McCormick

Northwestern Engineering

Mechanical Engineering

Robert R. McCormick School of Engineering and Applied Science
Northwestern University

FALL 2014

Letter from the Chair

Kevin Lynch

Dear friends and colleagues,
As we begin the 2014-15 school year, I am pleased to share with you some of the exciting things happening in mechanical engineering at Northwestern.

As I was writing this letter, however, I learned of the passing of our longtime friend, colleague, and former department chair, Ted Belytschko. Ted was a titan in the field of computational mechanics and one of the brightest lights in our department. His accomplishments are too numerous to list here, but they include membership in the National Academies of Engineering and Science and the naming of the Belytschko Medal by the US Association for Computational Mechanics. More importantly, Ted was a great friend, and he will be fondly remembered for his sense of humor. Ted's life was celebrated at a beautiful funeral service attended by his many students and colleagues. Our condolences go to his wife Gail and his children Peter, Nicole, and Justine, and their families.

Fall 2014 marks the kickoff of our new Master of Science in Robotics (MSR) program, a collaboration with the departments of biomedical engineering, electrical engineering and computer science, and the Rehabilitation Institute of Chicago. Fifteen new MSR students began their Northwestern robotics experience in a unique way, attending and helping with the organization of ROSCon (Sept. 12-13), a robotics software developer's conference co-organized by MSR assistant director Jarvis Schultz, and IROS 2014 (Sept. 14-18), a robotics conference of 1700 attendees and 46 sponsors and exhibitors chaired by me. Both events took place at the Palmer House Hilton in Chicago.

The 2013-14 school year started off in a great way for our department, with Neelesh Patankar and Todd Murphey winning the 2012-13 Engineering Teacher and Adviser of the Year Awards, respectively. This was a rare occasion of the same department to win both major awards. Neelesh and Todd's excellent work with our students was again recognized by the Charles Deering McCormick Professorships of Teaching Excellence in May 2014. These teaching professorships are awarded to only four faculty members across the entire university each year. Neelesh and Todd's awards continue the recognition of outstanding teaching in mechanical engineering, which has one of the highest numbers of McCormick professorships awarded to any single department in the University. Other previous winners from mechanical engineering include Rich Lueptow, Ed Colgate, Michael Peshkin, and myself.

Teaching innovation continues in our department. Several courses have adopted the Lightboard technology developed by Michael Peshkin for video production (http://lightboard.info), either for flipped classrooms or for supplementary material. Our first Coursera MOOCs, on system modeling by Todd Murphey and on life cycle analysis by Eric Masanet, were used locally in Northwestern classrooms and were well received by thousands around the world. Undergraduates in Jane Wang's ME 346 Introduction to Tribology published the book *Remarkable Natural Material Surfaces and Their Engineering Potential* with Springer, based on their final class projects. Malcolm MacIver is co-teaching the new course "Artists and Engineers Collaborate," where teams of art and engineering students collaborate to design creative solutions to problems in their immediate environments. Liz Gerber received the IEEE Computer Society Computer Science and Engineering Undergraduate Teaching Award, in part for her creation and leadership of Design for America, a network of more than 20 student-led interdisciplinary design studios at universities across the country.

> "Ted Belytschko was a titan in the field of computational mechanics and one of the brightest lights in our department."
> *Kevin Lynch*

I am pleased to welcome our newest faculty member, Greg Wagner. Greg's expertise is in multiscale computational methods and thermo-mechanical modeling of complex engineered systems. Greg will join us as an associate professor from Sandia National Labs on January 1, 2015. His expertise complements our strengths in computational mechanics and our strategic investments in high-performance computing and multiscale simulation.

In our most recent strategic plan, we identified five thrust areas for the department: design, biosystems and health, energy and sustainability, nano- and micro-science, and multiscale simulation. In the pages of this newsletter, you will see some of our faculty's recent efforts in some of these areas, including the new Digital Manufacturing and Design Innovation Institute, flexible devices for wireless health monitoring, energetics of propulsion, nanoscale jets, and molecular simulations of flow.

Please enjoy the newsletter, and my best wishes for a healthy and fruitful 2014-15.

Kevin Lynch
Chair, Department of Mechanical Engineering

Northwestern Helps Chicago Secure Multimillion-Dollar Lab

THE UNIVERSITY WILL CONTRIBUTE TO INNOVATION IN DIGITAL MANUFACTURING FIELD

A $70 million federal grant will help position Chicago as a national hub for digital manufacturing and bring applied research and innovation opportunities to the Northwestern community. The goal of this five-year, US Department of Defense (DoD) grant, announced Feb. 25 by President Barack Obama at a White House ceremony, is to reinvigorate US manufacturing, create new jobs and economic development, and spur future innovation through the Digital Manufacturing and Design Innovation Institute (DMDII). Combined with an additional $10 million Adaptive Vehicle Make project award from DARPA and an expected $105 million in additional funding from 40 industry partners and approximately 30 academic, government, and community partners, including 23 universities, DMDII will receive at least $185 million in total funding.

