

MECHANICAL ENGINEERING

DESIGN FOR AMERICA EARNS NATIONAL DESIGN AWARD

Cooper Hewitt, Smithsonian Design Museum honors national program founded at Northwestern



Founded at Northwestern, Design for America is now a national program comprising 36 universities and more than 1,200 members.

Design for America (DFA), a national network of students, mentors, and community leaders using design thinking to tackle social challenges, has been recognized with Cooper Hewitt, Smithsonian Design Museum’s National Design Award for corporate and institutional achievement.

“This is an incredible honor recognizing the value of DFA’s innovative approach to creating societal impact,” said **Liz Gerber**, an associate professor of mechanical engineering and communication who founded DFA at Northwestern University

along with three of her undergraduate students in 2009.

The National Design Awards honor public impact and lasting achievement in American design and are bestowed in recognition of excellence, innovation, and enhancement of the quality of life. Past recipients of the award in the corporate and institutional achievement category include Apple (2000), TED (2013), and Etsy (2014).

DFA’s award will be conferred at the National Design Awards Gala at Cooper Hewitt in New York City in October.

DFA is now a national program comprising 36 universities and more than 1,200



Liz Gerber

members. Students take on more than 150 projects each year addressing topics ranging from the opioid crisis to homelessness to accessibility.

“You don’t have to be an art student or an engineer,” said

Hannah Chung (’12), a founding member of the organization and a Department of Mechanical Engineering alumna. “Participants in DFA can come from any background, and we learn human-centered design together. We learn design by doing, and we encourage students to fail and iterate because that’s how you grow.”

DFA provides a framework for innovation and positive impact, and for some students, such impact leads to entrepreneurship. DFA alumni have launched businesses including RISE Products (New York University chapter), a startup that upcycles spent grain from Brooklyn breweries, and Wellinks (Yale University chapter), a company that is now beginning clinical trials for smart wearable health devices.

“We chose the name ‘Design for America’ for two reasons,” Gerber said. “One: we wanted to design solutions to tackle social challenges across America; and two: we wanted to do so by having teams across America working in their local communities.”

Dear friends and colleagues,



Arthur Kovitz

It is with sadness that I report the passing of Professor Emeritus **Arthur Kovitz** in April. After receiving his PhD from Princeton, Art joined our department in 1958 and spent more than 40 years educating future leaders in mechanical engineering before his retirement in 2001. Art led the Department of Mechanical Engineering and Astronautical Sciences (as it was known then) as chair in the early 1970s, and he introduced several new courses during his time at Northwestern. His research interests focused on fluid mechanics and interfaces, combustion, and heat transfer in aircraft and rocket engines. We extend our

sympathy to his family and thank them for sharing Art with us for so many years.

A big congratulations to the Design for America team, led by Professor **Liz Gerber**, on the 2018 Cooper Hewitt, Smithsonian Design Museum's National Design Award for corporate and institutional achievement (page 1). This award, given previously to recipients such as Apple and TED, is one of the premier national design awards. It will be presented at a gala at the Cooper Hewitt, Smithsonian Design Museum in New York City in October. This award is major recognition of the impact of our faculty on design education, not only at Northwestern, but at a national level.

This newsletter also features some of our faculty's design research, particularly in additive manufacturing. **Cheng Sun** has developed a new process to 3D-print optical quality lenses in

record time (page 3). **Greg Wagner** and **Wing Kam Liu** received three first-place awards from the National Institute of Standards and Technology (NIST) for their multiphysics simulations of additive manufacturing processes (page 6). High-fidelity simulations of melting, deposition, and cooling, such as Wagner and Liu's, are critical for the design and control of high-precision additive manufacturing processes.

On page 4, you can read about the Robot Design Studio (RDS) two-course sequence piloted in 2018. RDS provided an advanced electro-mechanical design experience for teams of students with complementary prior expertise from different departments. Launching a new design-build-repeat course sequence with appropriate staffing is expensive, and we are grateful to ME alumna and SpaceX President and Chief Operating Officer **Gwynne Shotwell** for a gift to ME

that helped make RDS happen. Below, learn about the major ASME award about to be bestowed upon Gwynne.

In other good news, the 2018 Academic Rankings of World Universities once again rated us the #4 ME department in the US, based on research impact.

