Gaming for Grades
A Light in the Classroom
Discovering TAM

Global Weather Alert: Forecast for Planet Earth
Announcing...

After serving engineering alumni for 100 years, CSE, the Cornell Society of Engineers is changing its name to CEAA - Cornell Engineering Alumni Association.

A new name for a new century will better reflect our true inclusiveness of all alumni of the College of Engineering. Make CEAA a part of your future! If you’re an alum and are not yet a member, start fresh and join today.

Celebrate our Centennial

Celebrate the 100th anniversary of our founding during 2005. See the web for details as they become available.

Come to the Conference

Save the Date for our biggest event of the year. On April 21-23, 2005, we’ll be looking into the topic of Engineering as a Foundation for Business Leadership featuring engineering alumni who have successfully led companies. Return to campus for a great time with fellow alumni, faculty and students.

www.ceaa.cornell.edu

256 Carpenter Hall, Ithaca, NY 14853-2210
607-255-9920 • 607-255-9606 • ceaa@cornell.edu
FEATURES

Forecast for Planet Earth/6

BY KENNY BERKOWITZ

Like pieces of a jigsaw puzzle, the diverse research projects of Cornell’s earth and atmospheric scientists build a big-picture perspective on the evidence and impact of global warming.

Light Source/12

BY KENNY BERKOWITZ

An expert in research on the physical properties of light, award-winning teacher Chris Xu has a talent for illuminating a classroom as well.

Game On!/16

BY JAY WROLSTAD

A new course in computer game design brings together artists, programmers, musicians, and writers who improve their individual skills while adding cross-disciplinary ones.

The Best Department You Never Heard Of/22

BY MARK RADER

What does Sputnik have to do with Theoretical and Applied Mechanics? Learn this and more about Engineering’s “nontraditional” department.

News/2

Teams: FSAE wins, Moonbuggy is second, and ICE CUBE’s launch is rescheduled. Time: The Sundial is back and Duffield Hall gets top billing on the Cornell calendar. Tips: BME becomes a department, the state renews advanced technology funding, the university joins networking consortium, and Arecibo gets a radio camera.

People/26

Students: are robotics mentors, solar sprint judges, scholarship recipients, award winners, science communicators, and evening dancers. Faculty members: win a Guggenheim, study Saturn rings, and cut the ribbon on the new synchrotron facility. Alumni: lead community service, conference on energy, and excel as entrepreneurs.

Hometown Hero/32

Pedal Power: A couple of engineering students from MIT and Cornell pair up for their own “Le Tour de USA” to raise money for the FDNY Widows’ and Children’s Fund.
C
ornell's Formula SAE race car team won its eighth FSAE World Championship May 23 in Pontiac, Mich., prevailing over some 130 universities from 13 countries. The team of Cornell engineering students scored 926 points of a possible 1,000 in a series of events that ranged from design evaluation to competitive driving.

The competition, sponsored by the Society of Automotive Engineers and the Sports Car Club of America, challenges students to design and build a race car and drive it in a series of events. The final score is determined by adding points for driving, design, and presentation.

The climax is a 22-kilometer endurance race over a one-kilometer road course, at speeds of up to 60 mph. Other driving events were an acceleration test, skid pad (cornering in tight circles), and autocross (maneuverability and handling). Meanwhile, teams are judged on their designs, a “business presentation,” in which they pitch their designs as they would to potential investors, and on what the car would cost if put into production. Cornell placed either first or second in all the dynamic events and came in second in design, fourth in cost, and seventh in business presentation.

For winning first overall, the Cornell team received the SAE Foundation Cup. In addition, the team took home the Spirit of Excellence Award, the SAE Motorsports Award, the Bosch Engine Management Award, the PACE Best Engineering Design Award (second place), the Henkel Technologies Structural Foam Award (second place), the Goodyear Best Performance Award, the Hoosier Tire Autocross Award (second place), and the Solidworks Skidpad Award (second place). The various awards add up to $4,950, plus 18 tires and some software.

Cornell first entered the competition in 1987 and has won the title in 1988, 1992, 1993, 1997, 1998, 2001, 2002, and this year. "We win often because we take a systems approach," said Al George, the J.F. Carr Professor of Mechanical Engineering and principal adviser to the team. He summed up the systems approach as, "I'm designing this part, and it has to fit in with those other parts." He added, "We also have an unfair advantage, you might say, because we have an outstanding engineering school. Our students really do understand everything they're doing."

Brad Anton, Cornell associate professor of chemical and biomolecular engineering, is co-adviser for the team. Principal sponsors of Cornell's team include General Motors, Heller Industries, and Hunter Industries. Some 50 other firms contribute parts and other support.

—Bill Steele
Cornell News Service

SECONDS AWAY FROM FIRST

C
ornell came in second in NASA’s 11th annual “Great Moonbuggy Race” in Huntsville, Ala., April 3, losing to North Dakota State University by only a few seconds.

The competition, inspired by the compact vehicle used by astronauts in the 1960s Moon landings, challenges students to design and build a light, compact, human-powered vehicle and race it over a simulated Lunar landscape. The vehicle must collapse to fit in a cube, 4 feet on a side. Racers must carry the collapsed vehicle 20 feet and then set it up, racing against the clock, before actually driving over the course. Scoring is based on both setup and race time. North Dakota ran the course in 3:31 and Cornell in 3:33, but the Cornell
Students Marc Emond, M.Eng., and Simmie Bernan ’06 drive the Cornell Moonbuggy team’s entry in NASA’s “Great Moonbuggy Race” April 3 in Huntsville, Ala. The race requires a team of one man and one woman to drive a human-powered vehicle over a simulated moonscape peppered with bumps and other obstacles.

The team faltered on setup, so the total time was North Dakota 3:46 against Cornell’s 4:23.

“I don’t know how they did it,” said Andy Ruina, professor of theoretical and applied mechanics and the team adviser, of the Cornell team’s effort. “Last time I saw their moonbuggy, it was all in pieces.” The team was still working on the vehicle the night before they left for Alabama, he explained.

“We basically had a rough time putting the buggy together at the last minute. We ... worked on it all night till the last day,” said Daniel Hormaza ’04, one of the team leaders. “Lots of people doubted us, and we encountered lots of difficulties and problems, but we came through with really hard work and getting second place.”

NASA had 27 college-level entries in the competition from 13 states and Puerto Rico, with several schools entering two vehicles. There was a separate high school division. This is the third time Cornell teams have entered the competition. The first attempt, in 2002, was a “learning experience,” as the team had grossly underestimated the difficulty of the course and found their vehicle wouldn’t hold together. Last year, two Cornell teams entered, one with a new vehicle and another with a redesigned version of the 2002 model, and took first and second place, respectively.

In addition to Hormaza, the 2004 team consisted of Robyn Harmon ’06, who was co-team leader, and Roman Akhmechet ’06, Liz Connelly ’04, Nick Gerasimowicz ’04, Diego Jimenez ’04, with “a little help” from Roberto Malvaez ’04, Brett Spicer ’04, Adam Maher ’06, Pete Moran ’06, and Ellie Weyer ’06. Marc Emond, M.Eng., and Simmie Bernan ’06 drove the vehicle. Sponsors are Borg Warner, Emerson Power Transmission, the Bartels family, David H. Liu Foundation, and Learning Initiatives for Future Engineers (in the College of Engineering).

—Bill Steele
Cornell News Service

BIOメディカル APPROVAL

At the May 28 meeting, the Cornell University Board of Trustees approved the proposal of the College of Engineering to create a Department of Biomedical Engineering.

A cross-college “Biomedical Engineering Program” (BMEP) was established in 2001. It is expected that the department structure will accelerate Cornell’s national leadership in biomedical engineering while simultaneously enhancing existing departments that integrate the life sciences with engineering disciplines.

Michael L. Shuler, professor of chemical and biomolecular engineering and James and Marsha McCormick Director of the BME Program, will serve as the founding chair of the new department.

Here Comes the Sundial

Cornell President Emeritus Dale Corson, left, and Richard Phelan, professor emeritus of mechanical and aerospace engineering, shake hands at the reinstallation of the Joseph N. Pew Sundial on the Engineering Quad, May 17. The sundial, an icon of the quad for more than two decades, had been stored in Upson Hall during the Duffield Hall construction project. Designed by Corson, a professor emeritus of physics, it is accurate to within 30 seconds. Phelan was responsible for the manufacture of the internal mechanism that adjusts the sundial for the current date.
Night Lights
A striking image of Duffield Hall at dusk as seen from the top of Sage Hall has been chosen as the cover photo for the 2005 Cornell Calendar. It was taken by Nicola Kountoupes, Cornell University Photography. The calendars are available for $15 including postage. E-mail Diane Dibble of Cornell Communications and Marketing Services at dpl12@cornell.edu or phone her at 607 255-1860. Bulk discounts are available on orders of ten or more.

The ultimate objective is to improve GPS technology, commonly used in devices that can pinpoint the location of a person or object. A problem with the satellite-based system is that periodic, rapid fluctuations in the ionosphere interfere with the transmission of GPS signals. These scintillations have been measured from the ground, but not yet from orbit.

Campbell’s students, an interdisciplinary mix of majors in mechanical engineering, electrical and computer engineering, and computer science, have spent three years, working in teams of 20 to 25 members, designing and building the satellites.

—Jay Wrolstad

RENAMEING THE CAT

Ten-year funding commitments from the New York State Office of Science, Technology and Academic Research (NYSTAR) to programs at Cornell University, as announced June 30 by Gov. George E. Pataki, will help the university’s basic-research and technology-transfer efforts in the life and material sciences to emphasize regional economic development, as well as business and job creation.