The grant was awarded to UI LABS, a Chicago-based consortium of researchers that includes Northwestern faculty. Northwestern was one of the founding partners in the initiative, which is regionally anchored in the Midwest but also has partners in states ranging from New York to Texas to Colorado to Oregon.

Two professors from the Department of Mechanical Engineering and globally recognized leaders in manufacturing—Kornel Ehmann and Jian Cao—will provide technical leadership to DMDII. Ehmann is the thrust leader for intelligent machines, one of the three major technical thrust areas. The other two thrusts are advanced manufacturing enterprise and advanced analysis. Cao is a member of the Technical Advisory Committee.

"Manufacturing creates products and systems with new forms and functionalities using materials, energy, and most importantly, ideas," said Cao, who is also associate vice president for research. "It is a platform where sciences and technologies converge. At Northwestern, our talented faculty and students are well positioned to contribute to digital manufacturing and design innovation. Take mechanical engineering, for example. In addition to novel processes, such as rapid freeform forming and laser-induced plasma machining in Ehmann's and my group, the research in many other groups has great potential to change the future of advanced manufacturing. Examples include Wei Chen's design under uncertainty, Eric Masanet's life cycle analysis, Wing Kam Liu's multi-scale simulations, and Kevin Lynch's robot motion planning and control."

Jian Cao

Kornel Ehmann

"We are thrilled to have the opportunity to give our researchers the space, creativity, and collaborative connections they need to bring digital manufacturing to the next level." *Dean Julio M. Ottino*

DMDII will be the nation's flagship research institute for digital manufacturing and design innovation, applying cutting-edge technologies to reduce the time and cost of manufacturing, to strengthen the capabilities of the US supply chain, and to reduce acquisition costs for DoD.

DMDII will establish new projects on applied research with industrial partners, course development, and workforce development through a competitive process, which provides opportunities for Northwestern faculty to become involved in their areas of interest.

"Engineering researchers continuously look for opportunities and avenues to develop innovative solutions, increase efficiencies and address the world's most pressing needs," said Julio M. Ottino, dean of the McCormick School of Engineering and Applied Science at Northwestern. "We are thrilled to have the opportunity to give our researchers the space, creativity and collaborative connections they need to bring digital manufacturing to the next level."

ME Welcomes Three New Faculty

Greg Wagner

Manohar Kulkarni

Jarvis Schultz

The Department of Mechanical Engineering welcomes three new faculty members: Greg Wagner, Manohar Kulkarni, and Jarvis Schultz.

Wagner will join the department as associate professor in January 2015. His research is in the application of high-performance computing to simulate multiscale and multi-physics problems in engineering, with a special interest in simulations of fluid dynamics, heat transfer, and material microstructure. He received his PhD in 2002 from Northwestern, and he has spent the past 12 years at Sandia National Labs in Livermore, CA, where he was most recently manager of the Thermal and Fluid Sciences Department.

Kulkarni joined the department as assistant chair and clinical professor in January 2014. He joins us from the University of Illinois at Urbana-Champaign, where he was previously the Director of the Illinois Sustainable Technology Center. Before that, Kulkarni spent seven years in the Corporate Research Group at Johnson Controls and 17 years as a mechanical engineering faculty member, including six years as department chair. He teaches courses in heat transfer, energy management, and thermal systems design. His research interests include energy optimal control of thermal systems, energy management, and sustainability.

Schultz was appointed lecturer and assistant director of the Master of Science in Robotics in July 2014. During his PhD work at Northwestern, Schultz collaborated with engineers at Disney to develop robot-controlled puppet shows. Schultz teaches project-based courses on the practice of robotics, including a course on the robot operating system.

ME Heads Up New Master of Science in Robotics Program

FULL-TIME, ONE-YEAR PROGRAM PREPARES STUDENTS FOR CAREERS AS ROBOTICS ENGINEERS

The first class of McCormick's new Master of Science in Robotics (MSR) program arrived on campus in September.

