C-ENG.

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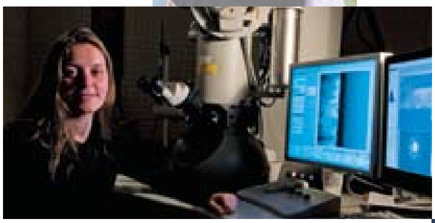

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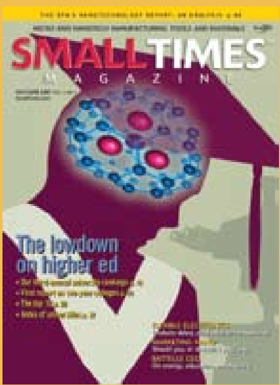


HIGH MARKS FROM SMALL TIMES

Small Times magazine's third-annual survey of top nanotechnology institutions placed Cornell in the top 10 of every category listed, including research, education, and facilities. Cornell also received high marks from peer institutions for its research and commercialization abilities.

The nanotechnology trade magazine calculated Cornell as second overall among nanotechnology institutions, behind only the University at Albany, State University of New York. The overall ranking was generated from questionnaires sent to dozens of scientists at research institutions who answered 26 questions about their nanotechnology programs.

In the overall ranking categories, Cornell was fourth in research, fifth in commercialization, sixth in facilities, and 10th in education.

"Cornell encourages interdisciplinary academic programs and research," *Small Times* noted about Cornell. "Its innovations include its nanofabrication facility and discovery in the field of nanobiotechnology."

In peer rankings, Cornell was fourth in nano research, fifth in micro research, and sixth in commercialization of both nano and micro sciences.

—Anne Ju, Cornell Chronicle

30 YEARS OF NANOSCIENCE

CNF celebrates past, looks to future

The Cornell campus buzzed with close to 380 participants at the 30th anniversary celebration of the Cornell NanoScale Science and Technology Facility (CNF), June 14. Topics addressed included drug delivery, ethics, and even science fiction.

Scientists from all over the world gathered to hear experts, participate in technical sessions, and attend a poster presentation.

The symposium, "The Future of Nanotechnology," kicked off with reflections from Edward Wolf, Cornell professor emeritus of electrical and computer engineering and CNF director from 1978 to 1988. He recounted that in the early years, CNF was called the National Research and Resource Facility for Submicron Structures. "Nano" was not part of the title until 1987, when the facility was renamed the National Nanofabrication Facility. In 2003 CNF took on its present name.

CNF has long been closely connected with the National Science Foundation, which has provided the majority of CNF's funding. Lawrence Goldberg, senior engineering adviser of NSF's Division of Electrical and Communications Systems, called CNF a "vibrant enterprise" that has surpassed its founding concept and evolved into a world leader in nanoscience and nanofabrication.

Sheila Jasanoff, professor of science and technology studies at Harvard University and founding chair of Cornell's Science and Technology Studies Department, delivers a plenary lecture, "Constituting the Nanoscale: Lessons from the 20th Century," at the CNF 30th anniversary celebration.

Robert Barker/University Photo

"The National Science Foundation is very proud to have played a continuing role in that success," said Goldberg, who oversees the National Nanotechnology Infrastructure Network, a 13-member consortium that includes Cornell.

The day's themes were laid out by three additional speakers. R. Stanley Williams, a senior fellow at Hewlett-Packard Laboratories, described the advances he and others at his company have made in nano-imprint lithography. The technique for creating nanoscale devices is a progression from the more traditional method of photolithography and involves creating a mold to stamp an imprint of a device.

Introducing the topic of nanomedicine, Tejal Desai, director of the University of California, San Francisco's Laboratory of Therapeutic Micro and Nanotechnology, spoke about therapeutics and drug delivery using nanotechnology. Nanomedicine, she said, continues to face the challenge of developing drugs or therapies that can be taken orally and are able to withstand the physiology of the digestive system.

Sheila Jasanoff, professor of science and technology studies at Harvard University and a founding chair of Cornell's department of the same name, spoke on the politics and societal implications of nanotechnology. While drawing comparisons between public perceptions of nanotechnology and the Manhattan Project or genetically modified foods, she also noted that built into the early stages of nanotechnology research is a widespread desire to take social and ethical considerations seriously.

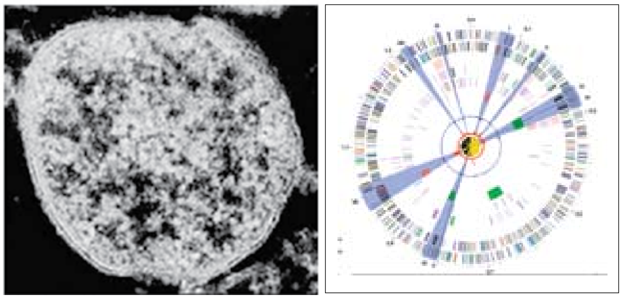
Following the plenary speakers, the participants spent the afternoon in tracks dedicated to each of the three topics: carbon nanotubes in electronics and optoelectronics, cellular mechanics through nanotechnology, and the social and ethnical dimensions of nanotechnology, some of which have already been raised in science fiction.

—Anne Ju, Cornell Chronicle

MYSTERIOUS BACTERIA

Cornell researchers hope to learn how certain bacteria break down pollutants to increase their effectiveness.

