People might expect a solar house to be futuristic and sterile, but the student-built House by Northwestern was thoughtfully designed to be warm and inviting.

That attention to detail resulted in a strong showing in the US Department of Energy’s Solar Decathlon in October, a competition that showcases innovative solar-powered houses designed, built, and operated by collegiate teams from around the world. Northwestern placed sixth overall, and earned first place honors in the Decathlon’s Market Potential Contest and Communications Contest, and third place in the Engineering Contest.

Called “Enable,” the house was Northwestern’s first-ever entry into the Solar Decathlon, and featured the work of multiple undergraduate students from the Department of Civil and Environmental Engineering.

As House by Northwestern’s project manager, senior William Bach oversaw the design and three-month construction of the house on campus, as well as the transportation of the solar house to Denver, where it was reassembled for the competition. He also helped design the house’s thermal envelope, mechanical and electrical systems, architectural plan, and structural system.

“There is no other project that would have provided me the experience of working with industry partners in the field as well as with skilled trades at the construction site,” said Bach, a civil engineering major.

Measured contest captain Sophie Sisson was responsible for ensuring that Enable’s key sustainability measures — temperature, carbon emissions, and energy production and consumption — were maintained throughout the competition. In addition, she worked with teammates to present to judges the house’s ability to complete functional tasks, such as cleaning laundry, charging an electric vehicle, and cooking and hosting a dinner party.

“House by Northwestern was unchartered territory for us,” said Sisson, a senior studying civil engineering. “We had big responsibilities and real deadlines that you don’t receive in traditional internships.”

“The Solar Decathlon is more than a competition,” said Sisson. “The real objective is to educate the public and make sustainability accessible in hopes of having a lasting impact on the US housing market. Enable achieves that objective completely, and I feel lucky to have been involved with House by Northwestern.”
FROM THE CHAIR

Dear friends and colleagues,

A little over a year ago, I became chair of the Department of Civil and Environmental Engineering. What an honor it has been to work with my colleagues and with Dean Julio M. Ottino to tackle the many exciting opportunities facing the department. I would like to highlight some accomplishments from the past year.

First, we hired three new assistant professors. Earlier this fall, the department welcomed Erica Hartmann, who moved halfway across the country from the University of Oregon to join our environmental engineering and science group as an expert in the “microbiome of the indoor environment.” Erica has a strong interest in molecular biology, environmental chemistry, and everything “omics” and uses these tools to determine how microorganisms develop resistance to the very chemicals we use to try to control them. James Hambleton moved halfway around the world from the University of Newcastle in Australia to join our geotechnical engineering team. Jim studies how geo-materials respond to human interactions, which is critical to the development of efficient construction, mining, and drilling operations in far-flung environments on Earth, at the bottom of oceans, and on other planets. Ange-Therese Akono is currently an assistant professor in civil and environmental engineering at the University of Illinois Urbana-Champaign and will move halfway across the state of Illinois to join the department’s materials, mechanics, and structures group in fall 2017. Ange is an expert in the area of nano- and micro-scale testing and analysis of materials — ranging from concrete to bone — in order to detail failure mechanisms.

These young researchers are defining entirely new areas in the field of civil and environmental engineering. The department, in concert with Northwestern Engineering and Northwestern University, has been working with each new professor to establish new, state-of-the-art experimental facilities. I would also like to welcome three new members to our external advisory board: Robert Kudder, principal with Raths, Raths & Johnson, Inc.; Sofia Berger, senior vice president at Louis Berger and division manager of Latin American and Caribbean operations; and Isam Khoury, vice president of NSCC International.

With a generous gift from Richard Halpern and the RISE International Fund, the Architectural Engineering Design (AED) certificate program was established eight years ago. Under the direction of Chicago architect Larry Booth, AED has evolved to become an attractive feature of the department’s curricula. The program aims to take our engineering students on a journey through architectural history, design studios, and hands-on activities with real architectural practitioners from around the world. In fall 2015, this journey took our students to the University of Stuttgart’s Institute for Lightweight Structures and Conceptual Design (ILEK). Then this October, ILEK faculty and students visited Northwestern and Chicago.