The governor also announced a new name and enhanced mission for Cornell’s 20-year-old New York State Center for Advanced Technology (CAT) in Biotechnology with a 10-year, $1 million per-year commitment to the redesignated Center for Life Science Enterprise at Cornell University.

In addition, Cornell researchers will be active participants in the Future Energy Systems CAT awarded to Rensselaer Polytechnic Institute (RPI) by focusing efforts in the Cornell Center for Materials Research (CCMR) on research and development and more job opportunities in fuel cells, “smart displays,” and “smart lighting.”

“Economic development and technology transfer have always been fundamental goals of the CAT, along with supporting new initiatives in basic research,” said Stephen Kresovich, director of the Life Science CAT at Cornell, “and we’re proud of our record. More than 200 patents and 28 companies have grown out of this targeted research.” Kresovich pointed to a well-known example: The so-called “gene gun,” which was invented by Cornell scientists, developed with support from the Cornell CAT and originally manufactured by a New York start-up company on the way to becoming one of the standard tools in biotechnology.

As the Cornell CAT shifts emphasis to economic and workforce development, basic research funded by innovation grants will continue to be a critical part of the mission, in order to provide new “platform technologies” that R&D specialists can cultivate in the marketplace, explained Margaret Arion, executive director of Cornell CAT. She noted one requirement of the NYSTAR designation of university-based CATs—that institutions must show matching funding (from corporate, governmental, and institutional sources) and those sources will help support basic research, she said.

Said Russell W. Bissette, M.D., executive director of NYSTAR: “Cornell University’s Center for Life Science Enterprise will be an extremely important component of the state’s high-technology economic development efforts. With the research in the life sciences, enabling sciences, and agricultural sciences being done at this center, coupled with technological research in a wide range of areas, Cornell will be a key partner in helping create a vibrant high-technology-based economy for New York state.”

—Roger Segelken
Cornell News Service
RIDING THE INTERNET RAILS

Cornell has joined a nationwide consortium that owns and operates a fiber-optic networking infrastructure for scientific computer communication. The action, announced in June, will provide the university’s researchers with unprecedented high-speed connections and will allow other upstate New York institutions to invest in and join the system.

Cornell has pledged to contribute $1 million immediately to the consortium, National LambdaRail (NLR), and another $4 million over the next four years. The funding will enable NLR to extend its existing cross-country network of optical fiber to New York City. Cornell will complete the network by leasing fiber from Ithaca to New York City, also allowing more efficient collaboration between the Ithaca campus and the Weill Cornell Medical College in Manhattan.

“The trains don’t come to Ithaca anymore, but this guarantees that there will be a stop in Ithaca on the new information railroad,” said Cornell Vice Provost for Research Robert Richardson, the F.R. Newman Professor of Physics. “I expect it to have a major impact on categories of Cornell research that depend on collaborations in which we exchange large quantities of data.” Such research might include particle physics, astrophysics, and biosystematics.

NLR is a consortium of leading U.S. research universities and private-sector technology companies deploying a nationwide networking infrastructure to support research in science, engineering, health care, and education, as well as the research and development of new Internet technologies, protocols, applications, and services. Cornell will be its first member in the Northeast and will have a seat on the NLR board of directors, Richardson said.

NLR represents a major step forward in research computer communication because it owns its “dark fiber” and owns and operates the hardware that “lights” the fiber with signals, rather than simply buying bandwidth on commercial networks.

Funding NLR members include the Corporation for Education Network Initiatives in California; Pacific Northwest GigaPop; the Pittsburgh Supercomputer Center, Duke University, representing a coalition of North Carolina universities; the Mid-Atlantic Terascale Partnership and the Virginia Tech Foundation; Cisco Systems; Internet2; Florida LambdaRail; Georgia Institute of Technology; and the Committee on Institutional Cooperation.

—Bill Steele
Cornell News Service

THE BETTER TO SEE YOU WITH

The Arecibo Observatory telescope in Arecibo, Puerto Rico, the largest and most sensitive single dish radio telescope in the world, is getting a good deal more sensitive.

In April the telescope got a new “eye on the sky” that will turn the huge dish, operated by Cornell for the National Science Foundation, into the equivalent of a seven-pixel radio camera.

As morning mist blankets the Puerto Rico hills, workers prepare to bring the ALFA unit (hanging from a cable at the left) into the Arecibo telescope’s Gregorian dome, April 21.

The complex new addition to the Arecibo telescope was hauled 150 meters (492 feet) above the telescope’s 1,000-foot-diameter (305 meters) reflector dish starting in the early morning hours. The device, the size of a washing machine, took 30 minutes to reach a platform inside the suspended Gregorian dome, where ultimately it will be cooled and then connected to a fiber optic transmission system leading to ultra-high speed digital signal processors. The new instrument is called ALFA (for Arecibo L-Band Feed Array) and is essentially a camera for making radio pictures of the sky. ALFA will conduct large-scale sky surveys with unprecedented sensitivity, enabling astronomers to collect data about seven times faster than at present, giving the telescope an even broader appeal to astronomers.

The ALFA receiver was built by the Australian research group, Commonwealth Scientific & Industrial Research Organisation (CSIRO), under contract to the National Astronomy and Ionosphere Center (NAIC) at Cornell in Ithaca. Development of ALFA was overseen by the observatory’s technical staff. The rest of the ALFA system, including ultra-fast data processing machines, are under development at NAIC.

Radio telescopes traditionally have been limited to seeing just one spot—recorded as a single pixel—on the sky at once. Pictures of the sky have been built up by painstakingly imaging one spot after another. But ALFA lets the telescope see seven spots—seven pixels—on the sky at once, slashing the time needed to make all-sky surveys. Steve Torchinsky, ALFA project manager at Arecibo Observatory, said the new device will make it possible to find many new fast-spinning, highly dense stars called pulsars and will improve the chances of picking up very rare kinds of systems—for instance, a pulsar orbiting a black hole.

—David Brand
Cornell News Service
From the perspective of their individual specialties, Cornell's earth and atmospheric scientists weigh in on climate change and global warming.
PLANET EARTH

by Kenny Berkowitz
T multiplexes all over the country, Tokyo is being pummeled with hailstones the size of fists, Delhi is covered in snow, and New York City is facing a new ice age, the temperature falling at a rate of ten degrees per second. It’s all part of *The Day After Tomorrow*, Hollywood’s doomsday version of global warming, wreaking havoc on even the wildest scientific predictions.

Back in the real world, Arthur DeGaetano, in his office at the Northeast Regional Climate Center (NRCC) on the Cornell campus, talks calmly about the weather and the statistical realities of climate change. After decades of debate between scientists who saw global warming as the end of the world and others who saw it as nothing but hot air, DeGaetano places himself in the middle of the spectrum, convinced of the reality of climate change but unconvinced of any immediate danger for most of the world.

“There are still skeptics in the field, but in the last few years, I’ve seen them change their views on global warming,” says DeGaetano, associate professor in the Department of Earth and Atmospheric Sciences (EAS) and director of the NRCC. “At this point, the evidence for climate change is just too compelling, and anyone who wants to argue that it’s not happening is just fooling themselves.”

With his colleagues in EAS, he’s moved the discussion beyond theories of global warming and into the world itself. Instead of creating models to predict the long-range effects of global warming, Cornell scientists are studying the impacts of climate change all around us and investigating the physics underneath those changes. Charles Greene and Andrew Pershing study changes in the North Atlantic Oscillation, using an index that measures the difference in atmospheric pressure between Iceland and the Azores, and its impact on endangered right whales feeding off the coast of North America.

Kerry Cook uses computer models to study physical interactions at the interface of earth, ocean, and atmosphere to better understand the mechanics of climate change and variability. Applications include African drought, mountain glacier retreat, and the stability of the climate that supports the Amazon rainforest. Susan Riha studies how land use change, such as deforestation in the Brazilian frontier, alters the transfer of water and chemicals between the land and the atmosphere, which can influence climate.

“The idea of having a Department of Earth and Atmospheric Sciences is to emphasize the interactions between the spheres—the lithosphere, the biosphere, the hydrosphere, and the atmosphere—that in the past have been studied more or less in isolation from each other,” says Riha, until recently the associate department chair in EAS. “We’re interested in identifying the drivers of climate change. We’re interested in understanding how climate change impacts systems. We’re interested in knowing how people can respond to the impacts of climate and climate variability. What ties our work together is an interest in understanding how each of these parts affects the others.”

Focusing on the last hundred years of weather in the United States, DeGaetano sees a few clear trends in climate change. Since the beginning of the 1900s, when scientists started keeping data, temperatures have risen, plateaued, and risen again. Though DeGaetano’s work doesn’t try to pinpoint the origins of the changes, that first rise, from 1900 to about 1940, was probably due to natural causes like solar variability and volcanic eruptions; the second rise, starting around 1970 and continuing steadily into the present, is probably man-made, resulting from the growing effects of greenhouse gases in the atmosphere, largely from the increased use of fossil fuels.

Over the same hundred years, the amount of precipitation has stayed fairly constant as its distribution has become increasingly uneven, with longer rainfalls and longer droughts.
DeGaetano’s work focuses on extreme events, and its basic applications are in building design, where it can be used to model snow loads on roofs and frost depths for foundations. As for the larger question, DeGaetano is still open for debate: Are changes in atmospheric circulation influencing changes in temperature, or is it the other way around? “It’s not only that temperatures are getting warmer; the atmosphere is behaving in a different manner,” says DeGaetano. “And the more you study climate change, the more difficult it is to see any one piece. You really have to look at the whole system.”

