

Department of Civil and Environmental Engineering

The past several years have been ones of transition, renewal, and success for the Department of Civil and Environmental Engineering (CEE). The new undergraduate curriculum better integrates the human infrastructure and natural environment aspects of our disciplines, we have had successes in promoting and hiring faculty, CEE faculty are now central to several new Institute-wide research initiatives, and we have redesigned the department's website and alumni newsletter to better communicate the department's enhanced role at the Institute.

In spring 2009, MIT launched a large research initiative whose focus aligns with the research of many of this department's faculty and researchers. Transportation@MIT, headed by professor Cynthia Barnhart, is an interdisciplinary program that involves faculty from CEE, Aeronautics and Astronautics, Urban Studies and Planning, Architecture, and the Sloan School of Management, among others. It will address the ever-increasing environmental impact of the world's transportation needs. (The interdisciplinary MST and PhD programs in transportation continue to be administered by CEE.)

In 2008, MIT created the Environmental Research Council, which is headed by CEE professor Dara Entekhabi and includes CEE professors Sallie (Penny) Chisholm and Martin Polz in its membership. The council is expected to draw together environmental work from many different labs and departments to create an Institute-wide collaboration comparable to the MIT Energy Initiative.

CEE faculty continue to be very involved in the Center for Environmental Sensing and Modeling (CENSAM), a research group associated with the Singapore-MIT Alliance. Professors Andrew Whittle (who heads the initiative), Dara Entekhabi, and Ole Madsen each spent six months in residence in Singapore. A number of other faculty, teaching staff, and students (both graduate and undergraduate) have also spent time in Singapore working on CENSAM research.

The department is very pleased to announce the hiring of three exceptional junior faculty members. Last year we announced in this report that the department had launched a search for two faculty appointments at the assistant professor level, one jointly with the Department of Chemical Engineering. That search resulted in the hiring of Jesse Kroll, an environmental chemist whose research involves experimental study of the properties and chemical transformations of organic species in the Earth's atmosphere. Kroll joined the CEE faculty in January 2009. He has joint appointments in CEE and the Department of Chemical Engineering, with CEE as his home department. During the spring, CEE completed renovations of a 900-square-foot laboratory for Kroll on the third floor of the Parsons Laboratory (Building 48).

The second search resulted in hiring Pedro Reis, an instructor in the Department of Mathematics who will join CEE in July 2010 with a dual appointment in the Department of Mechanical Engineering. Reis's research interests are in mechanics and materials, including the elasticity of thin objects, deformation, fracture, and granular media.

In addition, Marta C. González joined the department in July 2009, following the School of Engineering's search for a transportation faculty member. González's research integrates methods of complex systems with statistical physics approaches, computational sciences, geographic information systems, and network theory to characterize and model human dynamics, much of which is applied to transportation research. CEE is González's home department. She has a joint appointment with the Engineering Systems Division (ESD).

Four CEE faculty members received promotions effective July 1, 2009. Markus Buehler and Roman Stocker were promoted from assistant professor to associate professor without tenure. Martin Polz and John Williams were promoted from associate professor with tenure to full professor.

Three CEE faculty members continue to hold senior leadership roles in the MIT administration: Cynthia Barnhart is associate dean for academic affairs in the School of Engineering, Steven Lerman is vice chancellor and dean for graduate education, and Yossi Sheffi is director of ESD.

In 2007, CEE began placing increased emphasis on communicating the department's research and educational activities to students and colleagues within MIT, to CEE alumni, to colleagues at other institutions, and to the general public. This focus has begun to pay off with increased undergraduate enrollment (which is likely due at least in part to improved visibility at MIT) and greater recognition of the department among non-MIT colleagues. (CEE has moved up in the *U.S. News and World Report* ranking two years in a row.)

We redesigned the department website and alumni newsletter during summer and fall 2008. The first issue of the redesigned newsletter, now called CEE In Focus, was mailed to alumni in October 2008. The new website launched in December 2008. Moth Design of Boston designed both projects.

