Department of Civil and Environmental Engineering

The Department of Civil and Environmental Engineering (CEE) undergraduate curriculum has significantly changed toward an integrated program that stresses interactions between the built and natural environments. The new curriculum ensures that all our undergraduate majors—civil engineering, environmental engineering science, or the combination—take the same set of core courses, which by design incorporate consideration of environmental stewardship.

Our graduate students continue to be engaged in cutting-edge research in a variety of disciplines and move on to leading jobs in academia, industry, and government after completing their degrees.

Our four junior faculty members—Eric Alm, Markus Buehler, Ruben Juanes, and Roman Stocker—are quickly proving to be integral members of our department as they get their research programs off the ground, begin taking on teaching responsibilities, and participate in faculty meetings and departmental planning activities. Each of the four assistant professors presented a department-wide seminar on their work this spring, attended by faculty and graduate students.

We have a fifth assistant professor joining us this summer. Janelle Thompson, an environmental microbiologist, completed her postdoctoral research at Harvard University and will join us on July 1. 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 active presence on our faculty.

The department decided to elevate our communications effort, and in late fall we hired a senior communication officer to lead this effort. In January, we launched a research newsletter, *On Balance*, with the goal of 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 550 engineering deans and heads of civil and environmental departments at universities around the United States. The email version of the newsletter is distributed more broadly, including to any alumni who request it. Most of the research stories in *On Balance* are distributed to science journalists as press releases, resulting in articles in newspapers and magazines worldwide and bringing additional public awareness to the department. We are in the process of rebuilding our web site to include more news items and more in-depth information about the department's education and research programs.

We recently reaffirmed the leadership position the department should play at the interplay between energy needs and environmental stewardship.

Many of the new R&D projects of the department—though drastically different in appearance—converge on one point: involving the environment as an integral part of engineering design. A cross section of civil and environmental engineering problems illustrates this.

- MIT CEE faculty and students are working on a way to make concrete—the most widely "consumed" material on Earth after water—more environmentally friendly by changing the nanostructure or mineral used in its primary component—cement—whose manufacture makes up nearly 10 percent of the total atmospheric carbon dioxide released by humans annually.
- MIT CEE faculty and students are designing mechanisms to capture carbon dioxide emissions from power plants and sequester the carbon dioxide. This means that it may be possible to design a clean power plant supplying the electricity and hydrogen for next-generation vehicles.
- Microbiologists in MIT CEE are using genomic tools to probe the diversity and abundance of microbes in all sorts of environments. These small life forms are the primary processors of matter and energy in the Earth system. Yet their diversity and much of their metabolisms are puzzles.
- Faculty in Systems, together with colleagues from different backgrounds, are studying new ways to address "sustainability" issues in transportation.

Whether we are looking at the design of building materials at the macro- or nanoscales, studying transportation systems, gathering genomic information about marine microbes, or collecting atmospheric data about the water and carbon cycle, our aim is to employ the solutions available in the natural world as design elements.

Educational Activities

Undergraduate Programs

On October 18, 2006, CEE's Department Visiting Committee reviewed our undergraduate programs and found that the educational objectives and learning objectives are in alignment with the department's vision and mission. The Committee believes this is the education required for the next generation of professional leaders in both civil and environmental engineering.

This is the second year for the new integrated CEE undergraduate program. The junior and senior years now build on the common sophomore core through new subjects:

1.035 Mechanics of Structures and Soils: Building on Engineering Mechanics I, this subject translates the engineering mechanics language into analytical engineering tools and illustrates their application through engineering component design. A true innovation is that materials, structures, and geotechnical mechanics are taught in a single subject, highlighting the synergy that exists between fields that are often separated professionally. A strong laboratory component brings the analytical tools in contact with the physical reality and achieves a seamless integration of lectures and laboratory.

1.036 Structural and Geotechnical Engineering Design: This design subject carries on 1.035 from the component scale to the scale of planning and design of structures. With an emphasis on problem-based learning through team design projects, the subject makes use of the synergy of structural engineering and geotechnical engineering in the presentation of the subject matter and development of design projects, bringing students as close as possible to real-life civil engineering design projects.

1.013 Senior Civil and Environmental Engineering Design: The capping subject was introduced in the 2001 1-C curriculum reform. Restricted to 1-C majors, student teams consisting of different "specialists" work on the projects, practicing teamwork throughout. The new integrated curriculum makes the capping subject common to civil as well as environmental students, who both bring their expertise to the team projects.

