESTERN ENGINEERING FOR ITS EDUCATIONAL APPROACH



PRINTING THE FUTURE

An intricately designed part emerges from the resin in Northwestern Engineering's Formlabs 3D printer, one of the industry's highest resolution and most precise printers available. Users can send their plans to the printer via WiFi and then watch as their designs get printed into reality. The Formlabs 3D printer can be found in the 3D Printing and Rapid Prototyping Lab, one of Northwestern Engineering's many maker spaces. Students can find information about these facilities and resources at the new MAKE Northwestern online hub, make.northwestern.edu.

Photograph by Sally Ryan

"WE ARE CONTINUALLY CURATING A WHOLE-BRAIN NETWORK TO CONNECT WITH NEW PARTNERS ACROSS THE UNIVERSITY, THE REGION, AND THE WORLD; INCREASINGLY, NEW PARTNERS SEEK US. LIKE ALL THE BEST PARTNERSHIPS, IT BENEFITS BOTH SIDES BY BRINGING NEW WAYS OF THINKING AND LOOKING AT PROBLEMS FROM MULTIPLE VIEWPOINTS."

GREETINGS FROM NORTHWESTERN ENGINEERING

The main story in this issue, on Whole-Brain Engineering, lies close to my mind and heart. Though we've been promoting this approach for years, this year was noteworthy in terms of recognition. I was pleased and humbled to receive the 2017 Bernard M. Gordon Prize for Innovation in Engineering and Technology Education from the National Academy of Engineering for our Whole-Brain Engineering philosophy.

In some ways, it is the culmination of more than a decade of work merging left-brain analytical thinking with right-brain creativity to educate the leaders of the future and to expand the impact of engineering. This has been a shared effort that involved a fantastic team composed of members from across the school and partners across the University; I share this prize with them.

Our Whole-Brain Engineering strategy has helped build a network of graduates who can think and work across disciplines—you'll find evidence of this in the alumni we profile in this issue. It is this type of thinking that allows us to partner with the Medill School of Journalism, Media, Integrated Marketing Communications to form a new Bay Area Immersion Experience (page 22). It is this type of thinking that allows students like Marc Gyongyosi to have the idea to use indoor flying robots for warehouse analytics, and then provide the space, and guidance, to turn that idea into a business (page 36).

This type of cross-disciplinary thinking is also now a part of our faculty, finding its way into our research enterprise. Our synthetic biology faculty group exemplifies part of this broad thinking and is redefining what biology can do for us.

Finally, our whole-brain thinking platform gives us the framework to help students live their best lives and achieve balance in what is often a rapidly moving chaotic world. Our Women in Computing group helps provide community and encouragement to our female computer science students. Our Designing Your Life course helps students ask the big questions about what they want from life and then use design thinking to achieve it.

The best part about this philosophy is that it is scalable and autocatalytic. We are continually curating a whole-brain network to connect with new partners across the University, the region, and the world; increasingly, new partners seek us. Like all the best partnerships, it benefits both sides by bringing new ways of thinking and looking at problems from multiple viewpoints.

As always, I welcome your feedback.

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

On the Cover

Dean Julio M. Ottino received the National Academy of Engineering's Gordon Prize for Whole-Brain Engineering, Northwestern Engineering's principal guiding strategy for more than a decade. Read more on page 14.

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Northwestern | McCORMICK SCHOOL OF ENGINEERING

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14

22

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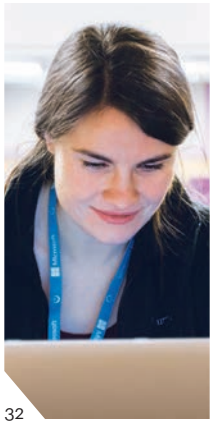

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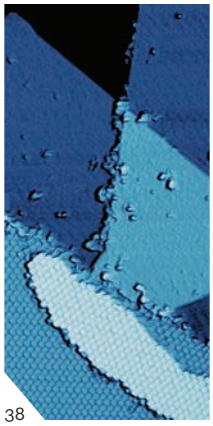


38

NORTHWESTERN ENGINEERING
SPRING 2017

4
NEWS

8
LAB NOTES

14
THE WHOLE STORY
Dean Julio M. Ottino wins a top education prize for Whole-Brain Engineering

22
IMMERSED IN INNOVATION, ENGINEERING MEETS JOURNALISM
Bay Area Immersion Experience sends students to America's startup capital

26
THINKING DIFFERENTLY
The Center for Synthetic Biology wraps-up a blockbuster first year

30
LIVING WELL BY DESIGN
New course teaches students to apply design thinking to life

32
A COMMUNITY FOCUSES ON SUCCESS
Young women in tech find support through Women in Computing

36
STARTUP TAKES TO THE AIR
Senior Marc Gyongyosi's robotics startup charts a course to success

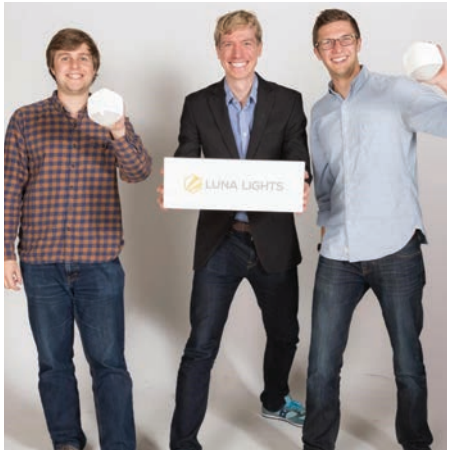
38
DIVERSIFICATION IN THE MATERIALS WORLD
Professor Mark Hersam identifies the best applications for new materials

41
GIVING REPORT

42
CLASS NOTES

NEWS

Startup Luna Lights Reaches Cupid's Cup Finals



Luna Lights, a startup founded by Northwestern Engineering alumni Matthew Wilcox ('14), Donovan Morrison ('14), and former team member Wesley Youman ('15), reached the finals of Cupid's Cup, an entrepreneurship competition started by Under Armour founder Kevin Plank. Northwestern hosted the finals on March 30, 2017 at Pick-Staiger Concert Hall.

Designed to help assisted-living residents navigate their surroundings at night, Luna Lights' ultra-thin bed sensor and lighting system can illuminate a pathway to the bathroom or bedroom door when its users leave their beds. Wilcox and Morrison, who started Luna Lights as a Design for America project, are looking to expand the service to senior communities throughout Chicagoland and beyond. They also hope to launch a consumer-ready model in 2018.

"AS YOU START TO LOOK AT THE METRICS OVER TIME, YOU CAN SEE HOW YOU MIGHT FIND SOME CORRELATION WITH PEOPLE'S OVERALL HEALTH."

MATTHEW WILCOX

SENIOR EARNS COVETED MARSHALL SCHOLARSHIP

Northwestern senior Daniel Kinch, a dual-degree student in physics and math, was one of 40 students from the United States to be named a Marshall Scholar. The scholarship is designed to train future leaders, instill a lasting understanding of British society, and fortify the relationship between the United States and Great Britain.

Kinch will spend two years in England: the first year studying math at Durham University, and the second exploring the relationship between physics and math as it applies to string theory at the University of Cambridge. He plans to pursue a PhD in theoretical physics upon his completion of the Marshall Scholarship.

221

Northwestern Engineering master's and PhD students who were celebrated during the winter commencement ceremony

25

Number of schools the MMM team beat to win the 2017 Rotman Design Challenge

SYNTHETIC BIOLOGISTS UNITE AT NORTHWESTERN

Northwestern hosted the 2017 Engineering Biology Research Consortium retreat in March. The event brought together nearly 170 faculty, researchers, and students from multiple universities to discuss how synthetic biology can be used to address national and global needs.

Speakers at the symposium shared their latest research, which included efforts to combat water scarcity by engineering plants to filter seawater. The two-day retreat encouraged attendees to work together to identify challenges and opportunities in the growing field.

"Northwestern is known for collaboration. We take pride in driving topics and activities that connect each other," says Dean Julio M. Ottino. "Synthetic biology is the kind of research that can emerge through collaboration."

The symposium corresponded with the one-year anniversary of Northwestern's launch of its new Center for Synthetic Biology, which Northwestern Engineering's Milan Mrksich directs with co-director Michael Jewett.

‘Data as Art’ Explores Distracted Driving, Contamination, and Social Media

Most people know that texting while driving is dangerous. So why do they continue to do it?

This is one of the questions posed by *Distracted Driving: The Choice is Yours*, an artistic installation that transforms the abstract issue into a tangible, immersive graphic. The piece was one of the six final projects that emerged from Data as Art, a fall 2016 course co-taught by faculty from Northwestern University and the School of the Art Institute of Chicago (SAIC). Each interdisciplinary team included students from SAIC and Northwestern Engineering, which organized the collaboration through the Segal Design Institute.

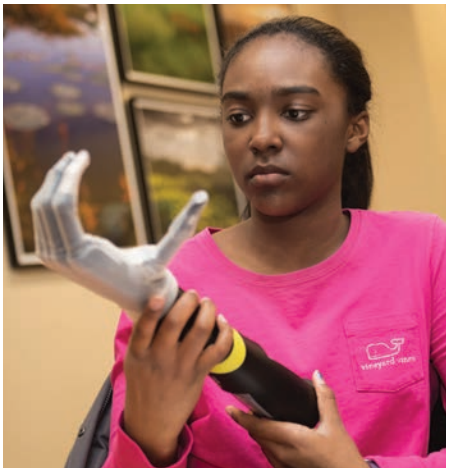
“The course alters the way each population—engineers and artists—thinks. They might seem very different, but they find commonality,” says Dean Julio M. Ottino. “This is valuable and rare. I hope it eventually becomes more commonplace.”

Other projects from the class included explorations of water contamination and social media, digital art that explored what it means to experience life through a screen, and an interactive tapestry depicting water quality data from the South Fork of the Chicago River’s South Branch, known as “Bubbly Creek.” *Lead*, a project inspired by the water crisis in Flint, Michigan, presented a hanging installation that showed the water contaminants and contamination levels in Chicago neighborhoods.

ALUMNI STARTUP PHENIXP2P REACHES FINALS OF TECHCRUNCH’S STARTUP BATTLEFIELD

PhenixP2P, a startup offering a scalable, real-time video streaming platform with minimal latency, finished as one of five finalists in TechCrunch’s Startup Battlefield competition at the Disrupt London 2016 conference in December. The PCast™ platform preserves a true, real-time experience by streaming live video programming, such as sports and online webinars, to thousands of locations worldwide without the delay that plagues current streaming services at that scale.

PhenixP2P’s executive team includes alumni CEO Stefan Birrer (MS ’04, PhD ’08), Andreas Schuler (MS ’01), and Philip Joseph (’03). Professor Fabián Bustamante serves as the startup’s lead scientist.

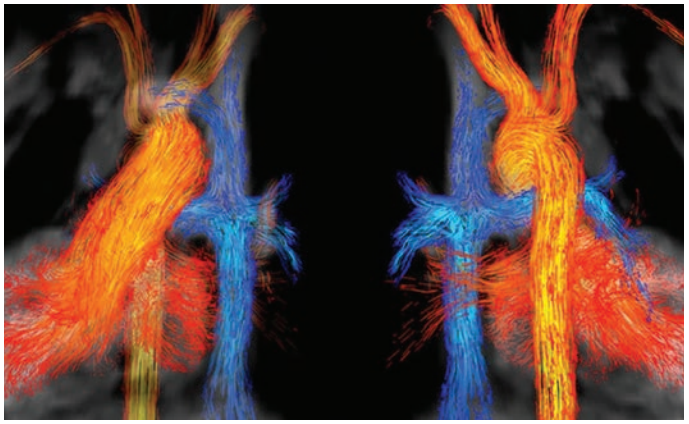


CHICAGO-AREA GIRLS EXPERIENCE HANDS-ON ENGINEERING

Nearly 300 Chicago-area middle school and high school girls performed hands-on experiments and toured Evanston campus laboratories during Northwestern’s 47th annual Career Day for Girls in February 2017. Inspired by the theme “Gear Up for Greatness,” the event included an engineering design competition, a goal-setting workshop, and panel discussions for students and parents. Career Day for Girls began at Northwestern in 1970, when only 4 percent of McCormick School of Engineering students were women. Today, women comprise nearly one-third of Northwestern Engineering students.

$25,000

Amount won by student startup IFM at the Rice Business Plan Competition



ENGINEERS SWEEP 2016 SCIENTIFIC IMAGE CONTEST

Northwestern Engineering entries took the top five spots and six honorable mentions in Science in Society's sixth annual scientific images contest, Capturing the Beauty of Science, in fall 2016.

An MRI image, "Blood Flow through the Heart," submitted by Kelly Jarvis, a graduate student in Professor Michael Markl's laboratory, won first prize. Markl's 4D flow MRI imaging technique captures the heart's blood flow at a single moment in time, allowing researchers to measure the flow's speed and patterns. The image shows a human heart from the front and back with blood flowing out to the body before returning to be re-oxygenated by the lungs.

75

Female hackers from across the US who attended BuildHer 2017, Chicago's first-ever student-run women's hackathon

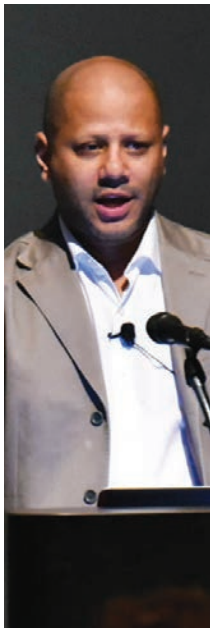
JEN BERVIN DISCUSSES MIXING POETRY WITH TECHNOLOGY

Interdisciplinary artist and poet Jen Bervin started her experimental work, *Silk Poems*, with a question: If I had a silk biosensor embedded beneath my skin, what would I want it to say?

Exploring the answer took Bervin on a five-year journey through more than 30 international nanotechnology and biomedical labs, textile archives, medical libraries, and sericulture sites worldwide. She discussed the project in a talk co-sponsored by Northwestern Engineering's Dean's Seminar Series and the Block Museum of Art.

Bervin collaborated with Tufts University's Silk Lab to nanoprint a poem onto a liquid silk biosensor that could be placed inside the body. The book-length poem, written from the perspective of a silkworm, embodies both the rich history of silk and cutting-edge medical technologies. The final work, which includes a poem nanoprinted on silk and viewed under a microscope, a video, and the poem's manuscript, debuted in 2016 at the Massachusetts Museum of Contemporary Art.

"There could be more to the sensor than just the sensing. It would not merely be functioning in the sensing capacity but in the imagination." **JEN BERVIN** INTERDISCIPLINARY ARTIST AND POET



HASAN ELAHI EXAMINES THE INTERSECTION OF TECHNOLOGY AND ART

Interdisciplinary artist Hasan Elahi, whose work "Tracking Transience" focuses on the relationship between location, repetition, technology, and surveillance in today's media age, spoke at a joint lecture hosted by Northwestern Engineering and the Block Museum of Art in October 2016.

Elahi became the subject of a thorough FBI investigation when he was added erroneously to a US terrorist watch list in 2004. Since then, he has posted nearly 85,000 images online to document his entire life for public consumption, from financial records to transportation logs to a tracker noting his location at any given time.

"As artists, we try to create experiences. 'Tracking Transience' is the experience of going through the information and realizing the reversal that's taken place," Elahi says. "By telling you everything, I'm really telling you nothing."

SCIENCE EDITOR DISCUSSES PUBLISHING DOS AND DON'TS

Science magazine senior editor Phillip Szuromi visited campus in fall to discuss the current landscape of scientific publishing. Hosted by Northwestern's Simpson Querrey Institute for BioNanotechnology, Szuromi's talk addressed the importance of clear writing for a more general audience, how publishing has changed in the Internet age, and what components make up a successful, publishable journal article. Szuromi said editors appreciate research with societal impact, novel ideas, and new general methodologies. Conversely, they are turned off by research that lacks clear metrics or impacts only a small audience.

WILDHACKS UNITES NEARLY 500 STUDENT HACKERS

Students from all over the United States and Canada met on Northwestern's campus in November 2016 for the third annual WildHacks hackathon. Designed around the theme "Build-Your-Own Hackathon," the 24-hour event challenged teams to create web, desktop, and mobile computer projects.

The students were also charged with selecting the hackathon's speakers, prizes, activities, and food. "We wanted to really engage our attendees this year and get them involved with more than just hacking," says Joshua Shi, co-director of WildHacks and junior in computer science.

The event culminated with teams presenting their projects to the judges' panel for scoring based on originality, technicality, design, and usefulness. A team from MIT won first place and $2,000 with its Stegosaur, a Google Chrome extension that animates static screenshots to enable user interaction.

MATTHEW AMROFELL NAMED CO-OP STUDENT OF THE YEAR

Chemical engineering senior Matthew Amrofell was selected as Northwestern Engineering's 2017 Walter P. Murphy Cooperative Engineering Education Student of the Year. Amrofell completed his co-op with Baxter Healthcare as a member of a research and development project team, where he had the unique opportunity to work as a supervisor. Collaborating alongside senior and seasoned engineers, he worked with multiple companies to coordinate the manufacturing and product reliability aspects of the research and development process. He also volunteered with Baxter on community service projects, including one that organized a STEM workshop for children.