For Kerry Cook, the key to predicting how climate may change in the future comes from understanding the physical mechanisms that underlie those changes. “When I started teaching climate dynamics 12 years ago, the warming signal was less pronounced and I expressed a level of scientific skepticism to my students,” says Cook, professor in the Atmospheric Science and Science of Earth Systems programs, two of three undergraduate majors offered by EAS. “Now, however, with the increased and consistent warming of the last decade, there is negligible uncertainty that human-induced global warming is a reality, and it is past time for humanity to react.

“One way of learning about climate change and of building confidence in our ability to predict it,” Cook says, “is to apply the same models used to predict future climate to climates of the past. For example, the Sahara Desert was green from 5,500 to 14,500 years ago and dotted with large lakes. And 21,000 years ago, the Amazon basin was significantly drier than today.” Cook and her research group have been able to capture these climate change signals in computer models, and they are analyzing the information to understand how observed past climate states were established and how future climate change scenarios may play out. Of special interest is an evaluation of climate system nonlinearities, such as those associated with interactions between land surface and atmospheric processes, which can lead to threshold behavior. When a threshold is reached, the climate system can change rapidly, making adaptation very difficult for human and natural systems.

Another way of building a physical understanding of future climate, Cook says, is to study the variability of today’s climate. She and EAS postdoctoral associate Ned Vizy have studied how warming in the Gulf of Guinea forces drying across the African Sahel through the regulation of surface moisture fluxes into the West African monsoon. Along with graduate students Jen-Shan Hsieh and Samson Hagos, she has found that summer warming over southern Africa causes drying over northeastern Brazil. Cook and undergraduate researcher Christina Patricola have cataloged the characteristics of African easterly waves, which are shed off the west coast of Africa into the
tropical Atlantic in summer and initialize hurricane formation.

On Georges Bank and in the Gulf of Maine, where they were analyzing year-to-year variability in zooplankton populations, Charles Greene and Andrew Pershing happened onto one of the most significant climate changes in the last hundred years. Their 1997 data was exactly as they’d expected, but when they returned a year later, their results were unlike anything they’d ever seen in the literature.

“We knew something big was going on, but we didn’t really know what,” says Greene, professor in EAS and director of Cornell’s Ocean Resources and Ecosystems Program. “In fact, two years earlier we had seen the strongest drop in the North Atlantic Oscillation index during the 20th century, and we were able to show that the NAO can have really dramatic influences on the physical environment. We’ll be able to study their behavior as the ocean changes.”

In the Brazilian rainforest, where large-scale deforestation has had a major impact on carbon production and the hydrologic cycle, Riha focuses on the interaction of soils, plants, and the atmosphere. Studying the effects of deforestation on radiation interception and evapotranspiration, she laid the groundwork for applied problems of deforestation on radiation interception and evapotranspiration, she laid the groundwork for applied problems. That’s what all this comes down to—the surface exchange of water and energy, and how that can affect your climate.

“In the Brazilian rainforest, where large-scale deforestation has had a major impact on carbon production and the hydrologic cycle, Riha focuses on the interaction of soils, plants, and the atmosphere. Studying the effects of deforestation on radiation interception and evapotranspiration, she laid the groundwork for applied problems of deforestation on radiation interception and evapotranspiration, she laid the groundwork for applied problems.”

Like Cook, Riha is concerned about triggers that can cause rapid climate change; and like DeGaetano, who’s heard too many questions about this past January’s cold spell—"If you look at the lows this winter,” he says, “it’s really not unprecedented”—Riha faces

At the Kohala Center in Hawaii where EAS has established a field program, Greene is creating the Hawaiian Ocean Resources and Ecosystems Observatory (HI-OREO) and the Hawaiian Underground Listening Array (HULA) to track fish, marine mammals, and sea turtles from the coast of the Big Island to the point where the ocean becomes 1,000 meters deep. “It’s a tremendous volume of ocean, a scale that biological oceanographers have never tried to observe before,” says Greene. “Our goal is to get continuous, three-dimensional, high-resolution positions of animals to track them, and once we’re able to do that, then we’ll be able to see how animals react to both natural and man-made changes in their environment. We’ll be able to study their behavior as the ocean changes.”

With the larger trend toward more droughts and more floods, DeGaetano sees a world of haves and have-nots, of the demand for water outstripping the supply.

At the Kohala Center in Hawaii where EAS has established a field program, Greene is creating the Hawaiian Ocean Resources and Ecosystems Observatory (HI-OREO) and the Hawaiian Underground Listening Array (HULA) to track fish, marine mammals, and sea turtles from the coast of the Big Island to the point where the ocean becomes 1,000 meters deep. “It’s a tremendous volume of ocean, a scale that biological oceanographers have never tried to observe before,” says Greene. “Our goal is to get continuous, three-dimensional, high-resolution positions of animals to track them, and once we’re able to do that, then we’ll be able to see how animals react to both natural and man-made changes in their environment. We’ll be able to study their behavior as the ocean changes.”
the task of teaching the non-scientists around her about the constant, ongoing process of climate change.

"Most people think of climate as remaining fairly stable, so it’s the challenge to get people to see that climate is dynamic," says Riha. "Clearly, we can see that here in Ithaca, because just 12,000 years ago, there was a half-mile-high sheet of ice where we’re sitting right now."

For DeGaetano, looking at the photographs of his children as he talks about the future, the real questions aren’t about temperature—they’re about water, “which I think is going to be the biggest problem to face society in 50 years.” By then, as his children reach retirement age, they will have gotten used to the warmer temperatures, adapting to long-term changes in climate, and coming to accept them as perfectly normal. But with the larger trend toward more droughts and more floods, DeGaetano sees a world of haves and have-nots, of the demand for water outstripping the supply.

“Groundwater is being depleted and not replenished, and there are already places out West where by the time you get to the end of the river, there’s very little water left to draw,” says DeGaetano. "It creates problems, because to avoid flooding you don’t want to have a reservoir full of water. And to avoid a drought, you want to make sure your reservoir has enough water to meet all your need. So globally, water is going to be a huge issue."

For DeGaetano, as well as for the rest of the department, the answers are as simple to understand as they are difficult to implement: We need to decrease our reliance on fossil fuels, cut back on emissions of greenhouse gases, and prepare to adapt to the changes around us. "The increases in temperature and the changes in rainfall are going to continue," says DeGaetano. "In the short-term, we’ll learn to adapt to changes in the weather, because it’s a gradual process, and we tend to adjust to it in our thinking. But in the systems that we build, that we’ve designed for a certain set of conditions, there may not be as much room for adaptation, and we may see the same kind of reactions that we see in the natural world.

"Even if there’s a breakthrough tonight in fuel cell technology, and we shut off all carbon dioxide emissions tomorrow, there’s still going to be global warming," says DeGaetano. “The climate can’t just react in a moment — it has a memory.”

Which is, in a sense, reassuring, suggesting that the sudden climate change scenario in “The Day After Tomorrow” is unlikely. But it also lends urgency to the real message: if we want to make a difference in the future, we have to act now.

Kenny Berkowitz ’81 is a freelance writer in Ithaca.
An expert in optics research, Chris Xu shines in the classroom as well.
Ever since his high school days, Chris Xu dreamed of becoming a college professor. So when the offer came to join the faculty in Cornell’s School of Applied and Engineering Physics, where he’d earned his master’s degree in 1993 and his doctorate in 1996, Xu jumped at the chance. There was only one problem: Although he was confident about the research part of the job, he’d never taught a class before and didn’t know if he’d be any good at it.

“A friend at Bell Labs warned me that teaching was going to be hell, that I would be sweating blood every day,” says Xu, less than two years later. “Coming here to teach, I had this apprehension that maybe it wasn’t going to work out. Then after two or three classes, I actually found it enjoyable to go to class. And after a month, I was convinced I could teach, because I could see how much the students wanted to learn. The teaching turned out very well, much better than I had anticipated.”

It’s a cool, rainy day at the beginning of summer, and a month after winning the Cornell Society of Engineers/Tau Beta Pi Excellence in Teaching Award, Xu is still feeling the shock. After all, there’s only one award winner each year, elected by Engineering students, and for Xu to have won it his first year teaching is unheard of. But the plaque really does have his name on it, and Xu, sitting in an office that’s about the size of his childhood apartment in Shanghai, speaks quickly, quietly, leaping from one metaphor to another: A new professor is like a sports car that can only drive in first gear, but the teaching itself—once he’s finished the hard work of mapping out the entire semester beforehand—is like riding a locomotive, steaming forward under its own power.

He’s a natural storyteller, and the words come pouring out as he talks about the excitement of finishing his fall course, Intermediate Electromagnetism, and then his spring course, Applied Solid State Physics. The stories keep coming: There’s the breakthrough concept for optical communications that was formulated in only three hours; the moment he first saw his future wife, as he wandered lost around Beebe Lake during his first fall break; or the last class of his fall course, when he saw his students passing notes back and forth, and worried that he’d missed a button on his shirt. If he had,
they probably hadn’t noticed; actually, they were just getting ready to sing “For He’s a Jolly Good Fellow” to their teacher, and Xu was the only one who couldn’t see it coming.

“It didn’t surprise me at all,” says graduate student Anthony Johnson, who was given AEP’s Trevor R. Cuykendall Memorial Award in part for his work as Xu’s teaching assistant (TA). After four years at the University of Colorado and one year at Cornell, Johnson has never seen anything like the scene that closed AEP 355, but it’s easy for him to understand what made Xu worth all the applause. “He’s very good at relating to his students,” says Johnson. “He comes across as being almost like one of them, pretty laid back. But at the same time, he assigns homework problems that are really, really challenging.”

