Cornell University
School of Civil and
Environmental Engineering

UPDATE

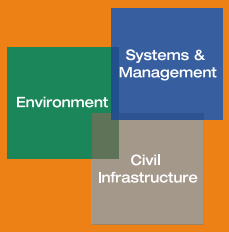
Spring 2008

Microbial Source Tracking
Good Science

INSIDE

FROM THE Director

James M. Gossett



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Spring 2008

Greetings, alumni and friends!

I'm happy to present this latest edition of *Update.* In it, you'll find an interesting article profiling a project undertaken by undergraduate student researchers to track the ultimate sources of bacterial contamination in local waters. It's a fine example of the type of hands-on research experience that is now common within the undergraduate educational experience. It satisfies desires to "make a difference," while teaching engineering fundamentals—and it's great fun, too!

Also in this edition are profiles of our two most recent faculty hires—Steve Koutsourelakis and Derek Warner. As you will see, both represent the best of what Cornell has always managed to do: take very, very fundamental approaches to problems that are ultimately practical and important. While visiting with an alumnus out in California a while back, I was pleased to note his pride in relating a story of his early years as a practicing engineer. "Floyd Slate taught us fundamentals of concrete behavior. Consequently, I was the only engineer on the project who could contribute to the unorthodox solution of an unusual problem that required 'thinking outside the code.'" I have no doubt that Steve's and Derek's students will one day be able to say the same.

We also present an interesting profile of a successful alumnus and friend, Carl Neuss. Carl is yet another example of someone who has taken the fundamental, yet analytical approach he learned from his Cornell CEE education and brought it into new arenas. He credits his Cornell education with teaching him to think. I've been gratified in my term as director to have met so many alumni with similar stories of their appreciation for their Cornell CEE educations—whether or not they ever practiced engineering, per se.

Speaking of my term as Director . . . it's about over. On July 1, 2008, some as-yet-unnamed successor will take the reins. It's been a rewarding five years, but I am looking forward to "having my old life back." I feel honored and privileged to have served as Director during a particularly active period. Some highlights of my term include: the recruitment of five new faculty (with search for a sixth now underway); fulfillment of our $7.1 million capital campaign, with the laboratory renovations it supported; and construction of a new grad-student/faculty lounge in Hollister Hall, promoting increased social interactions among and within both constituencies. Many other things happened of course, too (e.g., ABET reaccreditation; launching of our separate BS degree program in environmental engineering, jointly with BEE; our once-per-decade external program review; self-study of our MEng programs; strategic-planning; etc.). All-in-all, it was a busy time that seemed to fly by.

Most prominently, I shall always remember fondly the many alumni events we held in different parts of the country, through which I had the opportunity to meet with many of you. As I've stated before, it's very affirming to faculty to hear from enthusiastic alumni about their Cornell experiences. I am sure that whoever succeeds me will be similarly gratified.

From "Far above Cayuga's Waters," with gratitude,

Director

Source-Tracking Microbes Back to the Responsible Animals: **Cornell CEE Students CLEAR Up a Messy Mystery**

Call the bacteria in their drinking water "too cosmopolitan," and rural residents just might take that the wrong way.

So Cornell students in the course CEE 492 Engineers for a Sustainable World try to be scientifically objective amidst a near-campus dispute that pits farmers against residents. Without passing judgment, students like Kait Hanley and Melina Diaconis on the CLEAR Team (Cayuga Lake Engineering Analysis and Research) are helping to set a new standard for microbial source tracking (MST).

They are showing that *Bacteroides* spp. (various species) are more precise than coliform bacteria (such as *E. coli* species) for tracking fecal contamination back to the responsible animals—dairy cattle, for instance. Or will the microbial trail lead back to humans (with failing septic systems, perhaps) who are blaming farm animals for the high fecal coliform counts in their well water?

An Education in *E. coli*

"I grew up in a family of environmentalists," says Philadelphia native Diaconis, "but I was really surprised how much concern there is for water quality and environmental protection here in Ithaca." Her role as community liaison on the CLEAR team's MST project—when she's not collecting water samples for analysis in the laboratory—puts Diaconis in touch with stewardship outfits such as the Cayuga Lake Watershed Network, the Salmon Creek Watershed Group, and the Fall Creek Watershed Committee.

Kaitlyn Hanley analyzes the DNA in the water samples using gel electrophoresis.

Diaconis is meeting a lot of people who care passionately about what flows into the longest of the Finger Lakes—and where the water has been along the way—people such as Sharon Anderson, the lake network's watershed steward. (There's even a local 4-H youth group called

4H2O Monitors, that knows more about water quality and aquatic insects than most parents.) Anderson and her network are anxiously awaiting results of the MST project, which could give them the best-ever basis for deciding whether to channel limited resources toward improving farm practices—or to helping residents upgrade their water supply and waste disposal infrastructures.

Clearing the Air About Water Terminology

From New York City's East River to upstate's Salmon Creek, Brooklynite Hanley has learned more than she ever expected about harmless bacteria and the other kind. Coliforms, she now knows, are any kind of bacteria that pass some simple biochemical tests. Coliforms live in the intestines of warm-blooded animals—be they pigs, cattle, and other farm animals; wildlife, like geese or the raccoons that leave Cornell's Fall and Cascadilla creeks to raid Dumpsters; dogs and assorted pets; or people. The often-misunderstood term, fecal coliform, refers generally to bacteria associated with human and animal waste, and *Escherichia coli* is part of the general group of coliforms.

When health authorities close a beach or post a boil-water order, citing a spike in fecal coliform levels, it is not because coliforms themselves are necessarily harmful. Rather, *E. coli* and other readily tested-for coliforms in water samples indicate the possible presence of disease-causing bacteria. The microorganisms that cause typhus, hepatitis A, dysentery, and cholera could be in the same water with *E. coli* and the other fecal coliforms.

A Better Test?

"Professor Richardson told us that *E. coli* is a widely recognized indicator of fecal contamination because *E. coli* has a well-established test—but it's not ideal for microbial source-tracking purposes," Hanley says, referring to the project's faculty advisor, Ruth E. Richardson, a specialist in the genomics of microbial communities. "She said *E. coli* is too cosmopolitan—that genetically similar *E. coli* are associated with humans and with many kinds of animals, and that *E. coli* can survive and even grow almost anywhere in the environment.

"We needed a fecal bacterium that, genetically, is a little different when it comes from pigs, dogs, cattle, or humans," Hanley continues. "That's why Professor Richardson suggested, when we started this project, that *Bacteroides* might be a better way to assign fecal contamination more precisely to its source."

To distinguish dairy cows' *Bacteroides* from that of wildlife and humans, the Richardson lab in Hollister Hall performs assays with a sensitive polymerase chain reaction procedure called quantitative PCR. Not only does quantitative PCR determine whether genes specific to human or cow *Bacteroides* strains are present in a water sample, the procedure also determines how many organisms of each type are present.

A New York First

Some tests for *E. coli* and other coliforms are conducted in the certified laboratories of the Community Science Institute, an Ithaca-based nonprofit that organizes citizen-volunteers to monitor water quality around Cayuga Lake. But the PCR assay for *Bacteroides* strains is conducted only in the Richardson lab. They test, using portions of water samples that were collected for other purposes in Fall Creek and elsewhere, as well as samples that Diaconis and Hanley get in the Salmon Creek watershed.

The idea to use *Bacteroides* for microbial source tracking is about 10 years old, Richardson notes. Most state health departments still trust *E. coli* and coliform testing, Richardson adds, and she hopes the work of the Cornell CLEAR team will change some minds.

continued

Melina Diaconis retrieves samples.