1,000

Square footage of a solar-powered home being built by Northwestern students

30

Students who participated in *Launch*, Northwestern's year-long, student-led business accelerator

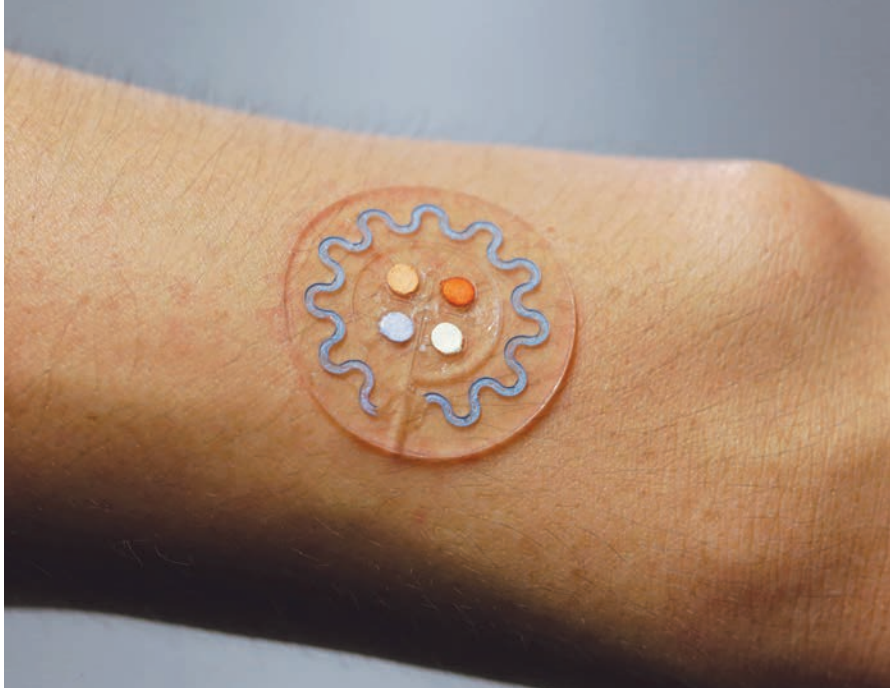
NORTHWESTERN WINS PROGRAMMING CONTEST, ADVANCES TO WORLD FINALS

For the third time in four years, a Northwestern Engineering team won the Association for Computing Machinery Mid-Central USA Regional Programming Contest. Computer science PhD students Abhratanu Dutta and Yiding Feng joined undergraduate Ruohong Zhang and coach Goce Trajcevski to make up the victorious Team WildWildCats, beating out 150 teams from 56 different schools. The win qualified the team to compete in the ACM International Collegiate Programming Contest World Finals in spring 2017.

WORLD WILDLIFE FUND CALLS FOR BETTER INFRASTRUCTURE PLANNING

In November 2016, as part of the Dean's Seminar Series, the World Wildlife Fund's Emily McKenzie and Nirmal Bhagabati discussed ways to implement infrastructure without adversely affecting nature and wildlife. The two revealed that within the next 20 years, 90 percent of new infrastructure projects will happen in developing countries, which are also the world's most biodiverse areas. They called on planners to evaluate the environmental impact of their work before beginning such projects.

LAB NOTES



RESEARCHERS DEVELOP 'LAB ON THE SKIN' FOR SWEAT ANALYSIS

Professors John Rogers and Yonggang Huang developed a soft, flexible, first-of-its-kind microfluidic device that adheres easily to the skin and measures its wearers' sweat to indicate how their bodies are responding to exercise. Sweat contains a number of important chemical compounds that, when analyzed, can reveal critical physiological health information.

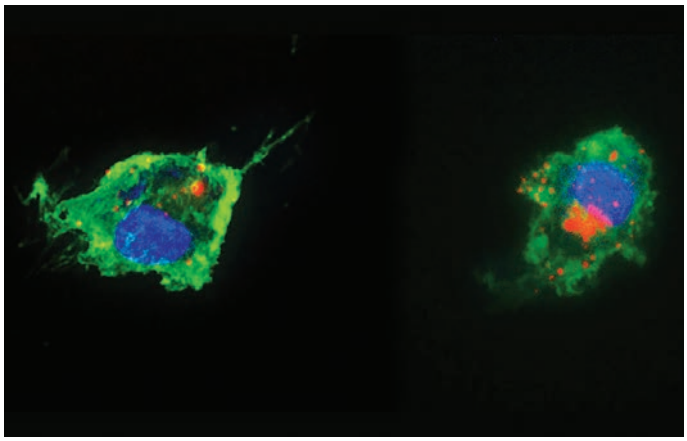
"The intimate skin interface created by this wearable, skin-like system enables new measurement capabilities not possible with the kinds of absorbent pads and sponges currently used in sweat collection," Rogers says.

Slightly larger than a quarter and about the same thickness, the simple, low-cost device analyzes key biomarkers, which can help people decide quickly if they should drink more water or replenish electrolytes. In medical settings, it can facilitate disease diagnosis, for example, by detecting a biomarker for cystic fibrosis present in sweat. The device, which adheres directly to skin of the forearm or back, is designed for one-time use of a few hours and may be used more broadly for disease diagnosis in the future.

"With integrated electronics that don't require a battery but still enable wireless connection to a smartphone, our sweat analysis platform will allow people to monitor their health on the spot without the need for blood sampling," Huang says.

"BY EXPANDING OUR PREVIOUSLY DEVELOPED 'EPIDERMAL' ELECTRONICS PLATFORM TO INCLUDE A COMPLEX NETWORK OF MICROFLUIDIC CHANNELS AND STORAGE RESERVOIRS, WE NOW CAN PERFORM BIOCHEMICAL ANALYSIS OF THIS IMPORTANT BIOFLUID."

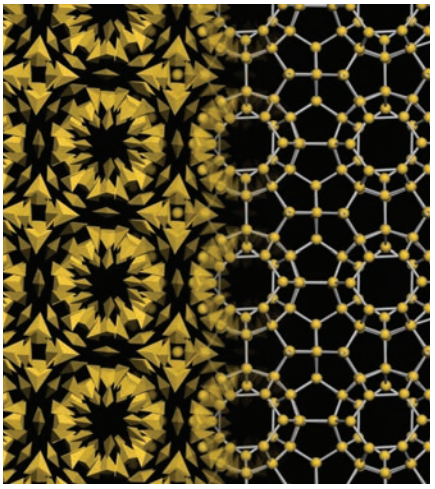
JOHN A. ROGERS
PROFESSOR OF MATERIALS SCIENCE AND ENGINEERING, BIOMEDICAL ENGINEERING, AND NEUROLOGICAL SURGERY



ENGINEERING VACCINES FOR NEWBORNS

Most vaccines aren't effective for newborns because their immune systems haven't developed sufficiently. Unfortunately, this leaves newborns highly susceptible to infectious diseases. Professor Evan Scott and his collaborators are using nanotechnology to make more vaccines that can be administered successfully immediately after birth. They have employed a small molecule that, when delivered into the body via nanoparticles, successfully mimics a tuberculosis vaccine that works safely and reliably in newborns. Next, Scott plans to incorporate this nano-carrier system into other vaccines to see if and how that works.

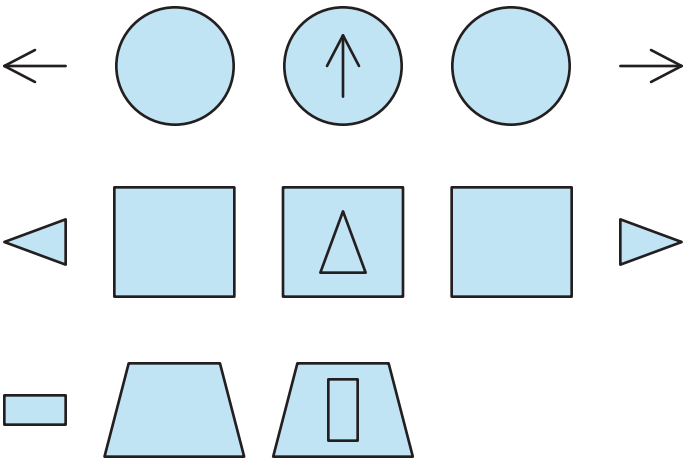
THE MOST COMPLEX NANOPARTICLE CRYSTAL EVER MADE BY DESIGN



Northwestern and University of Michigan researchers designed and built the most complex crystal ever made with nanoparticles. The work demonstrates that some of nature's most complicated structures can be assembled deliberately if researchers can control the shapes of the particles and the way they connect using DNA.

"This is a tour de force demonstration of what is possible when one harnesses the chemistry of DNA and combines it with nanoparticles whose shapes encourage a particular crystal structure," says Professor Chad A. Mirkin.

Nanotechnology promises to bring materials together in new ways, forging new capabilities by design. One potential application for crystals built of nanoparticles, such as these newly reported ones, is the control of light—nanoparticles interact well with light waves because they are similar in size.



A.I. Systems that See the World as Humans Do

Professor Ken Forbus and collaborators developed a new computational model that performs at human levels on a standard intelligence test. This work is an important step toward making artificial intelligence systems that see and understand the world as humans do.

The model is built on CogSketch, an artificial intelligence platform with the ability to solve visual problems, understand sketches, and give immediate feedback. Forbus tested his new model on a nonverbal standardized test that measures abstract reasoning. All of the test's problems consist of a matrix with one image missing, and the test taker must choose an option to best complete the matrix. Forbus's computational model performed in the 75th percentile—better than the average American.

"THE PROBLEMS THAT ARE HARD FOR PEOPLE ARE ALSO HARD FOR THE MODEL, PROVIDING ADDITIONAL EVIDENCE THAT ITS OPERATION IS CAPTURING SOME IMPORTANT PROPERTIES OF HUMAN COGNITION."

KEN FORBUS WALTER P. MURPHY PROFESSOR OF COMPUTER SCIENCE

500

Number of students Ken Forbus tested his sketching feedback software on

STUDY EXPLAINS EVOLUTION PHENOMENON THAT PUZZLED DARWIN

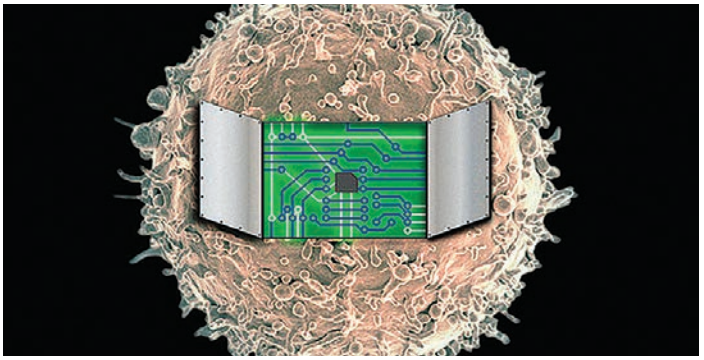
Why do some animals have extravagant, showy ornaments—think deer antlers, peacock feathers, and beetle horns—that can threaten their survival? Charles Darwin couldn't figure it out, but mathematics offers a possible explanation.

Professor Daniel Abrams developed a mathematical model that determined that species split into two subspecies as the result of the ornamentation battle that occurs over time. Because of tension between natural selection and sexual selection, male animals have either flashy, "costly" ornaments for attracting mates or subdued, "low-cost" ornaments.

‘Rewired’ Cells Show Promise for Targeted Cancer Therapy

A major challenge in truly targeted cancer therapy is cancer’s suppression of the immune system. Professor Joshua Leonard developed a general method for “rewiring” immune cells to flip this action around. When cancer is present, molecules secreted at tumor sites render many immune cells inactive. Leonard’s team of synthetic biologists genetically engineered human immune cells to sense the tumor-derived molecules in the immediate environment and to respond by becoming more active, not less.

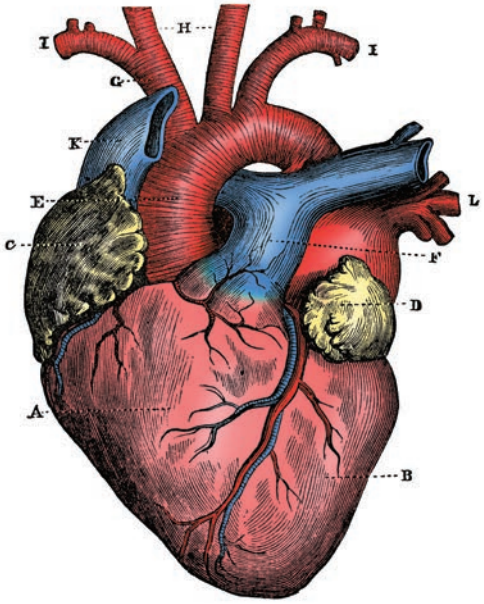
This customized function, which is not observed in nature, is clinically attractive and relevant to cancer immunotherapy. The general approach for rewiring cellular input and output functions should be useful in fighting diseases other than cancer as well.



Joshua Leonard and Kelly Schwarz

“The simple cell rewiring we’ve done ultimately could help overcome immunosuppression at the tumor site, one of the most intransigent barriers to making progress in this field.”

JOSHUA N. LEONARD ASSOCIATE PROFESSOR OF CHEMICAL AND BIOLOGICAL ENGINEERING



Nanomaterials that Deliver Precise Heart Disease Therapies

Professor Evan Scott and his collaborators demonstrated an enhanced approach to using nanomaterials to target inflammatory cells involved in atherosclerosis. The findings could lead to improved diagnosis and treatment of this hardening of arteries due to a buildup of plaque.

A chronic inflammatory condition with limited therapies, atherosclerosis is a leading cause of heart disease. As such, there’s been strong interest in developing novel nanomaterials that might directly target key immune cells associated with atherosclerosis and serve as platforms for diagnostic imaging and more precise treatment delivery.

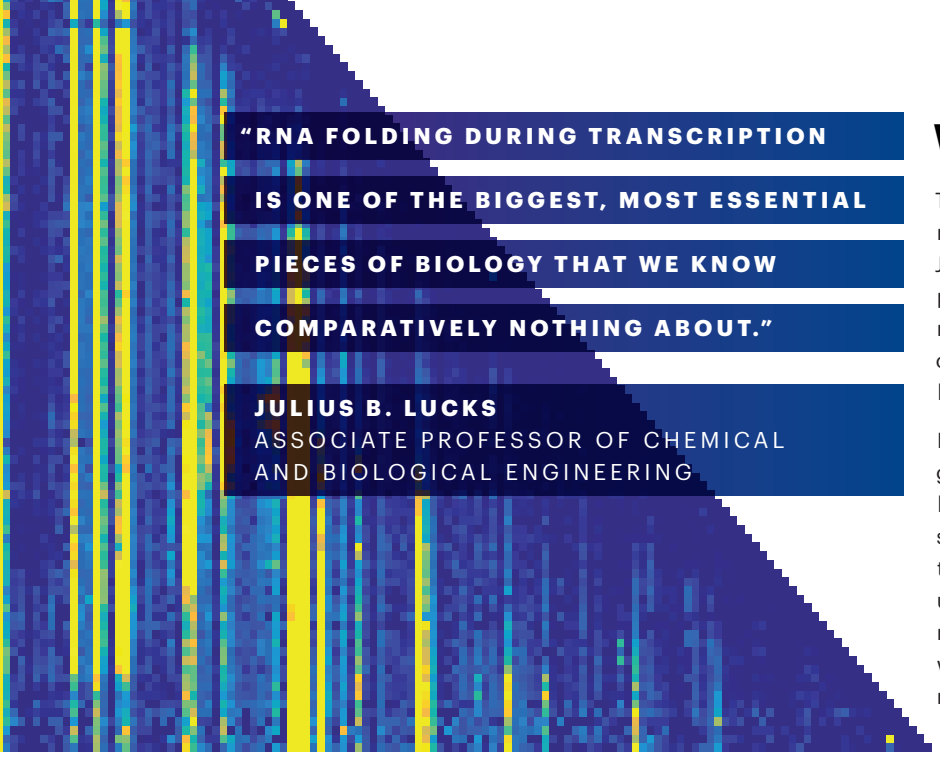
Scott and his team tweaked the nanostructure’s form, shape, and size while maintaining the same surface chemistry to target a cell population that plays a role in atherosclerosis and a variety of other pathologies. The findings have important indications for the design of future nanomaterials, underscoring the idea that a nanostructure’s form can be modified to improve targeted drug delivery.

NEW EXTENSION IMPROVES INFLIGHT WI-FI

Professor Fabián Bustamante led the development of an extension for the Google Chrome browser that dramatically improves web browsing speeds at 30,000 feet. Called ScaleUp, the extension makes everything bigger. Much like a responsive website adjusts the layout to your desktop, tablet, or phone, ScaleUp adapts content by increasing the size of images, which pushes content down the page and reduces the number of objects the browser has to handle at any one time.

NEW DESIGN STRATEGY FOR LONGER LASTING BATTERIES

In most cases, a battery slowly loses life because its cathode degrades over time. Professor Christopher Wolverton developed a new computational design strategy that can pinpoint optimal materials for coating the cathode in lithium-ion batteries, protecting it from degradation and ultimately extending the battery’s life. After scanning a database of more than 470,000 compounds, Wolverton’s team identified and ranked 30 top candidates, one of which the Dow Chemical Company tested as a coating to discover that it successfully prevented battery degradation.



"RNA FOLDING DURING TRANSCRIPTION IS ONE OF THE BIGGEST, MOST ESSENTIAL PIECES OF BIOLOGY THAT WE KNOW COMPARATIVELY NOTHING ABOUT."

JULIUS B. LUCKS
ASSOCIATE PROFESSOR OF CHEMICAL AND BIOLOGICAL ENGINEERING

Watching RNA Fold

The folding of RNA is essential to life, yet because it happens so rapidly, researchers have difficulty studying the process. Professor Julius Lucks's group has developed a technology platform that provides a super high-resolution representation of RNA folding right as it's being synthesized. Allowing researchers to view this crucial biological process could lead to future discoveries in basic biology, gene expression, RNA viruses, and disease.

Lucks's technology combines two existing components: a next-generation sequencing technique, typically used for sequencing human genomes, and a chemistry technique to turn RNA structure measurements into big data. The technique captures the RNA folding pathway in a massive dataset. Lucks then uses computational tools to mine and organize the data, which reveals points where the RNA folds and what happens afterward. From the structural information he gathers, Lucks can reconstruct a movie of the RNA folding process.

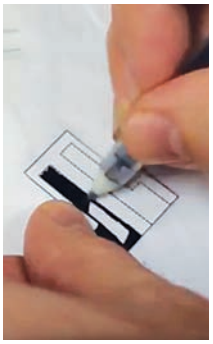
30

Width in centimeters of a small satellite on which Northwestern students will test their space ice

STUDY LOOKS AT FEMALE FACULTY STEM REPRESENTATION

Succeeding in the male-dominated science, technology, engineering, and mathematics (STEM) disciplines can be very challenging for female faculty. A Northwestern study by Professors Luís Amaral and Teresa Woodruff found that STEM female faculty are underrepresented most in molecular biology, particularly in genomics, which could indicate a negative cultural milieu in this particular subfield. Researchers hope that if they can understand why the playing field is so uneven in STEM fields, they can work to level it.

