

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

SPRING 2013

Mobilizing for a Sustainable World

MECHANICAL ENGINEERING STUDENTS HELP MAKE NORTHWESTERN AND THE WORLD MORE SUSTAINABLE



ESW members erect a windmill by the lagoon on Northwestern's campus.

Through new courses, research opportunities, and special programs, energy and sustainability topics play a greater role in engineering education than perhaps ever before. Many students aren't satisfied to just learn about these subjects in the classroom; they want to apply their knowledge to help fight some of the world's most pressing problems. Engineers for a Sustainable World (ESW), a national student group that promotes sustainability, helps make this possible.

In the past several years, several mechanical engineering students have been central to ESW's activities at Northwestern. Through education, training, and practical action initiatives, they have worked to advance sustainability on campus and throughout the world.

ESW's recently completed Nicaragua Wind Project, co-managed by **Jesse Lee** (BS/MS mechanical engineering, '12) and **Dylan Barstow** (civil engineering, '13), was committed to developing low-budget wind turbines using local materials and equipment. The project culminated in a trip to Nicaragua in 2010, where the team assembled its design in El Corózo and Las Peñas. Currently, **Aliza Abraham** (mechanical engineering, '14) works on a continuation of the project called NUWind, which aims to continue wind turbine development in Nicaragua.

Mechanical engineering students also engage in sustainability projects closer to home. **Brooke Stanislawski** (mechanical engineering, '13) currently works as project manager with ESW's Northwestern Clean Energy Project

(CEP). The CEP aims to reduce Northwestern's energy consumption by initiating new renewable energy projects on campus.

Projects that Stanislawski and her team are currently implementing include a wind survey of campus to determine feasibility of wind energy at Northwestern, occupancy sensor lighting in the Technological Institute, and constructing a solar tree on campus. Stanislawski also helped implement the Centennial Solar Panel System, a solar photovoltaic array covering the roof of the Ford Engineering Design Center, the LEED-certified building adjacent to Tech.

Sam Malin (BS civil engineering, '12, MS mechanical engineering, '12), a former co-president of ESW, recently co-organized another local ESW project called GRIN (Green It Now), an energy auditing and consulting student group. Malin conducted energy audits of eight campus residences, and consulted with outside businesses and restaurants in Evanston looking to conserve energy. He was also involved in Northwestern Sustainable Events Counseling, which consults with extracurricular and outside groups at Northwestern on how to host "green" events. He was also involved in the Centennial Solar Panel System alongside Stanislawski.

For more information about ESW, please <http://eswnu.org/>.

From the Chair



"This newsletter highlights the impact our faculty and students have on energy and sustainability, long core disciplines in ME and more important than ever today."

Cate Brinson

Dear friends of ME@NU, Mechanical engineering is a broad and highly sought-after engineering field due to its impact on so many aspects of life: from innovative manufacturing to systems engineering design; from nano-networks for stretchable electronics to robotic assists for successful stroke rehabilitation; from windmills to life cycle analysis of energy and environmental impact.

This newsletter highlights the impact our faculty and students have on energy and sustainability, long core disciplines in ME and more important than ever today.

We have deep roots in these fields, with a history of excellence in combustion, turbulence, and chaos. Today, the department has a large research effort in the energy and sustainability sector, including nanostructured materials for future batteries, large-scale composites for

Continued on page 2

Northwestern ME Students Participate In Solar Car Competition



Members of the Solar Car Team on race day

In July, undergraduates on the Northwestern University Solar Car Team took a solar car of their own design to the Formula Sun Grand Prix at the Monticello Motor Club in New York. Several mechanical engineering students helped to design the car and participated in the event, including **Matt Felz** ('15), **Mihir Boddupalli** ('15), and **Ola Okeowo** ('15).

The car, named "Solar Car 6" (SC6), was the sixth car in NU Solar's 14-year history. The car was designed with a carbon fiber monocoque frame—the same technology used in advanced sports cars and racecars.