Xu’s research straddles three main areas—optical fiber communications, biological imaging, and instrument design—and in a twist, he takes an out-of-the-box approach toward each of them, solving the problems of one with the tools of another. In fiber communications, building on his research at Bell Labs, where he found himself working with a graduate student, but with the input of fiber optics. The new strategy is adapting tools from optical communications to expand the possibilities of medical endoscopy. In design, the work he calls “fun and games,” Xu is trying to develop “a brand new way to create a short pulse,” which could then be adapted for applications in optics, imaging, and chemical sensing; like his best work, it borrows an idea from somewhere else, in this case, a little-used concept that “turns out to be very old, as old as my age.”

At 36, waving his hands as he talks, Xu still looks young and excited, and it’s hard to imagine him any other way. Born on the last day of 1967, he grew up at the height of China’s Cultural Revolution, and remembers spending his early school days in the streets, shouting slogans he was too young to understand. His mother worked for the postal service, and his father, who’d grown up too poor to ever attend a day of school, worked as a machinist in a shirt factory, gradually rising to the title of chief engineer after years of inventing and reinventing the company’s machinery.

Taking after his father, Chris grew up fascinated by machines, and as a boy, he was constantly taking things apart, especially cuckoo clocks, which were all much harder to put back together again. At twelve years old, feeling too cramped to study in the apartment he shared with his grandmother, parents, and three sisters, Xu went away to boarding school, where one teacher encouraged him to become an engineer. “He set my path,” says Xu. “By now, I’m sure he wouldn’t even remember the conversation, but to me it was very significant. He called me to his office and spent about ten minutes telling me that I was doing well, and that he had very high expectations of me. And he actually said, ‘I want you to go abroad.’ For six years after that, my goal was very clear: I wanted to study in the United States, to see the world outside China.”

Graduating from Fudan University in 1989 with a bachelor’s degree in physics, Xu came to Cornell in 1991, where he spent a semester as Professor Joel Brock’s TA in Intermediate Electromagnetism before joining Professor Watt Webb’s biological imaging group. Webb became his mentor, modeling the kind of career Xu wanted for himself, always moving forward and constantly seeking out exciting new directions. Xu created his motto—“Do not spend more than one hour at a time in the lab,” which he’s typed and taped to his computer—from Webb’s advice to “Never grab a soldering iron from a graduate student.” At heart, they share a single message: Trust and challenge the people around you.

After five and half years with Webb, a telephone call from a former Ph.D. student of Webb brought Xu to Bell Labs, where he found himself working alongside a group of Cornell Engineering alumni, including Linn Mollenauer ’58, BEE ’59, a member of the National Academy of Engineering, who’s become Xu’s closest collaborator. “Chris has a marvelous ability to understand what’s really important, quickly grasp what the problems are, and come up with some very creative ideas to solve them,” says Mollenauer, who rejoins Xu this semester as a visiting scientist in AEP, where they plan to continue their telecommunications work together. “In every interaction, Chris tends to be the leader, the fellow who provides the ideas and much of the momentum for getting things done.”

Walking through the lab he uses for his ultra-long-haul telecommunications experiments, Xu glides past a million-dollar test bed, Mollenauer’s retirement gift from Bell Labs, with its 600-kilo-
meter spools of fiber surrounding the stacks of components that Xu calls “pizza boxes.” One by one, he points out the instruments sitting on a table—a high-bandwidth power splitter, a torque wrench, a fiber splicer, rattling off the cost of each. Though it looks well organized, Xu thinks it’s a mess—which is good. “I always say, if a lab is too clean, it’s a bad sign,” he says. “It means that nobody is working.”

Moving down the hallway to his other lab, Xu talks about a revolution in medicine, when photons will be able to painlessly reach beneath the skin, creating an image that can be read and diagnosed. He talks about seeing the beauty in equations, like the one scrawled on the blackboard in his office that resolves the timing jitters in long-haul transmissions, restoring light pulses to their proper places. He talks about the simple pleasures of optics, where all he needs to do is come up with an idea, grab a handful of components, assemble them into something new, and run an experiment to see if it works.

Xu has 15 patents granted or pending, and some of his best ideas have come at lunch, with 48 hours being his fastest time from initial concept to finished prototype. At Bell Labs, Xu helped create a world-record transmission capability with an idea that began at lunchtime, and he’s co-authored more than 40 papers, including four book chapters, and participated in dozens of conferences. And though he feels the pain in writing grants — “It’s like pulling teeth,” he says, “writing a paper before you’ve done the work.”—he’s just been awarded two in the last two months, $520,000 from the National Institute of Health for endoscopic imaging and $550,000 from the National Science Foundation for a novel concept in ultrafast pulse generation. He is also expecting a grant from the National Cancer Institute for cancer detection and diagnostics.

“Chris is able to see right to the heart of the question,” says Joel Brock, professor and director of the School of Applied and Engineering Physics. “He’s not distracted by extraneous details, and whatever problem he’s looking at, he’s able to immediately identify the key issues and isolate them in experiments. He learns extraordinarily quickly, and from the outside, makes it look perfectly effortless. He has a real gift, not just for explaining things but for conveying his excitement about the material.”

To prepare for teaching Intermediate Electromagnetism, Xu borrowed an old set of solutions from Brock, and though the handwriting seemed familiar, it took Xu 10 pages before he realized he was looking at his own work, finished a dozen years earlier when he was Brock’s TA. Then, as September arrived after weeks of preparation, Xu set his lecture notes aside, and inside the classroom, he hardly looked at them. He teaches instinctively, talking off the top of his head, and always deriving his equations in front of the class.

“I take the material as a challenge for myself,” says Xu. “How do I explain these complex concepts in a way that makes intuitive sense? Sure, anybody with a background in math can solve these problems the same way that I do. But that’s not enough. You have to understand this intuitively, so you can close your eyes and see it happen in front of you. Only then can you create new things on top of the existing knowledge.”

Outside of work, in the little time he has left after teaching, researching, and writing, Xu relaxes with his wife, Alice Li (Ph. D.’98, Cornell), a biologist who works in Cornell’s patent office, and their two children, taking evening walks together. At home, their eight-year-old son Raymond (whose Chinese name means “light”) has already overtaken Chris in classical guitar, which they’ve been studying together; while their two-year-old daughter Sophia (whose Chinese name means “calm”) continues to teach him about patience, which helps both at home and in the classroom.

“I always remind myself that I need to be calm, calm, calm, but I set very high standards,” says Xu, his thoughts moving quickly from his children to his students. “If I expect only very little out of them, they might just say, ‘The professor doesn’t think much of us.’ I teach my undergraduates at the graduate level, because if I set a high level of excellence, they will have to work very hard. And if they do, they will be able to compete with the best of the best.”

It’s a bootstrap philosophy that’s worked for Xu all of his life, and even now, as he describes the path of his career as a pencil passing across a blank piece of paper, he’s convinced that his style works best here in the States, and that this is really where he belongs.

“I love this place,” he says, talking at once about his lab, his university, his country. “Life has treated me well, and I’ve been grateful that everything I wanted to do, I did. In China, I wanted to come to the United States, so I did. I wanted to get a good education, so I did. When I was in grad school, I dreamed of working at Bell Labs, so I did. Then after five years there, I came back to Cornell to be a college professor, which has always been my plan. Really, it sounds almost unbelievable, but it is very true.”

Kenny Berkowitz ’81 is a freelance writer in Ithaca.
GAME ON!

David Schwartz
A new course in computer game design brings together artists, programmers, musicians, and writers who hone their individual expertise, gain cross-disciplinary skills, learn to work in diverse teams, produce an actual product, and have some fun while they’re at it.

By Jay Wrolstad
I

T'S a Wednesday afternoon in mid-May and a standing-room-only crowd has gathered in the two computer labs on the third floor of Upson Hall, spilling out into the hallway. The open house visitors, mostly college students with a handful of school-aged kids and their parents added to the mix, have been drawn to the labs to test their skills against the creations of a collection of undergrads who have toiled all semester to create the computer games that are running on all of the PCs.

He says, "It was the first group project for me and most of the other students, so in that respect it was a good learning experience. We got to work on something that people can use and enjoy."

The Game Design Initiative at Cornell (GDIAC) is the brainchild of David Schwartz. He explains that the initiative is based on the model of other academic endeavors in that the components include instruction, research, and community service.

So how does a person with a Ph.D. in civil engineering from SUNY Buffalo become a game design instructor? Schwartz explains that as a grad student he published two books on introductory computer skills, which led to teaching intro computer courses at Cornell. The game course was a natural outgrowth: tapping into student interests to motivate their learning.

"There was so much interest in games among CS students that it made sense to pursue this," he says.

It was while serving as an adviser for the computer science student organization that Schwartz first conceived of a game class. Observing the club’s game night—students in the lab playing commercial computer games—some faculty members expressed concern about the violent content and inappropriate treatment of ethnic groups and women portrayed in some of the games.

"The department wanted an educational aspect to the game nights," Schwartz recalls. "So students were asked to write research papers on violence in games and the positive and negative effects of playing them." Club members balked at the requirement and game night was cancelled.

But Schwartz’s teaching instincts were sufficiently stimulated, and he decided that perhaps the best way to introduce an academic component was to have students create their own games. He approached the students, suggested a game design group, and found that they were interested, but that they, understandably, wanted academic credit for the work.

"I thought it would be fun to create a Cornell game class, and I spent a
year looking into what it would take to offer undergraduate credit for it,” says Schwartz. “There is a significant demand for game design in schools, companies, and the computer industry, and I thought we could do more than just offer a basic instruction course.”