I am pleased to present this newsletter highlighting some of the achievements of our students and faculty. Thank you for taking the time to look through it, and I wish you a healthy and fruitful 2018-19.



Kevin Lynch
Department Chair

Department Welcomes New Faculty

Northwestern Engineering's Department of Mechanical Engineering welcomes **Victor Lefèvre** and **Ping Guo** as assistant professors in fall 2018.

Lefèvre studies the development of analytical and computational tools to describe, analyze, and predict the macroscopic behavior of soft solids in terms of their microscopic properties. Given their capability to undergo very large deformations in response to a wide range of external stimuli, these soft smart materials hold potential for practical uses in new technologies, especially in fields like robotics, energy, and medicine. He was previously the Hibbitt Engineering Postdoctoral Fellow at Brown University. He earned his PhD from the University of Illinois at Urbana-Champaign.



Victor Lefèvre



Ping Guo

Guo's research interests are in advanced manufacturing, precision engineering, and 3D printing, with a special interest in utilizing non-traditional physical principles to develop new and enhanced manufacturing processes and equipment. He previously worked as an assistant professor at the Chinese University of Hong Kong. He earned his PhD in mechanical engineering from Northwestern and his bachelor's degree in automotive engineering from Tsinghua University.

Shotwell to Receive Roe Medal



Alumna and SpaceX President and Chief Operating Officer **Gwynne Shotwell** will receive ASME's prestigious Ralph Coats Roe Medal, recognizing outstanding contribution toward public appreciation of the engineer's value to society, during a ceremony on November 15 at 7 p.m. at Northwestern's Allen Center.

NEW METHOD SPEEDS UP 3D PRINTING OF MILLIMETER-SIZED IMAGING LENSES

The method could impact optical imaging, vision correction, and disease diagnosis

A new method to make a low-cost, high-quality lens quickly using a 3D printer has promising potential to create optical imaging lenses, customized contact lenses for correcting distorted vision, or even to turn iPhones into microscopes for disease diagnosis.

Developed by Professor **Cheng Sun** and Northwestern Engineering researchers after two years of research, the customized optical component, which is 5 millimeters in height and 5 millimeters in diameter, can be 3D printed in about four hours.

“Up until now, we relied heavily on the time-consuming and costly process of polishing lenses,” said Sun, whose lab developed the 3D printing process. “With 3D printing, now you have the freedom to design and customize a lens quickly.”

Like all 3D printing, creating lenses involves placing layer upon layer of material. “We realized that the layers on top of each other created surface roughness. The layer thickness is typically 5 microns, while the wavelength of visible light is around 0.5 micron. This creates an optically rough surface,” Sun said. “That was the bottleneck. The roughness made the lens incapable of clear optics.”

To solve that challenge, Sun’s group developed a two-step process of layering and polishing the surface with the same photo-curable resin.

“First, we used grayscale images to create more transitions between steps,” Sun said. “Then, we coated the surface



The team’s new method uses 3D printing to make high-quality customized lenses quickly and at low-cost.

with the same photo-curable resin. That then forms the meniscus that further smooths the surface.” The result: a transparent lens with a smooth surface.

German-based company Nanoscribe previously developed a high-precision femto-second 3D printer with 150 nanometer precision, but it builds the lens in a point-by-point fashion instead of layering.

“It is a time-consuming process. That is their limitation,” Sun said. “We wanted to make something comparable but faster and with better quality.”

The process could lead to a plethora of new devices with a wide variety of applications in optics and biomedical imaging, Sun said.

Next, the group will experiment in making larger lenses as well as investigating how to integrate the 3D-printed lens with medical devices, such as an endoscope or optical microscope, in order to help detect genetic diseases.

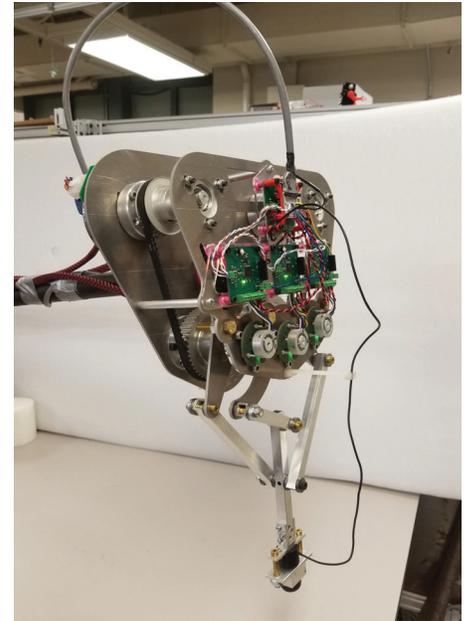


“WITH 3D PRINTING, NOW YOU HAVE THE FREEDOM TO DESIGN AND CUSTOMIZE A LENS QUICKLY.”