SKETCHING SENSORS WITH CONDUCTING POLYMER PEN



The development of a novel "smart ink" pen by graduate students Daniel Hickox-Young and Luke Prestowitz propelled them to the KAUST DIY Electronics Innovation Challenge, an international contest to encourage creative and inexpensive electronics. Dubbed the "PolySketch Pen," the patent-pending tool emerged from a course project in MSE 337: Introduction to Conducting Polymers, developed and taught by Professor Jiaxing Huang. The pen contains a conductive polymer ink made from polyaniline nanofibers dispersed in water, which can be used to sketch chemical and mechanical sensors.

"CREATIVITY IS IMPORTANT IN EVERYTHING, BUT IN SCIENCE, IT IS HOW YOU DISCOVER NEW THINGS. IT'S HOW YOU PUSH BOUNDARIES."

JIAXING HUANG
ASSOCIATE PROFESSOR OF MATERIALS SCIENCE AND ENGINEERING

SPOTLIGHT
on eating in dining halls

HOPE FOR FOOD-ALLERGIC STUDENTS COMING TO COLLEGE

In their transition to college, food-allergic students face challenges that reach far beyond the meals served in dining halls, according to Northwestern research. Tasked to address the issue, graduate students in the Engineering Design Innovation (EDI) program produced a website, allergyspotlight.com, and an accompanying video with recommendations for how colleges can prepare for and support food-allergic students better. Professor Elizabeth Gerber and EDI's associate director Amy O'Keefe instructed the class.

The toolkit suggests that colleges address student-life components to help ease the transition: preparing for college, orientation, joining a club or sports team, attending an event, and facilitating an emergency response.

DECIPHERING THE BEETLE EXOSKELETON WITH NANOMECHANICS

Professor Horacio Espinosa is working to understand the underlying design principles and mechanical properties that give insect and crustacean exoskeletons their unique, ideal properties. Ultimately, he could uncover information to guide the design and manufacturing of new and improved artificial materials by emulating these time-tested natural patterns.

Espinosa's team cut the fibers that comprise an exoskeleton along a plane. This resulted in a surface composed of closely packed cross-sections of fibers with different orientations, which the team could then analyze to identify their geometry and material properties.

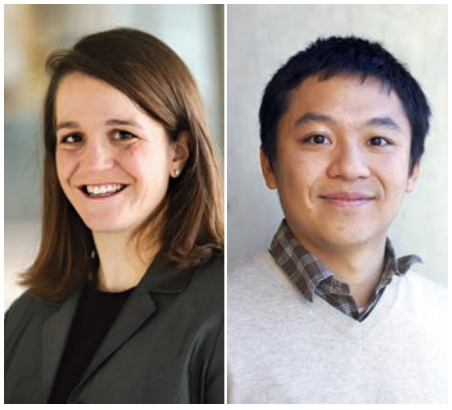
4

Members of an international synthetic biology team who will work to create an RNA-based cell

New Tool Promotes Collaboration and Productivity

Researchers have long known that collaboration and help-seeking are keys to boosting productivity and producing better work. But few tools exist to facilitate these behaviors in effective ways. To help fill this void, Professors Elizabeth Gerber and Haoqi Zhang developed a new online platform, Pair Research. Free to users at pair.meteorapp.com, the platform helps users overcome productivity blocks and build teams by simplifying the process of asking for and receiving help.

Upon visiting the online platform, a user types in a request for help and how much time is needed to accomplish the task. For example, the user might need help to proofread a paper, test computer code, or stop procrastinating. Other users respond to the request and rate their ability to help with the task on a scale of one to five. A matching algorithm then recommends the optimal pairings for collaboration, informal learning, and productivity.



"NORMALIZING THE STRUGGLE OF WORKING ALONE AND NOT ASKING FOR HELP IS DETRIMENTAL TO PRODUCTIVITY AND LEARNING. I WANT MY STUDENTS TO BE WILLING TO HELP EACH OTHER."

HAOQI ZHANG ASSISTANT PROFESSOR OF COMPUTER SCIENCE

New Material Regrows Bone

A team of researchers led by Professor Guillermo Ameer repaired a hole in a mouse's skull by regrowing "quality bone," a breakthrough that could drastically improve the care of people who suffer severe trauma to the skull or face. The interdisciplinary work shows that a potent combination of technologies could regenerate the skull bone with supporting blood vessels in just the discrete area needed without developing scar tissue—and could do it more rapidly than with previously used methods.

Injuries or defects in the skull or facial bones present significant treatment challenges, often requiring the surgeon to graft bone from the patient's pelvis, ribs, or elsewhere, a painful procedure in itself. Ameer's new approach may make painful bone grafting obsolete.

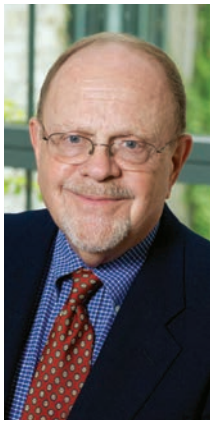
CHICAGO'S RED-LIGHT CAMERA PROGRAM SHOWS SIGNIFICANT SAFETY BENEFITS

A study by the Northwestern University Transportation Center found that Chicago's red-light cameras reduce serious injury crashes at intersections where they are placed and improve safety at intersections without cameras.

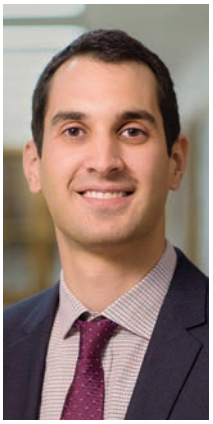
The research team, including Professors Hani Mahmassani and Joseph Schofer, presented three key recommendations for strengthening the program: review crash and other data on a routine basis, consider the "dilemma zone" (when the light is turning from yellow to red) in which law-abiding drivers can be caught, and ground the program in clear safety benefits.

Yonggang Huang

Hao F. Zhang



Joseph Schofer



Sinan Keten

Vadim Backman

Mitra Hartmann

Koray Aydin

Michael Rubenstein

Joseph Moskal

Neda Bagheri

John Rogers

Faculty Awards

Yonggang Huang Elected to National Academy of Engineering
Huang is among the 84 new members and 22 new foreign members in the NAE class of 2017 to receive this professional distinction, one of the highest accorded to an engineer.

Presidential Early Career Award for Scientists and Engineers Goes to Sinan Keten
Conferred at the White House, this prestigious award honors his discoveries on the mechanical behavior of biological materials and for establishing materials-by-design approaches.

Koray Aydin Receives Office of Naval Research Honor for Young Faculty
From one of the nation's most selective research advancement programs, the Young Investigator Award honors those who show exceptional promise for creative research.

Neda Bagheri Receives National Science Foundation CAREER Award
With support from the NSF's Faculty Early Career Development Program (CAREER) award, Bagheri will work to explain biological observations through mathematical formulations.

Vadim Backman and Hao F. Zhang Receive PNAS Cozzarelli Prize
Given to papers of scientific excellence and originality recently published in *Proceedings of the National Academy of Sciences*, the award honors the duo's report of blinking DNA.

Michael Rubenstein Receives 2017 Sloan Research Fellowship
Given by the Alfred P. Sloan Foundation to outstanding early-career scholars, the award honors Rubenstein's potential in computer science.

Bernard J. Matkowsky Receives SIAM's John von Neumann Lecture Prize
The Society for Applied and Industrial Mathematics recognized Matkowsky, one of SIAM's most prolific authors, with its highest honor for his contributions to the field.

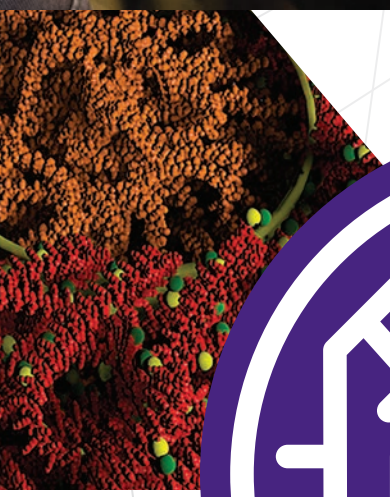
Joseph Schofer Receives S.S. Steinberg Award
Given by the American Road & Transportation Builders Association, the award honors Schofer for his contributions to transportation education.

Five Elected to American Institute for Medical and Biological Engineering Elite
Mitra Hartmann, Joseph Moskal, Ferdinando Mussa-Ivaldi, John Rogers, and Teresa Woodruff were elected to the prestigious AIMBE College of Fellows, Class of 2017.

The Minerals, Metals and Materials Society Renames Award for Weertmans
TMS recently renamed its Julia and Johannes Weertman Educator Award to honor the materials research pioneers for their dedication to educating generations of students.

THE WHOLE STORY

How whole-brain thinking revolutionized the McCormick School of Engineering philosophy, curriculum, and community



Never mind that he doesn't remember when or how the whole-brain philosophy occurred to him, or that he never experienced an aha moment or sudden flash of insight about the concept. Julio M. Ottino, dean of Northwestern Engineering, has lived and led as a whole-brain engineer for decades.

Born in Argentina, Ottino grew up with a passion for both the physical sciences and visual arts. As a long-time painter, he finds catharsis in creating new works of art. In his experimental and theoretical pursuits as a chemical engineer, he strives to discover the connection between chaos and fluid mixing. This work not only affects the fields of complex systems, fluid dynamics, microfluidics, and geophysical sciences, it has also produced swirling images with an undeniable aesthetic appeal.

"I have always had a math side and an art side," Ottino says. "I'm fascinated by the role of visualization and imagination in chaos and complexity."

He flips through a copy of a book he co-authored, *The Mathematical Foundations of Mixing* (Cambridge University Press, 2006), points to the schematics, figures (all of which he drew), and photos, which are sprinkled throughout to illustrate the chaotic flow structures of mixing fluids, and adds, "For me, math and images go together. Math can be explained in terms of pictures."

Revealing itself piece by piece, Ottino's vision for merging art and science eventually became the backbone for Whole-Brain Engineering, the McCormick School of Engineering's guiding principle for more than a decade. His non-linear approach to developing and implementing the whole-brain philosophy mirrors the philosophy itself. Whole-Brain Engineering avoids finding shortcuts to produce quick answers. Instead, it embraces taking time to frame the problem correctly, trying often and failing repeatedly, and collaborating with diverse groups of people who might debate and disagree.

That Ottino cannot recall when he coined the term "Whole-Brain Engineering" or initially outlined his vision is also fitting. "There are lots of pieces in a complicated network," he says. "It may be work for some people, but I can see the pieces of the puzzle. The final piece isn't special. It's different only because it is the last one."

PRIZE-WINNING PHILOSOPHY

Whole-brain engineers merge the analytical and technical components of engineering (left brain) with creativity, design, and divergent thinking (right brain). Since Ottino articulated it definitively in 2005, this interdisciplinary approach for developing leaders has led to new Northwestern programs and initiatives for engineers and non-engineers alike and has attracted the attention of other engineering schools and communications media worldwide.

The accolades peaked in January 2017 when the National Academy of Engineering awarded Ottino the Bernard M. Gordon Prize for Innovation in Engineering and Technology Education. Established in 2001, the Gordon Prize is the nation's highest honor for engineering education.

The Gordon Prize recognizes leaders in academia who have developed new educational approaches to engineering. In Whole-Brain Engineering, Ottino has delivered much more than a new approach; he has completely reframed and reimagined how engineering is taught and practiced.

Northwestern President Morton O. Schapiro notes, "Julio's leadership and vision have helped form a new culture of collaboration at McCormick with far-reaching effects across the University and beyond. He has made engineering central to numerous initiatives across the University's disciplines—music, journalism, social sciences, and law—and led collaborative partnerships with premier institutions."

In response to receiving the award, Ottino says, "It's an incredible honor to be recognized on behalf of the outstanding faculty and staff for the work we've done. From the beginning, we set out to reframe engineering, emphasizing that engineers should be defined by how they think, not just by the things they make."

WHY WHOLE-BRAIN ENGINEERING?

The Whole-Brain Engineering philosophy, however, encompasses more than combining different ways of thinking. Ottino views it as a tool to tackle many of life's greatest challenges, including environmental degradation, hard-to-treat diseases, the future of work, and economic disparities.

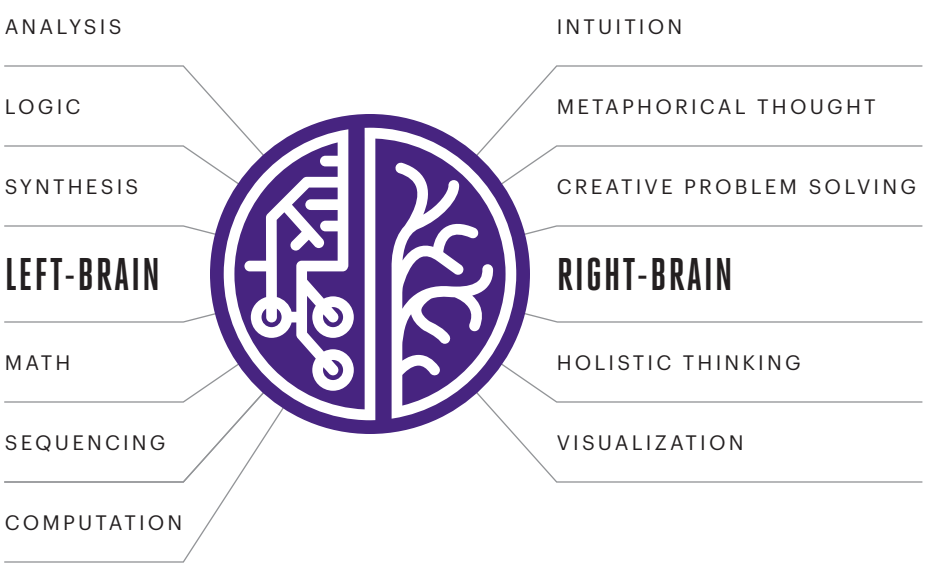
Take the Great Recession, for example. Ottino quotes an International Monetary Fund that attributes many of the world's major crises, including economic downturns and rising unemployment rates, to uniformity of thinking. "Economists couldn't predict the crises because they all said the same thing," he observes. "They operated in an echo chamber. Without different modes of thinking, they were subject to paralyzing biases. They couldn't see the problems in a complete way."

While he says that engineers are "excellent problem solvers," Ottino says not much is gained by solving correctly the wrong problem. That's where right-brain thinking comes in. Using human-centered design, for example, engineers must interact and empathize with clients to pinpoint the clients' often-unarticulated needs.

"The world is constantly changing, with new needs and challenges emerging every day," Ottino says. "We cannot continue to use old ideas to address new challenges. We want to produce students who are best suited for this new reality."

DISSECTING THE WHOLE BRAIN

WHOLE-BRAIN THINKING combines non-negotiable left-brain skills to solve problems with right-brain skills to see those problems through a new lens. Dean Ottino says that this combination of skills helps engineers imagine—and build toward—an ideal future. Here's a side-by-side look at the different right- and left-brain skills that make up whole-brain thinking.



“THE WORLD IS CONSTANTLY CHANGING, WITH NEW NEEDS AND CHALLENGES EMERGING EVERY DAY. WE CANNOT CONTINUE TO USE OLD IDEAS TO ADDRESS NEW CHALLENGES. WE WANT TO PRODUCE STUDENTS WHO ARE BEST SUITED FOR THIS NEW REALITY.”

Photograph by Chris Strong

THE WHOLE-BRAIN NETWORK

Northwestern Engineering puts its whole-brain philosophy to work not only in the classroom, but also in its research, in collaborative initiatives on and off campus, and in the world at large by educating and inspiring the leaders and entrepreneurs of tomorrow.

Our whole-brain approach to engineering encompasses five elements: analysis, leadership and personal development, collaboration, design, and entrepreneurship. Here's how we integrate those elements and set them into motion.

ANALYSIS includes math, logic, scientific reasoning, and rational thinking. It epitomizes the systematic way that engineering leaders think. This is central to engineering.

ANALYSIS

- Engineering First, with its innovative Engineering Analysis and Design Thinking and Communication courses, introduces first-year students to the fundamentals of a rigorous engineering education alongside practical applications and experiences that emphasize the power of communication.
- Engineering Analysis engages students with engineering concepts from the beginning of their first year, including linear algebra, engineering mechanics, physics, differential equations, and MATLAB programming.
- Design Thinking and Communication challenges students to work on solving real clients' problems while strengthening communication skills so others can better understand and use the results.
- Collaborative and cross-disciplinary research is most apparent in the dozens of research labs that continually produce the innovations of tomorrow. We are making strategic investments in research areas that will drive our progress in the coming years. Our award-winning faculty, including several national academy members, work across disciplines to create new knowledge while maintaining a solid grounding in the fundamentals.

LEADERSHIP AND PERSONAL DEVELOPMENT require students to ask the right questions, work as a part of a team, and inspire and mobilize others. Northwestern Engineering provides the resources and preparation that foster success, personally and professionally.

LEADERSHIP AND PERSONAL DEVELOPMENT

- The Center for Leadership helps students improve their skills in an environment that nurtures experimentation and innovation. The center's portal offers them opportunities to assess and advance their leadership and teamwork capacity through two innovative tools:

  The 360° Leadership Assessment collects insights from professors, classmates, and others to help determine a student's leadership strengths and weaknesses.

  The Teamwork Assessment, based on industry best practices and proprietary research, identifies typical teamwork problems at the individual and group levels and provides a process for solving them.
- The Office of Personal Development empowers students to take ownership of their learning and personal growth by fostering five core competencies: awareness, optimization, fidelity, resilience, and self-reliance. It offers several innovative courses that pull engineers out of their comfort zones.
- Emotional Intelligence 101 gives students skills to manage stress, express themselves, build interpersonal relationships, and make decisions.