During the summer of 2002, Schwartz connected with Rama Hoetzlein ’01, a software engineer and an experienced game developer who graduated with a dual major in computer science and art. Hoetzlein suggested teaching an interdisciplinary course and introduced the technology (GameX) needed to make the collaborations with music, art, and CS possible.

Starting from scratch, the two men put their heads together and organized the first interdisciplinary computer game design course under the CS 490 research category. “Rama was able to offer his experience, and he also brought in art students,” says Schwartz of his co-instructor. “We saw that students could produce some decent games during the first offering in fall 2002.”

Hoetzlein cites the interdisciplinary nature of the course as a significant benefit for students, who get to work on tangible projects that they don’t always have in other coursework. “Tying in art and music with CS was critical,” he says. “I believed that the connections could be made, but being able to provide an official course offering has exceeded our expectations.”

Building on that initial success, the introductory course (part one) was offered again in the spring. But rather than focusing on instruction for the first half of the semester and spending the second half in actual game design, a second section was formed comprising students who had already completed part one. They would spend the entire semester designing games. Those interested in game research also were included in part two.

The interdisciplinary nature of the project inspired collaborations with faculty members across campus: Todd McGrain, an associate professor in the art department; David Borden, director of Cornell’s Digital Music Program; and most recently, Xiaowen Chen, a visiting associate professor also in the art department. And music and art students join their peers on the Engineering Quad in game design teams.

Digital media have established a following among today’s artists, notes Chen, particularly animation and game design. “I fully support interdisciplinary study, and this is a great way for art students to gain exposure to the field of engineering. It would be great if the course could be cross-listed in art and engineering, or if we could make game design an art class.”

In fall 2003, Hoetzlein became the outreach coordinator for GDIAC and Mohan Rajagopalan, who holds master’s degrees from Cornell in both mathematics and computer science, became the new co-instructor. Equally promising was a cash infusion from the General Electric Fund, which enabled Schwartz to pay Rajagopalan for his time. Full financial support for spring 2004 was provided by software giant Microsoft.

“We have learned from our experience, and from our mistakes, and the course is now much more organized.
Research has become an integral part of the game design initiative, with graduate engineering students participating, and a community service component has been added, through participation by the Learning Web organization in Ithaca, which provides educational and occupational opportunities for youth in need of guidance.

“We place one or two of the younger people with each of the student groups, each of which has a community liaison, in part one,” Schwartz says. “The kids don’t learn how to program, but they can sit in on lectures, and in the groups they can help with character names, storylines, artwork, or music. It depends upon their interests.”

To those who question the value of “playing games” for Ivy League students, Schwartz points out that the courses present a number of relevant challenges. For engineering students it’s all about creating software. “Students can approach this from the programming angle and learn about artificial intelligence, networking, user interfaces, collision detection, and the engineering process using the C++ programming language,” he says.

For upper-level students, the courses offer an opportunity to apply what has been learned in algorithm courses, for example. “At one level, students learn how to design a very large software package, which is valuable skill,” says Schwartz. “They learn how to design a product in a team setting, working with non-programmers.”

Then there is the more abstract theory component, with a focus on the qualities that make a compelling game, the various types of games, and the social and artistic impacts of the finished products.

Rajagopalan explains that throughout the semester, instruction in a variety of topics, such as technical aspects, design issues, and production schedules, gives students a sense of the big picture in game design.

“Even if you don’t believe that games are worthwhile, this is unique opportunity because it brings students of different backgrounds and abilities together in the same room—artists, engineers, and musicians,” he says. “The students want to make computer games, but don’t always know what is involved.”

Schwartz concurs, saying, “We want to give students a multi-disciplinary experience, letting them work with people in different fields, and we can do that because game design merges these different areas of study.”

As might be expected, given the time constraints and the background knowledge of the students involved, the finished products are relatively simple. Most are arcade-oriented digital amusements, lacking the sophistication of 3D video game software designed for PlayStation or Game Cube consoles. And players who check out the games available for download on the initiative’s web site (www.cs.cornell.edu/projects/game/) will see that there is nothing close to the murder and mayhem provided in consumer video games such as the wildly popular “Grand Theft Auto.”

Instead, there are role-playing games featuring Japanese ninjas and samurai, fighting robots, spaceships,
and curious characters who are warm and fuzzy or fat and funny. There is even a version of Chinese checkers and a text-only virtual-world design game in which players create their own environments, adding components such as lights, objects, and doors to a room and placing the characters within.

Students enjoy the course, says Hoetzlein, in large part because they are collaborating with students in other areas to create something unique and because they are gaining exposure to fields outside of computer science.

If anything, student enthusiasm runs a bit too high. "They always bite off more than they can chew and the projects are typically scaled back as the students learn their own limits," says Schwartz. "But that’s good for them; they have to create their own homework and control their own projects instead of being told the details of what is expected."

The end result, says Rajagopalan, is that some groups do a more polished project than others. "You have to keep in mind that commercial games are developed by large teams that may take years to complete their projects. Our philosophy is to teach basic design principles and let the students do their own thing."

"This is the coolest thing that I’ve done at Cornell," says Colin Campbell, a CS major in the arts and sciences college who took both parts of the course. "I wasn’t sure what to expect when I got into this, but I did learn how to create a game."

Campbell appreciated the free rein given to participants, and noted that learning C++ programming, organizing software, and serving as project leader were among the valuable skills he acquired.

His first project was the spaceship game “Rampant Rampage.” For part two of the course he served as lead designer and programmer for “Guys!,” an innovative puzzle game in which both fat and skinny characters build a pathway using blocks with the goal of reaching an exit without falling and disappearing from the screen.

“We had art students on our team who don’t know programming, but can create backgrounds,” says Campbell. “I realized that it requires broad range of talents to make a compelling computer game.”

Zach Shalla, a freshman CS major whose team created the “Blade of Honor” turn-based game featuring characters from feudal Japan, offers a similar take. "During the course we heard lectures on music, art, and artificial intelligence—things I did not usually think about when playing computer games."

The characters in Blade can hide, kill with a weapon, use Zen power to heal, and have stealth and ambush capabilities. But they have to follow the rules: a monk cannot attack or be attacked, for example, and the Samurai cannot launch a sneak attack from behind. Players who demonstrate more honor gain more functionality.

Teamwork is a critical component.

As the group leader, Shalla says, his biggest challenge was getting everyone on the same page when the project started. "We had three programmers, an artist, a musician, and a high school student from the Learning Web program. It took a while to get organized, but I’m very pleased with the finished product," he says.

Schwartz’s enthusiasm and thoughtful development of the courses have won over the decision-makers in the computer science department, who may have also been swayed by the number of students signing up for the game design courses. Part one will be a recognized course, emerging from the broad CS 490 undergraduate research label to be listed as CIS 290 (a preliminary version) in the summer and as CIS 300 in the fall.

The course listing describes both the technical aspects — software engineering, artificial intelligence, game physics, computer graphics, and networking — as well as the aesthetic and cultural ones—art and modeling, sound and music, history of games, genre analysis, the role of violence, gender issues in games, game balance, and careers in the industry. The goal is to attract a mix of students who are computer scientists, artists, musicians, and writers. Each group has to meet specific prerequisites for taking the course, and their classroom contributions and evaluations will be based on their major.

“The CS department has been very supportive,” says Schwartz. "We had to prove the academic merit of a game design course. The case we have made is that people love playing games—it’s part of our nature—and we should be studying this.”

Jay Wrolstad is a freelance writer in Ithaca.
PROFESSOR Tim Healey wouldn’t say there’s a direct link between Laika the space dog and the evolution of the Department of Theoretical and Applied Mechanics (TAM), of which he is now chair. But had that Russian dog not gone into space, thus lighting a fire under America’s space program, who knows how things would have turned out? “A lot of departments like ours sprung up in the sixties,” Healey says. “And a big reason was Sputnik. After that happened, there was a tremendous push for more science and math in engineering education and more fundamental research.”

Almost five decades after the Russian space launch, the department is still in the business of fundamental research—research, Healey explains, in which methods are general and the results are often applicable to phenomena in widely disparate fields. Case in point: in 2002, the fourteen faculty members in TAM collaborated on projects with faculty from ten other departments—including physicists, neurobiologists, astronomers, and researchers in textiles and apparel. Not surprising then is how diverse the areas of research being done in TAM are: topics include planetary dynamics, the mechanics of walking and running, mathematical modeling of disease dynamics, DNA elasticity, insect flight, flow and segregation of granular materials, fracture and failure in metals and composites, and complex small-world networks, which includes the study of the collective behavior of simultaneously flashing fireflies.

“Sometimes when people hear about us,” Healey says, “they think we sound like the department of misfits.” But, he hastens to add, “While our specific fields of application are typically quite diverse, what we have in common is an approach to research based upon the fundamental and grounded in modern science and mathematics—we all speak the same language.”

One might assume, since there’s no undergraduate major in TAM, that the faculty would be far removed from the everyday lives of undergraduate engineering students. Healey says, however, that one of the hallmarks of the department is outstanding undergraduate teaching, particularly in the area of first-and
What you might not know about Theoretical and Applied Mechanics
second-level courses in engineering math (Math 191, 192, 293, and 294). This kind of commitment from an engineering department to math instruction is rare; in fact, of all the Theoretical and Applied Mechanics or Engineering Mechanics departments in the country—Healey estimates that fewer than ten stand-alone departments now exist—Cornell’s department is the only one to participate in math instruction.