The AED program has also expanded to a second year with a set of new courses: Structural Art taught by Professor David Corr; High Performance Buildings taught by practicing architects and engineers at Skidmore, Owings & Merrill, and Design of Sustainable Urban Developments, taught by urban planners and architects from Perkins and Will Associates. By every measure, this program is providing our students with an unparalleled architectural experience inspired by the personal mentoring of practicing architects from some of the most eminent firms in Chicago.

As you will discover in this newsletter, our distinguished faculty are making surprising discoveries, ranging in scale from the molecular to regional and from the ocean floor to the surface of Mars. Professor Luisa Marcelino has recently developed the first global index to measure the vulnerability of coral species to thermal stress, bleaching, and eventual death. Professor Gianluca Cusatis and his student, Lin Wan, have developed a new and durable concrete formulation using local materials found on Mars. Back on Earth, Professor Sinan Keten is computationally probing how small proteins can withstand mechanical forces causing them to denature. The Center for Water Research, directed by Professor Aaron Packman, just completed its inaugural year and is poised to find long-term solutions to ensure water security and sustainability.

Excellence in teaching continues to be recognized among department faculty. Professors Larry Booth and Neal Blair were nominated to the Associated Student Government’s Faculty Honor Roll. Professor Yonggang Huang received the 2016 Cole-Higgins Awards for Excellence in Teaching for his superb instruction in Engineering Analysis 2.

We began the 2016-17 academic year with our first departmental retreat in more than 10 years. At this gathering we laid the groundwork for a strategic plan that will identify new initiatives for the department. There is a strong consensus to embrace the design of resilient cities and to develop a sense of place around the wonders of Chicago.

I want to thank our alumni, students, faculty, staff, and friends for their support and commitment to our department. We look forward to continuing to work with you to solve some of the world’s most pressing problems and make the world a better place for everyone.

Kimberly Gray
Chair of Civil & Environmental Engineering

Kimberly Gray, professor of civil and environmental engineering, became department chair on August 1, 2015. She succeeds Jianmin Qu, who left Northwestern to become dean of engineering at Tufts University.

With a courtesy appointment in the Department of Chemical and Biological Engineering, Gray is an expert in environmental catalysis and physicochemical processes in natural and engineered environmental systems. Her research focuses on energy and urban sustainability applications. As chair, she aims to further the department’s work addressing many of the world’s most pressing problems, including infrastructure, urban redevelopment, transportation, energy, and water.
Chicago’s Red-light Camera Program Shows Significant Safety Benefits

The study is the first to document ‘spillover effect’ to intersections without red-light cameras

A study by the Northwestern University Transportation Center released in March found that Chicago’s red-light camera (RLC) program reduces serious injury crashes at intersections where they are placed and also have a measurable “spillover effect” that improves safety at intersections without cameras.

Authorized by the Chicago City Council and commissioned by the Chicago Department of Transportation, the report provides tools and analysis that can help the city identify existing and potential camera locations requiring further attention and notes that enforcing RLC violations occurring within fractions of a second after the light turns red might not provide significant safety benefits.

Hani S. Mahmassani, professor of civil and environmental engineering and director of the Northwestern University Transportation Center, led the study. His research team was composed of an expert advisory panel of traffic safety experts from across the country, including Joseph Schofer, professor of civil and environmental engineering at McCormick.

The report found that injury-producing crashes decreased by about 10 percent because of the camera program; more dangerous angle and/or turn crashes decreased by 19 percent. The study also found less dangerous and less frequent rear-end crashes increased by 14 percent, consistent with experience in other cities.

The Northwestern RLC researchers are the first to document that red-light cameras improve behavior at intersections without cameras through a “spillover effect.” The researchers estimated the spillover effect by comparing before- and after-crash data at 85 intersections where RLCs were installed in 2008 and 2009 with crash data for 103 intersections that were not equipped with cameras.