Scrupulous Science

With so much on the line, the CLEAR team is being particularly scrupulous in its experimental strategies and procedures, Diaconis reports. They judiciously selected PCR primers for pig- and cow-specific *Bacteroides* genes, based on work at other institutional laboratories. Every piece of water-collecting gear is sterilized in autoclaves, and they document meteorological and stream-flow conditions at each collection site. "Samples taken during a snow-melt event—when manure spread on snow-covered fields flows downhill—can be very different from samples taken on a dry fall day," Diaconis observes.

Getting It Right, the First Time

The CLEAR team's lab workers also document every step of the process—from membrane filtration to DNA extraction, through two kinds of PCR (endpoint and quantitative) and finally to gel electrophoresis.

"We know we need scientifically irrefutable results to present to the watershed network," Diaconis says. "We expect that our approach and our methods might be questioned, so we want to get this absolutely right."

The CLEAR microbial source tracking project is just one of several that Cornell engineering students undertake through the Engineers for a Sustainable World course, which was led in 2007 by an Electrical and Computer Engineering faculty member, Park Doing, and by a CEE research associate, Francis Vanek. Diaconis says the Cayuga Lake project has been "a great experience from an academic and personal perspective. I developed relationships with a new network of people—teammates and faculty members, and community advisors—and I learned new concepts in the identification of bacterial contamination."

The Lure of Environmental Engineering

And now she's hooked. After her May 2008 graduation from the School of Civil and Environmental Engineering, Diaconis will look for employment with environmental engineering firms that work in the areas of wastewater treatment or remediation.

Hanley is leaning that way, too. After trying other branches of engineering at Cornell and summer internships at engineering consulting firms, she landed in the Ag College's Department of Biological and Environmental Engineering. "Until last year I didn't even know I liked the biological aspects of environmental engineering," she says. "Now I'm beginning to know that world—and feel comfortable in it."

At Last, Some Real Science

At the watershed network's Interlaken, N.Y., headquarters, watershed steward Anderson ponders the dispute on the east side of the lake. "Too many people point to 'big agriculture' when there's contamination of the water. Most farmers we work with say, 'If we're the source of the pollution, we want to know about it, and we'll fix what's wrong.' But they don't want to spend millions of dollars unnecessarily."

Speaking hypothetically at this point in the microbial source tracking experiment, Anderson says that comprehensive testing might assess the blame "40 percent on cows, 50 percent on septic systems, and the rest on who knows what—maybe all those Canada geese! The important thing is that we will have some real science to help craft best-management solutions—wherever they need to be applied."

Ever alert for new opportunities to apply microbial genomics to real-world problems, Anderson thinks about a community dispute that is even closer to Cornell's campus. Ithaca's well-organized, outspoken dog owners are demanding public space for a "dog park" where pets can socialize off-leash and splash in the water. One popular-but-unofficial dog park had been located on the edge of Cayuga Lake, prompting environmentalists about bird habitats and fecal contamination of lake water.

Without taking sides in the off-leash dog issue, Anderson notes that properly performed microbial source tracking is better than a bloodhound.

— Roger Segelken

Renovation of Environmental Fluids Teaching Lab Completes CEE Capital Campaign

CEE alumni and friends have met the school's capital campaign goal of $7.1 million, for lab renovations—two 50-year-old laboratories have been completely renovated and equipped with the latest technologies.

Previous articles on the renovation of the Civil Infrastructure lab, now called the Harry E. Bovay, Jr. '36 Laboratory Complex, have appeared in past *CEE Updates*. In fall 2007, the second phase of scheduled renovations was completed—the Environmental Fluids Teaching Laboratory. Both labs now provide superb facilities for both undergraduate and graduate instruction and research.

The first-ever major fundraising initiative for the school, the campaign began with a challenge grant received from Harry E. Bovay, Jr. '36. A gratifyingly large number of alumni and friends joined in support of our vision for updating laboratory space in the school.

The newly renovated laboratory is located in the basement of Hollister Hall, adjacent to the DeFrees Hydraulics Laboratory. When Hollister Hall was built in 1959, this lab space was originally created to provide instruction and research in hydrology and hydraulics.

After 50 years in operation, the instructional lab required modernizing to fulfill today's educational needs. Now the space, painted in refreshing shades of blue, consists of new equipment and technology. Modern electronic data-acquisition systems were installed and power services upgraded. Three new large-scale facilities were purchased: a wave tank for studying water-waves and their effects on beaches and to simulate the generation and dissipation of tsunamis; a sediment flume, to study sediment transport typical of rivers, streams, lakes, and coastal environments; and a third flume, identical in cross section to the sediment flume, will be used to carry out comparative studies as well as to physically model river and boundary-layer flows.

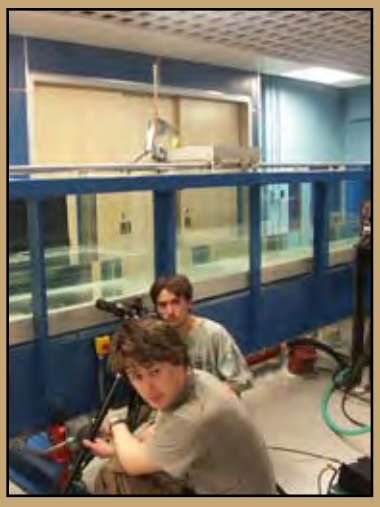
The flumes are not reserved for research alone but will be used frequently in many CEE courses, including 331 (Fluid Mechanics), 332 (Hydraulic Engineering), 435 (Coastal Engineering), 437/637 (Experimental Methods in Fluid Mechanics), and 655 (Transport, Mixing, and Transformation in the Environment). In addition to accommodating these three large facilities, the laboratory was designed to include a flexible teaching/seminar/laboratory space. Small-scale, course-specific laboratory exercises can be quickly set up and taken down, a seminar can be given, or a course can be taught—all in this space. The teaching lab is equipped to provide for distance-learning with video and teleconferencing capabilities. Professors Cowen and Liu anticipate collaborating with principal investigators on research projects at other universities, and Cowen will be using the capabilities to meet with his Spanish Exchange Program students who are studying this academic year at the Universidad de Cantabria as part of the new program that began in fall 2007.

Professor Edwin A. (Todd) Cowen, laboratory director, is excited about the new facility: "The ability to have undergraduates carrying out laboratory exercises in small groups while graduate students conduct their research, all in the same space, really enhances our ability to excite and motivate the next generation of environmental fluid mechanicians!" he says.

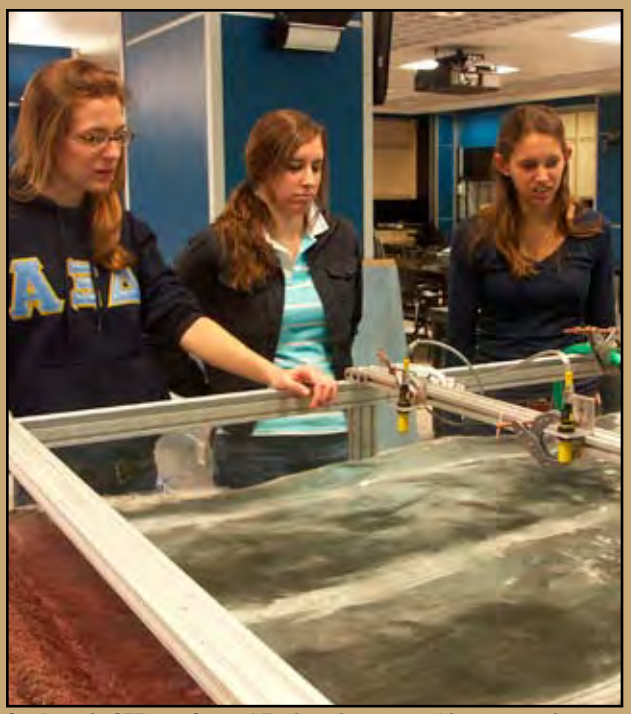
During the days when the school was housed in Lincoln Hall, the Environmental Fluid Mechanics Teaching Lab, then called the Hydraulics Lab, was located in the bedrock wall by the dam in Beebe Lake. It was an outstanding location for students to learn about water systems and controls with a body of water right outside the door. The Beebe Lake facility was in operation up until the late 1960s by Professors Liggett and Brutsaert, all the while, the new (at that time) Hollister Hall Lab was used for teaching. Now, with a newly renovated teaching lab, we have a modern laboratory teaching space where we can simulate a wide variety of fluid flows in the environment, while also furthering our research goals of enhanced fundamental understanding of fluid mechanics.