The relationship between TAM and the Department of Mathematics in the College of Arts and Sciences extends back nearly forty years. In the mid-sixties, as Edmund Cranch, professor emeritus, former TAM chair, and former dean of the college, explains it, a treaty was made between the two departments to share in the instruction of the second-level mathematics courses for engineers, partly in response to a desire shared by many engineering faculty members to see math instruction geared to the interests of future engineers. “This was, at the time, a groundbreaking development in the instruction of mathematics for engineering,” Cranch says. “It worked off the notion that engineering faculty are students, this set of notes is no longer being used, but TAM and the Department of Mathematics continue to collaborate in the management of these courses. Two or three times a year, the Math Liaison Committee, comprising two members from each department, convenes to discuss potential changes in curricula, syllabi, and textbooks. Says Professor Ken Brown, the current chair of the Department of Mathematics. “We just want to make sure we’re all on the same page and meeting the needs of the students.”

The next big innovation in the teaching of engineering math at Cornell came at the tail end of the 1980s, when the College of Engineering decided that its students would benefit from small-section courses in Math 191, first-semester calculus. “Bill Street, then dean of engineering, talked a lot about wanting to make first-year courses more friendly,” Healey says. It was felt by many professors that some students were alienated by the large class sizes and were too intimidated to come ask for help. “Everyone thinks of Cornell students as being extremely able, but even in fact qualified to teach the beginning mathematics courses—and vice versa, of course, that the mathematicians have something to contribute to the upper level of courses. There was an element of trust and willingness to learn that was implicit in this.”

This unique relationship soon gave rise to a book-length set of notes co-written by Cranch, his TAM colleague Professor David Block, and two professors from the math department—Bob Walker and Peter Hilton. The set of notes, never formally published, was the first program of study of its kind, in that it integrated the subjects of differential equations, linear algebra, vector calculus, and infinite series. “It really was a pioneering step,” says Cranch. Not long after it became the standard issue text for second-level math at Cornell, engineering professors at other schools caught wind of it and asked to use it in their classrooms.

With the advent of computer science and the evolving needs of engineering the most competitive ones sometimes feel like deer caught in the headlights,” says Joe Burns, professor and department chair in TAM when the small classes were established. “We were keeping only sixty or seventy percent of our students and part of it was that they weren’t getting to see engineering faculty early on.” The math department was already having success with the small-section calculus course it provided for students in the College of Arts and Sciences; why not provide the same services to engineers?

The project was given the green light. A named assistant professorship was added in the mathematics department, professors in TAM as well as other engineering departments were recruited to teach, and a new policy was instituted requiring that freshman advisers offer an hour of tutoring to their advisees every week. Six years later, under the guidance of the chairs of TAM and Math at that time, Professor Jim Jenkins and Professor Bob Connelly, small-section courses for Math 192, second-semester calculus, were added as well.

The program has been, not surprisingly, an unequivocal success. Although it’s difficult to measure the direct correlation, the attrition rate in the College of Engineering has shrunk by almost half since the small-section courses were instated, and results of a Student Satisfaction Survey taken after these curriculum changes were instituted show that students felt their professors were more approachable for help and cared more about their academic success.

“What’s great about these classes,” Healey says, “is that you have a real opportunity to make a safety net. Everyone who teaches these courses says that. You can be there for the struggling students, and if you have real crackerjack students, you can be there for them, too. It’s that personal touch that really has a big effect on the bottom and the top.”

Providing math instruction has also helped TAM stay as small, diverse, and autonomous as it is. The trend over the past few decades, Healey says, has
“What I’ll do,” he says, “is aim for the everybody regardless of their skill level. small-section math courses is to reach

profesional car engine, composed of ten
might talk about a simple three-dimen
abstract ten-dimensional space, Rand
might bring up the paper he and
stumped on, say, a vibrations problem,
gives examples. When students are
endeavor,” Rand explains. “They need
to be motivated by examples.” So Rand
gives examples. When students are
stumped on, say, a vibrations problem, Rand might bring up the paper he and Professor Bob Cooke, a colleague from biological and environmental engineering, wrote in which they calculated the optimal modes of oscillation for apples to be shaken (or vibrated), with their stems and without their stems, off a tree branch. Or when students studying matrices are struggling to visualize an abstract ten-dimensional space, Rand might talk about a simple three-dimen
car engine, composed of ten
moving parts, each associated with a
certain variable, to help them make the mental leap.

More generally, Rand says, the challenge in teaching both large- and small-section math courses is to reach everybody regardless of their skill level. “What I’ll do,” he says, “is aim for the middle and even spend a little bit of each lecture going over the material

again, in order to pull in a few more
people. Occasionally, I’ll give a lecture
aimed at the more accomplished stu
dents and will reassure the class that
this lecture will be something that’s interesting but it won’t be on the test. This way I hope to not discourage any of the students.”

While Hui doesn’t find it possible to
lift many “for instances” directly from
his own research (currently he’s study
how geckos adhere to a variety of
surfaces), he does try to bring across interesting ideas to his students that are related in a tangential way to his
own research, as well as make connec
tions between the material they are
studying in his class and things they are
learning in other engineering or physics
classes.

Hui finds teaching the smaller sec
tions to be easier and less stressful. “In
a small class if you make a boo-boo, it’s
much easier to correct. You can just
apologize and say ‘I made a mistake.’
You can also make eye contact with
everyone, and if you see eyes glazing
over, you can slow down. But in a large
class you just can’t afford to make
mistakes in a lecture. In a large class,
simply too many prerequisites to un
derstanding it. But he does occasionally
share questions that his former high
school math teacher sends him—ques
tions that ask students to solve prob
lems associated with kayaking across a
fast-moving river, or designing a swim
ning pool, or slicing up cylinders of
heating oil. In the small-section courses
especially, he makes a point to ask his
students not only to solve the problem,
but to convince their classmates of their
reasoning. “To do that takes an extra
degree of understanding.”

And even though he understands
that most of engineering students
taking calculus or linear algebra or dif
ferential equations see the courses as
hurdles on the way to receiving their
degree, Strogatz feels its worthwhile to
bring up the big questions that orbit the
disciplines of mathematics and engi
neering, those fundamental questions
that his colleagues ponder as well: “I’ll	sometimes ask the kids: ‘What is the
nature of this enterprise? Is it art? Are
we trying to create something beauti
ful? Is it science? Are we trying to figure
out something about how the world
works?’ And the answer, of course, is

They have excellent command of the material, they are enthusiastic
about their subject, and they really care whether students learn or not,
and that comes through loud and clear.

endeavor,” Rand explains. “They need
to be motivated by examples.” So Rand
gives examples. When students are
stumped on, say, a vibrations problem, Rand might bring up the paper he and Professor Bob Cooke, a colleague from biological and environmental engineering, wrote in which they calculated the optimal modes of oscillation for apples to be shaken (or vibrated), with their stems and without their stems, off a tree branch. Or when students studying matrices are struggling to visualize an abstract ten-dimensional space, Rand might talk about a simple three-dimen
car engine, composed of ten
moving parts, each associated with a
certain variable, to help them make the mental leap.

More generally, Rand says, the challenge in teaching both large- and small-section math courses is to reach everybody regardless of their skill level. “What I’ll do,” he says, “is aim for the middle and even spend a little bit of each lecture going over the material

if you lose [the interest of] ten percent
of the students, it’s a disaster, because
they’re going to make noises and pretty
soon the noises are going to propagate
throughout the hall, and you can’t give
an effective lecture.”

Hui also notes the importance of
presenting material in a way that will
get undergraduates’ attention. For
example, when Hui gives a lecture on
a probability principle called Markov chains, he chooses to illustrate his
point by setting up a problem dealing
with the predictability of a hypotheti
cal boyfriend or girlfriend’s bad mood
as opposed to the predictability of the
weather or certain stocks or bonds—
examples that he feels are well-worn
and alien to most college students.

Strogatz also says it’s difficult to
mine his research (which includes
human sleep-wake dynamics and
mathematical investigations of the “six
degrees of separation” phenomenon)
for real-life scenarios helpful to begin
ning-level math students; there are

that it’s all those things. At the same
time it’s a fight. The doing of math as
opposed to the appreciating of math is
a real struggle. There’s this thing that’s
resisting. And of course the real struggle
is with yourself.”

That struggle to define the enter
prise is reflected at the department level
as well. With its diversity of research
topics and its lack of a field-specific
undergraduate degree, TAM is often
referred to—even by its members—as a
“nontraditional” department in the Col
lege of Engineering. Yet the faculty is
internationally recognized for its funda
mental research in engineering science
and applied math, and they are rou
tinely honored for excellence in teach
ing. And that amounts to what Healey
simply calls “the best department you
never heard of.”

Mark Rader <mark_rader@yahoo.com> is
a freelance writer and a recent graduate of
Cornell’s master’s program in creative
writing.
What goes around comes around. Every year, mechanically minded high school students all over the United States and Canada compete in the FIRST (For the Inspiration of Science and Technology) Robotics competition, building and programming robots and entering them in regional and national game-playing competitions. And middle-school students have the FIRST Lego League, a competition to program off-the-shelf Lego robots.

As you might expect, some of these high school students end up studying engineering at Cornell. A few of those students decided to give back to the next generation and have formed the Cornell FIRST Robotics Club, to help provide mentoring to Ithaca High School’s FIRST Robotics team and a Lego team organized at Ithaca’s Sciencenter. The high school team is sponsored by Borg-Warner Automotive and Innovative Dynamics Inc., and some of their engineers also offer advice.

The group saw its work pay off this year as Ithaca High’s team, known as Code Red 639, won the Canadian super regional competition in Mississauga, Ontario, April 1–3, and the Sciencenter’s Lego team took the second-place programming award in their competition at Pace University in Pleasantville, N.Y., Feb. 8. The high school team currently includes 25 students, with Ithaca High School technology teacher Michael Peters as their adviser. The Sciencenter Lego team started this year with six students.

