Department of Civil and Environmental Engineering

The past several years have been ones of transition, progress, and success for the Department of Civil and Environmental Engineering (CEE). We have developed a new undergraduate curriculum that better integrates the human infrastructure and natural environment aspects of our disciplines, and we have had successes in promoting and hiring faculty.

Some of the recent faculty hires have consolidated our collaboration with the Department of Biological Engineering. CEE faculty members compose a major component of MIT's world-class Microbial Systems Group. Six of our faculty members work in the area of environmental microbiology, and they, particularly Martin Polz, were involved in creating the new interdepartmental and interdisciplinary graduate PhD program in microbiology at MIT. Others have brought new expertise and scale to fluid mechanics and materials, and some led to new research directions well aligned with the MIT Energy Initiative. The Department continues to actively help with development of the multidisciplinary Earth System Initiative and its affiliated Terrascope educational program for MIT freshmen.

Recently, a large initiative quite central to the Department has been launched: CENSAM (Center for Environmental Sensing and Modeling). CENSAM, which is headed by professor Andrew Whittle and involves several other CEE faculty members, is one of the first two research groups associated with the newly signed Singapore–MIT Alliance for Research and Technology.

In January, the Department launched a search for two faculty appointments at the assistant professor level, one jointly with the Department of Chemical Engineering. We considered exceptional candidates with interests in geomechanics and geomaterials and in environmental chemistry, broadly defined. We also considered outstanding candidates in other areas of civil and environmental engineering.

Our five junior faculty members—Eric Alm, Markus Buehler, Ruben Juanes, Roman Stocker, and Janelle Thompson—are quickly proving to be integral members of our Department. Our most recent addition, environmental microbiologist Janelle Thompson, completed her postdoctoral research at Harvard University and joined us in July 2007. Janelle uses the tools of molecular biology, genomics, and genetics to identify the components of microbial communities and study their dynamics, interactions, and organization. Her research area fits nicely with the microbial genomics group in our Ralph M. Parsons Laboratory, and we look forward to her continued active presence on our faculty. The department renovated lab space for Thompson on the third-floor of Parsons Lab. In the spring term, she taught Course 1.083 Environmental Health Engineering.

Markus Buehler, the Esther and Harold E. Edgerton assistant professor, was recognized this year with three prestigious national research awards. He received an Office of Naval Research Young Investigator Award for his research proposal "Hierarchical Nanomechanics of Amyloid Protein Fibers," a grant through the Air Force's Young

Investigator Research program to investigate structural hierarchies in biomimetic materials, and the DARPA Young Faculty Award for University Microsystems Research.

Edward DeLong was elected to the National Academy of Sciences (NAS) this spring, becoming the second CEE faculty member to hold that most prestigious of scientific honors. Sallie Chisholm also is a member of NAS.

Two CEE faculty members currently hold senior leadership roles in the MIT administration: Cynthia Barnhart is associate dean for academic affairs in the School of Engineering, and Steven Lerman is vice chancellor for MIT. Rafael Bras announced in the spring that he has accepted the position of dean of engineering at the University of California, Irvine, effective September 1.

With respect to our graduate programs, we have decided to expand our transportation offerings by providing a new MEng track in transportation, effective fall 2008. The Department produced a brochure for the program to introduce the new track.

The Department's research newsletter, *On Balance*, has succeeded in increasing awareness of faculty research among our colleagues at other universities. The monthly one-page newsletter highlights MIT CEE research and educational projects and is mailed to approximately 550 engineering deans and heads of civil and environmental departments at universities around the United States. In January 2008, we began sending the newsletter to all CEE alumni who teach or perform research at academic institutions. Anecdotal evidence suggests that the newsletter has increased name recognition nationally for our junior faculty and their research.

We are in the process of redesigning the CEE website to include more in-depth information about the Department's education and research programs and to highlight the fieldwork blogs kept by our students and faculty members. We expect the new website to be launched by November 2008. The Department is also redesigning the alumni newsletter, which will be published twice annually beginning in fall 2008.

Educational Activities

Undergraduate Programs

During the 2007–2008 academic year, CEE had an enrollment of 97 undergraduates—11 CEE general (1A), 47 civil engineering (1C), 37 environmental engineering science (1E), and two Cambridge/MIT exchange students—and awarded 23 bachelor of science degrees (seven in 1E, 13 in 1C, and three in 1A).

The class of 2008 was the first to complete the new integrated CEE undergraduate curriculum. As sophomores, the 1A, 1E, and 1C majors took the common core classes together, including the sophomore engineering design lab. Junior year they split into their respective majors, and senior year they came together again for the capstone course in civil and environmental engineering design.