COLLABORATION means working with partners across disciplines to tackle complex problems from multiple angles. Northwestern Engineering actively pursues formal collaborations with nearly every school at the University to enable students and faculty to explore different modes of thinking, break free from stereotypes and academic silos, and brainstorm new ideas.

DESIGN is essential for whole-brain engineers. Our view of design is broad, extending seamlessly from research and product design to systems and services design.

ENTREPRENEURSHIP is innovation brought to life. Entrepreneurship and innovation thrive everywhere at Northwestern, from centers and institutes to coursework and student groups. Northwestern Engineering strongly supports entrepreneurship by offering highly focused coursework, valuable resources, and mentorship.

COLLABORATION

- Northwestern Engineering, with an eye toward combining left-brain and right-brain thinking, has established several ongoing collaborations with artists.
- The Dean's Seminar Series has developed a popular partnership with the Mary and Leigh Block Museum of Art that features artists as guest speakers. The series recently included Jen Bervin, a multidisciplinary artist who used nanofabrication techniques to print an original poem on a silk biosensor.
- Data as Art, led by faculty at Northwestern Engineering and the School of the Art Institute of Chicago, challenges engineering and art students to work together to visualize complex data as works of art that communicate numbers in new ways.
- Northwestern Engineers often collaborate with researchers in the humanities, medicine, and law.

DESIGN

- The Segal Design Institute, a foundational part of Northwestern Engineering, educates the next generation of design thinkers and leaders. It provides a variety of immersive, interdisciplinary programs for undergraduates, graduate students, and working professionals.
- Courses such as Design Thinking and Communication help hone students' problem-solving and communication skills through practical experiences. A DTC team of four first-year students working with Chicago's Shedd Aquarium recently designed the Roll N Wash, a wheelchair-activated foot pedal that turns on the water at a hand-washing station outside the aquarium's Stingray Touch exhibit.
- PhD students at Segal work in the Design Cluster, which brings together dynamic faculty to discover, develop, teach, and practice the common principles and techniques underlying design and idea creation.
- Design for America, founded at Northwestern, is a national network of campus studios where students work in interdisciplinary teams with local community partners to design solutions that promote social good. A Northwestern DFA team recently tackled cycling safety in Evanston by designing road signs that encourage bikers to use hand signals.

ENTREPRENEURSHIP

- The Farley Center for Entrepreneurship and Innovation brings together faculty from multiple disciplines and various University schools to develop courses and student experiences across the entire innovation lifecycle, from ideation to prototyping to business plan development.
- NUvention brings the world of startups into the classroom through a suite of courses in which students design, plan, and launch their own businesses. The courses bring together students from nearly every school at Northwestern. NUvention: Medical, the first course developed nearly 10 years ago, brings together students from engineering, law, medicine, and business to develop new medical technologies.

"I love that McCormick requires us to take courses outside of engineering so we can gain a broader perspective and knowledge. In French, I have to consistently rework what I'm saying to make sure that it fits the French language structure. In engineering, I am similarly reworking designs or altering my point of view."

BOBBIE BURGESS

manufacturing and design engineering junior, minoring in French

WHOLE-BRAIN ATTRACTION

"Northwestern was my number one choice because it emphasized the whole brain. You can have all the data and technical skills in the world, but that's not worth anything unless you can communicate your ideas and apply them to the real problems. The creativity that I use in ceramics is the same creativity that allows me to brainstorm in a design session. And that same creativity helps me apply my understanding of physics to solve a math problem."

MAXWELL LEEF

mechanical engineering sophomore, ceramics artist

DTC: THE ENTRY POINT

All Northwestern Engineering first-year students know the letters DTC.

Launched in 1997, Design Thinking and Communication forms the cornerstone of the Northwestern Engineering experience. Dean Julio M. Ottino views it as the "entry point" to Whole-Brain Engineering. For students who have temporarily suppressed their creativity or focused solely on left-brain capabilities, DTC may very well be the first time they can reactivate whole-brain thinking.

Co-taught by faculty from the Cook Family Writing Program, DTC challenges students to attack potentially unsolvable problems by using design thinking to study problems from multiple perspectives, frame the problems correctly, communicate their ideas clearly, and ideate, prototype, and iterate solutions.

DTC: A STUDENT'S POINT OF VIEW

"I could never draw like the students in studio art classes, so I thought
I must not be creative," says junior Bobbie Burgess. "I thoroughly enjoyed DTC and learned most of my shop skills through the class."

During her DTC experience, Northwestern Memorial Hospital challenged Burgess and her team to solve a common communication problem. Because trips to the emergency room are sudden, unexpected, and emotional, patients rarely bring phone chargers. Their phone batteries ultimately drain, making it difficult or even impossible to contact family members.

Burgess's team attempted to solve this problem by designing a waterproof, tamper-proof, easy-to-use, portable cell phone charging station for hospital rooms. The students vacuum-molded a plastic covering over an electrical plate to make the charging station secure and added a shelf to keep the phone from dangling.

The elegant solution resulted directly from the whole-brain process: a team of students from different backgrounds collaborating on framing the problem correctly and iterating solutions with feedback from the outside client. "Diversity of thought has helped me grow," Burgess says. "Having different perspectives is always important for your overall sense of how the world works and operates."

She adds, "I do think I am creative now. I'm digging out that side of me."

"WHEN PEOPLE INTEGRATE WITH OTHERS NOT LIKE THEM, THEY CREATE POSSIBILITIES." **DEAN JULIO M. OTTINO**

THE WHOLE-BRAIN FUTURE

First, the individuals. Next, the systems and the masses.

Dean Ottino's whole-brain vision has moved well beyond the walls of Northwestern Engineering to encompass collaborations with other Northwestern schools and programs, increasing the centrality of engineering within a comprehensive university.

New courses and partnerships with local institutions, such as the Shirley Ryan AbilityLab and the School of the Art Institute of Chicago, unite students from myriad disciplines in collaborative endeavors.

Ottino believes that the next chapter lies in developing whole-brain organizations, where different types of thinkers—left-brain, right-brain, and whole-brain—converge to create more balanced, innovative, and productive hives.

"When people integrate with others not like them, they create possibilities," Ottino says. "They might look at things in new ways and see a more complete picture."

Some of Northwestern Engineering's students and graduates have launched their own whole-brain companies. Two successful start-ups from Northwestern's Design for America chapter, SwipeSense and Sproutel, combine right-brain design with data and medicine, two traditionally left-brain subjects.

When Mert Iseri ('11) and Yuri Malina ('12) met as undergraduates at Northwestern, they embodied very different schools of thought. Born in Turkey, Iseri studied industrial engineering. Malina, who was raised in France, studied physics and mathematics. Their company SwipeSense, which aims to redefine hand hygiene to reduce hospital-acquired infections, emerged from merging their different ways of thinking. Iseri, now CEO, and Malina, senior vice president, have raised more than $16 million in funding for SwipeSense.

Founded by Hannah Chung ('12) and Aaron Horowitz ('12), Sproutel makes interactive learning games for children with chronic illnesses. With Chung as chief creative officer and Horowitz as CEO, Sproutel has enjoyed significant success, having sold its signature Jerry the Bear, a platform for interactive health education, to 4 percent of the children newly diagnosed with type 1 diabetes in the United States.

Each year, Northwestern Engineering accepts new students, educates them, and sends them out into the world as whole-brain thinkers. Many take paths they never expected, following careers that they had never considered before college. Taking such a non-linear pathway can bring disappointing failures and great challenges as well as transformative experiences.

Ottino believes that setbacks, when they occur, are only a natural result of trying, which ultimately leads to significant rewards.

"If students work hard enough and really want it, then they will be successful in reaching their goals," Ottino says. "At the end of the day, only great things will come."

ACROSS THE UNIVERSITY AND BEYOND

The **WHOLE-BRAIN ENGINEERING VISION** and its integrated way of thinking are having an impact throughout Northwestern and beyond. Here are some of the ways:

Design for America, which was founded at Northwestern, now includes studios at 36 colleges and universities across the country and has spurred several successful, socially responsible startup companies.

Shirley Ryan AbilityLab: Nearly every engineering student works on a project to enhance the quality of life of a patient with a disability at the rehabilitation hospital. A DTC student team, for example, developed an adaptive fishing tool for a patient who had lost the ability to move his hands following a spinal cord injury.

NUvention, Northwestern Engineering's flagship interdisciplinary suite of courses covering the entire innovation and entrepreneurial life cycle, has grown from one track to eight tracks, ranging from arts and analytics to transportation and therapeutics.

The Segal Design Institute and the Farley Center for Entrepreneurship and Innovation attract students from across Northwestern to their events and courses.

Written by Amanda Morris

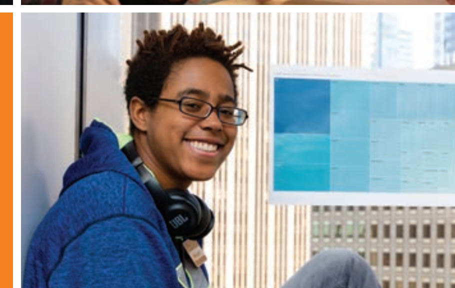
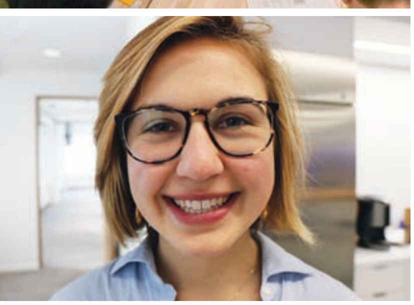







IMMERSED IN INNOVATION, ENGINEERING MEETS JOURNALISM

New Bay Area Immersion Experience sends journalists and engineers to America's startup capital for a true whole-brain experience.










Each morning, James Xie leaves his apartment on Telegraph Hill and walks through San Francisco's Chinatown headed to 44 Montgomery Street, just off of Market Street in the heart of the Financial District.

There, on the 18th floor in offices offering a 360-degree view of the city, he meets with his peers. Standing in front of hanging sticky notes arranged in the shape of a soccer goal, the group discusses the tasks of the day—meeting with startup executives perhaps, or developing a project to engage more Facebook users in political activism.

Xie isn't a Northwestern graduate working at a tech company, or even a full-time intern. He's part of the first cohort of Northwestern's new Bay Area Immersion Experience. Its goal: immerse 23 engineering and journalism students in San Francisco's unique culture at the dynamic intersection of media, journalism, and technology.

"It feels like I'm going to a job," says Xie, a Northwestern Engineering sophomore majoring in computer science. "It's a preview of adult life."

"It 100 percent does not feel like I'm in college," says Sasha Costello, a junior in the Medill School of Journalism, Media, Integrated Marketing Communications. "It's not a vacation quarter. There's a lot of work, but the work consumes your life in a good way."

Courtship of McCormick and Medill

The Immersion Experience, first offered in winter quarter 2017, is a natural extension of the ongoing collaboration between Medill and McCormick. The two schools' partnership began in 2011 with the Knight Lab, which creates technologies for media, and NUvention Web + Media, an entrepreneurship class in which students create web-based businesses.

"Abstractly, both journalism and engineering are about understanding a situation and acting on it," says Elizabeth Gerber, Charles Deering McCormick Professor of Teaching Excellence and associate professor of mechanical engineering and communication studies. "The concerns of both studies are now so intertwined. The production and distribution of information is almost always technologically mediated. It's getting more difficult to see the distinction between the two disciplines."

The San Francisco program is the new millennium's iteration of Medill's 50-year-old tradition of sending student journalists to Washington, D.C., for a quarter to immerse them in experiencing that city's distinctive culture and covering stories of international importance.

"Just as it does in D.C., what happens in the Bay Area and Silicon Valley touches every American, in fact, everyone in the world," says Owen Youngman, Medill professor and Knight Chair in Digital Media Strategy.





Rooted in the whole-brain approach

The cohort of this beta program included 11 students from McCormick, 11 from Medill, and one from the School of Education and Social Policy, chosen from dozens of applicants. In fall quarter 2016, most of the selected students took JOUR 390: Media Innovation and Chicago's Startup Scene with Youngman, meeting both at Medill and in The Garage, Northwestern's tech incubation space. That class introduced them to the tech industry's business practices and ideas, preparing them to hit the ground running once they arrived on the West Coast.

Once there, on Montgomery Street, all 23 students took the same four classes: two focused on media and two on design innovation—aiming to create a whole-brain experience for both sets of students. Each class had dedicated space, and no other sections of class moved through the space. "That brings a different feel, almost like elementary school," Costello says. "We hang up our work on the walls. It looks like it is really our room."

Gerber taught both design classes. In Communication Design, students learned to design information to elicit a desired response using data visualization and other methods. "It speaks to both groups—engineers and journalists. They learn how to make sense of a large amount of data, the fundamentals of information layout, and what pictograms are universally understood," she says.

"It's going to be the most useful class I take at Northwestern University," Xie says. "I made a poster at the beginning of this quarter. Now, I look at it and think, 'That is god-awful.' I've changed. I realize if you have a great idea and can't communicate it, it's worthless."

Encouraging activism

The Design Innovation Practicum focused on service design. One assignment looked at social media and civic engagement. Gerber charged student teams with helping people use Facebook to organize political involvement. Costello's four-person team, which included one other journalist and two engineers, created a Facebook feature called Political Pokes. A more personal interaction than group pages, the widget nudges people to go to protests, participate in marches, or sign petitions.

"We made journey maps and stakeholder maps," Costello says. "That's where my journalism background helped. We interviewed people and did research on who was affected by what we were creating. That's all stuff I knew how to do."

For the practicum in particular, the Montgomery Street location made all the difference, Xie says. "There was so much political action right there in San Francisco, with all the protests going down Market Street. We could walk two minutes in one direction, and we were in the middle of the protest where we could talk to the people involved."

Because all 23 students took all four classes, the curriculum connected in a unique way. "I could spend more time on each topic instead of repeating things to each class," Gerber says. "We could blend assignments, reinforce information, and make learning more efficient for them. For me as a teacher, that's terribly satisfying."

"Dr. Liz is probably the most incredible teacher I ever studied with. She encouraged us to think differently," says Mikowai Ashwill, a junior double majoring in music performance and industrial engineering. "Her classes broke me out of the rut of engineering. They opened my mind to be creative and think in a different way."

Pressures and pitfalls

Youngman's long-standing class, The Googlization of American Media, doubled as a technological experiment, with the former *Chicago Tribune* senior vice president splitting his time between the two campuses—with students in each place.

In adjunct lecturer Marcia Parker's class, Media Innovation in Silicon Valley, students went on field trips every other week to visit local startup companies or to attend conferences, including Startup Grind in Redwood City. There, students

"DEVELOPING INTERACTION SKILLS—HOW TO INTERACT WITH OTHERS EFFECTIVELY—IS KEY TO THIS PROGRAM. I WANT STUDENTS TO FUNDAMENTALLY BELIEVE IN THE POWER OF COMMUNITY TO TRY OUT IDEAS THAT ARE NOT PERFECTLY FORMED AND THEN GET HONEST FEEDBACK."

ELIZABETH GERBER ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING AND COMMUNICATION STUDIES

rubbed elbows with more than 5,000 attendees and heard a variety of speakers, including Elena Grewal of Airbnb; Jan Koum, CEO of WhatsApp; and Hamdi Ulukaya, chairman and CEO of Chobani.

Startup founders and executives regularly visited the classes to talk about the opportunities their work presents, as well as the pressures and pitfalls. "I learned that almost no one studied in college what they ended up doing as a career," Xie says. "I now see there is a lot of possibility for learning. Learning doesn't end after college.

"This is a super volatile environment, where companies come and go," observes Xie, who wants to return to Silicon Valley after graduation. "It will be stressful."

Tapping area Wildcats

The program tapped Bay Area Northwestern alumni as advisers on student projects. Pete Mortensen (Medill '03), a partner at Matter Ventures, for example, consulted on an assignment concerning changing media for good.

"We were connecting with alums who don't see Northwestern sweatshirts when they walk the street every day. They loved it. It was like a welcome home party," Gerber says.

The alumni provided inspiration too. Andrew Prince (Medill '08), a content strategist at Instagram, advised on the Facebook political activism project. "He talked to us about being a content strategist, and now I think it's awesome," Costello says. "It's what I want to do when I graduate."

Power of community

Class meeting times ranged from 90 minutes to four hours. Group work typically filled the rest of the day, sometimes into the evening. "In Evanston, everyone has entirely different schedules, and it is so hard to meet up," Xie says. "In San Francisco, everyone was present at every meeting."

All three students admitted the amount of collaboration and group work was intense, but each valued the experience. "Through these classes, I saw how helpful it is to work in a team with people from different backgrounds. You clearly see the same things differently, and amazing things can happen when you brainstorm together. The solutions are much more creative," Costello says.

As intimacy developed among the students, so did the confidence to offer honest, constructive criticism. "Developing interaction skills—how to interact with others effectively—is key to this program," Gerber says. "I want students to fundamentally believe in the power of community to try out ideas that are not perfectly formed and then get honest feedback."

Montgomery Street has a very different feel than the Evanston campus. "We knew it would. In a way it is less stressful, but it is also more tiring for the students," Youngman says.