CHENG SUN

'ROBOT DESIGN STUDIO' CHALLENGES TEAMS TO BUILD ROBUST ROBOTS

Multidisciplinary course brought together students from four departments and programs



Left: Students discuss their project designs. Above: The hopping robot.

In June, the Department of Mechanical Engineering wrapped its inaugural Robot Design Studio (RDS), a two-quarter course co-taught by professors in mechanical engineering, robotics, and electrical engineering and computer science that tasked student teams to design and build a sophisticated robotic device.

The 21-student cohort reflected a unique balance of undergraduate and graduate experience, with backgrounds ranging from mechanical engineering, electrical engineering, software design, and fabrication. Students were split up into three multidisciplinary teams, each working on one of three course projects:

[A smart actuator to be used as a building block for creating multi-degree-of-freedom robots](#)

[A hopping robot for NASA research](#)

[A two-degree-of-freedom robotic arm for controls education](#)

In the course, students learned advanced multidisciplinary engineering topics such as motor design and control, mechanical power transmission, electronic design and layout, software design, communications protocols, project management, and manufacturing and prototyping. They also learned to work together through robot “teardowns,” in which they disassembled a HEBI smart actuator and commercial hoverboards to gain insight into how companies integrate software, electronics, and mechanical hardware to make successful electromechanical products.

Teams were also audience to a series of guest lectures from robotics experts, including alumni Josh Mehling (BS '03, MS '04), technical discipline lead – robotic controls at NASA, and Ben Stephens (BS '04), senior roboticist at Boston Dynamics well known for his work on the first back-flipping humanoid robot.

After drafting a concept design of their robot, the teams worked to make their designs a reality. Leveraging support from RDS lecturers and staff, each group’s electrical, software, and mechanical members refined and integrated their work to turn their original vision into a robust robot.

“The teams learned about the hard work it takes to create a real product, including detailed documentation and demonstration videos,” said Ron Worth, adjunct lecturer in mechanical engineering and principal and co-founder of FlashCut CNC, who led the course. “I was impressed with the teamwork and dedication each student put forth to create high quality robots.”

When Music and Engineering Meet

Student Shane Choi combines his passions to create household lamps from scrapped instruments

Shane Choi has a passion for music and a mind for engineering, something he paired together as a dual-degree mechanical engineering and trumpet performance major at Northwestern.

Now a master's student studying mechanical engineering, he unites the two in a more tangible way by converting discarded musical instruments into artistic and functional household lamps.

Choi's whole-brain effort began in 2016 when he purchased a rickety cornet online. After realizing the cornet could not be restored to playing condition, he contemplated other uses for the instrument. When he saw images of lamps

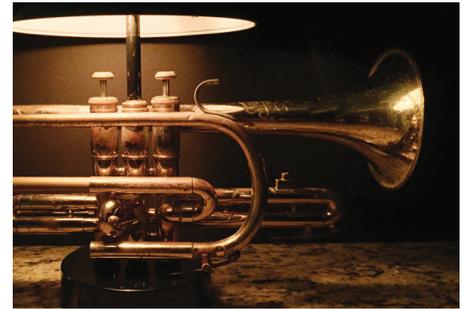
crafted from recycled goods, Choi found his inspiration.

Choi taught himself soldering and wiring basics and incorporated the trumpet valves into the design by lathing off the valve sections so that they would both compress and accommodate wiring. He then routed a power switch into the lamp wires before press fitting the wired button into the valve casing.

After sharing a photo of the finished lamp on Instagram, a number of people asked if they could purchase it.

"I never intended to sell this," Choi said. "The response was unexpected and overwhelming."

To date, Choi has created and sold about



Choi has built a dozen lamps using scrapped musical instruments.

a dozen lamps. He's dedicated profits from sales to local music teachers so they could purchase instruments for students and provide lessons. He also earmarked proceeds directly to individual students to fund music camps or projects.