Although the car did not qualify for the race due to a suspension failure, the students remained focused and determined. The team

worked around the clock in the week leading up to the race to make final modifications and test the car, demonstrating resourcefulness and creativity on short notice.

"Realizing I was part of an organization so resilient and so persistent that giving up wasn't even considered for a moment was very eye-opening and incredibly motivating," team member Alex Zhu wrote in a blog post on NU Solar's website. "Only once there was literally zero chance of success did the team pack up the trailer."

The team is currently modifying SC6 in preparation for the 2013 Formula Sun Grand Prix, which will be held in June at the Circuit of the Americas in Austin, Texas.

The team worked around the clock in the week leading up to the race to make final modifications and test the car, demonstrating resourcefulness and creativity on short notice.



Northwestern University Solar Car Team members prepare for the Formula Sun Grand Prix at the Monticello Motor Club. (Photos: Alex Zhu)



From the Chair *continued*

wind power, lubrication and friction technology to reduce energy losses, and green design and manufacturing methods. The research activities are broadly dispersed across many sub-areas of the department. As you will see in the following articles, we have a new faculty member with core expertise in energy/sustainability, a vibrant new MS program, and numerous undergraduate activities from the Northwestern Solar Car Team to Engineers for a Sustainable World.

We demonstrate in this issue the immense impact our faculty and

students have in this important area of research and education for the future of our world. The accolades of our faculty and students are exemplified with the list of a few selected recent awards and honors on pages 3 and 4.

Thank you for your continued interest in and support of the mechanical engineering department at Northwestern.

Cate Brinson
Jerome B. Cohen Professor of Engineering and Department Chair

Department News

FACULTY

Of the 50 most cited researchers at Northwestern in 2012, the Department of Mechanical Engineering claims three: **Zdeněk P. Bažant**, **Ted Belytschko**, and **Yonggang Huang**. In total, six McCormick researchers made the list, which was released in the Office for Research Annual Report.

Jian Cao, **Kornel Ehmann**, graduate student **Rui Zhou**, and visiting scholar **Xun Chen** received the Blackall Machine Tool and Gage Award for the best original paper published by ASME journals in the area of manufacturing and dimensional measuring instruments.

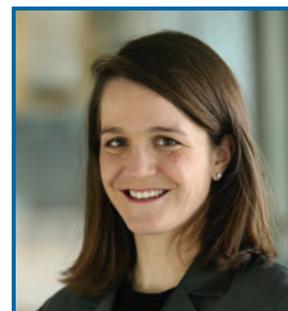
Cao was also recognized at the North American Manufacturing Research Conference last June for her leadership as president of the North American Manufacturing Research Institute. At Northwestern, Cao was appointed as an associate vice president for research to help with the collaboration between the physical sciences and engineering and other disciplines across the University.

Wei Chen and graduate students **Hongyi Xu** and **Steve Greene** received the Best Paper Award in the ASME Design Automation Conference. The paper was co-authored with the research teams of **Cate Brinson** and **Wing Kam Liu**, as well as industrial collaborators at Goodyear Tire & Rubber Company.

Isaac Daniel received the SAGE Award for the most highly cited paper over the last 10 years in the *International Journal of Damage Mechanics*. He was also elected foreign member of the Russian Academy of Engineering.

Kornel Ehmann was awarded the 2012 Milton C. Shaw Manufacturing Research Medal by ASME.

Horacio Espinosa was elected foreign member of the Russian Academy of Engineering.



Liz Gerber was a winner in the Digital Media and Learning Competition sponsored by the Mozilla and MacArthur Foundations. Gerber was also recognized in “Public Interest Design 100,” which commends 100 people and teams working at the intersection of design and service.

Sandip Ghosal was awarded a University of Cambridge Visiting Professorship by the Leverhulme Trust and was elected visiting fellow at Clare Hall, Cambridge.