Prepared for what's next

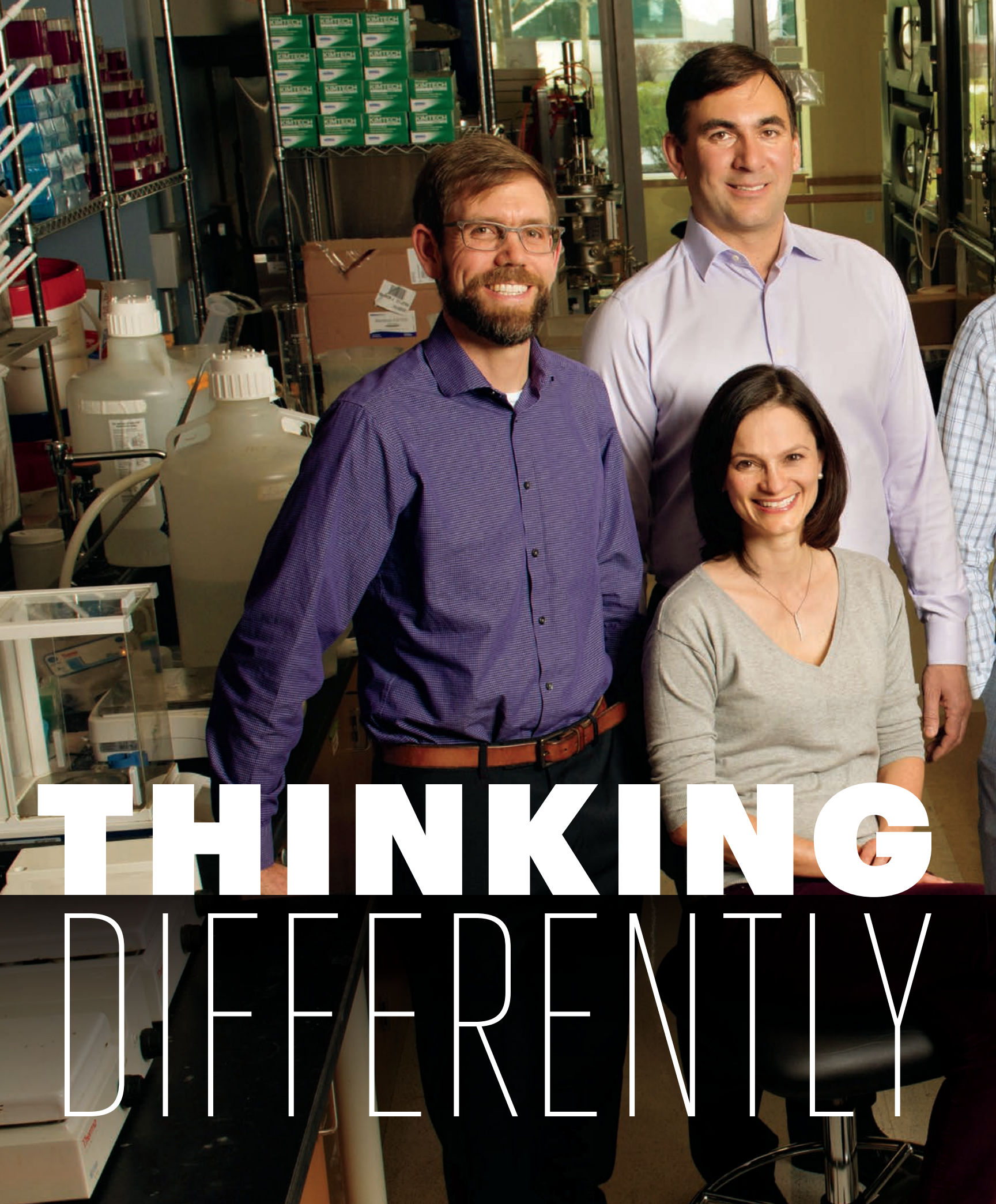
Some students decided to extend their experience to include part-time internships. Xie coded for Meedan, a software company that builds tools for journalism. Ashwill worked at Owlized, a startup specializing in virtual reality. Others took on side projects, working with their professors.

While the palm trees and temperate weather convinced several students to return to the Bay after graduation, the hope is that others will bring their expertise back to Chicago and serve as leaders in the Midwest, Youngman says. "Tech is a different but important culture in the Midwest."

With the quarter winding down and Youngman and Gerber planning for next year's cohort, the students of the beta version of the program were impressed. "I was honestly not expecting it to be so well organized," Costello says. "Dr. Liz constantly asked us for feedback about what could be better, and she tailored each class based on that."

"I grew leaps and bounds in coding experience," Xie says. "But that's not all. I have a new community. And the biggest thing is I have a new perspective. I have been able to get a much better grasp of life in general and what I want to do next."

JULIANNE HILL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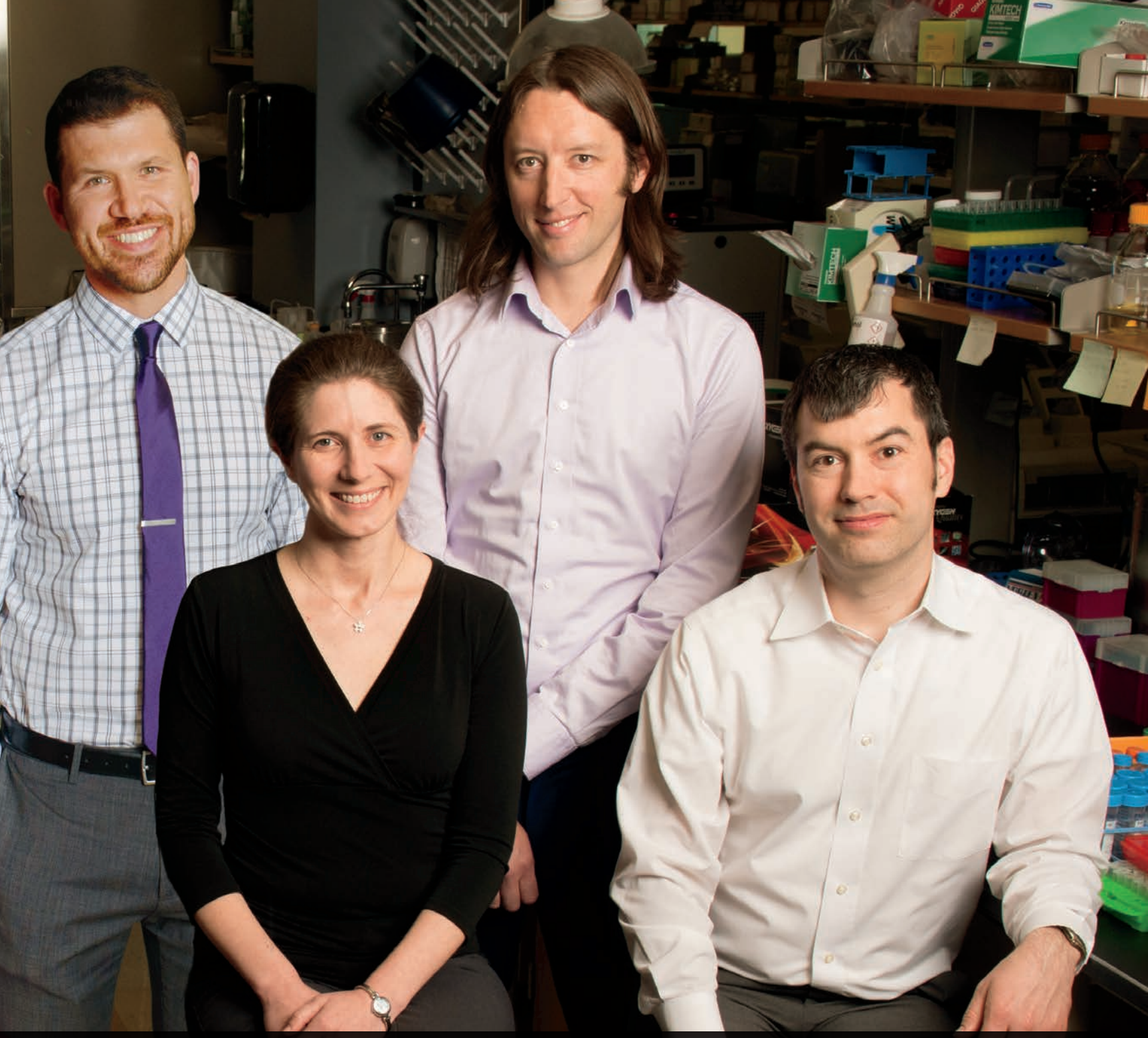


NORTHWESTERN'S CENTER FOR SYNTHETIC BIOLOGY TURNS IN A BLOCKBUSTER PERFORMANCE ITS FIRST YEAR OUT.

Photograph by Rob Hart

"'Thinking different' is what my group has been—and is—doing. I really wanted to be a part of a larger group of people who were thinking differently about other aspects of synthetic biology—a critical mass that could innovate biotechnology to solve real, pressing issues that face the planet."

JULIUS LUCKS ASSOCIATE PROFESSOR OF CHEMICAL AND BIOLOGICAL ENGINEERING

In the late 1990s, Apple aired a TV commercial featuring slow-motion, black-and-white footage of iconic personalities. As images of Albert Einstein, Martin Luther King Jr., Amelia Earhart, Mahatma Gandhi, and others flickered silently across the screen, a faceless narrator described them as the "crazy ones" who dared greatly enough to change the world.

As the commercial ended, the narrator urged viewers to "think different." Dubbed "Here's to the Crazy Ones," the ad not only inspired consumers to buy Apple products, it also encouraged them to follow the misfits and rebels by thinking differently and ultimately changing the world.

Julius Lucks sometimes reflects on this commercial and visualizes an ideal trajectory for his life and career. When Apple first released the commercial, Lucks was an undergraduate student, deep into his chemistry studies at the University of North Carolina. Today, he's a successful synthetic biologist and associate professor at Northwestern Engineering. The ad's 20-year-old message still remains at the heart of his work.

"'Thinking different' is what my group has been—and is—doing," he says. "I really wanted to be a part of a larger group of people who were thinking differently about other aspects of synthetic biology—a critical mass that could innovate biotechnology to solve real, pressing issues that face the planet."

Lucks found what he was seeking at Northwestern's McCormick School of Engineering. "Northwestern immediately came on my radar as a place that has a special combination of a 'think different' mindset and a critical mass in synthetic biology," he says.

Moving from Cornell University, he joined Northwestern in 2016, a few months after the University had launched its Center for Synthetic Biology and outlined plans to assemble a dream team of complementary faculty members to lead innovative research. As Lucks met other faculty and reviewed plans for the new center, he was reminded of the philosophy. "As I got to know more about Northwestern," Lucks says, "I realized it has a rare combination of far-reaching vision and a desire to act on that vision to make major impacts far into the future."

A BLOCKBUSTER YEAR

Pioneers in the relatively new field of synthetic biology use tools and concepts from physics, engineering, and computer science to build new biological systems. Much of their research focuses on reprogramming cells by changing the cells' DNA to take on new, specialized purposes, such as creating sustainable chemicals, next-generation materials, or targeted therapies.

The "far-reaching vision" that Lucks found so appealing is embodied in Northwestern's Center for Synthetic Biology, which creates a supportive ecosystem for research and education to thrive. Just as the University's synthetic biology team has quickly earned recognition as among the best in the world, faculty members and administration believe the Center will serve to sustain that reputation.

"This center will raise our leadership profile in the field rapidly," says Milan Mrksich, Henry Wade Rogers Professor of Biomedical Engineering, Chemistry, and Cell and Molecular Biology, and the Center's director. "It will create a community where the best faculty, students, and postdoctoral fellows find an intellectual home, partners from diverse backgrounds, technologies for conducting research at the highest level, and a vibrant program that will attract new visitors from within and outside Northwestern."

In its first year alone, the Center made significant strides toward these goals. It has inspired multiple unexpected collaborations, hosted two significant events, helped its members publish groundbreaking research, and coalesced a supportive, enthusiastic synthetic biology community. In arguably its biggest win, the Center successfully recruited Lucks and Danielle Tullman-Ercek, an associate professor in chemical and biological engineering, who joined from the University of California at Berkeley.

"When we recruited these two exceptionally talented people, it created enormous excitement," says Michael Jewett, associate professor of chemical and biological engineering and the Center's co-director. "That bodes really well for the future."

DREAM TEAM

The Center takes a distinctive approach to advancing synthetic biology's quest to discover enduring solutions for such seemingly insurmountable issues as disease, energy shortage, and pollution. Rather than assemble a group of researchers with similar or overlapping interests, Northwestern has curated a team of synthetic biologists who each lend a distinctive area of expertise.

"We've recruited an impressive group of colleagues, all at the leading edge of their own sub-disciplines," Jewett says. "The complementary nature of their work allows us to form new collaborations and learn from each other. This collaborative, inclusive, and creative culture allows us to innovate relentlessly."

Lucks, for example, studies synthetic biology as it applies to RNA, while Tullman-Ercek works to engineer proteins. Their work complements that of other members of Northwestern's high-powered synthetic biology team, which includes professors Mrksich, who has developed high-throughput methods to discover and optimize enzymes used in biosynthetic processes; Jewett, who transforms biochemical engineering with cell-free systems and synthetic biology; Neda Bagheri, who develops computational algorithms and models to understand biological functions; Joshua Leonard, who studies mammalian synthetic biology to enable design-driven medicine; and Keith Tyo, who works at the intersection of synthetic biology, metabolic engineering, and global health.

"I saw the opportunity to come to Northwestern and be the one person who does protein engineering," Tullman-Ercek says, "as opposed to joining a team where I am one of five who all do the same type of research and don't interact with others who have complementary skill sets."

GLOBAL STAGE

Within the past year, two major national events showcased some of this complementary work. The first, the Synthetic Biology: Engineering, Evolution, and Design (SEED) conference was held in Chicago and chaired by Jewett in July 2016. That was followed by the Engineering Biology Research Consortium (EBRC) retreat hosted by Northwestern in March 2017.

"Chicago was an obvious destination for SEED," Jewett says. "Our reputation for entrepreneurship is growing, and there's a lot of energy and excitement about the University's core synthetic biology group. Northwestern was chosen to host the EBRC retreat because of our new and strong presence in the field."

In addition to creating a lot of local excitement, these events gave Northwestern's synthetic biologists a highly visible opportunity to demonstrate that the "think different" approach is working. For example, at SEED, Julius Lucks received the 2016 Synthetic Biology Young Investigator Award, given annually by the American Chemical Society in recognition of a scientist's early impact on the field.

"To be recognized with this prestigious award is an inspiration for both my group and me," Lucks says. "We're more excited than ever about unlocking the potential of RNA and continuing to build the synthetic biology community."

Northwestern students also cleaned up with accolades at both events. Two graduate students from Jewett's laboratory, Erik Carlson and Ashty Karim, won awards for their posters at SEED: Carlson took the grand prize; Karim placed second. At EBRC, three students—Karim, Taylor Dolberg, and Angela Yu—received honorable mentions for their posters.

"You know that things are going well when you attract excellent students," Tullman-Ercek says. "I don't like to use the word 'amazing,' so I mean it when I say that the caliber of students here is amazing."

RESEARCH WRAP-UP

Northwestern's synthetic biologists rounded out the Center's first year by doing what they do best: research. Members of the community published several high-profile papers in high-impact journals.

Leonard's work, published in *Nature Chemical Biology*, relates to "rewiring" immune cells to sense and respond to tumor signals, an approach that could become a promising treatment for cancer. Says Leonard, "The simple cell rewiring we've done could ultimately help overcome immunosuppression at the tumor site, one of the most intransigent barriers to making progress in the field."

Lucks developed a new technology that can take a nucleotide-resolution snapshot of RNA folding during synthesis. Published in *Nature Structural & Molecular Biology*, the study lays the groundwork for future discoveries in basic biology, gene expression, RNA viruses, and disease.

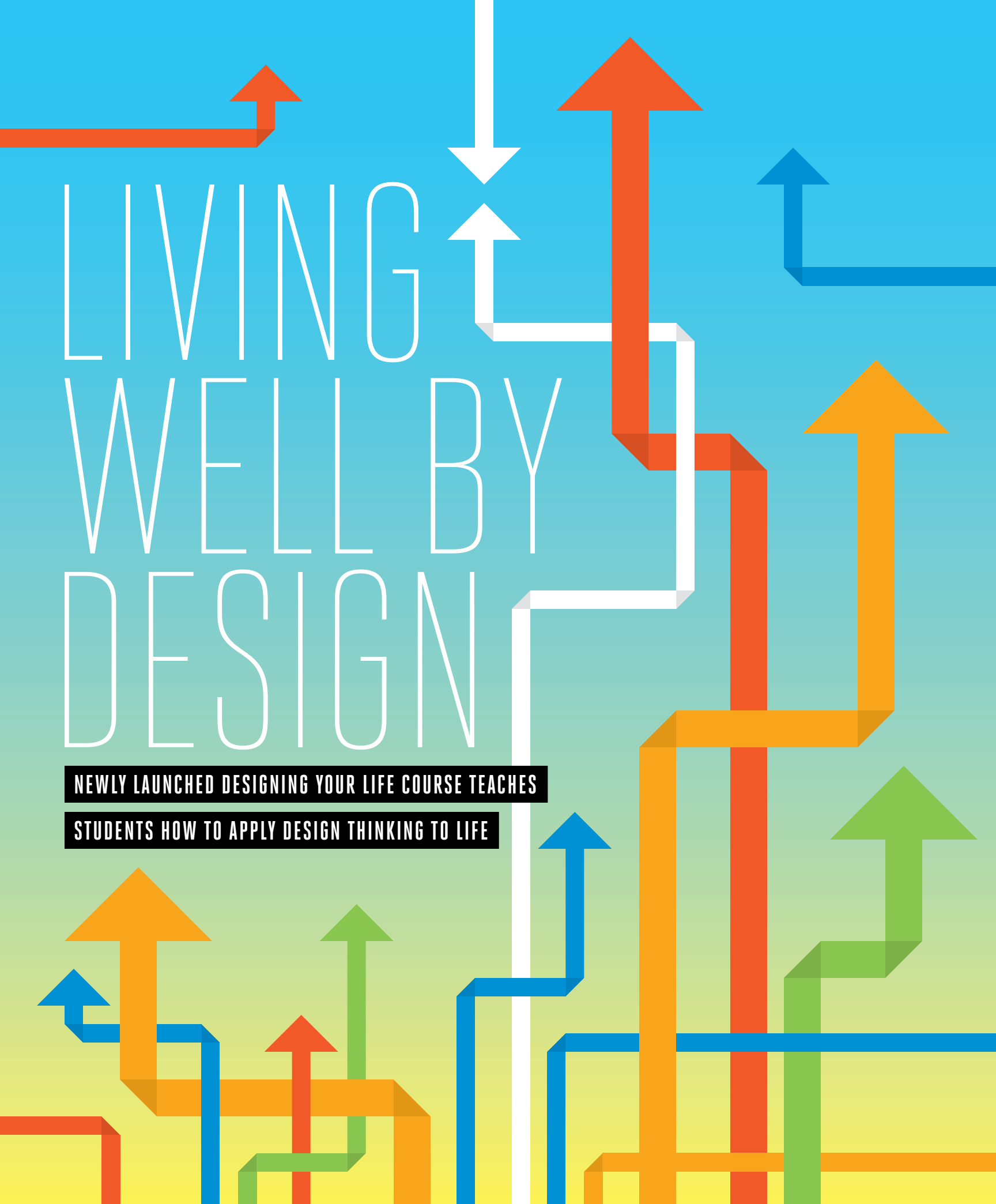
Tullman-Ercek published a paper in *ACS Synthetic Biology* about a new platform for protein production. Her team developed an inexpensive method that drives proteins in bacteria to secrete industrially or pharmaceutically relevant proteins at much higher scales without the need for purification. "For the past decade, many of the top-ten drugs on the market have been protein rather than small molecule," she says. "Our platform can lower the production cost for manufacturers, so they can now more easily make generic forms of these drugs as they come off patent protection."