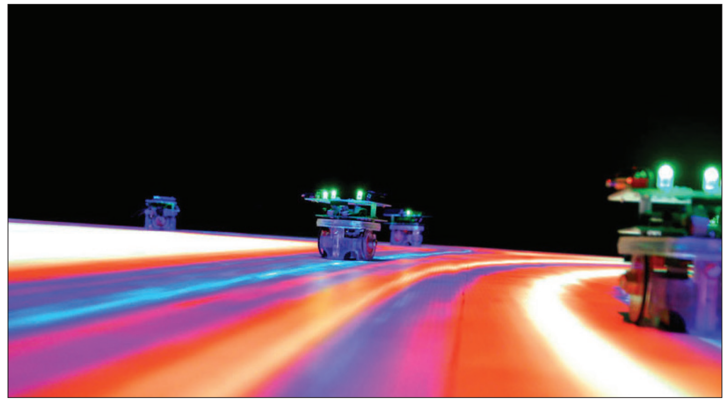
This interdisciplinary program, with its home in mechanical engineering, is designed to prepare college graduates for careers as robotics engineers.

The full-time, one-year program draws upon McCormick's strengths in mechanical engineering, biomedical engineering, mathematics, electrical engineering, and computer science to provide promising graduates the skills they need to succeed in the cutting-edge fields of robotics and artificial intelligence.

"Robotics is an incredibly fast-growing field, and the job opportunities for graduates in robotics are rapidly expanding," said Todd Murphey, associate professor of mechanical engineering and director of the MSR program. "It is challenging to obtain the technical breadth required for a career in robotics in an undergraduate program, so a one-year MS program makes sense for those students who want to work in robotics."

Featuring a combination of traditional and project-based courses, the MSR program provides training in multiple areas relevant to robotics applications in defense, manufacturing, and healthcare, taught by faculty from McCormick as well as the Rehabilitation Institute of Chicago and the Feinberg School of Medicine.

Course subject areas include automatic control, kinematics and dynamics, machine learning, path planning, human-machine interfaces, biomedical engineering, neuroscience, robotic rehabilitation, and prosthetics.



MSR students will work with a variety of robot systems, like the swarm robots pictured above.

Students have the opportunity to participate in a diverse set of robotics research projects with faculty from all over Northwestern, including the Neuroscience and Robotics Laboratory, a world leader in robotics, haptic interfaces, and bio-inspired systems. Project areas include multi-robot systems, robotic manipulation, haptics, simulation and control of multibody systems, swarm robotics, bio-inspired sensing and control, and prosthetics engineering.

Connections to the robotics industry play a significant part in the program through seminars, networking events, and projects from leading industrial partners. Students are encouraged to participate in industrial internships.

In Memoriam: Ted Belytschko

Ted Belytschko, Robert R. McCormick Institute Professor and Walter P. Murphy Professor Emeritus of Mechanical Engineering and Civil and Environmental Engineering, passed away Sept. 15. A member of Northwestern's faculty since 1977, Belytschko was a central figure in the McCormick community and an internationally renowned researcher who made major contributions to the field of computational structural mechanics.

One of the most cited researchers in engineering science, Belytschko developed explicit finite element methods that are widely used in crashworthiness analysis and virtual prototyping in the auto industry. He received numerous honors, including membership in the US National Academy of Engineering, US National Academy of Science, and the American Academy of Arts and Sciences.

After receiving his PhD in mechanics from the Illinois Institute of Technology in 1968, Belytschko joined the University of Illinois at Chicago, where he was a favorite among students. Wing Kam Liu, who is now a Walter P. Murphy Professor of Mechanical Engineering at McCormick, was one of his undergraduates. The two met in 1973 and became lifelong friends and collaborators.

"Ted and I had a great time during many summers while testing the theories of the computational mechanics of wind surfing on Lake Michigan," Liu said. "His research and teaching greatly influenced the modeling and simulation world in such a way that we call him the 'father of simulation-driven engineering.'"

At Northwestern, Belytschko was named a McCormick Distinguished Professor in 2003 and served as chair of the mechanical engineering department from 1997 to 2002. Students and colleagues enjoyed his sense of humor and admired his ability to explain complex problems in an easy-to-understand manner. He served as a role model for the Northwestern community.

"Ted was my department chair when I arrived at Northwestern, and he was my model for a successful academic," said Kevin Lynch, chair of the Department of Mechanical Engineering. "He was a great mentor, colleague, and friend. His passing is a deep loss for our department."

Ted Belytschko

Beyond his contributions to computer simulations of mechanical events, Belytschko took the most pride in his students. He delighted in watching his students learn and grow. In a 2013 video produced by ASME, Belytschko said, "The most important thing is to give a lot of freedom because it's remarkable what these young people can do on their own. And if I hadn't let them develop on their own, I don't think I would have the reputation I have. So much of my reputation rests on the contributions of my students."