The report presented three key recommendations for the program moving forward: 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.

Department Welcomes Ange-Therese Akono

Akono Joins Northwestern from the University of Illinois at Urbana-Champaign

Northwestern University is excited to welcome Ange-Therese Akono as an assistant professor of civil and environmental engineering.

Joining from the University of Illinois at Urbana-Champaign, Akono studies fracture mechanics, experimental nanomechanics, chemo-mechanical coupling, and multi-scale modeling. In her research laboratory, she focuses on understanding fracture resistance mechanisms in composite materials at the nanoscale, with applications in novel structural design, sustainable energy resources, and public health.

“I am thrilled to officially join Northwestern,” said Akono. “I look forward to working with Northwestern students and collaborating with faculty members on cutting-edge issues such as tough and strong cement alternatives, carbon dioxide geological capture and sequestration, and fracture resistance of biological tissues for improved public health.”

Akono received her master’s degree and PhD in civil and environmental engineering from the Massachusetts Institute of Technology and her bachelor’s degree in mechanical engineering from École Polytechnique in Palaiseau, France.
A new global partnership led by the Northwestern Center for Water Research is taking a multifaceted approach to water challenges facing the Middle East.

The research and academic collaboration between Tel Aviv University (TAU) and Ben-Gurion University (BGU) in Israel and Northwestern University further establishes efforts that began shortly after the center’s launch in 2016.

“This partnership substantially increases opportunities for Northwestern faculty and students to collaborate with peers in Israel, and allows us to contribute to solutions faced by the Middle East and other arid regions,” said Aaron Packman, professor of civil and environmental engineering and director of the Northwestern Center for Water Research.

The Water Center recently initiated a new seed grant program that supports research collaborations to solve these water challenges. The first round of seed grant funding has been awarded to four international groups. George Wells, assistant professor of civil and environmental engineering, will work with TAU’s Hadas Mamane-Steindel and Dror Avisar to complete a “metagenomics-guided analysis of antibiotic resistance genes in hospital wastewater treatment systems for decentralized water reuse.”

“These projects hold the potential to yield scientific discoveries and practical community-centered solutions for water security in Israel and beyond,” said Packman. “Water is central to life, and also to industry and agriculture. In a water-poor region like the Middle East, this makes water central to both peace and health for everyone in the region.”

Northwestern’s Center for Water Research was created in March 2016 to link the University’s water research efforts in basic sciences, technology development, law and policy, and systems analysis and simulation to address challenges in water systems sustainability and efficiency.

Local Ties, Global Leader
Northwestern engineers and social scientists, playing a leading role in seeking solutions to a global crisis over water insecurity, visited Israel in early September to deepen academic exchanges, create new partnerships, and collaborate with Chicago officials who are also working on the problem.

Members of the Northwestern community were in Israel participating in WATEC, a major international water industry conference, as part of a delegation with the city of Chicago.

On September 11, Packman and Fruma Yehiely, associate vice president for research at Northwestern, signed a memorandum of understanding (MOU) with Ben-Gurion University’s Zuckerberg Institute for Water Research in Israel. The MOU seeks to facilitate the exchange of students, faculty, and postdoctoral fellows.

Chicago Mayor Rahm Emanuel also attended and gave opening remarks at the WATEC conference in addition to witnessing the signing of the MOU.
Workshop Explores Opportunities in Large-Scale 3D Printing

Department hosts 3D printing pioneers to discuss latest advancements in the field

The Department of Civil and Environmental Engineering welcomed 50 members from academia, industry, and government to its first workshop on large-scale 3D printing in April. Called “3D Printing Across Multiple Length Scales: Is The Sky The Limit?,” the event explored how large-scale 3D printing is presenting designers, architects, and engineers with unexplored opportunities to construct large structures with stronger, tougher, more durable, and more environmentally friendly materials.

The workshop featured presentations from 3D printing pioneers from Stanford, University of Southern California, University of California Berkley, and architecture firm Skidmore, Owings & Merrill LLP that showcased the latest advancements in large-scale 3D printing techniques and with materials that go beyond metals and plastics.