On another research front, Jewett and Mrksich currently are collaborating to develop a first-of-its-kind cell-free protein expression platform that uses engineered enzymes to precisely control the placement of sugars on therapeutic proteins for use in new antibacterial vaccines. "By the year 2050, more people may die from anti-microbial resistance than from cancer today, if left unchecked," Jewett says. "That certainly has kept me up at night."

These research projects demonstrate how, by thinking differently, synthetic biologists can reshape the living world to discover new solutions for old problems. Jewett believes this type of thinking will become more mainstream in the future.

"Engineering biology is going to be the technology for the next century," Jewett says. "What better discipline to build excellence around than that?"

AMANDA MORRIS


LIVING
WELL BY
DESIGN
NEWLY LAUNCHED DESIGNING YOUR LIFE COURSE TEACHES
STUDENTS HOW TO APPLY DESIGN THINKING TO LIFE

After graduation, Northwestern Engineering senior Angela Hosbein will work at global manufacturer ITW as a product development engineer. Just because she's already accepted the job doesn't mean she knows how her life will look after June.

"I have a vision of what work will look like, which is great," says Hosbein, a mechanical engineering major. "But I'm nervous about all the stuff outside of work. How will I make friends? What activities should I be involved in? Where will I live?"

Although Northwestern students usually experience enormous pressure during their job searches, finding a job is just one piece of the puzzle. A new course offered by Segal Design Institute helps students fit the rest of the puzzle together in a way that can lead to a happy and fulfilling life. The course, Designing Your Life, gives students experience in approaching life as a series of design projects.

Hosbein was among the 27 undergraduate students who took the first offering of the elective course at Northwestern during fall quarter 2016. "A lot of students think finding a job will make them happy," she says. "But they possibly don't think beyond that."

THE STANFORD MODEL

Designing Your Life was inspired by a course of the same name offered at Stanford University. Through seminar-style discussions, role playing, writing assignments, guest speakers, and individual mentoring and coaching, that course teaches students to use design thinking to explore many of life's major challenges, such as pursuing careers they love and finding personal fulfillment.

Bill Burnett and fellow Stanford professor Dave Evans launched the course in 2008 because, as Burnett put it, "neither of us liked the advice we got in college."

"Life isn't something that you can plan or engineer," says Burnett, who is executive director of Stanford's design program. "Life is one wild and wonderful adventure. So if you're trying to invent the future, use a design methodology rather than a planning or engineering methodology."

NORTHWESTERN'S TAKE

After Dean Julio M. Ottino learned about Stanford's course, he worked with faculty at Stanford to successfully to bring it to Northwestern and use the same name. Ottino tapped Bruce Ankenman, co-director of the Segal Design Institute and professor of industrial engineering and management sciences, and Pam Daniels, Segal's design innovator in residence and clinical assistant professor, to develop a version of the course tailored to Northwestern's culture and curriculum. The Northwestern course emphasizes a more hands-on component involving fieldwork and prototyping.

"We want our students to get a good grounding in what the design process is through the class," Daniels says. "They should really feel what it means to create with intent and iterate, iterate, iterate."

"WE WANT OUR STUDENTS TO GET A GOOD GROUNDING IN WHAT THE DESIGN PROCESS IS THROUGH THE CLASS. THEY SHOULD REALLY FEEL WHAT IT MEANS TO CREATE WITH INTENT AND ITERATE, ITERATE, ITERATE."

PAM DANIELS ASSISTANT CLINICAL PROFESSOR, SEGAL DESIGN INSTITUTE

NOT FALLING BEHIND

Shortly after Northwestern launched its course, Stanford's Evans and Burnett visited to guest-lecture on the subject of "reframing," a powerful design-innovation tool that emphasizes getting the questions right long before exploring the answers.

"There's always an age in which the culture tells you that you're supposed to have it figured out," Evans told the students. "This whole notion that you're late or that something is wrong with you, all of these things are completely dysfunctional."

Reframing these assumptions gave undergraduate Evan Witort relief.

"Freshman year, I felt like everyone was smarter than me," says Witort, a junior studying industrial engineering. "Now I talk to people who admit they felt the same way, but people are afraid to have that conversation."

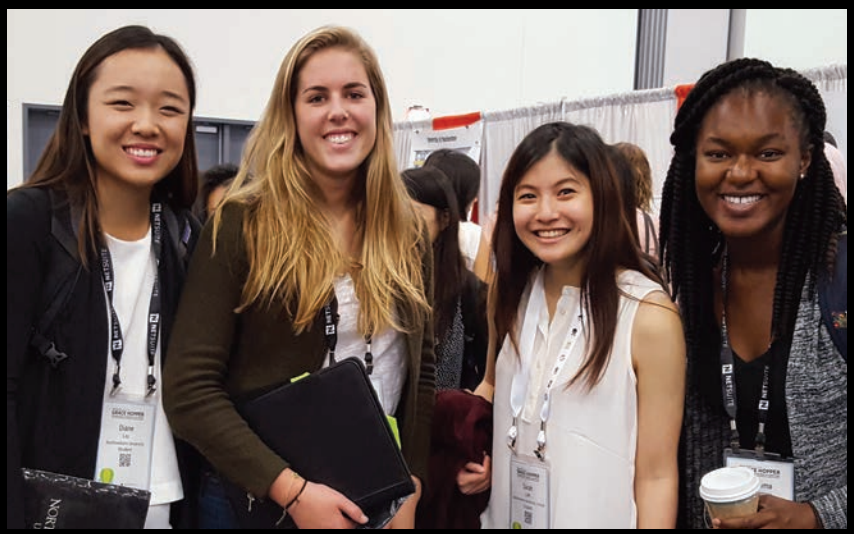
DOWN A DEEPER PATH

For several students in Designing Your Life, the class was the only place where they felt they could openly discuss these fears as well as true interests, curiosities, and different approaches to life. At the beginning of the quarter, students were organized into small groups in which they remained for the duration of the course. In addition to the class's regular meeting times, the small groups met for discussions during a lab section. This was often where the deeper, most fruitful conversations took place.

"It wasn't just small talk," Angela Hosbein says. "I formed relationships that will continue for a long time. For me, the class didn't answer all of my questions, but it taught me to at least start asking them."

According to co-instructor Ankenman, this class outcome was a success. "It's important for universities to help students develop values, develop themselves, and become good citizens of the world—not just good cogs in a machine," he says. "I feel like design is the perfect construction framework under which we can help students think about these issues."

AMANDA MORRIS



A Community Focuses on Success

NORTHWESTERN'S WOMEN IN COMPUTING CHAPTER OFFERS ACADEMIC, NETWORKING, AND CAREER SUPPORT FOR YOUNG WOMEN INTERESTED IN TECH.

Alaina Kafkes came to Northwestern in fall 2013 intent on studying chemistry and with dreams of working in medicine or science. One year later, after taking Fundamentals of Computer Programming—and with a newly kindled interest in technology—she felt less certain about her future.

"I thought only guys coded," she says. "Even though I really was enjoying tech, I didn't feel confident about my ability to code or about changing my major."

Still, her curiosity led her to a meeting of Northwestern's student-run Women in Computing (WiC). Expecting a typical half-hour college club get together, she got a surprise. "This was three hours long," she recalls, "and I was energized. I talked with the more experienced members about being a woman in computer science. I heard the same uncertainties I felt, but I also saw that good things had happened after they committed to computer science."

Inspired by that one meeting, Kafkes applied for and was chosen to sit on WiC's executive board. Soon thereafter, she changed her major. "WiC is definitely why I did it so quickly," said Kafkes, now the group's co-president.

MORE THAN A CLUB, A COMMUNITY

Northwestern's WiC chapter, launched in 2012, offers emotional, academic, and job search support for young women interested in tech. "Computer science is really hard," says Meg Grasse, WiC co-president. "It's easy to feel discouraged and not so smart. But if you belong to a community, you don't feel alone, and if you don't feel alone, you'll stay in tech."

Any woman with an interest in technology—regardless of her major—can become a WiC member. As more women enroll in and complete their computer science studies in the McCormick School of Engineering and the Weinberg College of Arts and Sciences, WiC gains prominence. At last count, the group had about 135 members on its Listserv.

"Due in part to organizations like WiC, we've seen a big change in the number of women interested in computer science in a short amount of time," says Anne Marie Piper, assistant professor of computer science in McCormick, communication studies in the School of Communication, and in Northwestern's Segal Design Institute. By all indications, the trend will continue. As of winter quarter 2017, women accounted for 126 of Northwestern's 489 computer science majors.

INDUSTRY SHIFTS

"Research shows that women tend to pursue careers that help others," says Ellen Worsdall, assistant dean for student affairs at Northwestern Engineering. "Computer science can make the world a better place—you can build platforms that truly help people. That is attracting more women to computer science."

"A lot of the women who come to me for job advice say they're thinking about computer science as a major but don't want to sit in a cubicle," says Sara Owsley Sood, clinical associate professor of computer science. "They absolutely can do more than that."

Still, women who want a career in technology must clear extra hurdles. "Stereotypes have a big impact. Historically, computer science was very male," Sood says. "It was a very geeky culture. We own that now, and women are part of it."

ROLE MODELS IN THE CLASSROOM

Many male computer science majors become interested in coding early in their lives through video games and arrive on campus with some programming experience. Conversely, faculty have observed that many female engineering majors take their first steps into computer science only after they get to college.

Still, computer science classrooms at Northwestern—and most other engineering schools—remain dominated by men. "As a woman, I might think there are no other people like me in this class, so I must not belong,'" Piper says.

Kafkes adds, "In my first computer science class, some of the guys had been programming since middle school. A lot of them start out far ahead of the women. It was intimidating for me."

As more female computer scientists teach tech, more women will be drawn to the field. "It's no coincidence that our numbers for women started going up just after Sara Sood joined the Northwestern faculty," Dean Worsdall says. Kafkes concurs. "Having a woman as my first computer science professor made all the difference in my decision to go into computer science," she says. "She is a role model."

Sood, who often teaches the intro class, says she shuts down grandstanding by the more experienced students who ask questions well beyond the scope of the course, attempting to impress her and other students. "It's not tolerated," she says. "It doesn't mean those who haven't been coding since they were 14 are any less smart. They will accomplish more, and grow more."

MENTORS IN THE COMMUNITY

Within WiC, more experienced engineering students serve as mentors to those newer to computer science, helping them combat the feeling that they don't belong. "Being in WiC, you already know a lot of these women, so when you walk into a classroom, you think, 'Ahhh. I know her,'" says Jennie Werner, a junior computer science major in the BS/MS program. "It helps line up study groups."

Junior and senior WiC members often help first-year students and sophomores with homework. "If you're stuck on a problem, you can get on a group chat for WiC and say, 'SOS! Can anyone help me?'" says Aiqi Liu, a junior computer science major.

CELEBRATION DELEGATION

To encourage women to network beyond Northwestern, McCormick sent a 55-member delegation of students and faculty to the 2016 Grace Hopper Celebration of Women in Computing, the world's largest annual gathering of women in technology. The delegation was supported by donations from Ben and Lisa Slivka and Bill and Jeanne Bliss.

The three-day October event, produced by the Anita Borg Institute, drew 15,000 women from 87 countries.

Attendees could choose from 270 sessions with more than 750 speakers, including Northwestern Engineering alumna Virginia Rometty ('79), president, chairwoman, and CEO of IBM; Megan Smith, chief technology officer of the United States; and Jeanette Epps, a NASA astronaut. "Grace Hopper really provided exposure to the whole industry," Liu says. "It showed me the kinds of roles and jobs there are in computer science—AI, machine learning, mobile apps, so many things."

The event also included a major career fair that drew some of the world's most prominent tech companies, including Google, Facebook, and Apple. More than half of Northwestern's students had two or more interviews during the conference, while a quarter scheduled interviews afterwards. Two students received job offers on the spot.

INSPIRATION ON CAMPUS

Back in Evanston, the Grace Hopper conference attendees shared their experiences with other WiC members. Liu, the group's corporate outreach chair, invited industry experts to speak at WiC on the wide-ranging opportunities in tech. For winter quarter, Liu set up a roundtable where eight professionals representing a variety of roles at Google, IMC, and Motorola Mobility met speed-dating style with members.

For a different take on coding, Liu brought in Braintree software developer Lauren Scott, who had studied poetry before going into tech. "Lauren talked about how poetry can make you better at coding," Liu says. "It was cool to see how coding relates in so many ways to the other things in the world."

WEEKLY HACK NIGHTS

To help members gain practical skills outside of the classroom, WiC co-sponsors a weekly Hack Night open to anyone with a laptop and an interest in coding, regardless of their level of experience. "WiC is not anti-male," adds WiC co-president Grasse. "We want to be inclusive, not divisive. Allies are very important. We've allowed guys to join in our events when there were open seats."

One of the weekly sessions was designated HackThisSite night, where students practiced hacking legally and safely. "We were actually investigating security vulnerabilities," Liu says. "We don't learn things like that in class." Other weeks, the group learned how to make basic apps, and Grasse, who interned at Apple in summer 2016, taught a course on basic iOS.

BEYOND NORTHWESTERN

WiC extends its efforts to encourage women to consider tech careers by going to local high schools and teaching girls how to code. "We expose them to computer science early. We serve as role models," Grasse says. "If they can gain exposure to tech early, they'll be ahead when they get to college."

Grasse and Kafkes have also launched a local event called BuildHer. "It's Chicago's first student-run, all-female hackathon," Grasse says. BuildHer brings women with various backgrounds and experience together for two purposes: to inspire those who want to get started in tech but don't know where to begin and to help those already involved in the tech community to network with other female thought leaders.

LAUNCHING PAD

With the skills and connections they make on campus, many WiC members have secured prestigious internships and promising jobs. Grasse, for example, will return to Apple for a second summer internship. Liu, an intern at Motorola Mobility in 2016, will intern at Google this summer. Kafkes, a senior, will head to San Francisco after graduation to become a software engineer at Medium, an online publishing platform.

Once in the workforce, WiC members know they will likely encounter gender-related issues. "There's whisper culture among women in tech, where we quietly let each other know where we've had a bad experience or discrimination," Kafkes says. "As more women get in the field, we want a culture shift so the industry is more inclusive, and the whisper network doesn't have to exist."

WiC members say they plan to stay connected beyond graduation, continuing to network and to help each other and future Wildcat WiC members in their careers. "The goal is for everyone to succeed," Kafkes says.

JULIANNE HILL

Photograph by Sally Ryan

STARTUP TAKES TO THE AIR

SENIOR COMPUTER SCIENCE MAJOR MARC GYONGYOSI CREDITS HIS NORTHWESTERN EXPERIENCE FOR HELPING HIS ROBOTICS STARTUP, INTELLIGENT FLYING MACHINES, GET OFF THE GROUND AND UP TO SPEED.

Marc Gyongyosi has always had a passion for things that fly. At age 15, he built a full-scale Boeing 737 flight simulator from scratch, complete with a cockpit, electronics, and software.

But it wasn't until he took Assistant Professor Brenna Argall's EECS 301: Introduction to Robotics Laboratory course as a first-year student studying computer science that he realized his love of flight and technology could become more than just a hobby.

"Professor Argall and EECS 301 opened my eyes to the world of robotics," Gyongyosi says. "I saw the possibility of combining smart software, like machine learning, with hardware, like robots, so the machines could make decisions and act on their own."

In 2014, Gyongyosi founded Intelligent Flying Machines (IFM), a data analytics startup that uses small, lightweight flying robots to perform data capture indoors. Many drones rely on GPS for navigation, which limits their uses to outdoor spaces. IFM's flying robots don't suffer from this limitation. They operate and gather data autonomously using onboard cameras, the company's proprietary computer vision algorithms, and NVIDIA graphics processing units (GPUs), high-performance computer chips that allow artificial intelligence applications like IFM's vision software to run on small and compact systems.

Accuracy, insight, efficiency

Gyongyosi believes IFM's technology has widespread application, but has chosen to tackle the warehouse inventory space first. Highly manual and slow, current warehouse inventory management approaches cost companies billions of dollars every year due to human error.

"Robotics are moving toward smaller and smarter models that work collaboratively with humans by adapting to changes in the environment," says Gyongyosi, who spent two summers building collaborative robots at the BMW Group Research and Innovation Center in Munich, Germany. He continues, "IFM embraces this collaboration trend with robots that provide safety, reliability, and accuracy to warehouse inventory processes and reduce the strain on factory workers caused by doing repetitive tasks."

IFM's robots autonomously navigate warehouse aisles, scanning large-scale inventory orders faster and more accurately than humans. Warehouse owners can easily integrate the data generated through IFM's analytics platform into their existing inventory software, revealing insights into inventory status and alerting them to possible errors.

"Our robots aren't going to replace people, but they will make processes in the warehouse more efficient," Gyongyosi says. "Nobody wants to spend time walking around searching for things the robots can locate much faster."

A home in The Garage

Before taking up residency in The Garage, Northwestern's 11,000-square-foot hub for entrepreneurship and innovation, Gyongyosi flew his prototype robots on Saturday mornings in his dorm. His neighbors in Kemper Hall were less than thrilled.