Huang Develops Two New Biomedical Devices

A STICKY HEALTH MONITOR AND A DEVICE THAT HARNESSES ENERGY FROM THE BEATING HEART

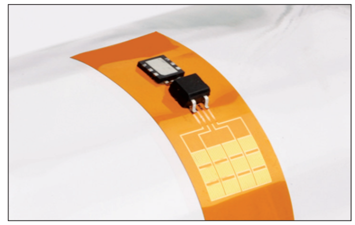
Yonggang Huang, the Joseph Cummings Professor of Civil and Environmental Engineering and Mechanical Engineering, has developed two new medical devices that could revolutionize clinical monitoring.

He was a part of a team that demonstrated thin, soft, stick-on patches that stretch and move with the skin and incorporate electronics for sophisticated wireless health monitoring. The patches stick to the skin and use a unique microfluidic construction with folded wires to allow the patch to bend and flex without being constrained by the rigid electronics components. They could be used for everyday health tracking and clinical monitoring, such as EKG and EEG testing.

"We designed this device to monitor human health 24/7, but without interfering with a person's daily activity," Huang said. "This device is wirelessly powered and can send high quality data about the human body to a computer in real time."

Huang also developed a new, flexible medical device that can harvest the energy of the beating heart. The device could power pacemakers, defibrillators, and heart-rate monitors naturally and reliably while reducing or even eliminating the need for batteries.

Huang and his longtime collaborator John A. Rogers of the University of Illinois developed and demonstrated the device that converts the mechanical energy



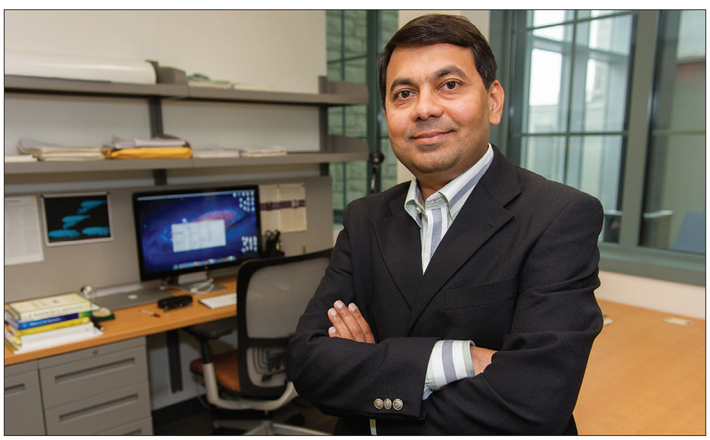
Huang has created two new biomedical devices: Left: A tiny rechargeable battery sits on the surface of a flexible implant and harvests the energy of a beating heart.

from the natural motions of the heart, lung and diaphragm into electrical energy. This works because one of the used materials has piezoelectricity, an electric charge that develops when the material is pressed or bent. The mechanical beating of the heart or the breathing motion of the diaphragm does the pressing.

"We carefully designed the device so the piezoelectric material would be pushed to nearly the breaking point, where we could capture the maximum amount of energy," he said. "Once this kind of energy is harvested, it can charge a lot of different implantable devices."

Which Has a More Efficient 'Engine,' A Tuna or a Whale?

NEW METRIC YIELDS SURPRISING ANSWER, COULD HELP DESIGN OF CARS AND UNDERWATER VEHICLES



Neelesh Patankar

Which is a more efficient swimmer, a skipjack tuna or a large gray whale? It has been difficult to compare propulsion efficiencies of animals of different sizes, like comparing apples and oranges, but now a team led by mechanical engineering professor Neelesh Patankar has developed a new metric, or standard, to measure individual energy consumption efficiency and make such a comparison possible.

Contrary to what one might expect, the team found that, despite the great difference in mass, the whale and the tuna are almost equally efficient.

The new metric for efficiency that enabled this comparison could be useful in designing underwater vehicles—such as those used to study fragile coral reefs, repair damaged deep-sea oil rigs, or investigate sunken ships—to be as efficient and agile as a real fish.

The metric, called the energy consumption coefficient, is a non-dimensional measure of energy expended per unit distance traveled. To calculate this coefficient, Patankar and collaborators estimated the minimum energy consumption required for an animal of a given mass to swim or fly. This estimate was found to be primarily dependent on the energy expended in deforming the body laterally with respect to the direction of motion. The actual energy consumption of an animal was divided by this theoretical estimate to obtain the energy consumption coefficient. The greater the value of this coefficient, the less efficient the animal.

Patankar and collaborators applied it to data for energy consumption by animals available from biologists. The data represented thousands of species of swimming and flying animals. Swimming animals ranged from tiny larval zebrafish to massive mammalian swimmers, such as dolphins and whales. Flying animals ranged from tiny insects to the largest flying birds.