Many thanks to our alumni, friends, and Cornell's College of Engineering for making the school's laboratory campaign a success.

Newly renovated Environmental Fluids Teaching Laboratory



Students set up a camera system to measure velocities in the research flume using Particle Image Velocimetery (PIV) for CEE 637



Students in CEE 435 Coastal Engineering are working on a project to design a plunger-type wavemaker and an energy-absorbing system in the new small wave basin

New Faculty Profile

Steve Koutsourelakis and the TMI Problem

Can the New CEE Faculty Member Get a Handle on Uncertainty?

When instant-messaging students of Phaedon-Stelios (Steve) Koutsourelakis complain of "TMI," it's not about Three Mile Island.

Although that 1979 accident at a Pennsylvania nuclear generation plant was a perfect storm of improbable coincidences—equipment failures, human errors, and design flaws—damage was limited and no lives were lost. The best-available engineering practices had produced a robust system that ultimately prevailed, way back when.

These days TMI means "too much information," at least to students who don't want to hear about it. And sometimes to decision makers who are paralyzed at the thought of uncertainty.

TMI also is a problem for the recently appointed assistant professor of civil and environmental engineering. Koutsourelakis is trying to condense computationally unmanageable amounts of information about probabilities—something like the way MP3 compresses digital information about sound for students with thousands of tunes on their iPods.

Quantifying Uncertainty

Koutsourelakis wants to give decision-makers usable, quantitative information about the role of uncertainty in the behavior of everything from an aging aircraft fuselage, or the international petroleum marketplace, to a cluster of cancer cells undergoing treatment with an experimental chemotherapy drug.

"It's about putting numbers to uncertainty," Koutsourelakis says, "about retaining the most important characteristics that account for effects at the micro scale and bridging information across scales—including time—to make predictions of high fidelity at the macro scale." Put more formally, his aim is to develop probabilistic models and numerical procedures for the analysis of systems in engineering mechanics in which uncertainties play an important role.

Of course today's supercomputers can deal with uncertainty—a few atoms at a time. But considering all the possible behaviors of all the atoms in the materials that make up a nuclear reactor and keep it

running—that's where engineering needs an MP3 of probability. "We need to condense our representation of original formulations and become more informative about the overall response of the system in a global sense," according to Koutsourelakis.

Grounded in C.E.

Before joining the Cornell faculty in August 2007, Koutsourelakis was an applied mathematician and research scientist at Lawrence Livermore National Laboratory. The son of a Greek civil engineer, his training is thoroughly grounded in C.E., including a Ph.D. (2002) and master's degree from Princeton University and a diploma in civil engineering (1998) from the National Technical University of Athens, Greece.

As a postdoctoral fellow at Leopold-Franzens University (Innsbruck, Austria), Koutsourelakis worked on structural reliability methodologies and fatigue modeling in mechanical components. At Lawrence Livermore, he worked on uncertainty quantification in large infrastructure systems, including applications to national energy policy, multiscale formulations, and data mining.

At Cornell Koutsourelakis is currently teaching a graduate-level engineering course in stochastic simulation methods and Bayesian computation. He was attracted to Cornell, he says, by the "environment of high-caliber, interdisciplinary scholarship—and a chance to learn and expand perspectives with challenges that take me out of my intellectual comfort zone."

But he is keenly aware that all the talk of uncertainty makes some people uncomfortable—while for others, TMI about uncertainty can paralyze the decision-making process. Or even worse for the efficiency-minded, over-engineer a system with needless redundancy.

> "With the same kind of information, people can still arrive at different decisions."

Incorporating Uncertainty in Analysis

"Most people look at engineering problems without considering uncertainties," Koutsourelakis says. "But engineers cannot ignore uncertainty. Or even if they can ignore it, uncertainty is still there." A better way, Koutsourelakis says, is to incorporate uncertainty in the analytical process, to define values for uncertainty the same way that engineers do in deterministic analysis.

With information about the role of uncertainty in their systems, decision makers can weigh risks and benefits and can proceed with reasonable confidence. They might decide to change the design of a system, in light of new information on the probability of failure, but at least they can proceed.

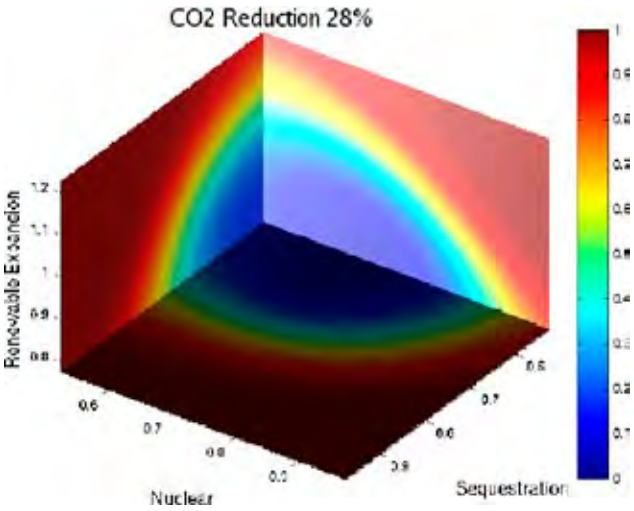
Recalling one of his projects at Lawrence Livermore, Koutsourelakis says, "With the same kind of information, people can still arrive at different decisions."

His prime example of that behavior is the formulation of national energy policy. Should a nation rely on oil and other fossil fuels? Or should it transition to reliance on renewable sources of energy? "If I say there is a 1 percent probability that renewable energy might not fulfill a nation's needs for an acceptable cost, some countries might decide that the benefits are worth the slight risk," he says.

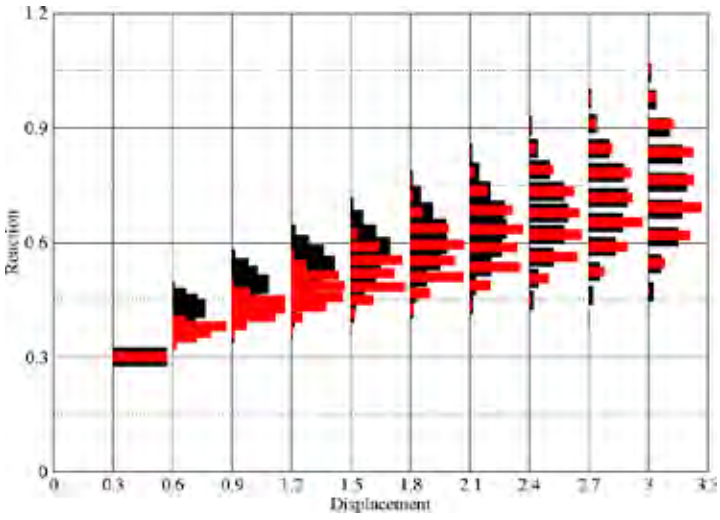
"But another nation that is more risk-adverse "might insist on 100 percent certainty, and stick with fossil fuels."