"I've fallen in love with this project because it's allowed me to see how music and engineering can be intertwined," he said. "It's been the best justification for me to keep these parallel tracks going."

Sinan Keten Receives Young Investigator Medal

Keten was honored for his contributions to molecular modeling



Sinan Keten

Professor **Sinan Keten** has received the Young Investigator Medal from the Society of Engineering Science (SES).

The prize is awarded to one or two early career researchers each year who have already made an impact on their fields. The Society cited Keten for "his outstanding contributions to the molecular modeling of the mechanical properties of polymer thin films, nanocomposites, biological, and bioinspired materials."

Keten joins Professors Yonggang Huang and Horacio Espinosa, who received the Young Investigator Medal in 2006 and 2007, respectively.

"I am extremely honored to receive the SES Young Investigator Medal," said Keten, associate professor of mechanical engineering and civil and environmental engineering. "SES is a vibrant society that promotes activities at the interface of basic sciences and engineering and is essentially

a natural 'home' for mechanics and materials researchers."

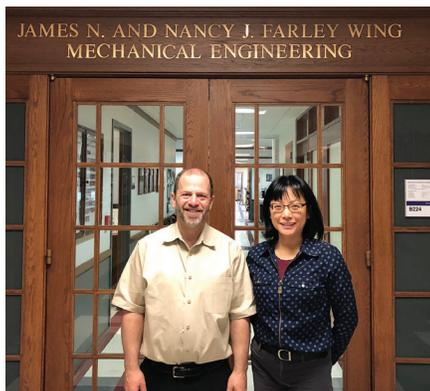
Keten works on computational materials science and mechanics with an emphasis on polymer nanocomposites and biomolecular materials. He has established theoretical models and multiscale simulation techniques to study the physics of soft materials more efficiently and accurately. His research group has made key discoveries in the mechanical behavior of biological materials and fundamental contributions to establishing materials-by-design approaches to bioinspired systems.

A member of Northwestern's faculty since 2010, Keten has received several awards, including the Presidential Early Career Award for Scientists and Engineers and the 2015 Young Investigator Award from the Office of Naval Research. In 2017, he was selected to participate in the National Academy of Engineering's 23rd annual US Frontiers of Engineering symposium.

KETEN HAS MADE KEY DISCOVERIES IN THE MECHANICAL BEHAVIOR OF BIOLOGICAL MATERIALS.

Cao and Peshkin Receive Blackall Award

Award given by American Society of Mechanical Engineers



Michael Peshkin and Jian Cao

Professors **Jian Cao** and **Michael Peshkin** received the 2018 Blackall Machine Tool and Gage Award from the American Society of Mechanical Engineers (ASME).

The award is given to the best original paper which demonstrates technologies that have led to major contributions toward new manufacturing processes and systems. Cao and Peshkin were recognized for their 2016 paper, “Pressure and Draw-In Maps for Stamping Process Monitoring,” published in ASME’s *Journal of Manufacturing Science and Engineering*.

Cao and Peshkin share the award with co-authors Sripati Sah, Robert X. Gao, and Numpon Mahayotsanun (BS/MS ’05, PhD ’10) — a former student of Cao’s and professor at Khon Kaen University in Thailand. The team accepted the award at the ASME 2018 International Conference on Manufacturing Science and Engineering.

Cao is one of only two people to earn the Blackall Award twice. She previously received it for her 2012 paper, “An Investigation on Deformation-Based Micro Surface Texturing.”

Jan Achenbach received an honorary professorship from Xiamen University, China.

Wei Chen received Northwestern’s Ver Steeg Award for faculty in honor of her significant contributions toward working with students in The Graduate School.

Isaac Daniel was elected a member of the Academy of Athens, the most prestigious academic recognition in Greece.

Kornel Ehmman received SME’s 2018 Society of Manufacturing Engineers Education Award, honoring the educator most respected for the development of manufacturing-related curricula. He also received the 2018 Hideo Hanafusa Outstanding Investigator Award as a leading contributor to the field of manufacturing automation.

Liz Gerber delivered a keynote talk at the annual Computer Human Interaction Workshops.

Yonggang Huang was elected foreign member of Academia Europaea, as well as foreign member of the Chinese Academy of Sciences for his significant achievements and contributions to promoting the development of science and technology in China.

Sinan Keten received the 2017 Journal of the Mechanical Behavior of Biomedical Materials Early Career Researcher Award.