Alumni feedback on the newsletter has been very positive. In addition, MIT's Publishing Service Bureau submitted the CEE In Focus newsletter to the Council for Advancement and Support of Education's annual CASE Circle of Excellence Awards in the category Tabloid and Newsletter Publishing Improvement. The newsletter won a gold award.

The redesigned CEE website was named an Official Honoree of the 2009 Webby Awards (often referred to as the Academy Awards of the Internet), which are presented in New York City by the International Academy of Digital Arts and Sciences. Of the nearly 10,000 entries from all 50 states and 60 countries, the judges select five from each category as official nominees and six as official honorees. CEE's 10 peer honorees and nominees in the school/college category included seven art and design schools and a private high school focused on the arts. The cee.mit.edu website was the only engineering website to be recognized.

The department's research newsletter, *On Balance*, continues to increase awareness of faculty research among our colleagues at other universities. The monthly (10 issues per year) one-page newsletter highlights MIT CEE research and educational projects

and is mailed to engineering deans and heads of civil and environmental departments at universities in the US and to all CEE alumni who teach at research institutions. Anecdotal evidence suggests that the newsletter has increased name recognition nationally for our junior faculty and their research. Also, more than one department head has written to CEE to praise the concept of the research newsletter. For instance, in a recent email, one department head wrote: "I am a faithful reader of your On Balance series. I have enjoyed these brief articles from their inception. I have also shown them to others in my department suggesting we should highlight our research in a similar way."

Educational Activities

Undergraduate Programs

Enrollment in our undergraduate programs rose in 2008 and will remain high for 2009. In spring 2008 and 2009, 40 incoming sophomores declared CEE as their home department, about double the number for the previous couple of years. During the 2008–2009 academic year, CEE had an enrollment of 115 undergraduates: 12 CEE general (1A), 57 civil engineering (1C), 45 environmental engineering science (1E), and one Cambridge/MIT exchange student. In spring 2009, CEE awarded 46 SB degrees, twice the number for 2008. Eighteen of these were in 1E, 21 were in 1C, and seven were in 1A.

We have now had two classes complete the integrated CEE undergraduate curriculum. As sophomores, the 1A, 1E, and 1C majors take the common core classes together, including the sophomore engineering design lab. Junior year they split into their respective majors, and senior year they come 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 to discuss the department's programs in civil engineering and environmental engineering science. The ABET draft statements resulting from the program evaluations identified one weakness related to the wording of the program educational objectives (PEOs) for each program. The department revised the PEOs to ABET's satisfaction and continues to receive ABET accreditation.

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. Students displayed and demonstrated their original machines around campus in May, inviting fellow students to try them out. The MIT News Office ran a photo of one of the machines in a May issue of *Tech Talk*.

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 overall at the regional competition of the American Society of Civil Engineers Steel Bridge Competition held April 5 at Wentworth Institute of Technology and earned a spot at nationals. The day before the regional competition, team member Emily Moberg won first place out of 20 participants in the paper competition. This year's topic was sustainability and engineering ethics. At the national competition held in Las Vegas May 22–23, the team placed 18th among 47 teams. After two days of judging, the MIT team's overall score was \$2.95 million, about the same as at the regional competition. Before going to nationals, the team performed a practice run of the assembly on the Student Center steps in front of a gathered audience.

This year for the first time, the steel bridge team members earned four credit units for their work by enrolling in a special course, 1.993 Steel Bridge Design Competition, during the fall, Independent Activities Period (IAP), and spring semesters. The course now has been assigned a permanent subject number (1.055 for undergraduates and 1.58 for graduate students). Professor Jerome Connor teaches the course.