Only a little frustrated, Koutsourelakis says he is still willing to work on the energy problem. Maybe if he creates an MP3 for uncertainty, national leaders will listen up.

— Roger Segelken



Probability of satisfying national energy needs with a cost increase of at most 1 percent the current GDP and a 28 percent reduction in CO_2 emissions, as a function of policy variables related to the expansion of nuclear energy production, CO_2 sequestration capacity, and renewable energy production.



Comparison of the probability distributions of the reaction force for various imposed displacements when the actual microstructure is resolved (black) and when a compressed representation is used (red). Good agreement is attained at a fraction of the computational cost.

New Faculty Profile

Derek Warner and Materials That Fail

What Is Happening When Metals Crack?

"Fracture Prognosis in Metals," the cover story of the November 2007 issue of *Nature Materials,* addresses one of the most basic problems in the mechanics of materials: what's going on when metal cracks?

At the time that the paper's author, Derek Warner, decided to become an engineer, he wasn't aspiring to examine such a fundamental question, certainly not at the atomic level. Committed to the visible world, Warner wanted to design practical things. Say, a superior mountain bike or an environmentally friendly car. That was before he fell in love with research.

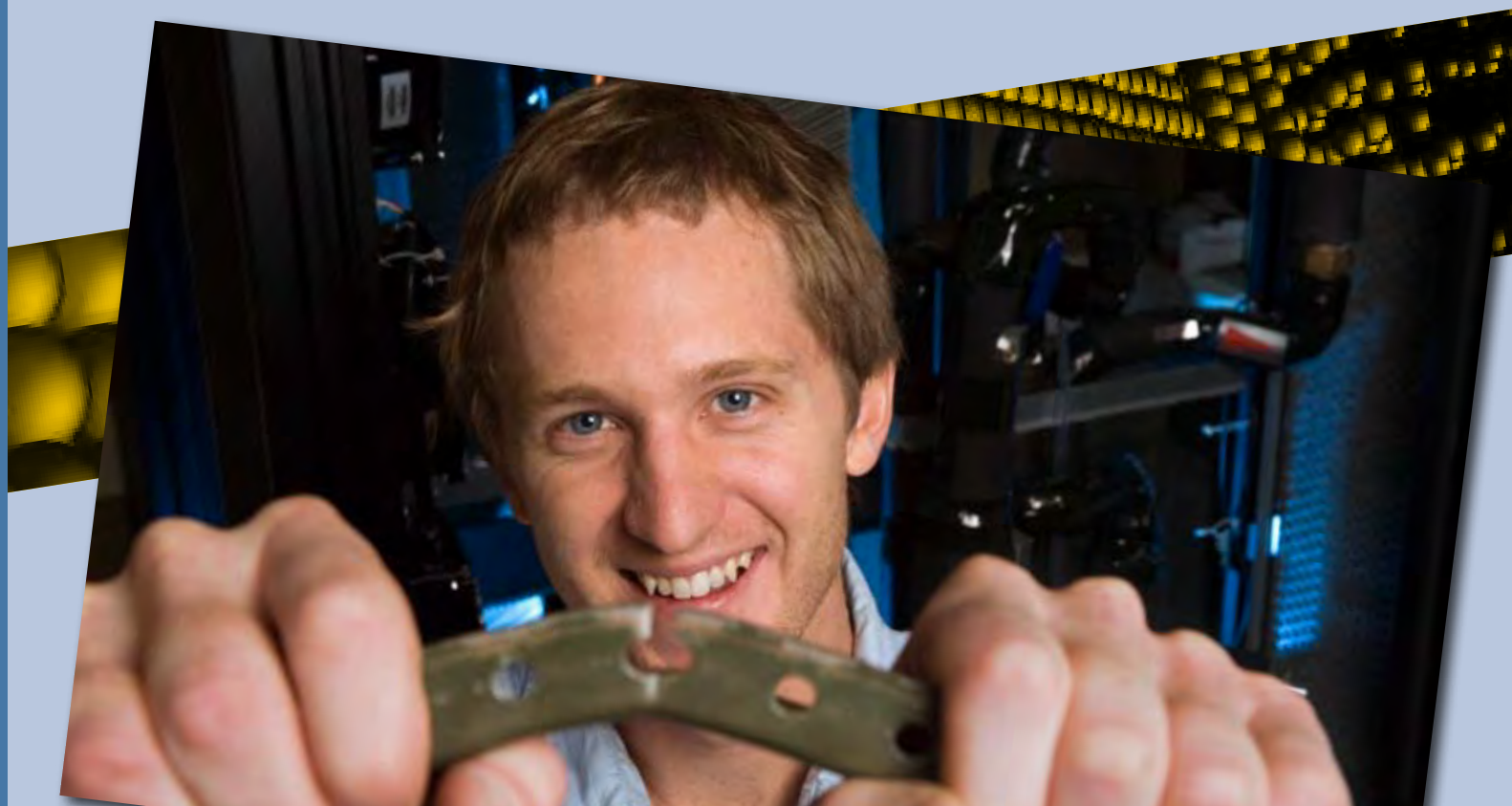
"It happened my first semester at Johns Hopkins," says Warner, who had arrived at graduate school with a strong foundation in mathematics he'd acquired as an undergraduate at Saint Francis University. "At first I found research was just a lot of fun."

But as he progressed through his doctoral training, Warner says he became a more and more serious scientist. He excelled in what is now called scientific supercomputing. His research interest in the general field of the mechanics of materials and computational solid mechanics sharpened to a fascination with understanding deformation and fracture mechanisms. To make real progress he needed to acquire the skills and theoretical tools of physicists working at the atomic level. Such tools would allow him to see what had never been seen before.

Warner wrote his doctoral thesis on the continuum mechanics modeling of nanocrystalline metals, metals associated with thin films such as those used in electronic devices. These advanced metals have strengths several factors higher than coarse grain metals because of the nano-scale dimensions of their internal microstructure.

"For these materials you don't have any input—or constituent laws—for your models," Warner explains of the new ground he was breaking. "So I had to move down in scale to modeling of individual atoms."

"The idea," Warner goes on to explain, "is that for a given material you have only protons, neutrons, and electrons—therefore, that's the only input you need to understand that system from a mechanical standpoint."



By the time he was a postdoctoral research associate in the Division of Engineering at Brown University, Warner was focused on atomistic simulations, pushing the boundaries of mechanics. The article published in *Nature Materials* was written while he was there. The secondary authors are W. A. Curtin and S. Qu.

Warner had become intrigued by a discrepancy between the results of a number of independently conducted atomistic simulations that predicted the formation of twin boundaries during the propagation of cracks in the conventional coarse-grained form of aluminum, whereas this had not been observed experimentally. (Interestingly, both atomistic simulations and conventional experiments had shown that deformation twinning in aluminum grains of sizes below 100nm was an important deformation mechanism.)

The answer, Warner found, lay in the different time scales accessible in experiments and in simulations. He solved it by devising a unique simulation that encompassed a time range of six orders of magnitude—from picoseconds to microseconds. The part of the simulation at the atomistic level focused on 15,000 atoms located around the crack tip and the rest of the system at the continuum level.