This year's total undergraduate enrollment is 96 students.

The department completed program self-study reports for the upcoming fall 2007 ABET review of its Civil Engineering and Environmental Engineering Science undergraduate degrees.

Undergraduate Research and Practical Applications

The Power Peddler on the Student Center Plaza.

The spring semester of the engineering design class (1.102 Introduction to Civil and Environmental Engineering Design II) followed a distributed energy-harvesting theme this year. Students ended the spring semester by showing off the energy-harvesting machines they built: six original designs that convert kinetic energy to electrical energy via a generator, which then powers a low-output device. They displayed their machines around campus, inviting fellow students to try them out. The six machines are a rowing machine with an attached generator that supplies energy to charge the battery of a coxswains box while the rower trains; a triple-helical windmill designed to catch wind coming from any direction; a merry-go-round that powers a light show; a stationary bike that generates enough power to operate a laptop computer; a traditional windmill tested at the MIT Sailing Pavilion; and the "Power Peddler," a stationary recumbent bike with a boat seat mounted on top.

Students in the senior engineering design class (1.013 Senior Civil and Environmental Engineering Design) designed and built portable footbridges that could be used in a savannah climate where seasonal streams crop up and then dry up once the rainy season ends. The CEE seniors assembled and tested the bridges at lunchtime May 16 on the Student Center Plaza, where a small crowd gathered to watch.

In March, a team of CEE students won the award for fastest construction and took second place overall in the regional ASCE/AISC Steel Bridge Competition at the University of Connecticut March 16–17. The team also competed in the national finals in May. This was the first team from MIT to enter the annual competition in many years. Professor Jerome Connor, senior lecturer John Germaine, and staff member Stephen Rudolph served as mentors to the team. Jerry and Steve traveled with the students to Connecticut and again to California for the finals.

Footbridges carry students from theory to practice.

The department did not make an undergraduate TREX (Traveling Research Environmental eXperience) trip during Independent Activities Period (IAP) 2007 but is planning for the next TREX, scheduled for January 2008.

The MIT steel-bridge-building team at the regional competition.

Summer Internships

Now in its 10th year, the CEE summer internship program (http://cee.mit.edu/index.pl?id=17066&isa=Category&op=show) continues to strengthen ties with dozens of prominent engineering firms around the world (many founded by department alumni). The internship program provides professional summer employment for our sophomores and juniors working with civil and environmental engineers in the field, lab, or office. Five members of the faculty/staff (Peter Shanahan, Carl Martland, Jerome Connor, Rafael Bras, and Eric Adams) assisted 37 CEE students in this year's summer internship program. All students who sought internships were placed, including four students who are working in Venice.

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

In the course of the 2006–07 academic year, 85 graduate students earned degrees through our department: 12 doctoral students, 21 master of science students, 31 master of engineering students, and 21 master of science in transportation (does not include dual-program students such as LFM and WHOI).

Our graduate students continue to be engaged in cutting-edge research in a variety of disciplines. While many students in our graduate programs go on to doctoral studies and then to 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 remains the ultimate research degree and is critical to our mission to educate intellectual leaders for academia and national research laboratories. Although research is often interdisciplinary, the following are areas of study around which the program curricula are organized: 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 FY08. CEE was awarded two Edward Linde Fellowships for the coming year. Maintaining a level of support that promotes recruitment of the most highly qualified applicants is a very high priority for the department. To attract the best graduate students, the department continues to provide funding for several graduate fellowships The department received an additional fellowship, the Speedwell Foundation Graduate Fellowship in Transportation, made possible by a grant from Michael (SM 1980) and Jenny Messner.

Lectures

The department cohosted the annual John R. Freeman Lecture at MIT on April 9 with the Boston Society of Civil Engineers. This year's lecture featured alumnus Denis LeBlanc, who has spent much of his career studying the hydrology of western Cape Cod. Denis described how the investigation into a single "plume" or tongue of contaminated water underground became a 25-year gold mine of hydrology research and fueled an ongoing effort to rid the Cape's groundwater of pollutants. The lecture series is named for the MIT alumnus who designed the original Charles River Dam.