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 senior lecturers Peter Shanahan and Eric Adams helped 33 CEE students find placements in locations ranging from Boston to Singapore. This program provides an important educational opportunity for our undergraduates and also helps 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 86 graduate degrees: 14 doctorates, 19 master of science degrees, 14 master of science in transportation degrees, and 39 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 continue on to doctoral studies and careers in academia, most students in two of our programs (MEng and SM in transportation) move on to leading jobs in industry and government after completing 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 FY2010, because this support promotes recruitment of the most highly qualified applicants to the

department. CEE has been awarded two 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. Paul V. Rush, PE, deputy commissioner of the Bureau of Water Supply of the New York City Department of Environmental Protection, gave the Freeman Lecture in Wong Auditorium titled, "Big City, Big Aqueduct, Big Challenge: Planning Repairs of NYC's Leaking Delaware Aqueduct." The lecture series is named for the MIT alumnus who designed the original Charles River Dam.

John Krafcik, who was acting president and chief executive officer of Hyundai Motor America, gave the annual Charles L. Miller Lecture on April 8 in Bartos Theater. Krafcik spoke on "Great Leaps, Persistence, and Innovation: The Evolving Story of Hyundai," recounting Hyundai's turnaround from laughingstock of the auto market to fifth-largest car maker in the world. The lecture series is named for Miller, who was CEE department head from 1962 to 1969.

During fall 2008, assistant professor Ruben Juanes hosted a weekly lecture series, "The ENI-MIT Seminar Series on Energy Production from Methane Hydrates," which featured guest speakers involved in energy exploration, including Timothy Collett, chief scientist with the US Geological Survey.

Shyam Sunder, who earned an SM '79, ScD '81 from CEE and was on the faculty for 13 years before joining the National Institute of Standards and Technology (NIST), gave a talk on October 8 attended by faculty and students from many departments and titled, "The Fire Safety Investigation of the World Trade Center Disaster." Sunder is director of the Building and Fire Research Laboratory of NIST.

Faculty and Staff Notes

As mentioned earlier, professor Cynthia Barnhart, who is associate dean for academic affairs in the School of Engineering, was named director of the Institute's Transportation@MIT interdisciplinary program established to address the environmental impact of the world's transportation.

Moshe Ben-Akiva, Edmund K. Turner professor of civil and environmental engineering, received an honorary doctorate on November 21 from KTH Royal Institute of Technology in Stockholm. The degree recognizes Ben-Akiva as a "visionary and leading researcher within the transport modeling field with strong links to KTH, Swedish transport organizations and the Swedish telecom industry. His unique contributions have led to the development and application of discrete choice analysis theory to transport demand models, and he is considered to be the initiator of the entire modern era within this particular area of research."

Ben-Akiva also coedited a book titled *Recent Developments in Transport Modelling: Lessons for the Freight Sector* (Emerald Group Publishing, 2008) with Hilde Meersman and Eddy Van de Voorde of the University of Antwerp.

Professor Rafael Bras (on leave) returned to MIT from his post as dean of engineering at the University of California at Irvine to deliver the annual Killian Lecture and attend a symposium in his honor held March 29–30. A half-day of scientific presentations by former students preceded the Killian Lecture, which is presented each year by the winner of the James R. Killian Jr. Faculty Achievement Award, the highest honor bestowed by the MIT Faculty on one of its own. A video of Bras's speech, "Planet Water: Complexity and Organizations in Earth Systems," can be viewed online at MIT World.

Denise Brehm, senior communications officer in CEE, received an Infinite Mile Award for Excellence from the MIT School of Engineering for her communications' work, including publishing a new monthly newsletter, revamping the department's website, and raising the public's awareness of the department.

Associate professor Markus Buehler is executive editor of a new journal launched March 2009: *The International Journal of Applied Mechanics* (IJAM). IJAM focuses on innovative research in mechanics including solid mechanics, fluid mechanics, thermodynamics, and material science and in emerging areas such as biomechanics, electromechanics, and the mechanical behavior of advanced materials and nanomechanics.

Buehler's new book, *Atomistic Modeling of Materials Failure* (Springer, 2008), was published in July. Intended as a reference for engineers, materials scientists, and researchers in academia and industry, the book provides an introduction and an overview into the field of atomistic-based computational solid mechanics.