"Using multi-scale modeling and parallel computing we saw this transition in behavior between what had typically been seen in previous simulations and what's observed in experiments," Warner says. "You couldn't go all the way to see what you would see under normal loading conditions, but we did go farther than anyone had ever gone before."

Commenting on the importance of Warner's findings in the News & Views section of the publication, Vesselin Yamakov of the National Institute of Aerospace and Edward Glaessgen from NASA Langley Research Center, wrote: ". . .the study by Warner et al. is probably the most serious attempt undertaken so far to understand the effects and artifacts arising from the enormous gap in time- and length-scales that separate atomistic simulations from experimental conditions. Furthermore, the paper is of timely importance as the use of simulations in materials research is rapidly expanding and the issue of their relation to experiments is of increasing importance."

Warner appreciates coming to what he calls a progressive civil engineering department where his twin skills in physics and computing are valued. Most broadly put, his research goals are to harness the power of grid computing to extend atomistic and continuum modeling to domains previously impossible. Grid computing (or distributed computing) makes use of compute cycles and storage resources on computers around the world. Warner cites as an example IBM's world community grid, consisting of nearly half a million processors that have volunteered their unused compute cycles for use on projects such as identifying candidate drugs to block HIV protease and improving cancer treatment through better examination of tissue microarrays. Warner foresees using such computing power to solve problems not only in medicine but other important areas, among them the viability of alternative energy solutions such as hydrogen.

At present there is no economical means for distributing hydrogen, Warner observes. The most obvious method is through natural gas pipelines. These, however, are made of steel, which is known to become brittle and crack when exposed to pressurized hydrogen.

"Although the phenomenon of hydrogen embrittlement has been known for years, a clear understanding of the process has remained elusive," Warner says. "By harnessing newly developed modeling techniques and the emerging power of grid computing, crucial links can be formed between the chemical processes occurring in these pipelines and mechanical response."

In addition to his research, Warner looks forward to teaching a variety of classes from undergraduate introductory structural engineering courses to graduate-level ones on scientific supercomputing. The latter, his first, has attracted graduate students from across the campus.

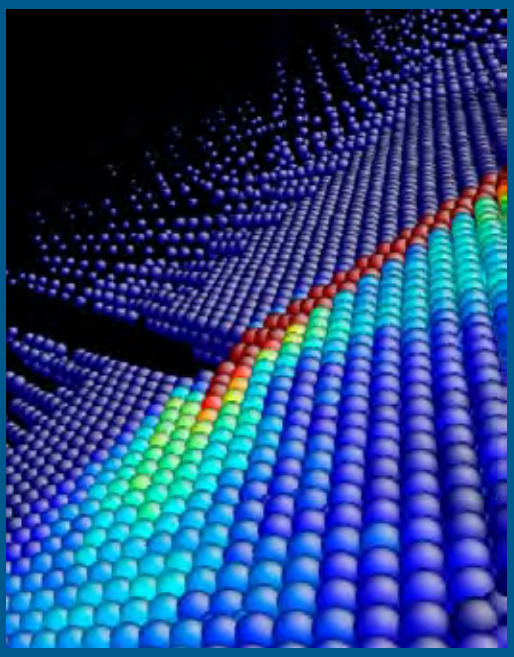
Warner brings to the classroom his own experience in working with supercomputers. For their homework, students have access to some of the largest computing resources on the planet, the Teragrid.

"I use the biggest computer you can get, but you still have to be clever with your models or you'll end up with just a billionth of a second instead of a millionth!" he says.

Still, Warner brings a playful approach to his work that he wants to share with students.

"While the course is basically about how to solve big problems on big computers," he says, "I want to be a little more unconventional, like solving problems on PlayStations in parallel because that's cheaper to do."

— ***Metta Winter***



Depiction of multiscale simulation of plasticity at a crack tip in pure aluminum. The simulation simultaneously combines atomistic, discrete dislocation, and finite element methods so that nanoscale fracture can be studied under more realistic loading conditions than in previous models.

"You couldn't go all the way to see what you would see under normal loading conditions, but we did go farther than anyone had ever gone before."

Carl F. Neuss '76: Loss of Job Leads Ultimately to Happiness

"I thought I was sitting on top of the world—one day I was dealing with engineers, another with architects, marketing consultants, bankers, and lawyers," Carl Neuss recalls of his time as a project manager in California's real estate boom of the late 1980s. With his BS from Cornell/CEE, a master of engineering degree in structural engineering and structural mechanics from UC Berkeley, a Harvard MBA, a PE license, and five years of professional engineering experience in hand, Neuss was working for the Buie Corporation, a southern California land development and residential construction company. "I thought I had found the perfect career where I could finally put all my technical, business, and general management skills to work for many years to come," he says.

Then, in the early 1990s, the recession hit. The economy and real estate industry collapsed. Buie downsized. Neuss was out of a job and no one was hiring.

"It was a rude awakening!" Neuss recalls, able to laugh about it now. "Here I had all these credentials—I was all dressed up with no place to go."

In this time of turmoil, Neuss was able to draw upon what he terms his "deep roots as a Cornell engineer." After turning down Princeton and Brown, Neuss became a Cornell engineer and now gratefully recalls the tutelage he received from outstanding Cornell/CEE faculty members of the 1970s such as Profs. Bill McGuire (most especially), John Abel, Peter Gergely, Arthur Nilson, Robert Sexsmith, Richard Gallager, and Floyd O. Slate. After Cornell and UC Berkeley, Neuss was a National Science Foundation principal investigator for a research program looking into the response of multistory buildings to earthquakes, which led to his authorship of the SUPER-ETABS earthquake engineering structural analysis program. "In transitioning from an engineering to a business career," he says, "unbeknownst to my Cornell professors, I applied their instruction to examine the housing economy as an engineering problem—that is, to break it down and examine its fundamental mechanics and behavior." The goal: to figure out what had caused the demise of the real estate industry and to develop methods to forecast (and to avoid) similar economic travesties in the future.

"Cornell's undergraduate curriculum—particularly the advanced structural engineering curriculum—always focused on a deep understanding of 'fundamental behavior' as the foundation for assessing system performance rather than relying on the more superficial cookbook methods and code-based design approaches taught at most engineering schools," Neuss explains.

Applying the "make sure you understand behavior" lessons learned as a Cornell engineer, Neuss made his mark in California's development industry by devising and applying highly innovative real estate investment and market analysis methodologies to assess prospective development projects. Using these tools, Neuss was able to accurately assess the workings of the housing economy and real estate markets through the cycles of the 1980s, 1990s, and 2000s.

The resulting understanding of fundamental market behavior became the linchpin, Neuss says, of his success in development and investment activities over the past 17 years.

"I once viewed real estate as a construction and development business, but the market collapse of the early 1990s taught me that the real estate and construction industry is, most importantly, a gigantic capital market driven by a limited number of critical input variables (or, in structural engineering terms, 'loads')" Neuss says. "My engineering roots allowed me to examine and grasp the F=ma mechanics of the housing economy in ways that few industry participants or economists understood."

> "The housing industry is right in the crosshairs of the current economic malaise."

Armed with his new theory on "housing market mechanics", in 1994, Neuss took a job on the investment side of the development industry with IHP Capital Partners, a leading investment partner of the $180 billion California Public Employees Retirement System (CalPERS), the largest institutional investor in the United States today. A partner at IHP, Neuss saw the firm grow from an $80 million project portfolio into the industry's leading venture investment fund with assets of well over $1 billion. By making equity investments in land and real estate development projects, IHP earned a 40 percent compound return for CalPERS over a 10-year period, making the firm the most important player in creating the highest returning investment class ever held in CalPERS' portfolio history.