“Most of us have been involved in our own high schools or have been friends of people who did it,” explained Vicki Niebrzydowski ’04, president of Cornell’s FIRST Robotics Club. The club started four years ago, she said, with Patrick Dingle ’04, who helped to organize the first Ithaca High School team and eventually brought in other Cornell students. In the fall of 2001, the Cornell club was formally registered as a student organization, and it now has “about 10 members,” Niebrzydowski said. Daisy Fan, assistant professor of computer science, is the faculty adviser.

More than 800 teams participate nationwide and internationally in 23 regional events and a championship event. The competitions are sponsored by FIRST, an organization dedicated to motivating young people to pursue opportunities in science, technology, and engineering.

—I Bill Steele
Cornell News Service
doubling the seating were first-rate,” said Cox. “I was particularly impressed with the graphics they used, how diverse the designs were, and how the students presented the designs.”

Cox, who has had season tickets to Cornell hockey for more than 25 years, said he sympathizes with students who camp out-side the rink for hours to get tickets but often can’t get them due to inadequate seating.

A couple of the engineering students’ designs “were really radical and showed out-of-the-box thinking, such as a transparent roof and an asymmetrical flying wedge-shaped roof,” Cox added. The designs, though unusual, were realistic design solutions and merit further consideration when Cornell decides to consider a Lynah expansion, he noted.

Hover pointed out that “the students had to research and consider all the parts and pieces involved in supporting a new roof—such details as having to anticipate the impact of temperature changes on the roof, from minus 30 degrees Fahrenheit in the winter to a summertime roof temperature of 120 degrees,” he said.

Robyn Jadney, a junior civil engineering major from East Windsor, N.J., said, “We were responsible for designing everything from the roofing system down to the footings, including detailed plans for the additional second-level bleachers.” The faculty, she said, “treated us like we were professional engineering firms. We had to submit conceptual and final designs as well as prepare final presentations. The assignment has definitely prepared me for work after Cornell.”

The course was instructed by six CEE professors in all: Hover on concrete; Anthony Ingraffea on fracture and failure of structural elements; Teoman Pekoz on structural steel; and Fred Kulhawy, Thomas O’Rourke, and Harry Stewart on soil behavior and foundation engineering.

—Susan Lang
Cornell News Service

A DAY AT THE SWASH ZONE

Edwin A. (Todd) Cowen, associate professor in the School of Civil and Environmental Engineering, was one of three Cornell faculty members to win the prestigious Guggenheim Fellowship award for 2004. They are among 185 artists, scholars, and scientists from the United States and Canada selected from more than 3,200 applicants for

STRIKING GOLD

Mark Polking, a junior in the College of Engineering, has received a 2004 Barry M. Goldwater Scholarship, considered the premier undergraduate award in mathematics, science, and engineering.

Polking grew up in Boone, Iowa, and graduated from nearby Ames High School. He is majoring in materials science and engineering, and has been conducting research under Christopher Umbach, assistant professor in the Department of Materials Science and Engineering, on the nature of fractures in glass, with the goal of creating more resilient glasses.

In his senior year he hopes to find a research project on electrical and magnetic properties of solids, perhaps with application to superconductors. He also has spent the past two summers in research jobs at the University of Iowa and a nearby Department of Agriculture laboratory. He plans to go on to graduate school, with the eventual goal of becoming a faculty member in a research university in the United States or the United Kingdom.

Polking is a member of the engineering honor society Tau Beta Pi and the Golden Key Honor Society, and he resides in the German Language House. He has worked as a tutor in freshman engineering classes.

—Bill Steele
Cornell News Service
RESEARCH REWARDS

Cornell seniors in the College of Engineering took the top two prizes in the 2003–04 Intel Student Research Contest last spring. Eugene Lee, majoring in computer science, received the first place award of $5,000, and Sara Parker, majoring in materials science, received the second prize of $3,000. The third place prize of $2,000 went to Ankur Bala of Georgia Tech.

Lee, working under Kavita Kalra of Georgia Tech, Cornell assistant professor of computer science, developed software that speeds the rendering of computer graphics on desktop computers. He also credits postdoctoral researcher Bruce Walter in the Cornell Program of Computer Graphics with assistance on the project. Lee developed an implementation of a graphics technique known as the “edge and point system” for simulating light and shadows that uses the graphics processor on a desktop computer, allowing the desktop machine to perform tasks that formerly required many hours on a supercomputer cluster. According to Bala, the work will help to make high-quality computer graphic images “available to the common man.”

Parker worked in the research group of George Malliaras, assistant professor in the Department of Materials Science and Engineering. The group has been developing new types of flat-panel displays using organic materials that give off light with very high efficiency and are not subject to the dark spots that appear on current displays. One problem has been that these materials require up to four hours to light up when first activated. Parker studied the effects of an additive that reduces the turn-on time to only one or two minutes. She found that too much of the additive made poor displays, but an appropriate level increased efficiency.

In the Intel competition, undergraduate students nationwide submit research proposals to the company, which selects up to 20 projects for funding. Students work on their projects over the summer and fall in consultation with their faculty advisers and an Intel engineer, and in the spring they are flown to the Intel facility in Oregon to present their results. The three presentations judged best receive cash prizes.

—Bill Steele
Cornell News Service
THREAD THE NEEDLE

As the Cassini-Huygens spacecraft arrived at Saturn at 10:36 p.m. on June 30, among the most anxious participants was Joseph Burns, Cornell’s vice provost for physical sciences and engineering. As a member of the Cassini imaging team, he has been jointly responsible for observing the gaps in two of the planet’s outer rings that the spacecraft had to slip through to become the first mission to orbit Saturn.

The decision to go through these gaps in the ring debris was made on May 20 after multiple observations by Burns and his colleague at NASA-Ames, Cornell alumnus Jeff Cuzzi ’67 EP. “I am looking at the place where the spacecraft is going to make sure there is nothing there,” said Burns, who is the Irving Porter Church Professor of Engineering in the Department of Theoretical and Applied Mechanics as well as professor of astronomy.

The fear was that something might have changed since May 20 in one of the two entry rings, known as the “G” ring. “We ask ourselves the question: Are we basing our orbit insertion strategy on old data?” he said.

Well before Cassini began its approach to Saturn, Burns and Cuzzi were studying images of the area taken by the Voyager spacecraft (Voyagers 1 and 2 flew past Saturn nine months apart in 1980 and 1981), as well as at ground-based observations and images taken by the Cassini camera every other day. “We were trying to see whether or not anything might have changed in the region to make sure it is still the safest place to go,” said Burns.

There was jubilation at the Jet Propulsion Laboratory that night and signs of relief from Cornell researchers as the spacecraft successfully made its perilous passage through two of Saturn’s rings and went into orbit around the giant planet. The $3 billion-plus mission is the result of an international cooperation between NASA and 17 European nations. After a nearly seven-year journey, the spacecraft will make 76 orbits of the giant planet over four years, touring Saturn’s rings, icy moons, and magnetosphere and sending a probe onto Titan, the planet’s largest moon.

The mission, said Burns, will transform our knowledge of Saturn, with the almost certain discovery of new rings and new moons beyond the 31 already known. Voyager, he said, “essentially took a couple of beautiful photos of a glorious dance as it went by. We are going to have the motion picture.”

—David Brand
Cornell News Service

SUSTAINABLE GOALS

No longer the “me generation,” American engineering students are actively taking on some of the world’s toughest problems.

A Cornell-based national engineering service organization took some of its many stories of students and professional engineers working to improve the lot of some of the world’s poorest communities, many in the developing world, to New York City in May.

The group, Engineers for a Sustainable World (ESW), hosted students and supporters from across the United States at the Mezzanine Conference Room, 30 Rockefeller Plaza. The event, which was both fundraiser and a call for volunteers, featured students recently returned from Bosnia, South Africa, and Nigeria describing their community-service engineering projects that have made a big difference in people’s lives by enabling self-help, making the projects sustainable.

Founded at Cornell in 2002 as Engineers Without Frontiers, the organization now has a presence on more than 80 campuses in the United States and includes more than 1,000 students and professional engineers. Current projects being funded by ESW include a rural water-supply project in Honduras, a composting-education project in Bosnia-Herzegovina, and computer training in China.

This summer, a multidisciplinary team of ESW volunteers from various university chapters traveled to Umuahia, Nigeria, to develop a project to turn biomass waste into energy. The project was set up over the spring break last March by eight Cornell students and alumni from the College of Engineering and the Johnson Graduate School of Management as Engineers Without Frontiers.

Among the attendees at the event were from left, Regina Clewlow, director of ESW, and Jo Pak ’05 CE. Eight Cornell students and alumni from the College of Engineering and the Johnson Graduate School of Management spent their spring break in Umuahia, Nigeria, setting up a project to turn biomass waste into energy. Over the summer, a multidisciplinary team of volunteers from several chapters of the Cornell-based Engineers for a Sustainable World (ESW) further developed the project. Among those in Umuahia receiving instruction in adobe brick making were, from left, Regina Clewlow, director of ESW, and Jo Pak ’05 CE.
School of Management.
The organization recently changed its name to Engineers for a Sustainable World because of its focus “on the challenges of long-term, sustainable development—by seeking lasting solutions for reducing poverty, and by working to improve sustainability in the United States and abroad,” said ESW director Regina Clewlow ’01 CS, M. Eng. ’02 CE. “The new name more accurately reflects these goals and activities.”