Yossef Sheffi gave the annual Charles L. Miller Lecture on April 5, speaking on "Geeks and Chiefs: Engineering Education @ MIT." The lecture series is named for Charles L. Miller, CEE department head from 1962 to 1969.

On May 17, the department hosted the New England Science Writers with a presentation on coal power plants and carbon dioxide sequestration made by professors Ruben Juanes and Howard Herzog of the Laboratory for Energy and the Environment.

On November 21, 2006, the department hosted Chris Calladine, Emeritus Professor of Structural Mechanics at the University of Cambridge, who gave this year's Horace A. Crary Lecture titled Buckling of Cylindrical Shells: A Paradox Resolved.

Faculty Research Highlights

A number of department research papers received publicity, including those listed below with the faculty name and press release headline:

Markus Buehler—Collagen model may aid study of ailments

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

Penny Chisholm—Ocean model reflects diversity of underwater forests

Edward DeLong—Center for Microbial Oceanography plumbs depths of ocean life

Herbert Einstein—Landslide risk during typhoons analyzed; new system could aid Southeast Asia

Elfatih Eltahir—MIT team describes unique desert cloud forest

Charles Harvey—Deep-sea sediments could safely store man-made carbon dioxide

Ruben Juanes—Storing CO_2 below ground may prevent pollution above

Susan Murcott—Murcott takes global approach to local problems

David Simchi-Levi—Flu vaccine shortages can be avoided, MIT engineers say

David Simchi-Levi—Supply chain to the moon

Franz-Josef Ulm—Nanoengineering concrete could cut world CO_2

Faculty Notes

Eric Alm was appointed an associate member of the Broad Institute and received a James H. Ferry Fund Award for the proposal "Reconstruction of Ancestral Regulatory Networks in *Vibrio* Species."

Cynthia Barnhart served as president of the INFORMS Transportation Science and Logistics Society and was named president-elect of INFORMS.

Moshe Ben-Akiva received the Samuel M. Seegal Prize from the School of Engineering for inspiring students in the pursuit of excellence. He also received two lifetime achievement awards this past year: the Dupuit Prize from the World Conference on Transport Research Society in June; and the Lifetime Achievement Award from the International Association for Travel Behaviour Research in August.

Rafael Bras and Andrew Whittle completed work as members of a national committee reviewing the federal report of the Interagency Performance Evaluation Task Force (IPET) on hurricane protection systems failures in New Orleans. The committee, appointed by the National Research Council and National Academy of Engineering (NAE), reviewed IPET's 6,000-page report on geotechnical and hydraulic systems failures. Rafael Bras continues to direct the Terrascope program.

Markus Buehler is one of 83 engineers invited by the NAE to attend its prestigious 2007 Frontiers of Engineering meeting in September. He received a CAREER award from the National Science Foundation on the mechanics of chemically complex, hierarchical nanostructured protein-based materials under extreme conditions.

Oral Buyukozturk received a special citation from the Istanbul Technical University for outstanding contributions to the University in October 2006.

Penny Chisholm continues to direct the Earth System Initiative. Their research published two papers in the same issue of *Science* this past year on *Prochlorococcus*.

Edward DeLong was named associate director of research for a new center for exploring the microbial inhabitants of the sea. The Center for Microbial Oceanography: Research and Education (C-MORE) will facilitate collaborations among the previously separate disciplines of oceanography, microbiology, ecology, and genomics.

Richard de Neufville received the award Best Paper at the International Council on Systems Engineering (INCOSE) International Congress.

Herbert Einstein received the Award for Outstanding Contributions to Rock Mechanics from the American Rock Mechanics Association. The citation praises Einstein for his work in education and engineering, calling him a "distinguished educator, engineer and scientist in civil engineering, geotechnical engineering and rock mechanics."

Dara Entekhabi was appointed director of the Parsons Laboratory for Environmental Science and Engineering. He was a member of the National Academies panel that sets NASA's long-term research agenda through the decadal study.

Ruben Juanes received a $1.5 million grant from the Department of Energy to pursue studies on methane hydrates. He and Howard Herzog, a colleague in the Laboratory for Energy and the Environment, have presented a number of public talks on the topic of coal power plants and carbon dioxide sequestration.

Eduardo Kausel's second technical book, *Fundamental Solutions in Elastodynamics*, was published by Cambridge University Press.

Harold Hemond received the Bose Award for Excellence in Teaching at the Institute's annual awards convocation on May 9.