Kevin Lynch launched the Coursera online course specialization Modern Robotics, consisting of six individual courses. It currently has thousands of active learners worldwide. More information: modernrobotics.org.

NIST AM-Bench Awards



Greg Wagner

A team of Northwestern postdoc students led by Professors **Greg Wagner** and **Wing Kam Liu** earned three first place awards at the National Institute of Standards and Technology’s Additive Manufacturing Benchmark Test Series (AM-Bench) in June. AM-Bench challenged teams from academia, industry, and national labs to develop manufacturing models for metals and polymers that could be tested against highly controlled additive manufacturing benchmark data. The team earned top marks for best predicting the cooling rate, grain structure, and dendritic microstructure within three single laser tracks on a bare IN625 alloy plate.

Department Leadership at Top Journals

Jian Cao was appointed editor-in-chief of the *Journal of Materials Processing Technology*. She is also a founding technical editor of ASME’s *Journal of Micro and Nano-Manufacturing*.

Wei Chen was named editor of ASME’s *Journal of Mechanical Design*.

Kornel Ehmman is serving as editor-in-chief of *Manufacturing Letters*.

Yonggang Huang is serving as editor-in-chief of *Journal of Applied Mechanics* and *Theoretical and Applied Mechanics Letters*.

Kevin Lynch is serving as editor-in-chief of the *IEEE Transactions on Robotics*. He also served as editor-in-chief of the Conference Editorial Board of the 2018 IEEE International Conference on Robotics and Automation.

Formula Team Takes on Two Races



Northwestern's Formula team unveiled their 2017-18 car in April.

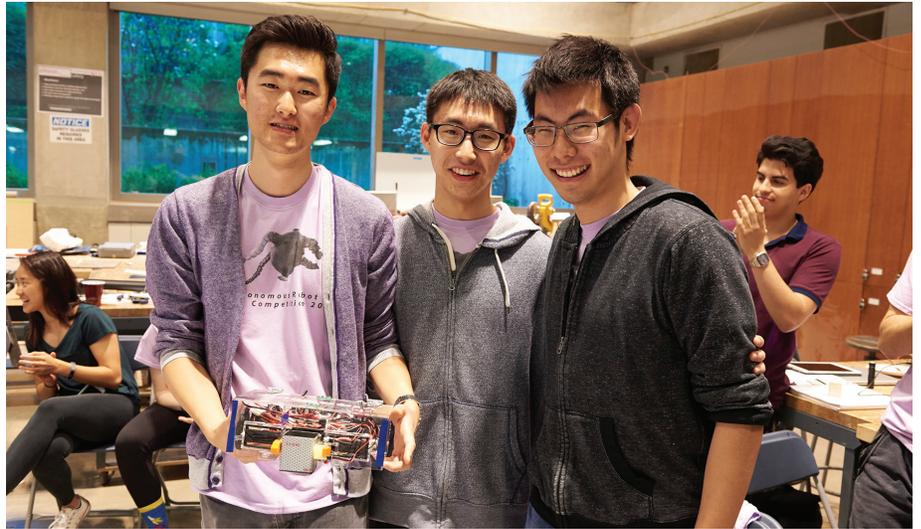
With a redesigned car, Northwestern's Formula SAE (Society of Automotive Engineers) team competed at Formula SAE Michigan in May and again at Formula SAE Lincoln in June.

Formula SAE's 2017-18 executive committee included several mechanical engineering students, including chief engineer **Russell Ohnemus**, suspension lead **Weston Kulman**, chassis lead **Ellen Zhao**, and powertrain leads **Jiahao Guo** and **Jason Fishman**. Sophomore **Chelsea Ye** will join the team's 2018-19 executive committee as the suspension lead.

Seniors Take Part in Send-off Celebration

The Department of Mechanical Engineering held its 2018 Senior Send-off Celebration in May at the Firehouse Grill in Evanston. Organized by the Advisory Council of Mechanical Engineering students (ACME), the event brought together students, faculty, and Chair **Kevin Lynch** for an evening of food and games in commemoration of this year's senior class.