—David Brand
Cornell News Service

ENERGY ISSUES

By the year 2020 the world will be consuming about 40 percent more energy than it does today, so that daily energy consumption will equal 2,000 round trips to the sun, or a mid-size car traveling roughly 378 billion miles a day, an analyst for Exxon Mobil Corp. said at a Cornell engineering conference in April.

The graphic estimate was made by Elissa P. Sterry ’79 ORIE, speaking at the Cornell Society of Engineers (CSE) conference at Barnes Hall. Sterry is manager for economics and energy in Exxon Mobil’s Corporate Planning Department, the fact-finding unit for senior management and directors on energy issues.

This year’s conference, sponsored both by the CSE and the College of Engineering, featured talks on the applications and business potential of new technologies in energy, as well as sustainable development in industry, presented by Cornell alumni who are leading energy industry figures and faculty members who are leading the research at Cornell. The talks included topics such as bringing an environmental approach to mining and manufacturing and development of wind power and fuel cells.

Sterry, who was looking at energy trends through 2020, noted that energy demand will continue to be driven by economic growth, estimated at 3 percent annually, and by the expected rise in the world’s population over the next two decades.

The question most often asked these days, Sterry said, is “how much oil is there and when will it run out?” While admitting that the question is difficult to answer, she illustrated her answer by putting world oil supplies in three “buckets.” The first—conventional resources that can be exploited using available technology—contains 3 trillion barrels (compared with the 1 trillion barrels of petroleum that have been pumped since production began in the 1800s).

The second bucket contains oil sources that can’t be recovered using conventional technology, such as oil sands and extra-heavy oil. These amount to an estimated 4.3 trillion barrels. And in the third bucket are unrecoverable resources that “we are pretty sure are there, but we are not sure how to get them economically,” she said. These amount to an estimated 4 trillion barrels.

“There are a lot of resources here,” Sterry said, “and will allow for oil and gas to be the primary sources of energy through at least the middle of the century.” She noted that new technologies likely will continue to extend the recoverable resource base, making additional, but currently uneconomic, resources commercially attractive.

—David Brand
Cornell News Service

POWER OF SCIENCE

Graduate students at Cornell want to make their campus and their surrounding communities more aware of the power of science and the role that science and technology play in decision-making in Washington and the world at large. To spread this awareness, they invited leading authors and journalists to a one-day conference on science communication on campus in May.

The students and their faculty adviser, Steven Strogatz, professor in the Department of Theoretical and Applied Mechanics, author of the recently published book Sync, and a well-known science communicator himself, invited all interested people on and off campus to attend the conference. The featured writers, including Ivan Amato, author of Stuff: The Materials the World is Made Of, and journalists Rick Weiss (a 1974 Cornell graduate) of The Washington Post and Robert Krulwich of ABC News, described the problems and rewards of successful science communication.

The conference, “Science for Everyone,” was funded
by grants from the National Science Foundation’s Integrative Graduate Education and Research Traineeship Program, which is designed to expand the interdisciplinary backgrounds of scientists, engineers, and educators.

“This conference is consistent with so much of the spirit of Ithaca, going back to Carl Sagan, in bringing science to the public,” said Strogatz. “We would like this event to be held every year and to take its place in the community along with the Sciencenter and the Museum of the Earth.”

“Public perception affects everything from political decisions to what our kids will study in school,” said Thomas Oberst, an astronomy graduate student, who helped organize the workshop. “At the rate at which science and technology are shaping the world today, it is important that everyone have a respect and understanding for science.”

—David Brand
Cornell News Service

**BEST IN THE BUSINESS**

Cornell alumnus Steven B. Belkin ’69 IE, chairman and founder of Trans National Group (TNG), a Boston-based privately held corporation, and the principal owner of the professional sports teams the Atlanta Hawks and the Atlanta Thrashers, will be honored on campus in October as Cornell Entrepreneur of the Year 2004.

The award, managed by Cornell’s Entrepreneurship and Personal Enterprise (EPE) Program, is given annually to a Cornell graduate who best exemplifies entrepreneurial achievement, community service, and high ethical standards.

Belkin founded Trans National in 1974. Principally a direct response marketing and investment company, TNG has a staff of 250 and has more than $200 million per year in sales. Belkin was the founder of “affinity” credit cards, those Visas and Mastercards that also bear the logo of both businesses and nonprofits, which can generate special deals for the user or income for the organization. He also pioneered the concept of using direct mail marketing to provide products and services to the affinity group marketplace.

Belkin has started more than 20 companies under the TNG umbrella. Eight of those have been sold, including an affinity credit card company that originated more than 10 million credit cards.

—Simeon Moss
Cornell News Service

Trans National companies currently include: TNT Vacations, a wholesale tour operator; Trans National Communications, a long-distance telephone service reseller; Trans National Ventures, an investment and venture capital firm; Trans National Marketing, a marketer of limited edition books and videos; B.E. Realty, a real estate investment firm; and Charlestage Management Co., a real estate management company.

Belkin received his bachelor’s degree in industrial engineering from Cornell in 1969 and his MBA from Harvard Business School in 1971.

———

Cornell engineering student Christine Chang ’04, center, and Michel Louge, right, professor of mechanical and aerospace engineering, question Andrew Sternglass, a student at Boynton Middle School in Ithaca, on his vehicle during judging at the annual Junior Solar Sprint, May 22, in Barton Hall. The competition, sponsored, in part, by Cornell’s Sibley School of Mechanical and Aerospace Engineering, involves middle-school students from all over central New York, who build and race small solar-powered cars. Cars are judged on design features as well as speed. Due to an absence of consistent sun on race day, this year’s competition was held inside, with AA batteries substituting for the solar panels that ordinarily power the cars.
Peter Gregg biked a lot of miles during the June and July months of his ’04 summer vacation—about 3,336 of them. Gregg ’06, a biological and environmental engineering major, biked from Los Angeles to New York City to raise money for the Widows’ and Children’s Fund of the New York City Uniformed Firefighters Association, which benefits the families of fallen firefighters, including those killed on 9/11. He was accompanied by Adam Kaczmarek, a mechanical engineering student at MIT whose cousin, a fireman, died in the World Trade towers. The two covered up to 100 miles a day for 42 days, over the Sierra Nevadas and through the Mojave Desert, past the Grand Canyon, Monument Valley, and the Continental Divide.

Reached via cell phone on Day 37 in Conneaut, Pennsylvania, Gregg says, “I was expecting to be sore the first week or so, but it wasn’t so bad. In the Rockies, one of my knees started to bother me, but it cleared up.” He is speaking from a firehouse, one of the dozens whose crew offered him and Adam a place to sleep, plus dinner and breakfast, all across America. “That’s been the most amazing thing by far—the kindness and brotherhood of the firemen.”

Gregg and Kaczmarek’s route anticipates exactly the route to be used by 35 members of the New York City Fire Department in September. Sponsored by dozens of large corporations, the firefighters will raise not only money for the Widows and Children’s Fund but also awareness of the plight of the FDNY, without a contract or a raise for the past two-and-a-half years.

Joshua Gallo of Engine 258 in Long Island City organized the firemen’s tour. He appreciates the students’ contribution as guinea pigs. “I’m glad they’re back safe; now maybe they can tell me about the perils.” The bicyclist firefighters range in age from 22 to 51, and represent largely the department’s elite. “We’ve got a lot of guys from SOC, Special Operations Command—they’re the guys who save us if we get in trouble,” Gallo says. “We have guys who compete in the Fire Olympics.”

Gregg himself got into shape biking the hilly roads surrounding Cornell. The Ithaca terrain was good practice, but the mountain ranges of Colorado were beyond anything he had imagined. “I thought the mountain roads would be like the Ithaca hills—steep but short—but because of snow, they can only build roads up to a certain grade, so the hills go on forever. The Monarch Pass across the Continental Divide reaches 11,000 feet; the slope was six-and-a-half or seven [percent] grade for 12 miles.”

Gregg rode a Fuji World touring bike that he bought from Glenn Swan, owner of Swan’s Cycles, a legendary Ithaca bike racer, and research technician in the College of Engineering for 25 years. Kaczmarek rode a Cannondale racing bike that was ridden in the 2000 Tour de France. Both of them carried rear panniers with clothes, toiletries, and spare tubes and tires, sleeping bags, and tents, and Camelbak packs, a special backpack with a straw used to carry and sip water on the go. On an average day they each carried three quarts of water; in the desert they each carried a gallon and a half. Kaczmarek estimates that, although the frame of his bike weighed only three pounds, his gear weighed close to 30 pounds.

Gregg spent the last weeks of his summer vacation sailing his 16-foot catamaran in Great Peconic Bay, near his Long Island home. When he returns to Cornell this fall, he plans to focus on biomedical engineering, maybe prosthetics. He’s also the president of Theta Chi, the fraternity to which Kaczmarek belongs at MIT.

It’s hard to know exactly how much money the two raised because they asked people to send checks directly to the FDNY. But it’s not too late to participate. Sponsors are welcome to send checks to: FDNY Cross Country Bike Tour, 404 West 46th Street, New York, NY 10036 (please specify the Gregg-Kaczmarek tour) or visit the web site at http://cross-country.mit.edu. “The more we can raise for the families, the better,” believes Peter Gregg. “It’s hard to measure their loss.”

—Melanie Bush
Focusing Vision. Driving Solutions.

Learn how you can help shape the future – and own the vision – with Systems Engineering at Cornell.

Opportunities for Study
- Master in Systems Engineering (part and full-time)
- Certificates in Systems Engineering and Systems Engineering Management
- Short Courses
- Traditional, Distance Learning and Online Courses

www.systemseng.cornell.edu