In October 2007 the Department met with Accreditation Board for Engineering and Technology (ABET) representatives for the Department's programs in civil engineering and environmental engineering science. The ABET draft statements resulting from the program evaluations identified one weakness for each program. These weaknesses related to the wording of the program educational objectives (PEOs). In May 2008, the Department submitted to ABET, through the School of Engineering, written responses to the ABET comments. These responses provided revised PEOs, together with data indicating that the revised PEOs had been achieved.

Undergraduate Research and Practical Applications

The spring semester of the engineering design class 1.102 (Introduction to Civil and Environmental Engineering Design II) again followed a distributed energy-harvesting theme this year. The sophomores built their own generators as well as energy machines of their own design that converted kinetic energy to electrical energy and powered low-output devices. The six original designs are a solar collector made from a satellite TV unit, a triple-helical windmill designed to catch wind coming from any direction, a bicycle that generates enough power to operate a laptop computer, a turnstile that uses a flywheel to capture and store energy, a full-sized swing-set, and a hydropower collector. Students displayed their machines around campus near the end of term, inviting fellow students to try them out.

CEE seniors once again capped their undergraduate engineering education by designing portable bridges in Course 1.013 (Senior Civil and Environmental Engineering Design), led by professor Herbert Einstein. They assembled and load-tested the bridges in a lunchtime exhibition on the Student Center plaza.

The Department's steel bridge team placed first in construction time and second overall in the regional competition of the American Society of Civil Engineers (ASCE) Steel Bridge Competition in March. The team's bridge design—described as a frame-supported, cable-stayed bridge—is an original that did well in the competition against girder bridges, truss bridges, and an arch bridge with a box girder deck. Junior Lauren Biscombe placed third in the ASCE paper competition with her paper and speech on infrastructure privatization. The team had a construction time of just five minutes at nationals, held at the University of Florida, Gainesville, on May 24 but suffered a few penalties and ultimately earned a ranking of 21 out of 42 competitors. The team performed a practice run of the assembly on the Student Center steps in May. The MIT News website featured a video of the event.

Sixteen undergraduates spent Independent Activities Period on the island of Hawaii with CEE TREX (Traveling Research Environmental eXperience), an undergraduate field research course. The students studied groundwater flow through coastal anchialine ponds and collected data to judge the potential impact of nearby commercial development on the ponds in Kaloko Honokohau National Park. TREX director Sheila Frankel and other faculty and graduate students accompanied the students. Sophomore Adam Talsma kept a blog that ran as an RSS news feed on the MIT News website for the MIT community to follow.

Summer Internships

The CEE summer internship program continues to strengthen ties with dozens of prominent engineering firms around the world, many of which were founded by Department alumni. The internship program helps our sophomores and juniors find professional summer employment working with civil and environmental engineers in the field, lab, or office. This year five members of the faculty/staff (Peter Shanahan, Lisa O'Donnell, Lucy Jen, John Attanucci, and Eric Adams) assisted 37 CEE students in finding appropriate summer internships, including several students who worked in Venice and Reykjavik and some who were placed with firms in their hometowns. This program provides an important educational opportunity for our undergraduates, more than half of whom participate. The internships also help facilitate employment offers after graduation.

Graduate Programs: Master of Engineering, Master of Science, and Doctoral Programs

In the course of the academic year, the Department awarded 82 graduate degrees: 22 doctorates, 14 master of science degrees, 18 master of science in transportation, and 28 master of engineering. These numbers do not include dual-program students such as Leaders for Manufacturing and Woods Hole Oceanographic Institution.

Our graduate students continue to be engaged in cutting-edge research in a variety of disciplines. While many students in our graduate programs continue on to doctoral studies and careers in academia, most students in two of our programs (the master of engineering and master of science in transportation) move on to leading jobs in industry and government after completing their degrees.

The PhD degree is critical to the Department's mission to educate intellectual leaders for academia and national research laboratories. Although research is often interdisciplinary, the program curricula are organized around the following areas of study: aquatic sciences, hydrology, environmental fluid mechanics and coastal engineering, information technology, transportation, civil and environmental systems, geotechnical and geoenvironmental engineering, and structures and materials.

The level of funding for doctoral students continues to be a priority for FY2009, because this support promotes recruitment of the most highly qualified applicants to the Department. CEE has been awarded four Presidential Fellowships for the coming year, and the Department continues to provide funding for several graduate fellowships.