In 2005 with the housing market "beginning to look very risky," Neuss decided to leave IHP, taking a team of people with him to form

Carl Neuss admits he has gained a few pounds since he played forward for Big Red Basketball. But he allows that he doesn't feel so bad about it since, at 6 5 1/2", he weighed only 175 pounds back then. This was not much help at pushing around his 220-pound teammates—but, he claims, it did make him the "highest leaper" on the team.

Carl and his wife, Elaine (of 25 years), have three children: Carla, a senior at UC Berkeley; Alex, a first-year student at Williamette University in Oregon; and Rebecca, a freshman in high school.

The Neuss family resides in Laguna Hills in Orange County, Calif., and they enjoy horseback riding, fishing, and outdoor activities when not working.

his own firm, Pacific Cascade Group (PCG). Together with Prudential as its institutional investment partner, Neuss' company has founded an investment fund focusing on longer-term land planning, investment, and development projects throughout California.

The company's current longer-term projects include a 9,000-dwelling, mixed-use master plan for a new town in Santa Nella (a 45-minute commute from the high-tech employment centers of California's Silicon Valley) and a 6,000-unit master plan and employment center just north of the rapidly growing Sacramento metro region.

"In founding PCG, we initially kept our heads low, focusing on longer-term, added-value land investments during a time when our 'market mechanics' tools were flashing warning signs to avoid the growing risks in overpriced, short-term real assets such as housing and buildable lots," Neuss explains. "Now that the pricing correction for these shorter-term assets is in full swing, we are refocusing on emerging opportunities to build a portfolio of ready-to-build residential real estate positions at prices that finally make sense."

Now running his own company, Neuss continues to find great satisfaction coping with the special challenges of the real estate development and construction industry. "The housing industry is right in the crosshairs of the current economic malaise," Neuss says. "It's exhilarating to be operating within an arena of such critical importance to the national and global economy." Unlike 17 years ago, however, Neuss is thankful that, in this cycle, the steering wheel of his enterprise rests firmly within his own grasp.

Neuss grew up in the small town of Newburgh, N.Y., in a working-class family. He was the first in his family to earn a college degree. "My parents lacked the resources to send me to Cornell," he says, but with the help of a four-year College of Engineering scholarship and with a Cornell education and its reputation, he received a full ride to grad school at UC Berkeley where he met his wife. "Cornell Engineering gave me the confidence and credentials to successfully attack the many challenges over the past 30 years in my career and life," Neuss says. "In my view, armed with a Cornell Engineering education and plenty of hard work, there is nothing that a young man or woman cannot accomplish in this life. The sky is the limit!"

Somewhere down the line there is something else Neuss longs to do: a secret ambition, he confesses, is to come back to Cornell and teach. In fall 2003, Neuss spent time on the Hill teaching a course in Cornell's Graduate Program in Real Estate (PRE). Neuss is a member of PRE's Advisory Board and continues to participate regularly in PRE lectures and conferences (he will be on campus this April for Cornell's Entrepreneur Conference). If he tackles a teaching assignment at Cornell again, Neuss hopes he can get more involved with the CEE program and students. Also, he is keen to participate in one aspect of campus life that he didn't take advantage of when he was an undergrad: Cornell's active religious community. While Neuss says his Christian faith has always been central to his family and business life, it's been his daughter Carla (currently a senior and English major at UC Berkeley) who has made him think about the importance of establishing a solid foundation of faith and values as part of a young person's education. Neuss promises "If I teach on the Hill again, I'll be sure to get engaged with students in faith-based activities. Watching Carla grow her faith at Berkeley has been an inspiration and has reinforced to me how important personal values and ideals are in preparing today's best and brightest college students to be the kind of thinkers and leaders that the world so desperately needs."

— ***Metta Winter***

Meyburg and Schuler Announce Their Retirement Plans

Arnim Meyburg had every intention of returning to his home country of Germany after receiving a PhD from Northwestern University in 1971. However, in 1969, after his advisor, Edward K. Morlok, told him about the open faculty position in transportation systems at Cornell University, he decided to apply.

Thirty-nine years later, and already in phased retirement, Meyburg will retire in June 2008.

As a professor of transportation engineering and planning, Meyburg has been interested in disaggregate behavioral travel demand modeling, transportation planning models, the relationship between travel behavior and transportation systems performance, freight movement analysis, and travel survey methodology (i.e., how does one obtain quality data for modeling and planning purposes?).

Meyburg has worked with colleagues in many parts of the world. He spent leaves from Cornell teaching, researching, and/or consulting in Germany, Brazil, and Australia and in the United States at UC Irvine. After a semester as a guest professor at the Technical University Munich in 1974, teaching a subject matter whose vocabulary he had acquired exclusively in English that turned out be quite a challenge in his native tongue, he subsequently connected with the Alexander-von-Humboldt Foundation of Bonn, Germany, and received a Humboldt Fellowship that allowed him to spend 1978–79 at the Technical University Munich.

A few years later Meyburg was awarded the Humboldt Prize ("U.S. Senior Scientist Award") in recognition of his past accomplishments in research and teaching. The award entitled him to stay for an extended period of 12 months at the Technical University Braunschweig, whose faculty had nominated him for this award.

Meyburg co-authored and co-edited a number of books and wrote numerous published papers. He was and is actively involved with the Transportation Research Board of the National Research Council.

He has taught many undergraduates and graduates the fundamentals of transportation systems with special emphasis on the role transportation and mobility play in the national economy and our lifestyles. Undergraduates and graduate students will remember Professor Meyburg for teaching courses such as CEE 361 Introduction to Transportation Engineering and Planning. Meyburg derived great satisfaction from the opportunity to introduce students to the subject matter of travel and transportation (about which very few of them had thought before) and to get them to appreciate the importance of this discipline in a broader societal context.

In addition to his teaching and research in transportation systems and engineering management, Meyburg willingly served in an academic administrative role from 1977 to 1985. He was first acting chairman then chair of the Department of Environmental Engineering. In 1988 he became the first director of the "unified" School of Civil and Environmental Engineering, serving for 10 years. The "unified" school meant that the Department of Environmental Engineering and the Department of Civil Infrastructure no longer operated as individual departments reporting separately to the dean and cooperating on the undergraduate and MEng teaching program with the director of CEE. This was a decision made by the faculty and the dean before Meyburg took the directorship. During his tenure as director, Meyburg increased awareness and built strong relationships with CEE alumni. The school has benefited from his strong alumni liaisons as seen during our recent capital campaign. Meyburg was instrumental in implementing administrative change and improving facilities within CEE. Room 366 became the first electronic classroom as a result of funds raised by the Class of 1949. Room 162, located within the CEE Conference Center and named in honor of Meyburg's service as director, is the first-ever distance learning classroom in the College of Engineering.

Since 1996, he has served as director of the NYSDOT-sponsored Transportation Infrastructure Research Consortium (TIRC), which involves 10 New York State academic institutions along with Brookhaven National Labs and Calspan-UB Research Center (CUBRC). Cornell serves as the lead institution in the consortium, which acts as a research and consulting resource for NYSDOT.

In addition to his doctoral degree, Meyburg received his master's of science in quantitative geography in 1968 from Northwestern University; previously he attended the University of Hamburg (Germany) and the Free University of Berlin (West) where he received the equivalent of a BA in 1965.

Meyburg always felt exceptionally lucky to have been able to spend his academic career at such a great institution and with such gifted and wonderful colleagues in the Cornell School of Civil and Environmental Engineering. He feels privileged to live in such a beautiful area with four great seasons and has no plans of moving away from Ithaca.