A paper by **Mitra Hartmann** was selected as “Editor’s Choice” in the *Journal of Neurophysiology*. It is featured on the cover of the April issue.

Walter Herbst’s Herbst Produkt is one of the top three finalists for an award by the Edison Committee for Industrial Design.

Yonggang Huang became editor-in-chief of the *Journal of Applied Mechanics*. Huang was also recently elected to serve on the boards of the Society for Engineering Science and the journal *Current Opinion in Solid State and Materials Science*.

Sridhar Krishnaswamy received the V.S. Jain Memorial Award and gave the associated plenary lecture at the Indian Society of Nondestructive Testing’s Annual Meeting. Sridhar was also elected fellow of SPIE.

Wing Kam Liu was awarded the Gauss-Newton Medal (IACM Congress Medal) by the International Association for Computational Mechanics (IACM) in July 2012. This is the highest award given by IACM.

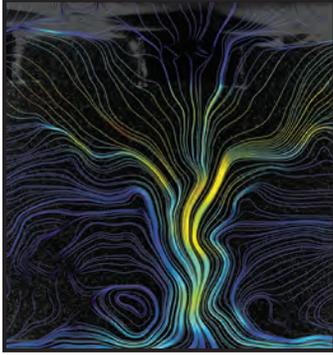
Richard Lueptow was named to serve on the Royal Society’s Editorial Board of Proceedings for a term beginning January 2013. He was also elected as fellow of the American Society of Mechanical Engineers.

Clockwise from top left: Jian Cao accepts an award at the North American Manufacturing Research Conference in June 2012; former graduate student Oscar Curet placed third in the 2012 Scientific Images Contest for this image, which maps the motion of a robotic ghost fish; Horacio Espinosa; Liz Gerber; Richard Lueptow; and Yonggang Huang.

Eric Masanet was named editor-in-chief of the journal *Resources, Conservation, and Recycling*, the leading journal on resource systems efficiency. He also received a Best of 2011 paper award (one of 12 awards out of 1,500 published articles) from *Environmental Science & Technology*, the top-cited journal in environmental sciences.

STUDENTS

Hannah Chung (BS '12) was chosen as one of the "15 Women to Watch in Tech" by *Inc.* Magazine in February 2012. She was the youngest woman on the list.



Oscar Curet received third place in the 2012 Northwestern Scientific Images Contest for his image, which maps the motion of a robotic ghostfish. The research was conducted in the lab of **Malcolm MacIver**. (Photo courtesy of Science in Society.)

Rogers Feng ('13) won a €1,000 (~\$1,300) prize as a semi-finalist in the 2012 James Dyson Award competition for his hand-crank vaccine refrigerator.



Luke Hemenetz (BS/MS '12) and **Tim Rockers** (BS '12, current MS student) won second place in the annual ASME Manufacturing Design Competition in June 2012. The prize included \$750 for their work on the design of the temperature control system in electrically-assisted metal forming work supervised by **Jian Cao**.

Jesse Lee, a BS/MS student who will earn both degrees in June 2013, was awarded the 2012-13 Congress-Bundestag Fellowship for a yearlong program of study and work in Germany.



Doctoral student **Ying Li** was awarded a Ryan Fellowship, which provides for up to three years of support for graduate students "dedicated to the exploration of fundamental nanoscale science and to advancing this knowledge into practical applications of benefit to society."

Zhe Li and **Hualong Yu** won a second-place Student Poster Award at the 2012 STLE Annual Meeting. The title of their poster was "Indentation Creep Behavior of PDMS Quantified with a Semi-Empirical Adhesive Viscoelastic Contact Model."

Rajiv Malhotra, a graduating PhD student in **Jian Cao's** research group, was given the Best Poster Award at the bi-annual North American Deep Drawing Research Group symposium held at Oakland University in May 2012.

Mike Roenbeck received a National Defense Science and Engineering Fellowship.