> "Our metric can be used to determine the point where an animal or vehicle would function most efficiently. We want to know the sweet spot."
> *Neelesh Patankar*

The new metric collapsed energy consumption data onto a single trend with respect to mass — mass that varied almost a trillion times from the smallest to the largest animal. Specifically, it showed that swimmers heavier than 10 kg had nearly same energy consumption coefficient, implying they are almost equally efficient.

While the Northwestern study focused on swimming and flying animals, the concept potentially could be applied to define efficiencies of cars, something the researchers are now pursuing.

The study was published in May 2014 by the *Proceedings of the National Academy of Sciences* (PNAS).

Molecular Traffic Jam Makes Water Move Faster through Nanochannels

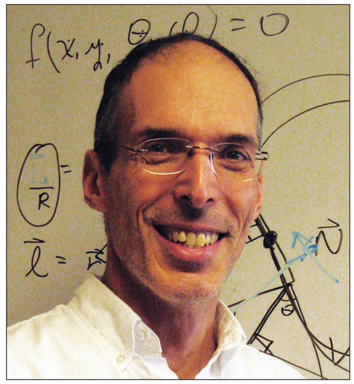
RESEARCHERS FIND THE UNUSUAL MOVEMENT OF WATER MOLECULES THROUGH CARBON NANOTUBES EXPLAINS THEIR FASTER-THAN-EXPECTED TRAVEL TIMES

Cars inch forward slowly in traffic jams, but molecules, when jammed up, can move extremely fast. New research by Professor Seth Lichter finds that water molecules traveling through tiny carbon nanotube pipes do not flow continuously but rather intermittently, like stop-and-go traffic, with unexpected results.

"Previous molecular dynamics simulations suggested that water molecules coursing through carbon nanotubes are evenly spaced and move in lockstep with one another," said Lichter. "But our model shows that they actually move intermittently, enabling surprisingly high flow rates of 10 billion molecules per second or more."

The findings could resolve a quandary that has baffled fluid dynamics experts for years. In 2005, researchers—working under the assumption that water molecules move through channels in a constant stream—made a surprising discovery: water in carbon nanotubes traveled 10,000 times faster than predicted. The phenomenon was attributed to a supposed smoothness of the carbon nanotubes' surface, but further investigation uncovered the counterintuitive role of their inherently rough interior.

Lichter and post-doctoral researcher Thomas Sisan performed new simulations with greater time resolution, revealing localized variations in the distribution of water along the nanotube. The variations occur where the water molecules do not line up perfectly with the spacing between carbon atoms—creating regions in which the water molecules are unstable and so propagate exceedingly easily and rapidly through the nanotube.

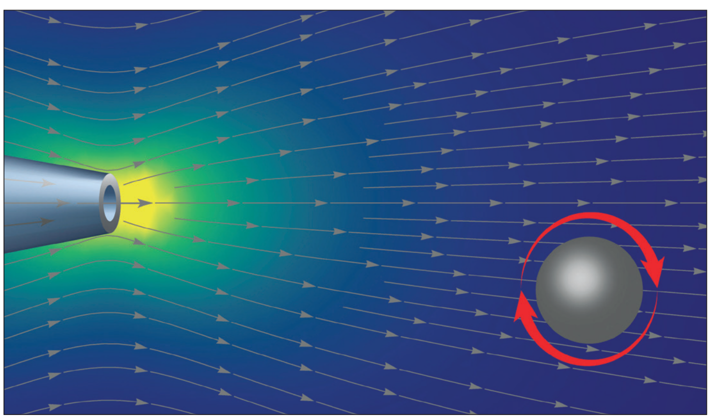


Seth Lichter

Nanochannels are found in all of our cells, where they regulate fluid flow across cell membranes. They also have promising industrial applications for desalinating water. Using the newly discovered fluid dynamics principles could enable other applications such as chemical separations, carbon nanotube-powered batteries, and the fabrication of quantum dots, nanocrystals with potential applications in electronics.

Researchers Measure Flow from a Nanoscale Fluid Jet

JET MEASURES 20 TO 150 NANOMETERS IN DIAMETER—JUST A FEW HUNDRED WATER MOLECULES ACROSS



A research team has recently verified the classical Landau-Squire theory in the world's tiniest submerged jet—in the range of 20 to 150 nanometers.

> "At this rate, if you had started to fill a two-liter soda bottle at the time the first pyramid was being built in Egypt, the bottle would be about half full now."
> *Sandip Ghosal*

Fluid jets are all around us: from inkjet printing, to the "Old Faithful" geyser in Yellowstone National Park, to cosmological jets several thousand light years long.

Mechanical engineering associate professor Sandip Ghosal and collaborators have recently verified the classical Landau-Squire theory in the tiniest submerged jet. The diameter of their jets were in the range of 20 to 150 nanometers, which is the length of just a few hundred water molecules lined up in a row.