Fortunately for them, after The Garage opened in 2015, Gyongyosi found a home where he could develop his idea for Intelligent Flying Machines and transform that vision into a burgeoning startup. "The Garage has been absolutely instrumental in helping build the company," Gyongyosi says. "We have a wealth of essential resources at our disposal."

These resources include IFM's workspace, available 24/7, and access to valuable professional services like patent lawyers. "Family dinners" encourage networking with Northwestern alumni entrepreneurs who have launched successful startups of their own. The Garage's summer accelerator program, Wildfire, also allocated to IFM five interns to boost its technical and business development workforce.

Through The Garage, Gyongyosi connected with Rich Padula ('84), a veteran enterprise software entrepreneur and adjunct lecturer in Northwestern's Farley Center for Entrepreneurship and Innovation. Padula and Gyongyosi meet weekly to discuss all aspects of business development, from fundraising strategies to product management structure to marketing.

Padula, a member of the McCormick Advisory Council, believes IFM is on a path to success. "So many startups fail to execute the vision they promised. They drum up interest but don't deliver any value," he says. "IFM is at a critical juncture, and Marc's priorities are correct. He's focused on proving that Intelligent Flying Machines is viable and robust enough to hold up in industrial environments, essential to capturing that first customer."

From NUVC to TechCrunch

In June 2016, Gyongyosi presented his automated inventory solution to Chicago-area entrepreneurs and venture capitalists as part of the Northwestern University Venture Challenge (NUVC), the University's largest business plan competition. IFM finished among the contest's 11 finalists.

Three months later, Gyongyosi took to an even broader, international stage: TechCrunch Disrupt in San Francisco, one of the world's preeminent startup competitions. Gyongyosi pitched IFM's analytics platform and business plan to a panel of leading entrepreneurs, investors, and technologists, as thousands of others around the world watched via live-streaming video.

Gyongyosi believes his experience at NUVC prepared him for the attention and expectations at TechCrunch's renowned competition. "The Northwestern Venture Challenge was one of our first business plan competitions," Gyongyosi says. "It was a great opportunity to practice our pitch and assess our approach before we presented at TechCrunch Disrupt."

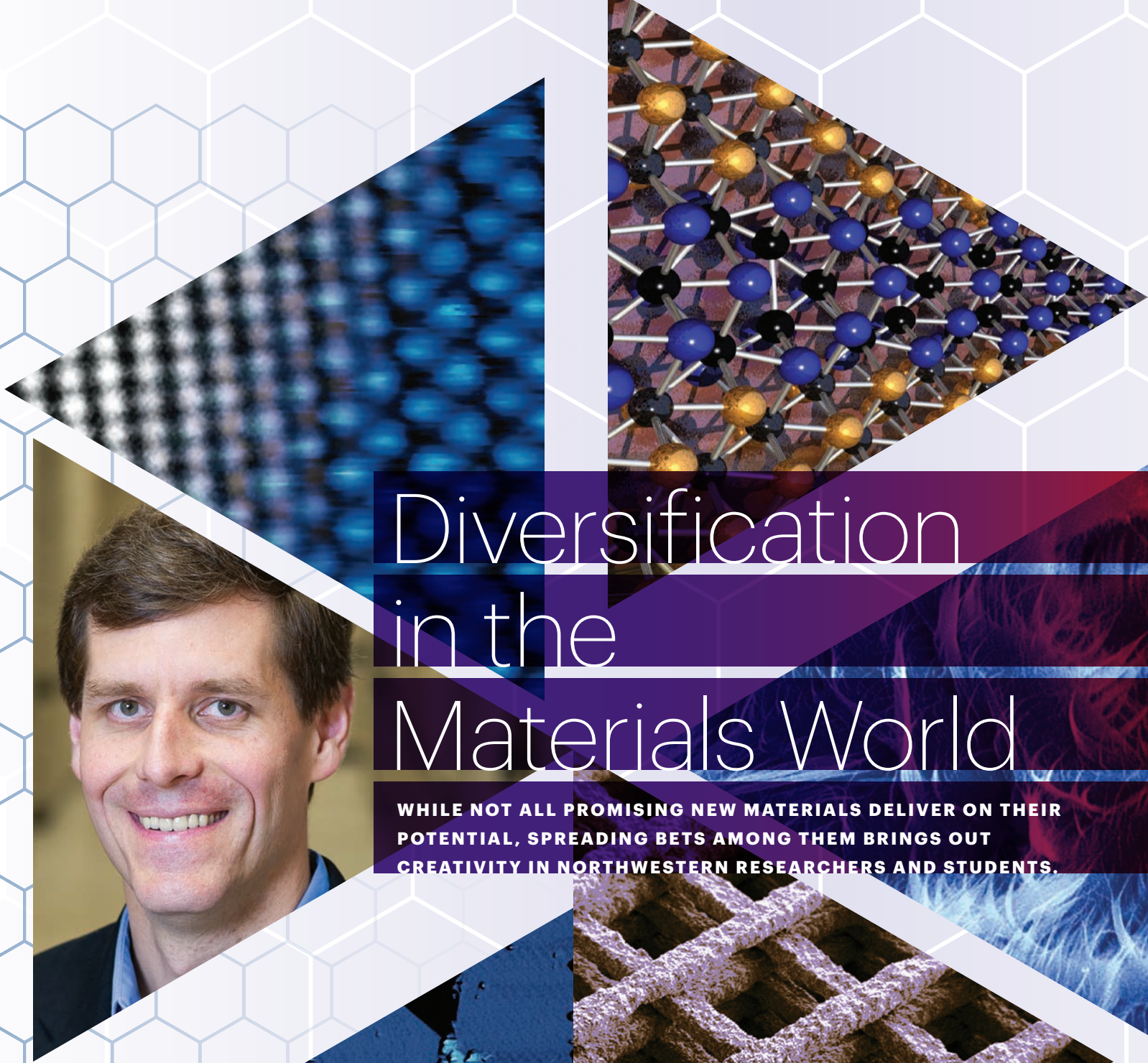
Preparing for takeoff

Gyongyosi and his IFM partners, computer science PhD students Siddarth Jain (MS '15) and Nathan Matsuda ('08, MS '15), are working toward achieving four major goals in 2017: grow the team with new hires and a permanent company space, develop 30 next-generational robots with improved functionalities, expand testing through increased corporate partnerships, and continue work on bringing the startup's first commercial product to market.

While Gyongyosi will step away from campus following his graduation in June, he believes his Northwestern experience will leave a lasting impact on the company. "The Northwestern community has greatly influenced how I think about IFM and plan to run it in the future," Gyongyosi says. "Northwestern's hands-on approach to education and its supportive professors who conduct research with students have given me four years of experience identifying problems and coming up with solutions. In the end, that is what has benefited me the most."

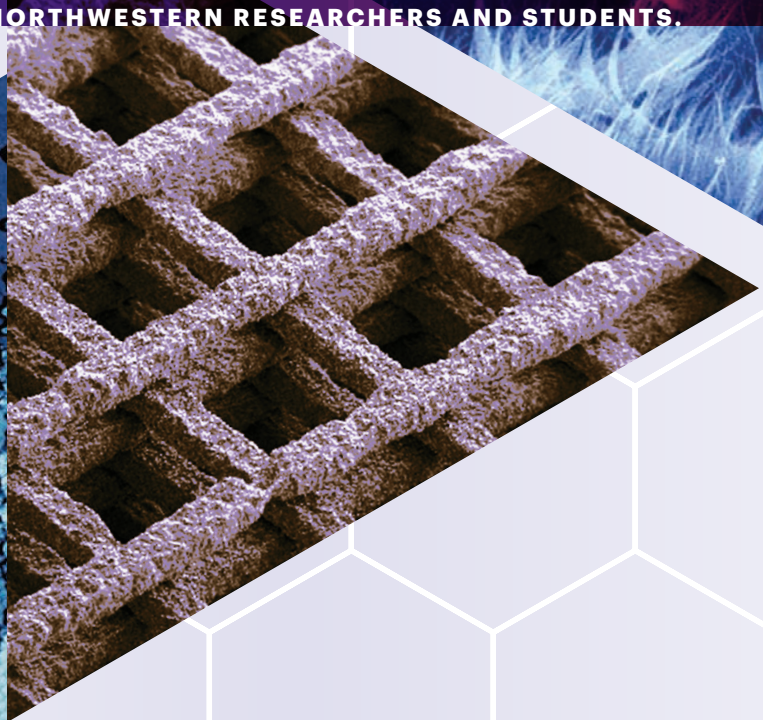
ALEX GERAGE

Photograph of Marc Gyongyosi by Michael Goss



Diversification in the Materials World

WHILE NOT ALL PROMISING NEW MATERIALS DELIVER ON THEIR POTENTIAL, SPREADING BETS AMONG THEM BRINGS OUT CREATIVITY IN NORTHWESTERN RESEARCHERS AND STUDENTS.



Early in his career, Mark Hersam immersed himself in the study of carbon nanotubes. At the time, the ultra-lightweight, high-strength, flexible material appeared to have nearly unlimited potential. Researchers imagined using carbon nanotubes to build everything from bridges to solar cells to water filters to scaffolds for regenerative medicine.

Although these applications have not yet fully delivered on their promise, Hersam is not disappointed. After all, he has many more materials up his sleeve. His already bulging portfolio, which includes graphene, boron nitride, molybdenum disulfide, phosphorene, and borophene, is still growing—and likely will never stop. He intends to keep generating new materials of his own.

"If you look around a room, you see many different types of materials that serve different purposes," says Hersam, Walter P. Murphy Professor of Materials Science and Engineering. "I don't think that any single material will solve all the world's problems. That's why I prefer to diversify."

RESISTING THE "HYPE CYCLE"

A flagship material of nanotechnology, carbon nanotubes are rolled sheets of carbon—cylinders with a diameter that measures on the nanoscale. When they came onto the scene in the 1990s, many researchers touted their exceptional mechanical, thermal, optical, and electrical properties. Then, reality set in.

Hersam refers to the initial excitement and subsequent crash in enthusiasm as the "hype cycle," a recurring phenomenon in the materials science field. "A new material comes on the scene, possibly wins a Nobel Prize, and everyone starts working on it for every application they can imagine," he says. "When it doesn't quickly live up to the hype, people abandon it."

Hersam, however, is never so quick to abandon. Instead, he identifies a material's best application and continues to push in that direction. With carbon nanotubes, for example, he acknowledged that the material was too expensive—and not substantially better than existing materials—to use in structural pursuits. But their flexibility set them apart, making them excellent candidates for use in flexible, wearable electronics.

Hersam recognized the same hype cycle with graphene. Noticing the material's superlative electrical properties, researchers predicted its use in high-performance, high-speed electronics. The problem? Existing materials had already cornered that market.

"It will always be a tough proposition for a new material to supplant an incumbent technology," Hersam says. "If we stick with graphene for another 20 years, it may actually do that. But the world we live in is one where people expect quick returns. Our attention spans are getting shorter. It's important for a material to have some near-term successes."

Hersam believes that graphene's chemically inert nature—rather than its conductivity alone—could be the key to its near-term success. Graphene can survive in highly caustic environments without corroding, which is unusual for an electrical conductor. Materials of this type are particularly important for lithium-ion batteries, where chemical inertness is key to their stability and safety.

left to right
PHOSPHORENE Mark Hersam and Xiaolong Liu
CARBON NANOTUBES Mark Hersam and Laila Jaber-Ansari
GRAPHENE Adam Jakus, Ramille Shah, and Mark Hersam
BOROPHENE Mark Hersam and Xiaolong Liu

The Search for the Next Plastic

Professor Mark Hersam believes strongly that materials can change the world. "In the twentieth century, the advent of plastics changed everything," he says. "The advent of semiconductors changed communications and electronics. We know from history that new materials have profound impact on society. We will keep striving to find the next one."

Here's a look at what Hersam is currently studying:

CARBON NANOTUBES

Potential flexible, printable electronics and wearables

Advantages low weight, high strength, flexibility

Recent advances Hersam developed encapsulation layers to protect carbon nanotubes from environmental degradation.

GRAPHENE

Potential batteries, conductive inks

Advantages conductivity, inert nature

Recent advances Hersam demonstrated a scalable graphene composite material with superlative performance for lithium-ion battery cathodes.

BOROPHENE

Potential interactive displays, electrical conductors

Advantages two-dimensional metal, theoretically predicted to be a relatively high-temperature superconductor, mechanically flexible and stretchable

Recent advances Hersam has integrated borophene with organic semiconductors, forming a near-perfect interface that is useful for electronics applications.

MOLYBDENUM DISULFIDE

Potential solar cells, light-emitting diodes, lasers

Advantages semiconducting, efficient absorption and emission of visible light

Recent advances Hersam has developed a method to isolate atomically thin sheets of the material in a scalable manner.

PHOSPHORENE

Potential biomedical imaging, communication

Advantages semiconducting, absorbs and emits infrared light

Recent advances Hersam has developed a method to exfoliate phosphorene with higher yield while keeping it stable in open air.

Northwestern spin-off SiNode Systems, a company that Hersam advises, develops silicon-graphene composites for batteries that last longer and charge faster while remaining safe. The company, which grew out of research by Harold Kung, Walter P. Murphy Professor of Chemical and Biological Engineering, has cleaned up with awards in multiple venture competitions and landed a partnership with Motorola Mobility.

TRANSPARENT POSSIBILITIES

Borophene is the most recent material to enter Hersam's growing portfolio. A team of scientists, including Hersam, first synthesized borophene—a two-dimensional sheet of boron—in late 2015. Based on theoretical predictions, this new material should be a promising transparent conductor with potential applications in interactive displays. Borophene is also expected to be flexible and stretchable, enabling integration into wearable technologies.

"Having true metallic behavior and optical transparency would be fundamentally different than common alternatives that are semiconducting," Hersam says. "It has the potential to be orders of magnitude better. Without experimental confirmation, we don't know for sure yet, but there's certainly hope."

Theoretical models also predict that borophene should be a relatively high-temperature superconductor. Today's best high-temperature superconductors are ceramics, which are often too brittle for realistic applications. The flexibility and stretchability of borophene would again differentiate it from competing materials.

But if the impressive predictions about borophene's applications never come true, Hersam will continue to explore the new material until it reveals its best application, and then he will focus his research in that area. The whole process also provides a rare and powerful learning opportunity for his students.

"I don't get disappointed when a new material doesn't work exactly as predicted because the exercise of trying is very useful training for students," Hersam says. "Working on frontier problems forces students to be extremely creative. That's what I care about most."

AMANDA MORRIS

WE WILL.

THE CAMPAIGN FOR NORTHWESTERN

NORTHWESTERN UNIVERSITY LAUNCHED THE MULTI-YEAR WE WILL CAMPAIGN IN MARCH 2014. HERE ARE SOME RECENT NOTABLE GIFTS TO NORTHWESTERN ENGINEERING'S CAMPAIGN.

Roger O. Brown and **Barbara Brown** made a $500,000 contribution to establish the Roger and Barbara Brown Computer Science Fund, an endowed fund for the transformation of computer science.

Timothy E. Burton ('72) made a $250,000 bequest provision to Northwestern Engineering.

Patrick R. McCarter ('98) and **Amy McCarter** pledged $250,000 to create the Patrick and Amy McCarter Fellow in Residence in the Department of Industrial Engineering and Management Sciences.

Jay D. Schroeder ('71, KSM '74) made a $225,000 bequest provision to Northwestern Engineering.

Paul Schneider (WCAS '96, KSM '11) has pledged $1.25 million to the Schneider Family Graduate Endowed Fellowship Fund in support of the Transportation Center.

Jeffrey W. Ubben ('87) and **Laurie Ubben** created the Ubben Program for Climate and Carbon Science, a joint effort between Northwestern Engineering and the Weinberg College of Arts and Sciences, with a gift of $5.5 million to the Institute for Sustainability and Energy at Northwestern (ISEN). This latest gift increases their total University support to $21.6 million throughout the campaign.

Arul Velan ('01) made provisions in his estate plans to support Northwestern Engineering. His estate gift was made in honor of his graduating class.

ITW gave $1.5 million to create an endowed undergraduate scholarship.

Thanks to these and thousands of other donors, Northwestern Engineering has raised more than $160 million of its $200 million campaign goal to date.

If you would like to join in making a special gift to the campaign, please contact Patrick Hankey, development director, at 847–467–2950 or patrick.hankey@northwestern.edu.

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Mr. Scott Allen Joyce '96

THE SMILE MAKER

Brooke Aldendifer MacLean ('93) delivers happiness to Chicago area healthcare facilities with Random Acts of Flowers.

"THERE'S ALWAYS A SOLUTION SOMEWHERE, SO FIND IT AND THEN MOVE ON TO THE NEXT STEP. IT'S A VERY ENGINEERING WAY OF THINKING."

As Brooke MacLean and her four children walked through a Chicago-area senior care facility with dozens of floral bouquets in tow, an older man stepped out and bellowed, "Who wants a quarter pulled from their ear?"

MacLean's then nine-year-old son, Alister, volunteered. The promised shiny quarter appeared, followed by smiles and wonder all around.

"It's a genuine and real moment you just don't forget," MacLean says.

Such heartwarming encounters have increasingly become the norm for MacLean, board chair of the Chicago branch of Random Acts of Flowers (RAF). Founded in 2008 by MacLean's brother-in-law, Larsen Jay, the Tennessee-based nonprofit delivers donated flowers to the ill and infirm.

Hospitalized following a near-fatal fall, Jay noticed that, unlike him, few of his fellow hospital patients had received flowers from well-wishers. Knowing how much such thoughtfulness meant to him, Jay responded by removing cards from bouquets he had accumulated and then delivering the floral arrangements to others.

"Random Acts of Flowers starts with something so simple, yet so beautiful," says MacLean, a former engineering consultant.

Since its January 2015 debut, RAF's Chicago branch—located just two miles southwest of Northwestern's Evanston campus—has delivered more than 55,000 bouquets to approximately 150 senior facilities, rehab centers, and hospitals across Chicagoland. (RAF also has branched out to Tampa Bay, Indianapolis, and Silicon Valley from its original headquarters in Knoxville, Tennessee.)