Buehler, along with MIT students and other faculty members, spent spring break in Aachen, Germany, at a week-long course: "The 2009 Aachen-MIT Spring School on Methods and Tools for Computational Engineering." The goal of the course, which was supported financially by MIT MISTI and the MIT-Germany Program, was to bring together researchers and students to advance the role of computation and foster new collaborative activities.

In recognition of his multidisciplinary work in fundamental fields, including the mechanics of structures and materials for sustainable civil infrastructures, professor Oral Buyukozturk was elected a corresponding fellow of the Royal Society of Edinburgh, Scotland's national academy of science and letters. The award citation mentioned Buyukozturk's leading role in the improvement and advancement of engineering education in the United States and abroad and his pioneering research in the mechanics of concrete and advanced composite materials, in the mechanics of infrastructure deterioration and assessment, and on the remote nondestructive testing of bridges and other structures with electromagnetic waves.

CEE professor Sallie (Penny) Chisholm teamed up with a Caldecott Award-winning author/illustrator to produce a lavishly illustrated children's book that explains how the sun kindles life on Earth through photosynthesis, *Living Sunlight: How Plants Bring the Earth to Life* (Scholastic 2009).

Professor Jerome Connor received an honorary doctorate degree from the Department of Civil Engineering at the Aristotle University of Thessaloniki, Greece, on April 29,

for his pioneering work on theories of computational mechanics, finite elements for solids and fluids, motion-based design, and control systems for structures. Professor Demos Angelides SM '75, PhD '79, chairman of the Aristotle University Department of Civil Engineering and Connor's former student, said of Connor: "His pioneering mind, scientific contribution, and integrity and honesty [have made] him a model and an example for the younger generation." Connor was praised for his talent in conveying the process of scientific thinking to his students in a simple and methodical way. Connor also delivered the speech, "Future Challenges in Civil Engineering."

Professor Edward DeLong was inducted into the National Academy of Sciences (NAS) at its annual meeting in Washington, DC, April 25–27, where he gave a featured talk, "The Microbial Planet," and appeared on the conference schedule along with President Barack Obama, who addressed NAS members two days later.

Professor Richard de Neufville of CEE and ESD received the Francis X. McKelvey Award from the Transportation Research Board, a division of the National Research Council, at its annual meeting in January. The McKelvey Award recognizes individuals whose work has contributed to the betterment of the aviation industry. In this case, it honors de Neufville's lifelong achievements in education, research, and consulting in airport planning, design, and management.

As mentioned previously in this report, Dara Entekhabi, the Bacardi and Stockholm Water Foundations professor in CEE, director of the Parsons Lab, and director of the Earth System Initiative, was selected to chair the MIT Environmental Research Council.

The American Society for Testing and Materials International (ASTM) presented its highest honor, the Award of Merit, at a ceremony last summer to John Germaine, senior research associate in CEE. This award is given to a member for distinguished service and outstanding participation in ASTM committee activities. A geotechnical specialist, Germaine was recognized for his contributions and leadership in developing and greatly improving existing standards and for his longtime participation in an ASTM committee on soil and rock.

A book based on Germaine's 25 years of experience teaching geotechnical and other civil engineering measurement subjects has just been published by John Wiley & Sons. *Geotechnical Laboratory Measurements for Engineers*, written by Germaine and Amy V. Germaine, covers many of the basic geotechnical tests used in undergraduate and graduate courses and commercial laboratories.

CEE professor Phillip Gschwend was awarded MIT's Perkins Award at the Awards Convocation May 5. The Frank E. Perkins Award, named for CEE's professor Frank Perkins, who served as dean of the graduate school from 1983 to 1995, is given each year to a professor who has served as an excellent advisor and mentor for graduate students.