Lectures

The Department cohosted the annual John R. Freeman Lecture with the Boston Society of Civil Engineers at MIT on April 14. This year's lecture was presented in Wong Auditorium by Dr. Brendan Harley, senior vice president of Camp Dresser & McKee Inc. Harley is project director for the construction phase of Singapore's $250 million Marina Barrage project and has been involved since the project's conception in 1985. This project will integrate flood control, water supply, and lifestyle attractions in the heart of Singapore. Modeled in concept after Boston's Charles River Basin, the new facility will

provide flood protection to low-lying areas that have been subject to tidal and storm flooding. The lecture series is named for the MIT alumnus who designed the original Charles River Dam.

José Mariano Gago, Portugal's Minister of Science, Technology and Higher Education, gave the annual Charles L. Miller Lecture on April 7 in the Bush Room. Gago spoke on "The Future of Science and Technology in Europe." The lecture series is named for Miller, who was CEE department head from 1962 to 1969.

Professor Chiang C. Mei hosted a three-part lecture series in February on wave energy presented by professor Antonio Sarmento, director of the Center for Wave Energy Research at the Institute of Advanced Technologies, University of Lisbon, Portugal.

Faculty Research Highlights

A number of faculty received publicity for their research, including those listed below with headlines.

Eric Alm—Gene's "selective signature" aids detection of natural selection in microbial evolution; Scientists reveal the lifestyle evolution of wild marine bacteria (with Martin Polz).

Moshe Ben-Akiva—An episode of The History Channel's "Modern Marvels" titled "Superhighways," featured Ben-Akiva's traffic modeling program, MITSIM.

Markus Buehler—MIT probes secret to bone's strength; Speed plays crucial role in breaking protein's H-bonds; Protein's strength lies in H-bond cooperation.

Roman Stocker—Be still my beating heart: Researchers solve mystery of the throbbing drop of oil; Marine bacteria's mealtime dash is a swimming success.

Dara Entekhabi—Entekhabi will lead science team for NASA satellite mission to map Earth's water cycle.

Oral Buyukozturk—Handheld device "sees" damage in concrete bridges, piers.

Sallie Chisholm—Small-scale parasitic battles may have epic evolutionary proportions; Team probes mysteries of oceanic bacteria (with Ed DeLong).

Ed DeLong—Team probes mysteries of oceanic bacteria (with Sallie Chisholm).

Richard de Neufville—Flexible airport design essential for courting low-cost airlines, the new major players.

Heidi Nepf—River plants may play major role in health of ocean coastal waters.

Martin Polz—Scientists reveal the lifestyle evolution of wild marine bacteria (with Eric Alm).

David Simchi-Levi—New study will compare European and American supply chains.

Franz-Josef Ulm—Green concrete: Nanoengineered materials could reduce greenhouse-gas emissions, invited Op-Ed in *Technology Review*.

John Williams—Tracking all things great and small, an article in *EWeek* about Williams' quest to build the Internet of things.

Nigel Wilson—Helping transit agencies use data wealth wisely.

Faculty Notes

Eric Alm was named a 2007 Doherty Professorship in Ocean Utilization from the MIT Sea Grant College Program in February.

Cynthia Barnhart was named associate dean for academic affairs in the School of Engineering. She also is current president of INFORMS.

Moshe Ben-Akiva, the Edmund K. Turner professor of civil and environmental engineering and director of the MIT Intelligent Transportation Systems Program, received the Dupuit Prize from the World Conference on Transport Research Society at its conference at the University of California, Berkeley. The Dupuit Prize, the highest honor presented by the society, is named after Jules Dupuit, often credited as the founder of transportation research.

Rafael L. Bras was named dean of engineering at the University of California, Irvine. MIT awarded Bras the James R. Killian Jr. Faculty Achievement Award for 2008–2009, and Bras received the American Geophysical Union (AGU) 2007 Robert E. Horton Medal in December for his contributions to the geophysical aspects of hydrology. The Horton Medal is the highest award given to hydrologists by geophysicists.

As stated earlier in this report, Markus Buehler was recognized this year with three prestigious national research awards: the Office of Naval Research Young Investigator Award, a grant through the Air Force's Young Investigator Research program, and the DARPA Young Faculty Award for University Microsystems Research.

A research paper by Oral Buyukozturk and Ching Au (SM 2001, ScD 2005) was named Best Basic Research Paper 2006 published in the *Journal of Composites for Construction*, an ASCE publication. The paper deals with the durability of multilayer composite material systems under different environmental conditions. Buyukozturk and PhD student Tzu-Yang Yu received the 2008 American Society for Nondestructive Testing (ASNT) Fellowship Award for their work on far-field airborne radar for the condition assessment of critical civil infrastructure.