2018 Design Competition



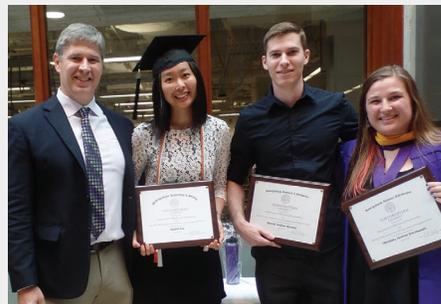
Winning team (left to right): Simon Zhao, Eric Hao, and Sean Ye

A student-designed, autonomous robot named "VeggieButt" took down the competition to win first place in "Find that Block!", the theme of Northwestern's 27th annual Design Competition in May.

The robots earned points by collecting randomly scattered cubes and cylinders in an arena.

Members of the winning team included mechanical engineering seniors **Sean Ye** and **Simon Zhao**, and computer science student **Eric Hao**.

Department Awards Celebrate Graduates



From left: Department Chair Kevin Lynch, Suwei Liu, Daniel Brewer, and Christina Dornbusch

Daniel Brewer, who will join Apple as a human interface devices engineer, received the Undergraduate Research and Innovation Award.

Puikai Cheng received the Graduate Leadership and Service Award, which recognizes service to fellow mechanical engineering graduate students and the department.

Christina Dornbusch, who will work for Merit SI on solar and energy storage projects, received the Undergraduate Academic Achievement Award, given to the graduating senior with the highest GPA.

Suwei Liu, who will continue her PhD working with Professor Sinan Ketten, earned the Undergraduate Leadership and Service Award.

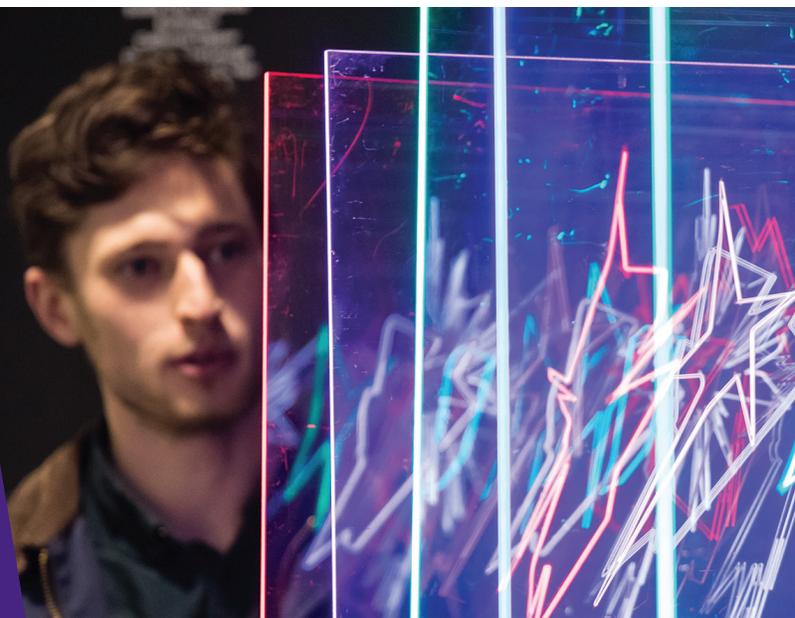
Hongyi Xiao received the Ted Belytschko Outstanding Research Award, honoring a graduating PhD student.

‘Data as Art’ Explores Live Music in Chicago

How might a fleeting musical performance create a sense of place for residents in a large city?

Students from Northwestern Engineering and the School of the Art Institute of Chicago (SAIC) created a soundscape to illustrate one possible answer. Called Sound Lines, the artistic installation depicts live music performances across Chicago. Visitors to the exhibit in the Ford Motor Company Engineering Design Center in February could interact with the installation by flipping switches to illuminate panels representing musical genres and the neighborhoods where music was performed.

The installation was one of five projects that were part of Data as Art, a course co-taught by Professor **Malcolm MacIver** and jointly led by faculty from Northwestern Engineering and SAIC. During the course, students from both schools formed interdisciplinary teams, conducted research using data sets, and then represented that data through visual art. Supported by the Barry and Mary Ann MacLean Fund for Arts and Engineering, the course provides new opportunities for art and engineering students to enhance the way they see, perceive, and interact with the world.



Giving to Mechanical Engineering

Gifts to ME are used to fund research and innovative undergraduate experiences, such as Data as Art. To give to ME, please visit the WE WILL campaign homepage at wewill.northwestern.edu and direct your gift to ME using “Search additional gift designations.”