Meyburg plans to use his future flexibility and extra time to pursue his various hobbies, such as sports, travel, gardening, photography, birding, writing, and spending more time visiting with his daughter, Jenny, in Boston.

Richard E. Schuler will retire from his joint faculty appointment in the School of Civil and Environmental Engineering and the Department of Economics in June 2008. Schuler came to Cornell with his family as an assistant professor in 1972. He spent the first 10 years of his career in industry, initially as an engineer and manager with the Pennsylvania Power and Light Co. and then as an energy consultant with Battelle Memorial Institute. Schuler holds a bachelor's degree in electrical engineering from Yale University (1959), an MBA from Lehigh University (1969), and an MA and PhD in economics from Brown University (1972). He has been a registered professional engineer in the state of Pennsylvania since 1963.

Much of Schuler's teaching and research at Cornell has focused on the three-way intersection between engineered projects (particularly infrastructure), the natural environment, and their effects upon and interactions with human behavior and institutions. Schuler has always mixed theory with practice. While at Cornell, he took two leaves of absence to serve in government with the NYS Public Service Commission, initially in 1977 as director of the Office of Research, and then in 1981 for two years as commissioner and deputy chairman.

After returning from Albany, Schuler became director of the Cornell Waste Management Institute and the affiliated New York State Solid Waste Combustion Institute, with substantial support from the state. A substantial emphasis was on what he still considers to be the most stubborn obstacle to sensible investment in infrastructure: deciding on where and when to locate needed new facilities and reaching a public accord on those decisions. In the 1990s Schuler directed, the Cornell Institute for Public Affairs, solidifying its institutional and academic base as a university-wide interdisciplinary MPA

degree program that is thriving today. At the same time he taught courses in the Johnson Graduate School of Management for MBA students on the interface between government and private business, particularly in the context of evolving technologies. For the past six years, he has taught a managerial economics course within CEE's Master's of Engineering Management program.

His research over the past decade has been collaborative with Cornell colleagues from electrical engineering and applied economics and management on the design and testing of improved markets for electricity following that industry's deregulation. Schuler's focus has been to involve customers actively in these markets while maintaining the reliability of service. Other studies explore the proper balance between planning and markets in this industry to maintain adequate investment, and the interaction between markets for electricity and those for environmental permits. Together with colleagues at the Santa Fe Institute, he has also examined the optimal size and structure of organizations in the information age using numerical methods.

Schuler has served on many academic (NSF, NAE, NAS) and professional boards and panels over the years, including the Cornell Board of Trustees (1994–98) where he was a member of the executive committee. He has been a consultant to many businesses and government agencies, including the World Bank. Schuler has been on the Board of Directors of the New York Independent System Operator, which is responsible for operating the electricity system reliably and conducting an efficient wholesale market in New York State since its formation in 1999 where he has chaired its Market Performance Committee. He was recently reappointed to another four-year term on this board, and he is taking over the chairmanship of its governance committee this April.

Dick Schuler plans to remain active academically in retirement, to pursue his research on energy markets and infrastructure and to serve on professional panels. He and his wife, Mary, will continue to live in Ithaca, travel, and spend more time visiting their three children and seven grandchildren, the oldest of whom will be a first-year student at Cornell in the fall. He is also planning to help Mary, an artist, frame and market her paintings.

In Memoriam

Jackson L. Durkee MS '47, a registered professional engineer who held a visiting professorship in Cornell's School of Civil and Environmental Engineering in 1976, died on June 14, 2007. He was an honorary member of ASCE, Class of 1996 and a member of the Structural Engineering Institute. Mr. Durkee was a renowned expert in the fabrication and erection engineering of longspan steel bridges, and particularly for the origination and development of the parallel-wire-strand and plastic-covering techniques for suspension bridge main cables. *Engineering News Record* cited Durkee as one of the "Men Who Made Marks in 1967" in the construction industry, and he was the 1982 recipient of the ASCE's Ernest E. Howard Award. His high-profile projects can be seen today in the second Tacoma Narrows bridge and spans over the Chesapeake Bay. His expertise was called on in the legal case resulting from the collapse of the Kansas City Hyatt Hotel walkway.

Durkee's recent commissions include the San Francisco–Oakland Bay bridge east-bay crossing, the Golden Gate Bridge, and the third Tacoma Narrows suspension bridge. He recently commented, "A couple of years ago I had a good look at the cables of the San Francisco–Oakland Bay Bridge west-bay suspension spans . . . I will wager 5 cents in cash that I am the only honorary member who has walked the SFOBB cables."

Durkee began his career in 1943 as a stress analyst and test engineer with Douglas Aircraft Company. During World War II, he served in the U.S. Navy as a deck officer on board cargo ships in the U.S. Pacific Fleet. He returned to establish his career at Bethlehem Steel Corporation where, from 1947 to 1976, he was engaged in steel bridge construction and design with the Fabricated Steel Construction Division. In 1976, Durkee became visiting professor of structural engineering at Cornell University and in 1977 became a partner in the firm of Modjeski and Masters. Since 1978, he was a consulting structural engineering in Bethlehem, Pa. Durkee was elected to the National Academy of Engineering in 1995.

He is survived by his wife, Marian, three daughters and their husbands, seven grandchildren, a great-grandchild, a sister, two nieces, and a nephew.

Professor Emeritus Leonard B. Dworsky passed away peacefully on March 28, 2008. He was 93.

Dworsky joined Cornell in 1964 as a professor and the first director of the Water Resources and Marine Sciences Center. He came from a career in the Public Health Service, where he held major leadership positions during the formative years of pollution control and water resources planning efforts. He was a faculty member in Civil and Environmental Engineering for 40 years. He became emeritus in 1985 but continued to teach his water policy course until 2001. He worked for many years as an advisor to the International Joint Commission and other international water-management agencies.

Born in Chicago in 1915, he received his B.S. in civil engineering (and a varsity letter in track) from the University of Michigan in 1936. He began his public career in Illinois, focusing on rural development. From 1941 to 1946 he was with the Army Sanitary Corps, rising to the rank of Lieutenant Colonel. During the next 18 years he was a commissioned officer in the U.S. Public Health Service. Dworsky assisted in writing Congressional testimony for the Surgeon General that resulted in the enactment of the Federal Water Pollution Control Act of 1947, its extension in 1953, and amendments in 1955. He earned an MA in public administration from American University.

Len Dworsky never quit caring about water policy, the wise use of water resources, intergovernment cooperation, and the development of his students and colleagues. Len was on a mission, and he often encouraged his colleagues to join him by thinking bigger thoughts and exploring broader issues. He was always talking about new ideas and paradigms for planning: watershed-based, ecosystem-based, risk-based planning. If we could just work together, he knew we could all be better off. He served as a tremendous role model for us all. He received numerous honors including the 1994 Caulfield Medal for Exemplary Contributions to National Water Policy from the American Water Resources Association.

Predeceased by his wife, Diana Levin Dworsky, Leonard had three sons, two daughters, and six grandchildren.

news student, alumni, and faculty

ASCE News

This year's ASCE Regional Conference will be held on Saturday, April 19, 2008, at the United States Military Academy at West Point. ASCE members have put together strong teams for the Steel Bridge and Concrete Canoe competition and are looking forward to doing well!

ESW News

AguaClara team, the Honduras water project of the Cornell chapter of Engineers for a Sustainable World (ESW), received honorable mention at the EPA's third annual People, Prosperity, and the Planet Awards National Sustainable Design Expo held in Washington, D.C., for the creativity and utility of their sustainability designs.