Sallie (Penny) Chisholm co-organized and hosted a two-day celebration honoring the 20th year since the discovery of the cyanobacteria *Prochlorococcus*. Prochlorococcus Fest, held May 30–31 at MIT, featured a range of talks highlighting past, current, and future research on the smallest—and most abundant—photosynthetic organism in the oceans. NPR's Joe Palca attended and interviewed Chisholm on "Science Friday."

Edward DeLong was elected a member of the National Academy of Sciences this year. DeLong, a marine microbiologist whose groundbreaking work on ocean microbes is

internationally recognized, also received two other major awards this spring, from the European Geosciences Union and the American Academy of Microbiology.

Richard de Neufville was awarded a Fulbright Scholarship to participate in a Fulbright German Studies Program held in Berlin and Brussels in June. He joined 15 other academics from the United States to learn about current German approaches to environment risk and management in the context of the European Union.

Elfatih Eltahir was elected a Fellow of AGU, an honor granted every year to only 0.1% of AGU's 50,000 members. Fellows are elected based on their acknowledged eminence in the Earth and space sciences and their contributions to the scientific community and the advancement of the public's understanding.

Dara Entekhabi was appointed next director of the Earth System Initiative, effective July 1, when Sallie Chisholm steps down. Entekhabi also will lead the science team designing a NASA satellite mission scheduled for a 2012 launch. The satellite will measure global soil moisture and freeze/thaw data, which are essential for the accuracy of weather forecasts and predictions of global carbon cycle and climate. Entekhabi also was the first member of the Department to spend six months in residence at Singapore as part of the MIT–Singapore Alliance. Entekhabi was a member of a committee of the National Research Council convened to look at the effect energy crops would have on the nation's agriculture and water management. The committee's report, released in October, said that boosting ethanol production in the United States through increased corn crops nationwide could put a significant strain on water resources in some parts of the country.

Ruben Juanes was one of three CEE professors whose work was named by *Boston* magazine as second of "61 New Best Things About Boston." Juanes, Chiang Mei, and Franz Ulm were recognized for their work on carbon sequestration, wave energy, and green concrete, respectively.

Senior lecturer George Kocur, who teaches Course 1.00 (Introduction to Computers and Engineering Problem Solving), was recipient of the Institute's Graduate Student Council Teaching Award.

Steven Lerman was named MIT vice chancellor, effective July 1.

Ole Madsen was presented MIT's inaugural Earll M. Murman Award for Excellence in Undergraduate Advising at the Institute's Awards Convocation in May.

Yosef Sheffi was named director of the Engineering Systems Division. Sheffi holds faculty appointments in CEE and in the Engineering Systems Division. He is also director of the Center for Logistics and Transportation.

Joseph M. Sussman, JR East professor and professor of engineering systems and civil and environmental engineering, was elected a Fellow of the American Association for the Advancement of Science. He was also presented the 2008 Career Achievement Award

by the Engineering School Alumni of the City College of New York and was named the first chair of the Intelligent Transportation System (ITS) Program Advisory Committee by the US Department of Transportation.

As mentioned earlier, Andrew Whittle was named lead principal investigator on the CENSAM research project, a research component of the Singapore–MIT Alliance for Research and Technology Centre. CENSAM held its inaugural workshop in Singapore in January.

Student Awards and Notes

AGU announced that Rebecca Neumann and Alejandro Flores, PhD candidates in the Department, won Outstanding Student Paper Awards from AGU's hydrology section. Flores' paper, coauthored with professors Rafael Bras and Dara Entekhabi, is titled "Modeling Uncertainty and Correlation in Soil Properties Using Restricted Pairing and Implications for Ensemble-Based Hillslope-Scale Soil Moisture and Temperature Estimation." Neumann's paper, coauthored with professor Charles Harvey, is titled "The Hydrology and Chemistry of Rice Field Recharge in Bangladesh."

Senior Quinn Vollmert of Sioux Falls, South Dakota, was elected to Phi Beta Kappa. Vollmert is captain of the Department's steel bridge team.

The Department's chapter of the civil engineering honor society, Chi Epsilon, inducted seven new members: seniors Katherine Jarrell, Tamara Sheldon, and Alia Whitney-Johnson, and juniors Lauren Biscombe, Alexandra Konings, Allison St. Vincent, and Patricia Tcaciuc.