"The flow rate from this nanojet is in the range of tens of pico liters per second," said Ghosal. "At this rate, if you had started to fill a two-liter soda bottle at the time the first pyramid was being built in Egypt, the bottle would be about half full now."

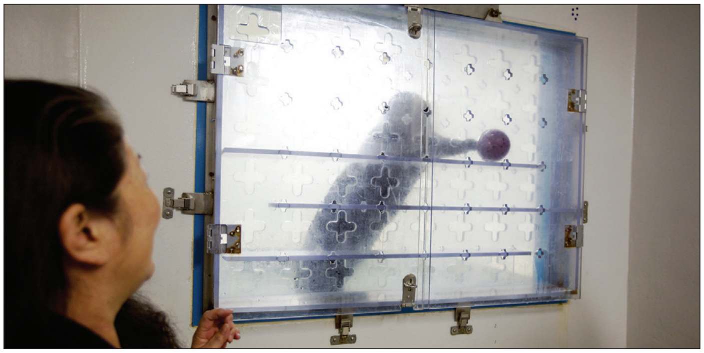
The nanojet is designed around a glass "nano capillary," which the researchers fabricated by heating an ordinary glass capillary—a hollow glass tube—with a laser and gently pulling it until it broke, creating a fine tip. The researchers applied an electric voltage across the capillary, which was submerged in a salt solution to create an electroosmotic flow that then emerged as a jet.

To measure the jet stream, the researchers built a tiny anemometer—a windmill-like device used for measuring wind speed—from a polystyrene bead less than one-fiftieth the width of a human hair. The bead was held in place by an "optical trap," a finely focused laser beam that served as a spindle for the tiny anemometer. When the bead was positioned in front of the jet, it spun around, and a video camera picked up tiny fluctuations of light from a dimple on the bead.

The nanojet has a number of potential novel applications. One possible use is as an ultra-low-volume injector for transferring biomolecules into cells or vesicles, a process used in recombinant DNA technologies important in the production of human insulin and disease-resistant crops.

Maze Keeps Shedd Aquarium's Otters Challenged

MECHANICAL ENGINEERING UNDERGRADUATES WORKED ON THE DESIGN PROBLEM



An otter works to retrieve a ball from a maze-like puzzle developed by students in the Interdisciplinary Design Projects course.

"This year we simply asked for enrichment for the sea otters. The only specifications we gave (the students) were that it had to be otter-proof and rust-proof, and they came back with about six concepts."

Lisa Takaki, senior director, Shedd Aquarium

Take a piece of Plexiglas, some shrimp, and a plastic ball, and what do you get? The perfect puzzle for a sea otter — and the latest project to come out of a unique partnership between McCormick and Chicago's Shedd Aquarium.

Sea otters are highly energetic and love to play, so goal-driven playtime is important to keep them mentally stimulated and active. Students in the Interdisciplinary Design Projects course in Northwestern's Segal Design Institute were called on to create an enrichment experience that would do just that.

Each year, McCormick students are challenged to design a solution to meet the needs of the Shedd's Fishes, Marine Mammals, and Animal Health departments.

"Sometimes the projects are very specific, such as an anesthesia machine for fishes," said Lisa Takaki, the Shedd's senior director of marine mammals. "This year we simply asked for enrichment for the sea otters. The only specifications we gave (the students) were that it had to be otter-proof and rust-proof, and they came back with about six concepts."

The winning concept was a maze-like puzzle—a 44 x 32 x 6-inch block of thick Plexiglas—that fits into the window opening between the otters' pool and the trainers' area. When a trainer tosses in a special hollow ball stuffed with shrimp, the otter learns to slide the ball down the various levels to an opening at the bottom.

The students—Matthew Crocker (ME '14), Chloe Frizelle (ME '15), Samantha Hatfield (ME '14), and Sofia Maspons (radio, television, and film '14)—worked on the project for two quarters with John Lake, lecturer in the Segal Design Institute, and John Anderson, lecturer in the Writing Program at Northwestern's Weinberg College of Arts and Science.

Previous products developed for the Shedd include protective booties for penguin feet, a decompression machine designed with sea horses in mind, and a fish anesthesia system for medical examinations.

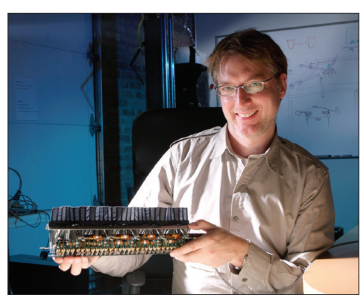
Robot Aids Understanding of How Animals Move

The weakly electric black ghost knifefish of the Amazon basin has inspired mechanical engineering associate professor Malcolm MacIver and an interdisciplinary team of researchers to develop agile fish robots that could lead to a vast improvement in underwater vehicles used to study fragile coral reefs, repair damaged deep-sea oil rigs or investigate sunken ships.