Michael Case, a project manager in the Army Corps of Engineers’ Construction Engineering Research Laboratory (CERL), discussed his team’s efforts to use large-scale 3D printing to streamline the process of constructing army barracks in warzones and disaster areas. Currently, barracks are made primarily out of wood, which must be transported to territories and manually assembled with a team of workers. Case’s team hopes to develop printing techniques that use local materials — like sand — and large-scale 3D printers to print barracks onsite in 24 hours.

Northwestern Engineering Professor Gianluca Cusatis, who is providing computational analysis on CERL’s barracks project, believes scalable 3D printing could add several benefits to building construction.

“3D printing would provide much more control over the quality of the final product since production is automated,” said Cusatis, who organized the workshop. “You would no longer need a construction team. You would only need to ship cement and water to the site.”

Cusatis added that the workshop was an important step in establishing Northwestern as a leader in scalable 3D printing. He hopes the University can one day manage its own large-scale 3D printing lab to further explore the performance of new composite structural materials.

“There is a lot of work to do, but many people from different fields are interested in pushing the boundaries of 3D printing,” said Cusatis. “We have the opportunity at Northwestern to contribute through our research on the mechanics of materials, as well as to educate students using the next generation of 3D printing technology.”
ARCHITECTURE
STUDENTS BUILD
FORMWORK SKILLS
IN STUTTGART

Students worked in teams to tackle 3D hydroplotting design challenge

Students took part in a one-week workshop on 3D hydroplotting of concrete formwork to build their skills in conceptual design.

Nine Northwestern civil and environmental engineering students, accompanied by Professor David Corr and adjunct lecturer Scott Cyphers, visited the Institute for Lightweight Structures and Conceptual Design (ILEK) at the University of Stuttgart in September. The students were part of the Department’s Architectural Engineering and Design (AE&D) program that prepares next-generation engineers to combine creative and algorithmic thinking to take on today’s sustainability challenges. Northwestern and Stuttgart have alternated visits for the past three years.

During their visit, students took part in an intensive, one-week workshop on 3D hydroplotting of concrete formwork to build their skills in conceptual design, 3D modeling, and experimental research while exploring topics like concrete’s limits as a building material.

The students used 3D modeling programs to program a Computer Numerical Control (CNC) machine fitted with a water jet. The CNC machine traversed a bed of dry sand and cellulose binder, forming a train of damp sand that created the students design. Following this hydroplotting procedure, the sand was dried to harden the binder, forming a rigid formwork into which a self-consolidating concrete mixture was poured.

Aided by University of Stuttgart researchers and students, AE&D students were placed in teams and urged to pursue a creative approach to the design challenge. One group designed a hexagonal pattern, another group created a design influenced by the human vertebrae, and the last group investigated moiré patterns of intersecting waves. After a week of iteration and prototyping, the teams presented their work to Northwestern and ILEK professors.

NEW COURSES LAUNCHED

The department is excited to introduce new courses that highlight the challenges facing global societies and how civil and environmental engineers are uniquely equipped to find solutions that improve the quality of human life and the integrity of nature.

INNOVATIVE GATEWAY COURSES

Biology, Ecology & Engineering (Prof. Erica Hartmann) explores biological principles and technologies that are transforming the landscape of engineering possibilities.

Engineering Possibilities: Data Science in the Age of Smart Technologies (Prof. Amanda Stathopoulos) examines the future of decision science in a period of unprecedented challenges of climate change, urbanization, and social inequality.

Structural Art (Prof. David Corr) teaches how to interpret and understand the built environment through an examination of the history of structural engineering as a creative art.

Earth System Science (Prof. Neal Blair) explores how human activity affect the physical, chemical, and biological processes have made the Earth habitable.

OTHER NEW COURSE OFFERINGS

Economics & Finance for Engineers (Prof. Pablo Durango-Cohen) teaches fundamental concepts in economics and finance in the context of modern engineering systems.