Two juniors were named Burchard Scholars: Samuel Hollander of Great Neck, NY, and Allison St. Vincent of Bristol, RI.

Graduate student Loai Na'amani received the Graduate Student Award from the MIT Arab Students Organization this spring.

Graduate student Tak Bun Denvid Lau was recipient of the fall 2007 Marvin E. Goody Award.

PhD student David Gonzalez-Rodriguez was recipient of the 2008 School of Engineering Graduate Student Extraordinary Teaching and Mentoring Award. Gonzalez-Rodriguez won the CEE Maseeh Award for excellence as a teaching assistant in 2007.

Environmental engineering major Connie Lu helped to form the Global Poverty Initiative and organize its Millennium Campus Conference, held at MIT in April. CEE student teams took first and second place in the Millennium Challenge Competition to solve drinking water and sewage problems. Lu and MEng students Vanessa Green and Tamar Losleben were members of the winning teams, which were advised by CEE senior lecturer Susan Murcott.

Junior Allison St. Vincent won the $5,000 Simpson Gumpertz & Heger Scholarship at the annual Student Night of the Boston Society of Civil Engineers Section of ASCE, which was hosted by the Department this year.

The steel bridge team placed second in the regional competition of the ASCE Steel Bridge Competition in March and was ranked 21 out of 42 competitors at the national competition in Florida in May.

Junior Lauren Biscombe placed third in the related ASCE paper competition with her paper and speech on infrastructure privatization.

Seed magazine named CEE doctoral student Arne Bomblies to its list of "Revolutionary Minds" for his hydrological and entomological research on the connection between water, mosquito breeding, and malaria in Niger, Africa. The magazine included a profile of Bomblies in "revolutionary thinkers whose global research has the potential to effect worldwide change" in the October issue.

Visiting graduate student Theodor Ackbarow won the 2007 Gustav-Magenwirth Award from the University of Stuttgart, Germany, for best thesis in mechanical engineering. Ackbarow performed his thesis research at MIT under the supervision of CEE professor Markus Buehler.

As mentioned previously, PhD student Tzu-Yang Yu and his advisor, professor Oral Buyukozturk, received the 2008 ASNT Fellowship Award.

Junior Amy Gilpin (now a senior) coordinated the 2007 Giving Tree for the MIT Public Service Center, which provides holiday gifts to local children.

Graduate student Tegin Teich, recipient of an Eisenhower Graduate Transportation Fellowship from the US Department of Transportation, made a presentation on her research at the Transportation Research Board's annual meeting in January 2008. Teich's research is on bicycling as a form of sustainable transportation in Mexico.

Departmental Awards

This year the Department combined its annual awards dinner with the senior dinner on May 16. Department Head Patrick Jaillet and Associate Department Head Ole Madsen presented graduating seniors with frames for their diplomas. The seniors presented technical instructor Stephen Rudolph with cufflinks as an expression of their appreciation for his help and mentoring during their three years in the Department. Other recipients of untraditional awards included the undergraduate members of the steel bridge team, whose hard work was recognized by the Department with a gift of Swiss army knives.

Professor Ole Madsen was awarded the Department's Maseeh Award for excellence in teaching this year.

PhD student Jose Alberto Ortega received the Maseeh Award for excellence as a teaching assistant for his work in Course 1.050 Engineering Mechanics I. Ortega is a civil engineering PhD student from Cuenca, Ecuador.

Graduate student Todd Radford, a teaching assistant in the sophomore engineering design class, won the Trond Kaalstad (Class of 1957) Graduate Award for leadership and significant contribution to the well-being of the CEE community. Radford, a civil engineering PhD student, is from Fredericton, New Brunswick, Canada.

Gwendolyn Johnson received the Steinberg Prize for outstanding undergraduate academic achievement and demonstrable interest in construction management. Johnson, a senior majoring in civil engineering, is from Scottsdale, AZ.

The Leo (1924) and Mary Grossman Award went to senior David Baumgartner for his academic achievement and interest in transportation. Baumgartner is from Aitkin, MN.

MEng student Sanusi Dantata won the Tucker-Voss Award for showing promise in the field of building construction. Dantata is from Kano, Nigeria.

The Richard Lee Russel Award for an outstanding undergraduate who plans to continue study in graduate school went to senior Kristen Burrall, an environmental engineering major from Elk Grove, CA, who will stay on next year to earn the MEng degree.

Patrick Jaillet
Department Head
Edmund K. Turner Professor

More information about the Department of Civil and Environmental Engineering can be found at http://cee.mit.edu/.