Charles Harvey, the Doherty associate professor in CEE, received the 2008 M. King Hubbert Award from the National Ground Water Association at its annual meeting in December. The citation for the award praises Harvey's studies during 1994–2003 "as instrumental in shifting the course of transport research in groundwater" and his

"trademark ability to think 'outside the box' ... and to produce creative solutions that both advance the theory and the practice." The citation also recognizes Harvey's field studies of coastal hydrology and his investigation into the large-scale public health crisis of arsenic contamination in Bangladesh.

Colleagues, friends, and former students honored professor Chiang C. Mei at a special symposium June 1–2 during the 28th International Conference on Ocean, Offshore and Arctic Engineering in Honolulu. The C.C. Mei Symposium on Wave Mechanics and Hydrodynamics included 10 sessions and more than 50 papers celebrating Mei's extraordinary accomplishments over the last 45 years. A second symposium also honored Mei. The 24th International Workshop on Water Waves and Floating Bodies, held in St. Petersburg, Russia, April 19 and 20, was dedicated to him. Conference organizers said of Mei. "[He is] one of the most outstanding researchers and educators in fluid mechanics, with applications to civil, environmental and coastal engineering." In the published conference proceedings, former students praised his scholarship, range and depth of work, expertise, teaching, and lasting influence. Many also mentioned the warmth and home hospitality provided by Mei and his wife Carol.

Two D-Lab teams mentored by senior lecturer Susan Mircott won top prizes at MIT's IDEAS Competition May 4. Global Citizen Water Initiative was honored for its innovations related to Mircott's research supported by Google and the Tides Foundation. The team created a global water quality map and developed very-low-cost *Escherichia coli*/total coliform (*E. coli*/TC) water-quality test kits that use body heat for incubation. Heatsource developed a paraffin-based, solar-heated tile that can be enclosed in local textiles and worn against the skin to provide warmth.

Joseph Sussman, the JR East professor in CEE and ESD, was awarded ESD's 2008 Joseph A. Martore (1975) Excellence in Teaching Award at the annual Charles L. Miller lecture. The citation called Sussman "one of those rare, inspiring professors who becomes the ally of any graduate student who shares his passions."

Student Awards and Notes

Graduate student Rory Clune won Britain and Ireland's most prestigious award for science and engineering undergraduates: the GKN Award for the Science, Engineering and Technology Student of the Year. The GKN Award (named for the British engineering firm) is given to the top student of 15 winners of science, engineering, and technology student (SET) awards. Clune won the SET award in the mechanical engineering category for his undergraduate work at University College Cork, Ireland, on shape optimization of stainless steel coronary stents. He received the award at a ceremony in London September 26 attended by more than 500 people.

CEE PhD student Sinan Keten won the prestigious Silver Award at the Materials Research Society (MRS) spring meeting in San Francisco. MRS Graduate Student Awards honor and encourage graduate students whose academic achievements and current materials research display a high level of excellence and distinction and who show promise for significant future achievement in materials research.

CEE environmental engineering science sophomore Connie Lu was selected for the MIT Arts Scholars program for 2009–10. The program brings together students to explore the diverse arts available at MIT and around Boston and to interact with fellow students, faculty artists, and other experts in the art world. Lu does pencil and charcoal sketching, acrylic painting, screenprinting, and film and digital photography.

CEE junior S. Balaji Mani was selected as a Burchard Scholar in the School of Humanities, Arts, and Social Sciences. The award recognizes students who demonstrate unusual abilities and academic excellence in the areas embraced by the school. Mani, an environmental engineering science major interested in water and renewable energy, is also an accomplished musician and has served as arts editor of *The Tech*, MIT's student newspaper.

Senior Mahalia Miller received Phi Beta Kappa membership as well as an MIT award for excellence in foreign languages and literature and a Lufthansa prize for excellence in German studies.