Steven Lerman was named dean for graduate education effective July 1.

Ole Madsen was appointed CEE associate department head for education.

Chiang Mei received the 2007 Theodore von Karman Medal from the American Society of Civil Engineers at a ceremony in June. Mei was honored for his "fundamental contributions in fluid mechanics, wave theory, non-Newtonian flows, and understanding of ocean waves."

David Simchi-Levi was elected a 2006 Fellow of the Institute for Operations Research and the Management Sciences (INFORMS), an award that recognizes researchers who have made significant contributions to the advancement of operations research and the management sciences. INFORMS also awarded the Pierskalla Best Paper Award to a paper coauthored by Simchi-Levi.

Roman Stocker was named the 2007 Doherty Professorship in Ocean Utilization from the MIT Sea Grant College Program in February. He received an environmental health grant from the MIT Center for Environmental Health Sciences for a microfluidic investigation of motility of environmental pathogens.

Janelle Thomson will join the department as appointed assistant professor effective July 1, 2007, following her postdoctoral fellowship at Harvard University.

Franz-Josef Ulm was promoted to full professor.

Andrew Whittle was appointed by Governor Mitt Romney to the Special Safety Review Advisory Panel to oversee a safety review of Boston's Metropolitan Highway System's tunnels and facilities in August, after a fatality in a Central Artery tunnel.

Student Awards and Notes

Jason Alcaraz, Kendra Johnson, and Alia Whitney-Johnson received MIT Public Service Fellowships for IAP 2007.

Kristen Burrall received the Brad and Dorothea Endicott Award for distinguished service and music contribution to world music.

Kristen Burrall, Piotr Fidkowski, Gwendolyn Johnson, Shannon O'Connell, Sanusi Dantata, Antone Jain, Yun Lan, and Ante Vulin were inducted into Chi Epsilon, the honorary engineering fraternity.

Jae Hyeok Choi received a Ragnar and Margaret Naess Award for exceptional talent and commitment to private performance study as an Emerson Fellow (music scholarship).

Wen Feng received one of the two Best Thesis Awards in the Technology and Policy Program.

Farah Ghniem won a Boit Manuscript Prize for fiction; Robert A. Boit Writing Prizes in essay, poetry, and short story writing; and an award for IAP travel.

Mahalia Miller received a Lufthansa Award for excellence in German studies.

Rossella Nicolin, Jason Alcaraz, and Kendra Johnson were honored by the Public Service Center for building capacity in underserved communities and organizations.

Rossella Nicolin was also the recipient of the Department of Architecture's Marvin E. Goody Award for a master's thesis on design, building techniques, materials, and/or the industry.

Team Malaria Solutions—Arne Bomblies, Mustafa Dafalla, Rebecca Gianotti, and Paul Montgomery—received an award in the annual IDEAS Competition in April for their work reducing malaria in the mosquito-prone Sahel zone of Africa.

Alia Whitney-Johnson won a $30,000 Harry S Truman Scholarship and was named to *Glamour* magazine's Top 10 College Women list.

Matt Williams won the Harold J. Pettegrove Award for outstanding service to intramural sports.

Departmental Awards

The department held its annual Awards Dinner on May 8, 2007. Many students, faculty, and staff were honored for their achievements and accomplishments over the past academic year.

Staff members Vicki Murphy and Jeanette Marchocki were honored at the School of Engineering Infinite Mile Awards on May 10 and were acknowledged at the departmental award dinner.

Matt Williams received the Steinberg Prize for academic achievement and demonstrable interest in construction management.

Sueann Lee received the Richard Lee Russel Award, honoring an outstanding undergraduate in civil and environmental engineering who plans to continue with graduate study at MIT or elsewhere.

Kyle Frazier received the Tucker Voss Award, given annually to a student who shows particular promise in the field of building construction.

Joshua Maciejewski received the Leo (Class of 1924) and Mary Grossman Award, given to an undergraduate with a strong interest in transportation and an excellent academic record.

Sean Homem received the Trond Kaalstad (Class of 1957) Graduate Award for his leadership role in getting Course 1 involved in the national ASCE Steel Bridge Competition.

David Gonzalez-Rodriguez received the Maseeh Award for excellence as a teaching assistant for his outstanding performance in 1.060 Engineering Mechanics II.

Professor Amedeo Odoni received the Maseeh Award for excellence in teaching.

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/.