"Our technology for working in water is not very advanced," said MacIver. "Current underwater vehicles are large and lack agility, which means that working close to living or manmade structures is nearly impossible. We've taken lessons learned from the knifefish about movement and non-visual sensing and developed new technologies that should improve underwater vehicles."

The black ghost knifefish hunts at night in the murky rivers of the Amazon basin using closely integrated sensing and movement systems. It has the unique ability to sense with a self-generated weak electric field around its entire body and to swim in multiple directions. The fish moves both horizontally as well as vertically using a ribbon-like fin on the underside of its body.

MacIver and colleagues in Northwestern's Neuroscience and Robotics Lab have developed more than half a dozen robots based on the weakly electric knifefish. A major motivation for creating the robotic models of the knifefish is to generate a better understanding of how the nervous system combines the acquisition of information with movement.



Malcolm MacIver poses with his robotic fish.

Student News

Titan Aerospace, a company developing solar-powered drones, with DAN CORNEW (ME '11) as lead mechanical engineer, was acquired by Google in April 2014.

SwipeSense, a company developing a data-driven hand hygiene system to reduce hospital infections, was selected one of three finalists in the *Wall Street Journal*'s Startup of the Year competition. SwipeSense grew out of Design for America and is led by former students YURI MALINA and MERT ISERI.

HANNAH CHUNG (ME '12) won the pitch competition at *Fortune*'s Most Powerful Women Summit for Sproutel, a company developing interactive educational games for children with chronic illnesses. Sproutel was founded by Chung and classmate AARON HOROWITZ based on their Northwestern design work.

PhD students PINZHI LIU and TIFFANY LING received the Society of Tribologists and Lubrication Engineers Surface Engineering Best Paper Award.

MeterGenius, a startup co-founded by PhD student YAN MAN, won the $10,000 Illinois Clean Energy Student Challenge and the $25,000 McCaffrey Interest Prize at the Midwest Regional Clean Energy Challenge. The company recently received a $50,000 Arch Grant and moved to St. Louis.

PhD students MATT FORD, NEWELL MOSER, and KATIE FITZSIMONS received NSF Graduate Research Fellowships.

PhD student JOSEPH SCHAEFER received the American Society of Mechanical Engineers Graduate Teaching Fellowship.

PhD student HONGYI XU received the ASME Design Automation Conference Best Paper Award.

PhD student YING LI received the Outstanding Researcher Award from the International Institute for Nanotechnology.

Two Mechanical Engineering Professors Win Teaching Awards

TODD MURPHEY AND NEELESH PATANKAR WERE AMONG THE HONOREES

Two professors from McCormick's Department of Mechanical Engineering were honored with 2014 University Teaching Awards in May. Associate Professor Todd Murphey and Professor Neelesh Patankar were both named Charles Deering McCormick Professors of Teaching Excellence.

The University Teaching Awards recognize individual faculty members who have consistently demonstrated outstanding performance in classroom teaching or who have developed significant innovations that have also influenced the methods and teaching effectiveness of other faculty. The winners were nominated by undergraduate deans and selected by a diverse committee of Northwestern faculty, administration, and staff.

A member of the Northwestern faculty since 2009, Todd Murphey has had an impact on engineering education both on campus and nationwide. He created and taught a MOOC (Massive Open Online Course) to thousands of learners around the world and continues to share what he learned during that experience with colleagues and university administrators throughout the country. As a result of that effort, he was a featured speaker at a National Academy of Engineering workshop in 2013. Murphey also brought the online learning experience to his undergraduate Engineering Analysis students at Northwestern. That course was very well received by the students and received unusually strong student evaluations.

Throughout his 14 years at Northwestern, Neelesh A. Patankar's main teaching goal has been to "use the language of mathematics to analyze physical phenomena and apply the analysis to realistic problems." Student feedback indicates he has achieved this goal, and thus has had a lasting impact on many of his students and advisees. Repeatedly emphasized in student feedback is Patankar's effective teaching style. One summarized it this way: "Since the focus was on concepts versus just memorizing equations, I feel like I will remember the important material of this course."

Neelesh Patankar and Todd Murphey, the latest mechanical engineering McCormick Professors of Teaching Excellence, are joined by former recipients Ed Colgate, Kevin Lynch, and Michael Peshkin.

The University Teaching Awards recognize individual faculty who have consistently demonstrated outstanding performance in the classroom.