CEE doctoral students Amy Mueller and Matt Orosz won an Environmental Protection Agency grant for economically sustainable programs that protect the environment. Mueller and Orosz, who are in professor Harry Hemond's research group, have been developing solar power technology to replace polluting diesel generators in remote villages of Lesotho, Africa, for several years. Orosz also received a Fulbright scholarship for study abroad in the 2009–2010 academic year. He will travel to South Africa on the Fulbright to evaluate the technical, economic, and social applicability of solar technology for use in low-income housing in that country.

Graduate student James Vanzo was awarded the Marvin E. Goody Award to support his thesis, "Nanochemomechanical Analysis of Cement Paste Subjected to Carbonation." The \$5,000 award is given to MIT graduate students in any department whose work explores the bond between good design and good building, extends the horizons of existing building techniques and materials, and fosters links between the academic world and the building industry.

CEE senior Alia Whitney-Johnson won a prestigious Rhodes scholarship to study at Oxford University. Whitney-Johnson, a former Truman scholar and one of *Glamour* magazine's Top Ten College Women, founded Emerge Global, a nonprofit organization that seeks to empower young Sri Lankan mothers, in 2005. Whitney-Johnson plans to undertake the MSc course in development studies at Oxford's Queen Elizabeth House.

CEE's chapter of Chi Epsilon, the national civil engineering society, inducted 11 new members: seniors Tiffany Barkley, Clifton Dassuncao, Sebastian Figari, Wesley W. Koo, Drew Loney, Mahalia Miller, and Margot Spiller and juniors Kelcie Abraham, Amy Magnuson, Nicholas Murlo, and Naomi Stein.

Juniors Brooke Jarrett and Adam Talsma traveled to Peru this summer to work on separate projects, courtesy of Kelley-Douglas Summer '09 Traveling Fellowships. The Student Activities Office presented a Distinguished Dedication Award to junior Polina

Bakhtiarov. Senior Legacy Awards from the Fraternities, Sororities and Independent Living Groups went to seniors Amy Gilpin, Elizabeth Labuz, and Alberto Mena.

Aided by Public Service Center (PSC) grants and fellowships, students carried out projects around the world. During IAP and spring 2009, PSC fellowships and grants were awarded to graduate students Lisa Rayle and Sara Ziff; seniors Kendra Johnson, Samantha O'Keefe, and Mahalia Miller; junior Shammi Quddus; and sophomore Fatima Hussain. Seniors Alia Whitney-Johnson and Lucy Wu received the PSC AmeriCorps Student Leaders in Service Education Award.

Paul and Priscilla Gray Value-Added Internships for summer 2009 were awarded to graduate student Mehul Jain and sophomore Tracey Hayse.

Departmental Awards

This year the department held its annual awards and senior dinner on May 15 at Endicott House. Department head Patrick Jaillet and associate department head Ole Madsen presented graduating seniors with frames for their diplomas.

Professor Franz-Josef Ulm was awarded the department's Maseeh Award for excellence in teaching this year for his work in the core sophomore subject 1.050 Engineering Mechanics I.

The Maseeh Award for excellence as a teaching assistant went to Tanvir Ahmed of Dhaka, Bangladesh, for his work as a teaching assistant in 1.060 Engineering Mechanics II.

Graduate student Jose Alberto Ortega won the Trond Kaalstad (Class of 1957) Graduate Award for leadership and significant contribution to the well-being of the CEE community. Ortega, a civil engineering PhD student, is from Cuenca, Ecuador.

This year, two seniors majoring in civil engineering won the Steinberg Prize for outstanding academic achievement and demonstrable interest in construction management: Mahalia Miller, from Stevens Point, WI, and Lauren Biscombe, from Norristown, PA.

Junior Naomi Stein of Troy, NY, won the Leo (Class of 1924) and Mary Grossman Award for her outstanding academic achievement and strong interest in transportation.

The Tucker-Voss Award went to PhD student Asbjorg Kristinsdottir from Reykjavik, Iceland, for her promise in the field of building construction. The working title of Kristinsdottir's thesis is "Risk Management for New Power Plant Development."

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/>.