Students

John Erickson '07 was a recipient of a 2007 Merrill Presidential Scholars Award. He is among six other College of Engineering students to receive this award.

Alumni

Willie F. Harper MEng '93 recently moved to the University of Pittsburgh as an associate professor in environmental engineering. Before that he was an assistant professor of civil engineering at Auburn University, where he received the 2007 Auburn University, College of Engineering Junior Faculty Research Award. Harper is also a recipient of the National Science Foundation Early Faculty Career Award. His research interest is biological processes for environmental engineering.

James H. Hanson '91, MEng '96, PhD '00, assistant professor of civil engineering at the Rose-Hulman Institute of Technology, is a recipient of the 2007 Walter P. Moore, Jr. Faculty Achievement Award presented by the American Concrete Institute, "in recognition of his commitment to educational scholarship through his publications, teaching, student engagement, research, presentations, committee work, and conference participation."

Thomas T. C. Hsu MS '60, PhD '62, John and Rebecca Moores Professor of Civil Engineering at the University of Houston, is a recipient of the 2007 Concrete Research Council–Arthur J. Boase Award presented by the American Concrete Institute "for extensive research advancing the understanding of torsion in structural concrete members, and for many contributions to codification of design for shear and torsion."

Keith Kesner MS '98, PhD '03, a senior engineer in charge of WDP & Associates' South Norwalk, Conn., office, was elected American Concrete Institute fellow in 2007.

Brenda Shonkwiler MEng '02 was named 2007 Young Structural Engineer of the Year by the Institution of Structural Engineers (IStructE), U.K.

Donald W. White PhD '88, professor of structural engineering, mechanics, and materials at the Georgia Institute of Technology, School of Civil and Environmental Engineering, is a recipient of the 2007 Richard S. Fountain Award given by the American Iron and Steel Institute Steel Bridge Task Force and the American Association of State Highway and Transportation Officials Technical Committee for Structural Steel Design.

E. Roberts "Bob" Wood '51, professor emeritus at the Naval Postgraduate School and an aeronautical engineer, has been named an honorary fellow of the American Helicopter Society International. He was inducted during the society's 63rd annual forum and technology display awards banquet in May 2007. After obtaining his bachelor's degree he served as an air installations officer with the Air Force during the Korean War. After returning to civilian life, Wood earned a master's in engineering mechanics and a doctorate in engineering from Yale University.

Tso-Ren Wu PhD '04, assistant professor in the Graduate Institute of Hydrological and Oceanic Sciences at National Central University in Taiwan, announces the birth of his daughter, Julia, on December 13, 2007.

Faculty

Wilkins Aquino was selected as the 2007 Cornell Chi Epsilon Professor of the Year.

Wilf Brutsaert, the William L. Lewis Professor of Engineering, has been chosen to receive the "Hydrology Days Award for 2008" by Colorado State University, awarded March 27, 2008, at Fort Collins, Colo., "in recognition of his outstanding contributions to hydrologic science in the areas of boundary layer theory and evapotranspiration estimation, vadose zone and hillslope hydrology, and stream-aquifer interactions." Brutsaert has also been selected to be the inaugural speaker of the "Peter Eagleson Lectureship in Hydrologic Sciences." This lecture will be given at the July 14–16, 2008, meeting in Boulder, Colo., of the Consortium of Universities for the Advancement of Hydrologic Sciences, Inc. (CUAHSI).

Derek Warner has been selected as a 2008 recipient of the ONR Young Investigator Award for his proposal "An Atomically Informed and Experimentally Calibrated Ductile Fracture Model of Aluminum for Hull Structural Analysis." These prestigious awards recognize research achievements, potential for continued outstanding research efforts, and strong support and commitment from their respective universities and research institutions.

Ken Hover recently wrapped up his sabbatical year in 2007, with a lecture tour in New Zealand. As invited keynote speaker, he presented the opening and closing papers at the New Zealand Concrete Industry Conference at Taupo. He then presented evening lectures to structural engineering associations in Auckland, Wellington, and Christchurch, and met with students and presented seminars at the University of Auckland, Victoria University, and University of Canterbury.

Fred Kulhawy has been honored by his selection as speaker for the Fifth Lumb Lecture, to be delivered in fall 2008 at the University of Hong Kong. The Lumb Lecture is organized biennially by the Department of Civil Engineering of the University of Hong Kong and the Geotechnical Division of the Hong Kong Institution of Engineers (HKIE). Kulhawy is a 2007 honoree at the New Jersey Institute of Technology, for his acknowledged global leadership in deep foundation technology, his contributions to related research investigations,

and his volunteer role in many professional associations, including ASCE, ADSC, ASTM, and IEEE.

Kulhawy presented the 19th Hal W. Hunt Lecture at the Annual Conference of the Deep Foundations Institute (DFI) in Colorado Springs, Colo., in October 2007. The Hal Hunt Lecture was established by DFI in 1989 to recognize notable communicators in the Deep Foundations Industry. Kulhawy's lecture was titled "Communicating Technical Issues with Levity and Panache."

Phil Liu, professor of civil and environmental engineering, has been honored with the Kwoh-Ting Li Chair Professorship at the National Central University, Taiwan, the highest-level professorship at the university. Liu will help the university establish a joint graduate program or institute in ocean sciences with the Academia Sinica in Taipei. Liu expects to travel often to Taiwan and spend extended time there during summer and winter breaks. He is developing a plan to establish the Taiwan Coastal Observation and Assessment Station (TaiCOAST) on the west coast of Taiwan to study physical and geochemical processes in the near-shore environment. He is also working on an initiative to create a tsunami early warning system in the South China Sea region.

Liu is an internationally known expert on coastal dynamics, including tsunamis and their effect on shoreline structures. Liu also has been awarded a National Science Council Chair Professorship for the duration of one year starting July 1, 2008, to June 30, 2009. With this professorship, Liu will spend a portion of his sabbatical leave at the National Central University, Taiwan. Liu will participate in tsunami research in Taiwan and will lead an initiative in coastal study.

Arnim Meyburg was elected Life Member of ASCE "with appreciation for a lifetime of dedication and service to the profession of civil engineering." Meyburg also was elected vice president of the Alexander-von-Humboldt Association of America (AvHAA). The AvHAA is an alumni association representing several thousand U.S. recipients of Humboldt fellowships and/or "Humboldt Prizes" (U.S. Senior Scientist Awards). The AvH Foundation is based in Bonn, Germany. Current CEE faculty who have received awards from the AvH Foundation are Christine Shoemaker, Pete Loucks, and Arnim Meyburg (U.S. Senior Scientist Awards) and Charlie Trautmann and Arnim Meyburg (Fellowships).

Art Nilson, professor emeritus of civil and environmental engineering, was recognized at the April 2007 American Concrete Institute conference for his 50-year membership with ACI.

CONTACT CEE WITH YOUR NEWS

We would like to hear from you about your accomplishments, awards, and activities so we can tell faculty, students, and other alumni. Please send your news to
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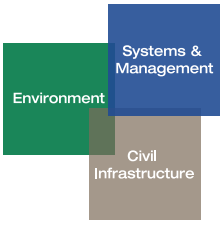

Reunion 2008: June 5–8

Saturday, June 7

Alumni breakfast buffet: Plan to attend this year's CEE alumni breakfast—especially if it's your reunion year. The breakfast will be held from 7:30 to 9:30 a.m. in McManus Conference Center, Hollister Hall. All alumni(ae) and their families are invited. After breakfast, tours of CEE laboratories will be provided upon request. Photographs and memorabilia will be on display.

Homecoming 2008: September 26–28

Saturday, September 27

Big Red vs. Yale