As the Chicago branch's nimble leader, MacLean tackles everything from mopping floors to delivering flowers to fundraising. With her two-person staff, she's responsible for overseeing some 500 volunteers, organizing deliveries, and strengthening relationships with healthcare facilities.

"Sometimes I'm the coach, and sometimes I'm the cheerleader," MacLean says. "But I'm never afraid to roll up my sleeves and do whatever it takes."

Save assembling bouquets, that is. "My background isn't artistic engineering, and I'm not allowed near the flowers," she jokes.

Put another way, MacLean serves best as the chief problem solver. Leveraging her engineering background, she uses data to drive efficiencies and preaches calm when challenges confront the blossoming nonprofit.

"Panic is never good," she says. "There's always a solution somewhere, so find it and then move on to the next step. It's a very engineering way of thinking."

And when the problems are solved, and flowers find their way into unsuspecting hands, hearty gratitude often follows. "There's a lot of loneliness, hate, and ugliness in the world, so it's meaningful to bring happiness to people," MacLean says. "When you see someone smile, you smile, too."

DANIEL P. SMITH

Sailing Is the Easy Part

AFTER A LONG CAREER AS A PRODUCT PLANNER AND EXECUTIVE IN THE AUTOMOTIVE INDUSTRY, **ERICK REICKERT** ('58) APPLIED HIS ENGINEERING SKILLS AND THINKING TO CIRCUMNAVIGATE THE GLOBE.

Cruising in the middle of the Atlantic Ocean, you're totally alone. With land a week or more away, the world consists of you, your crew, and your boat. As you plunge into the pitch-dark night beyond the range of helicopters, there's no one to help if something goes wrong.

"It's somewhat scary in the beginning, but you get used to it," says Erick Reickert. "You have to assume there's no assistance—anything medical or mechanical you're going to have to deal with on your own. You have to be totally cognizant of all of the risks and have confidence in your ability to handle them."

Reickert's confidence in his engineering skills pulled him through many tight spots as he circumnavigated the globe on Escapade, his Oyster 55 sailboat. He bought Escapade after retiring from an impressive 30-year product planning career in the automotive industry, where he served as CEO of New Venture Gear, CEO of Acustar, and CEO of Chrysler de Mexico.

Around the world

Built in 1996 to Reickert's specifications for long-term cruising, Escapade took him around the world, from Ipswich, England, where the boat was built, to Antalya, Turkey, and back again.

"My original objective was to sail both the Mediterranean and Caribbean, which meant crossing the Atlantic," he remembers. "But when you get to the Caribbean, and hurricane season approaches, you either have to go south or north to avoid it. We went north one year and the next decided to go south through the Panama Canal and kept going around the world."

With mid-ocean repairs to contend with and pirates to avoid, the entire circumnavigation took four and a half years, and the end was "absolute ecstasy." Reickert says the biggest lesson he learned is that sailing is the easy part. With government requirements for entry and exit, visa issues, customs, provisioning, timing, and weather conditions to consider, preparation is the most challenging aspect of the journey.

"One of the things I brought with me from Northwestern and my career experience is that I was a planner, and I planned nearly everything, not just the kind of boat I selected, but every step of the way," he says. That detailed, methodical approach has earned Reickert a reputation as an expert. In fact, so many people have asked him for advice on cruising that he's publishing a book titled *Sail the World*.

After 15 years of plying the seas, Reickert sold Escapade, after which the boat went through a series of owners and was renamed. When its current owner read Reickert's website detailing the ship's adventures, he restored the boat to its original name and recently took Reickert and his wife, Lady Susan Willis-Reickert, sailing through the British Virgin Islands.

Says Reickert, "I blinked my eyes and I could drift back ten years—it was amazing."

SARA LANGEN

THE ART & SCIENCE

When Joe Zadeh showed up for his interview with a Silicon Valley startup and found a loft apartment, he thought he must be in the wrong place.

Fresh from defending a dissertation for his bioengineering PhD at the California Institute of Technology in 2010, Zadeh was eager to join a startup. He'd spent a few months as a software engineer with Mint.com until it was acquired by Intuit, a large company he'd never even heard of.

Preferring to stay in an entrepreneurial environment, he began looking for opportunities with new ventures and soon heard about Airbnb, an online marketplace for accommodations. "The first thing I saw on the website was a Frank Lloyd Wright house that cost less to rent than staying at a hotel," he remembers. "That blew my mind."

Intrigued, Zadeh arrived at the company's headquarters, the founders' aforementioned loft apartment. During the interview, he saw a letter hanging on the wall and realized he was in exactly the right place. The letter was from an Airbnb host in New York who had turned to the organization to help rent out the family's house after the financial crisis of 2008.

"The letter was thanking Airbnb for saving their home," Zadeh says. "Until then, I hadn't realized how powerful an economic force Airbnb could be."

He accepted the job, becoming the organization's third engineer and ninth employee. Today, as VP of product, he leads large product management initiatives for the company. Watching the company grow from obscurity into an internationally recognized brand has been humbling. "Seven years ago no one had heard of us, and people were shocked that strangers would stay in each other's homes," he says. "Now Airbnb is becoming a verb and a household name."

BALANCING ART AND SCIENCE

Success hasn't changed the spirit of the company, which Zadeh says remains the same today as when he joined in 2010. Early on, when everyone worked together in the loft, he was given the nickname Joebot to distinguish him from founder Joe Gebbia.

"The feeling of energy and excitement we had in those days is still there," he says. "The culture of the company is even stronger today than it was back then."

With his hands-on style, Zadeh is involved in all aspects of product management across the organization, from technology to marketing to operations. "Product managers are like quarterbacks for really small cross-disciplinary pods made up of engineers, designers, data scientists, and researchers," he explains. "Each pod focuses on some important problem or feature for the platform."

"McCormick has always been great at fostering cross-disciplinary work. That's the hallmark of what I do—bringing together many different disciplines, including those that aren't technical, to create something powerful."

OF DESIGN

AIRBNB'S VP OF PRODUCT JOE ZADEH ('03) HAS USED DESIGN THINKING TO HELP TAKE THE STARTUP FROM OBSCURITY TO GLOBAL BRAND RECOGNITION.

Zadeh draws on what he learned at Northwestern as a computer science undergraduate to encourage teamwork across departments. "McCormick has always been great at fostering cross-disciplinary work," he says. "That's the hallmark of what I do—bringing together many different disciplines, including those that aren't technical, to create something powerful."

True to his ethos of "art and science," Zadeh encourages his teams first to look for inspiration in stories, the humanities, and their imaginations—things that are intangible or unmeasurable. He then urges them to use science to find solutions to problems and validate them.

"Some companies are good at just the art, others just the science," he shares. "I would love for Airbnb to be the company that really gets the two in ideal balance."

SIMPLE AND INTUITIVE

Zadeh's love of computers started when his dad brought home an IBM XT when he was eight years old and taught him how to program in BASIC. Throughout his childhood, he programmed for fun. When it came time for college, however, he chose pre-med at Northwestern.

Struggling with the memorization required, Zadeh didn't really enjoy his studies until he took Professor Larry Birnbaum's introductory computer science course. "I loved the content, the project work, and the fact that you didn't really have to memorize anything—you either understood the concepts, or you didn't," he remembers.

Zadeh soon shifted his focus to computer science. He remembers EDC: Engineering Design and Communication (now called DTC: Design Thinking and Communication) as his favorite course and the one he uses most in his day-to-day life. "It taught me the fundamentals of design and was one of the first classes that really taught how to collaborate with other disciplines," he says.

His coursework led him to a realization that computers and biology follow similar principals. Inspired by the idea of "writing programs" with biology, he chose to pursue a PhD in bioengineering. It was while building a web app for his synthetic biology research that the idea of product design captured his imagination.

"I loved making really complicated things simple and intuitive," he remembers. "Great design does that. No matter how great your technology, if people can't use it, it doesn't matter."

That love of design led Zadeh to where he is today, expanding Airbnb's products to include trips where hosts can monetize their personal passions by offering experiences to travelers. It's been an exciting journey, one that will lead him back to Northwestern. He has been invited to speak at the 2017 engineering undergraduate commencement ceremony to share the lessons he's learned along the way with the engineering leaders of the future.

"One thing I find really inspiring is McCormick's focus on Whole-Brain Engineering," he says. "I think it will lead to a generation of amazing technology leaders."

SARA LANGEN

TAKING THE INTERNET SKY HIGH

KRISTIN RICHARDSON ('09) HELPS PILOT GOGO'S EFFORT FOR SPEEDING UP INFLIGHT WI-FI PERFORMANCE.

When Kristin Richardson sees fellow airplane passengers power up their mobile devices to get an online update on the latest world news or stock market tallies, she smiles. She knows she had a hand in making that inflight convenience a reality.

As an aircraft electrical engineer at Chicago-based Gogo, Richardson has worked to retrofit aircraft with Gogo's 2Ku satellite-based, inflight Internet service. She began her career with defense contractor Northrop Grumman, moved on to Chicago's S&C Electric, and then joined Gogo in the fall of 2016. Recently, she discussed with *Northwestern Engineering* magazine her ambitious effort to bring faster Wi-Fi to the skies.

Please describe your primary responsibilities with Gogo.

Essentially, my team is responsible for making sure that the design is in shape so there are few problems upon installation. We do a lot of wiring diagram reviews and load analyses and provide engineering support during design reviews and prototype installations.

What's the scope of the 2Ku project?

Gogo started by offering air-to-ground Internet service, which was functional but slow. The difference with 2Ku service is basically the difference between a dial-up modem and today's faster Internet speeds. Right now, we've outfitted more than 100 airplanes with 2Ku, and the goal is to complete 1,400 installations by year's end.

What do you find particularly exciting about this work?

This Gogo project excites me because it touches the general population. I did interesting work at Northrop Grumman, but it was classified. Similarly, you'd probably never know of the innovation going on at S&C unless you work for a utility. But, if you're on a plane and using the Internet, it's likely you're interacting with the work we do at Gogo.

Has the project presented any unique challenges?

Learning the Federal Aviation Administration regulations and ensuring our equipment is compatible have definitely been exhausting, though understandably so. After all, we're putting a hole in an airplane and making modifications to the aircraft, something we have to do without altering performance or safety.

Another big challenge is not having an opportunity to test things in a lab and get immediate confirmation. We have to do all of our homework up front because nobody's grounding an airplane for a day or two so we can experiment.

How has your Northwestern Engineering education proven helpful?

In most cases, we don't have all the information we need up front, so we have to be flexible, creative thinkers to develop solutions. That's familiar to me. At Northwestern, I didn't just plug data into an equation. Instead, I was challenged to trust my skill set and think at the next higher level.

DANIEL P. SMITH

THE DEALMAKER

Nathan Learner ('80) brings engineering thinking to the private-equity world

"ENGINEERING IS MY TOOLBOX. WHEN I'M FACED WITH CHALLENGING QUESTIONS AND HAVE TO SYNTHESIZE THE RIGHT PATH OR BUSINESS STRATEGY, I GO BACK TO MY TRAINING AT NORTHWESTERN."

Nearly 40 years ago, Nathan Learner sat before Northwestern Engineering professor Charles Thompson, soaking in Thompson's instruction about organizational design and behavior.

Little did Learner know that Thompson, the McCormick School of Engineering's Professor Emeritus of Industrial Engineering and Management Sciences (IEMS), was providing the keys to Learner's future.

As a private-equity investor for the last two decades, Learner has leveraged Thompson's lessons and the "engineering thinking" he cultivated at Northwestern to drive his professional performance.

"Engineering is my toolbox," says Learner, an IEMS advisory board member. "When I'm faced with challenging questions and have to synthesize the right path or business strategy, I go back to my training at Northwestern."

Before moving into private equity in the late 1990s, Learner earned his MBA from the University of Chicago and honed his global business experience traveling the world for Daiwa Securities, working for Drexel Burnham Lambert, and spending more than a dozen years as an institutional trader. He directed his initial private-equity efforts toward an Arizona-based project designed to spur the adoption of natural gas vehicles. Colleagues advised Learner against the effort, calling it a losing proposition to run against the big three automakers, politics, and people's habits. For Learner, however, the altruistic opportunity proved too alluring.

"This was a new frontier and a big problem that I wanted to be a part of solving, even if natural gas vehicles weren't something people cared much about in the pre-9/11 world," he says.

Today, Learner's competitive fire—a trait he demonstrated on the baseball diamond as a left-handed pitcher for the Wildcats—continues to churn.

As the co-founder of BLCP Capital, Learner focuses on opportunistic investing, including asset-based lending on real estate, private equity, and raw land investment opportunities in high growth areas such as Phoenix, Denver, and Dallas. A small firm with big-firm capabilities, BLCP has also pursued ownership of a National Basketball Association franchise as well as large hotels and office buildings in marquee international cities.

Learner relishes the challenge of finding capital, discerning opportunities, and discovering ways to bring the two into a synergistic relationship, work often informed by lessons he gained as a Northwestern undergrad.

"Every day is a different Rubik's Cube," Learner says, "and the parameters of the discussions I have today go right back to my experiences with Professor Thompson. He set the tone for understanding organizations and how to examine an organization from several different distinct dimensions. That is so critical in private equity."

DANIEL P. SMITH

IN MEMORIAM


Bruno Boley


Thomas Goldstick


Gilbert Krulee


Wolfgang Sachtler


Edwin Rossow

Former Dean Bruno Boley

Bruno A. Boley, former dean of the McCormick School of Engineering, passed away on February 11 at age 92. He was a member of Northwestern's faculty for 16 years and served as dean for 13.

A member of the National Academy of Engineering, Boley extensively studied the mechanics of solids and structures, including thermal stresses and deformations, vibrational and dynamical behavior, and mathematical methods of analysis. He published more than 100 technical articles on these topics as well as four books. Boley was also founding editor-in-chief of *Mechanics Research Communications*, an international journal in the field of engineering mechanics.

Boley taught at The Ohio State University, Columbia University, and Cornell University before coming to Northwestern in 1972. He served as dean of Northwestern's Technological Institute until 1986 and then became a Walter P. Murphy Professor of Engineering. In 1988, he returned to Columbia University, where he remained for the rest of his career.

Noted Scholar Thomas Goldstick

Thomas K. Goldstick, emeritus professor of biomedical engineering and chemical and biological engineering, passed away on January 13 at age 82. A member of Northwestern's faculty for 32 years, Goldstick studied physiological oxygen transport in blood and tissue, specifically focusing on the arterial wall and the eye. His work with fellow Northwestern professor and former student Robert A. Linsenmeier produced a promising emulsified blood substitute that increased oxygen delivery to the eye and made national headlines in the 1990s.

Computer Science Leader Gilbert Krulee

Gilbert "Gil" Krulee, professor emeritus of electrical engineering and computer science, passed away on January 18 at age 92. Joining Northwestern in 1960, Krulee was a pioneer in the fields of computer science and artificial intelligence. He also had appointments in the Weinberg College of Arts and Sciences as a professor of linguistics and of psychology, two fields that informed his artificial intelligence work.

Krulee served as director of the University's Artificial Intelligence Laboratory and led the development of Northwestern's Department of Computer Science, which was established in 1971. As chair of the new department, Krulee was responsible for hiring the first faculty members dedicated to computer science, cementing Northwestern as an early leader in the field.

Catalysis Pioneer Wolfgang Sachtler

Wolfgang M. H. Sachtler, emeritus professor of chemical and biological engineering and chemistry, passed away on January 8. Sachtler was internationally known for his scientific and technical contributions to the field of heterogeneous catalysis, an essential technology for the production of fuels and chemicals and for pollution control. He is perhaps best known for his research into the importance of available metal surface area dimensions on catalytic function, referred to as the "ensemble size effect."

Sachtler joined Northwestern in 1983 as the third Vladimir Ipatieff Professor of Chemistry, named for the world's leading expert on catalysis in the first half of the twentieth century. He also became the first director of Northwestern's Center for Catalysis and Surface Science.

"The Students' Professor" Edwin Rossow

Edwin Rossow, professor emeritus of civil and environmental engineering, passed away on February 5 at age 80. Rossow joined the Department of Civil Engineering in 1965, where he specialized in computer methods for the analysis and design of structures. His research contributed to significant advances in structural analysis, steel design, and the behavior of reinforced concrete.

Rossow taught 19 different courses at Northwestern, which were perennially popular among students who were drawn to Rossow's enthusiasm and dedication to their success. As a lasting tribute, Rossow's students honored him by endowing the "Rossow Prize," which recognizes outstanding seniors who demonstrate high potential for professional success in the field of structural engineering.

BIG IDEA

THE EYES HAVE IT

A new study suggests that their eyes, not their limbs, first prompted our ancient aquatic ancestors to make that momentous leap—more likely a slither—from water to land. Crocodile-like animals seeing easy meals on shore eventually evolved limbs to take them there for dinner.

Professor Malcolm MacIver and collaborators studied the fossil record and discovered that fish eyes nearly tripled in size before the creatures made the water-to-land transition. The tripling coincided with a shift in location of the eyes from the sides of the head to the top.

By popping those eyes just above the water line, fish could see 70 times farther in air than in water. The massive increase in visual capability likely allowed newly limbed animals to evolve more complex cognition. Freed from the vision-limiting water, they were no longer forced to react with split-second speed to survive. Evolution, MacIver says, eventually gave humans the capacity to weigh options for the future and to choose strategically.

Northwestern | McCORMICK SCHOOL OF ENGINEERING

Robert R. McCormick School of
Engineering and Applied Science

Northwestern University

Technological Institute
2145 Sheridan Road
Evanston, Illinois 60208–3100

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GEARING UP

On April 26, students filled the Ford Motor Company Engineering Design Center's atrium to catch a glimpse of the Baja and Formula SAE teams' new models. This year's Formula car sports a redesigned intake and exhaust system for a boost in power and improved aerodynamic grip, allowing it to travel faster around curves and corners without experiencing lift. The Baja team anticipates that their dune buggy's uncharacteristic white and gold will soon be covered in dirt as it practices off-road agility tests in rough terrain. Both cars are geared up to speed past their opponents in competitions this spring and summer.

Photograph by Rob Hart