ASME Establishes Ehmann Medal

THE MEDAL ACKNOWLEDGES PROFESSOR EHMANN'S IMPACT ON MICRO- AND NANO-MANUFACTURING

A medal named for Kornel Ehmann was announced at this year's American Society of Mechanical Engineers (ASME) Manufacturing Engineering Division Conference Banquet Dinner. The Ehmann Medal will be awarded every year for the best paper published in the ASME *Journal of Micro- and Nano-Manufacturing*. The honor acknowledges Ehmann's profound impact on the field.

Faculty News and Honors

JAN ACHENBACH won the A. K. Rao Memorial Award from the Indian Society of Non-Destructive Testing.

CATE BRINSON received the Nadai Medal in materials engineering from the American Society of Mechanical Engineers.

JIAN CAO was elected a fellow of the International Academy for Production Engineering. She is one of only 15 fellows in the United States.

ED COLGATE was named an IEEE fellow.

ISAAC DANIEL received the Medal of Excellence, the highest award given by the American Society of Composites.

HORACIO ESPINOSA received the Murray Medal, the highest honor from the Society of Experimental Mechanics, and was named a fellow of the American Association for the Advancement of Science.

ELIZABETH GERBER received the IEEE Computer Society's Undergraduate Teaching Award and was named to *Crain's* list of 40 under 40.

YONGGANG HUANG received the Daniel C. Drucker Medal in applied mechanics from the American Society of Mechanical Engineers.

ELMER LEWIS received the 2014 Wigner Reactor Physicist Award from the American Nuclear Society.

WING KAM LIU received the 2014 grand prize from the Japan Society of Computational Engineering.

TODD MURPHEY was selected to join the 2014-15 DARPA Defense Science Study Group (DSSG). Past DSSG members from mechanical engineering include Cate Brinson, Kevin Lynch, Neelesh Patankar, and Mitra Hartmann.

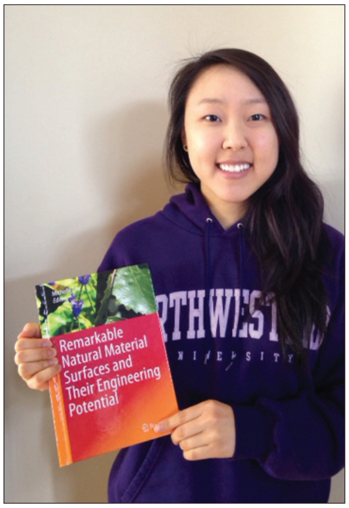
Mako Surgical, a surgical robotics company that grew out of Northwestern technology developed by MICHAEL PESHKIN, sold to Stryker in September 2013 for $1.65 billion.

JOHN RUDNICKI received the 2014 Engineering Science Medal from the Society of Engineering Science.

JANE WANG received the Captain Alfred E. Hunt Memorial Best Paper Award.

ME Students Publish New Book

THE BOOK BEGAN IN JANE WANG'S INTRODUCTION TO TRIBOLOGY COURSE



Michelle Lee (ME '13) edited and coauthored with her classmates the book Remarkable Natural Material Surfaces and Their Engineering Potential, *published by Springer in 2014.*

A new book, *Remarkable Natural Material Surfaces and their Engineering Potential*, explores a collection of natural surfaces, their scientific characteristics, and their unique engineering potential—demonstrating that engineering applications can be found in unexpected places. Michelle Lee (ME '13) edited the book and wrote several of the chapters.

The surfaces described in the book range from botanical ones, like rice and lotus leaves, to insect surfaces, like butterfly and dragonfly wings. The variety of surfaces and numerous engineering potentials described how biomimicry can be used to solve countless problems.

The book began in mechanical engineering Professor Jane Wang's Introduction to Tribology class during fall quarter of 2012. As an end-of-quarter project, many students wrote "journal articles" analyzing a distinct natural surface. Students wrote about the specific characteristics that made their natural surface unique, the engineering concepts behind these characteristics, and any potential and existing engineering applications.

Wang encouraged students to publish the articles together as a popular science book. The students proposed the book to Springer, and it was accepted for publication.

"Our students have great potential… even at the stage of their undergraduate studies," said Wang, who wrote the book's foreword. "As a professor, I should help them go as far as they can."

As editor, Lee spent the winter quarter crafting the book proposal and summer working on content. She said the book was written with a lay audience in mind. She wants more people—not just those with technical expertise or engineering backgrounds—to understand nature's power and potential to change the way we live.

"There are so many things in nature that can offer so much scientific intelligence and engineering wisdom," she said. "And a lot of people don't know they exist. I certainly didn't know about them before Professor Wang had us do this project."

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