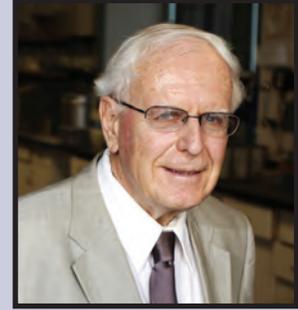
PhD candidate **Joseph Schaefer** received a 2012 ASME Graduate Teaching Fellowship.



Patrick Ward ('13) has been honored as a 2012 National Scholar-Athlete Award winner and is a finalist for the prestigious William V. Campbell Trophy. Ward is also a two-time Capital One Academic All-District honoree, a first-team Capital One Academic All-American in 2011, and a two-time recipient of the Big Ten Distinguished Scholar and Academic All-Big Ten awards.



Jan D. Achenbach



Zdeněk P. Bažant

Achenbach, Bažant Honored by ASME

Two mechanical engineering professors, Jan D. Achenbach and Zdeněk P. Bažant, received prestigious honors from the American Society of Mechanical Engineers (ASME) in 2012.

Achenbach, an expert in the propagation of sound waves in solids, was awarded the ASME's highest honor, the 2012 ASME Medal. The medal, established in 1920, is awarded for eminently distinguished engineering achievement.

He was cited "for his groundbreaking contributions to the theory and applications of waves and solids, particularly in the ultrasonic range, applied to acoustic microscopy, dynamic fracture, and laser-based ultrasonics," as well as "pioneering ultrasonic methods for quantitative nondestructive evaluation and structural health monitoring."

Achenbach is Walter P. Murphy and Distinguished McCormick School Professor Emeritus of Civil and Environmental Engineering, Engineering Sciences and Applied Mathematics, and Mechanical Engineering. He is a member of the National Academy of Sciences, the National Academy of Engineering, and five other academies.

Bažant, an expert in solid mechanics and structures, was recognized with an ASME 2012 Honorary Membership.

First awarded in 1880, the founding year of the Society, Honorary Memberships are bestowed upon people who have made "distinctive contributions" to engineering, science, industry, research, public service, or other pursuits allied with and beneficial to the engineering profession.

Bažant was recognized for his contributions to engineering science, including his size effect law, which is widely used in determining safety factors for large structures made of concrete and other composite materials. His models for materials behavior helps engineers design ships, aircraft, bridges, highways and other structures, and he has conducted detailed analysis of the collapse of the World Trade Center towers in New York City.

Bažant is McCormick Institute Professor, Walter P. Murphy Professor of Civil and Environmental Engineering, Mechanical Engineering, and Material Science and Engineering.

Eric Masanet, Sustainability Expert and McCormick Alumnus, Joins the Department

We welcome Eric Masanet to Northwestern as an associate professor in the Departments of Mechanical Engineering and Chemical and Biological Engineering.



Masanet comes to us most recently from a joint appointment at the University of California-Berkeley and Lawrence Berkeley National Laboratory (LBNL), where

His interests lie in conducting research that informs national and regional industrial energy and climate policy, and in developing decision models that capture important decision criteria in industry.

he was a staff scientist and deputy leader of LBNL's International Energy Studies Group.

Masanet received his MS in mechanical engineering from Northwestern and his PhD in mechanical engineering from UC Berkeley. We are thrilled to have him back.

Masanet brings to Northwestern a strong focus on

sustainability decision theory that is policy-relevant and can be applied to pressing problems today. His interests lie in conducting research that informs national and regional industrial energy and climate policy, and in developing decision models that capture important decision criteria in industry — cost, productivity, and quality, as well as sustainability.

This policy- and industry-related focus is central to Masanet's teaching, as well. He teaches several new courses on life cycle assessment, energy systems, and green design and manufacturing. (See right for descriptions of four new sustainability courses.)

Masanet also holds an appointment with the Initiative for Sustainability and Energy at Northwestern, where he has supported the launch of a new University-wide certificate in energy and sustainability.