High Performance Buildings (Joe Burns of Thornton-Tomasetti) pursues sustainable design for high performance in building energy, water, and material use.

Energy Law & Policy (Prof. Keith Harley) examines major laws that regulate the acquisition of energy resources, the conversion of resources into usable energy, and transmission and transportation infrastructure.

Hydrogeology (Prof. Joe Rossabi) & Ecohydrology (Prof. Aaron Packman) explores the intersection of geologic materials, and aquatic and ecologic systems to design efforts to protect, conserve, and restore.
Sinan Keten participated in the NAE’s US Frontiers of Engineering symposium in September.

Aaron Packman gave a plenary talk at the International Conference on Groundwater in Bogota, Colombia in August.

STUDENT NEWS

Michael D. Aronson received the Wallis S. Hamilton Award for Civil Engineering Senior.

Hannah R. Brady received the Jimie E. Quon Memorial Award for Environmental Engineering Senior.

Kathryn Eckhoff ('17) received the Thornton Tomasetti Foundation National 2017-2018 Scholarship, Alumnae of Northwestern University Graduate Fellowship, AISC Foundation/Associated Steel Erectors Fellowship, and the Department of Civil and Environmental Engineering Edwin C. Rossow Prize for Structural Engineering Senior.

Matthew Shaxted ('11) co-founded Parallel Works, a Chicago-based Supercomputing-as-a-Service company. In addition to designing and implementing the company’s product, he works with Parallel Works customers in the built environment and manufacturing verticals, helping them unlock the power of high-performance computing in their business practices.

Yonggang Huang, Walter P. Murphy Professor of Civil and Environmental Engineering and Mechanical Engineering, was elected to the National Academy of Engineering (NAE), one of the highest professional distinctions accorded to an engineer. Huang was one of 84 new members and 22 new foreign members announced by the NAE in February.

Huang, whose work has led to major advancements in stretchable and flexible electronics with biomedical applications, was cited by the NAE for “pioneering work on mechanics of stretchable electronics and mechanically guided, deterministic 3-D assembly.”

“We are tremendously proud of Yonggang,” said Julio M. Ottino, dean of the McCormick School of Engineering and an NAE member. “He exemplifies research excellence at the highest level, a strong commitment to education and outstanding collegiality.”

Huang’s recent work includes a wearable electronic device for on-the-spot health monitoring. Potential applications of his technology include thin “tattoo-like” sensors placed on the skin; implantable devices, such as pacemakers, defibrillators and heart-rate monitors; and electrocardiograms and electromyography.

FACULTY NEWS

Zdeněk P. Bažant was elected as a foreign member of the Academy of Athens. He also presented plenary lectures at the ASCE Engineering Mechanics Institute annual meeting, the 14th International Congress of Fracture, and the 7th International Conference Fibre Concrete.

William Oestreich ('15) entered his first year as a PhD student at Stanford University’s Hopkins Marine Station, where he’s working to integrate his interests in marine ecology, resource management, and environmental policy to explore management approaches for protecting highly-mobile marine animals.

After serving as a Peace Corps environmental conservation volunteer, Michael Reiner ('13) entered the University of Michigan to pursue a dual-degree in environmental engineering and sustainable systems. His current academic and research interests include urban energy justice, energy-efficiency adoption, and sustainable energy infrastructure.

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Department Launches Soil-Structure and Soil-Machine Interaction Laboratory

Aiming to reinvent how humans interact with earth, Professor James Hambleton’s research group has developed a new lab for advanced physical modeling that will help assess computational models for simulating fundamental processes in soil-structure interaction and soil-machine interaction. The lab uses a fully instrumented 6-axis industrial robot and 3D printing to complete tests with a variety of small-scale models for structures and tools operating on a range of soils, including rapidly reconstituted simulants and samples extracted from field sites.

The lab’s findings will enhance the performance and safety of geotechnical infrastructure and form the basis for future long-term studies on the optimization and automation of earthmoving machinery and off-road vehicles, enabling new machine designs and techniques.