ME Department Expands Energy and Sustainability Course Offerings

The Department of Mechanical Engineering is pleased to offer students several new course options in the areas of energy and sustainability.

ME 395: Special Topics: Energy and Society explores the relationship between energy and the organization of society. In teaching the course, Seth Lichter considers energy as it helps determine the geographic distribution, well-being, and social organization of mankind. Topics have included the relationship of energy and technological innovation, economic prosperity, migration, population distribution, warfare, and evolution.

ME 395: Special Topics: Energy Systems, taught in 2012-13 by Sandip Ghosal, explores complete processes for production and utilization of renewable and fossil energy sources; life cycle impacts of processes and design of energy production systems considering available feedstocks, desired fuels, and impact on greenhouse gas emissions.

A new course offered this spring by Eric Masanet, **ME/CHBE 395: Quantitative Methods in Life Cycle Analysis**, provides an overview of the life-cycle analysis framework for environmental

assessment of technology systems, with a focus on modeling methods for systems mass and energy flows, process- and input-output-based systems inventories, multi-scale environmental impact analysis, and life-cycle systems optimization.

ISEN 210: Introduction to Sustainability: Challenges and Solutions — a new course taught by Eric Masanet — provides an introduction to the importance of life-cycle systems perspectives in understanding major challenges and solutions to achieving more sustainable societies. Students will first learn about sustainability challenges in the context of energy and resource use, consumption and development, and environmental constraints. Next, basic methods for life-cycle environmental inventory and impacts modeling (i.e., the generally-accepted methods for quantifying the sustainability of products and processes) are introduced and applied. Finally, the life-cycle perspective is used to develop an understanding of potential solution pathways, including technology innovation and deployment, behavioral and societal changes, and policies, standards, and regulations.

PLEASE JOIN US FOR A SHORT COURSE ON ADDITIVE MANUFACTURING

**MAY 29-31
HILTON GARDEN INN
1818 MAPLE AVENUE, EVANSTON**

Hosted by the NSF Summer Institute on Nanomechanics, Nanomaterials and Micro/Nanomanufacturing, Northwestern University, and the University of Texas, Austin.

Organized by Professor Jian Cao (Northwestern) and Professor David Bourell (UT Austin).

For more information, visit <http://summerinstitute.mech.northwestern.edu>.

New Energy and Sustainability Option for the MS Degree



The Energy & Sustainability option for the MS degree was first offered in fall 2011, starting with three BS/MS students and two new MS students. The option — which includes the graduate-level course offered through the Initiative for Sustainability and Energy at Northwestern (ISEN), ISEN 410 Topics in Contemporary Energy and Climate Change,

and other ISEN courses — allows students to choose from a wide range of appropriate courses from mechanical engineering, civil and environmental engineering, materials science and engineering, chemical and biological engineering, and engineering science and applied math. Courses must be taken in four sub-areas: energy, environment, core principals of energy systems, and economics/policy.

One exciting course taken by several students was ISEN 430: NUvention: Energy, in which students from engineering, business, arts and sciences, law, and other graduate programs across Northwestern come together in interdisciplinary teams to develop a product or service and a business plan in the sustainable energy or clean tech industry. *Jesse Lee (BS/MS '12)* wrote a master's thesis under the supervision of Professor Cheng Sun on solar panels, and three of the Energy & Sustainability students did research under the supervision of new faculty member Eric Masanet.

All of the first five Energy & Sustainability students earned master's degrees between June and December 2012. Several have taken jobs in the field with companies such as Invenergy, a clean energy company, and Apple's Environmental Technologies division. We have

another cohort of students this year choosing to specialize in the area.

Even though the program is quite new, Energy & Sustainability has stimulated great interest from prospective graduate students with nearly 20 percent of MS applicants for the fall 2013 indicating it as their field of interest. We anticipate continued growth of the program in the future.

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