Dehalococcoides ethenogenes, discovered in Ithaca sewage sludge in 1997 by James Gossett, professor of civil and environmental engineering, and isolated and studied by Stephen Zinder, professor of microbiology, are now in wide use to detoxify carcinogenic chemicals like perchloroethylene (PCE) and trichloroethylene (TCE). By removing chlorine atoms from molecules, they leave less-toxic compounds behind.



Provided

The bacterium *Dehalococcoides ethenogenes* can extract chlorine from chemicals to help clean up toxic wastes. Its genome (charted at right) consists of 1,640 genes. Cornell researchers hope to learn how these genes work together to process chlorine and find ways to help the bacterium do its job.

But *D. ethenogenes* does not work well at all sites, and nobody knows why. Very little is understood about these organisms. Normal laboratory procedures haven't provided enough answers, because the bacteria are hard to grow in a petri dish, said Ruth Richardson, assistant professor of civil and environmental engineering.

She is partnering with Gene Network Sciences to create computer models of the inner workings of the bacterium. The project is funded by a three-year, $381,000 grant from the Department of Defense, which has some 6,000 toxic dump sites to clean up.

Richardson explained that in the field "the bacteria sometimes start and then stop. We might improve conditions for the organisms." For example, she said, *Dehalococcoides* grows better in a mixed community with other kinds of bacteria. "There are some factors it needs from other organisms, and we don't know yet what they are,' she said.

Her laboratory will test the *D. ethenogenes* strains under a variety of different conditions. The data will go to GNS, which will try to build computer models of how the bacteria's proteins work together under each condition and whether the pathway for each condition is the same for PCE and TCE, and if not, what steps they have in common.

Richardson, who grew up in the Hudson River Valley, notes that such pollutants are common in the river's harbors. "There are still thousands of sites around the country that need to be cleaned up," she said. "Ithaca has three or four, and that's not atypical."

—*Bill Steele, Cornell Chronicle*

100-MPG CAR

Imagine a car that gets 100 miles to a gallon of gas. A real car, seating four people, with 10 cubic feet of cargo space, that could accelerate from 0 to 60 mph in 12 seconds, top speed 100 mph—fully equipped with a heater, air conditioner, and audio system.

Let's not just imagine it. Let's build it. And sell it.

AUTOMOTIVE X PRIZE

A team of Cornell faculty, engineering students, and MBA candidates in the Johnson School is planning to compete for the Automotive X Prize, which offers a multimillion-dollar award for the team that builds such a car, wins a race against similar vehicles, and creates a realistic business plan to sell at least 10,000 cars.

"The best anyone has done with a mainstream car so far is 80 miles per gallon, with marginal performance, but it's doable," said John Callister, the Harvey Kinzelberg Director of Enterprise Engineering in the Sibley School of Mechanical and Aerospace Engineering. "What makes it possible are recent advances in batteries and in controls and electronics to make the engine more efficient."

Still in the study phase, the car will be some sort of hybrid, said Callister. It will likely be low slung to reduce air resistance and require passengers to sit "cheek to cheek," he said. Probably the hardest part will be to meet safety standards. "It has to be lightweight but safe," he explains. "It's almost a contradiction in terms."

The Automotive X Prize is offered by the X Prize Foundation, best known for awarding the $10-million Ansari X Prize to Mojave Aerospace Ventures for the flight of SpaceShipOne.

The project has received preliminary funding from the College of Engineering, the Roy H. Park Foundation, First Manhattan, General Electric, and the Triad Foundation. *Popular Mechanics* magazine has signed on to be a media sponsor and will cover the project in its pages. A great deal more funding and support from industry is needed. The team hopes to partner with a major automotive firm capable of building and marketing a car based on the design.

—*Bill Steele, Cornell Chronicle*

SOLAR HOME

Lindsay France/University Photo

AAP students working on the Solar Decathlon 2007 construction: Tim Liddell '10, Chris Werner '10, Kris Sellman-Johnson '10, Alana Anderson '08, Branden Collins '10, Sam Reilly '10.

Two years ago Chris Werner was living in the Washington, D.C., area when he saw a house powered by solar energy on display on the National Mall. It had been designed and built by Cornell students and was a second-place winner in the 2005 Solar Decathlon Competition.

The biennial competition, which is sponsored by the U.S. Department of Energy, calls for college students to design, build, and operate the most attractive, effective, and energy-efficient solar-powered house.

"I was so impressed I decided that sustainable housing was what I wanted to do and that Cornell would be the place for me to learn more about it," Werner said.

He enrolled in the College of Architecture, Art, and Planning's master of architecture program and is now on the 110-member Solar Decathlon team, which has a strong contingent of engineering students.

Werner and his teammates, who represent every college on Cornell's Ithaca campus, are competing against 19 other teams. Their entries will form a solar village on the National Mall in Washington, D.C., Oct. 12–20, for public viewing and for the judging.

"Every component was meticulously researched and analyzed," Werner said. "We considered properties such as recyclability, pollution potential, production waste, and efficiency, and we used advanced energy modeling techniques to make decisions ranging from the size of the heat pump to the placement of windows."

The 600-square-foot solar home's most innovative feature is the freestanding "light canopy" that surrounds it. A sort of exoskeleton made from industrial scaffolding, the canopy can support everything needed to make the house function, from photovoltaic panels to rainwater collectors to evacuated tubes to bike racks. Also suspended from the scaffolding are "green" screens supporting webs of plants, which not only add beauty but can be moved to wherever they are needed to shade the house.

The Cornell solar house is supported by grants from a range of sponsors, including the DOE, General Electric's Sun Division, and Cornell.

—Linda Myers, Cornell Chronicle

This image, created by Samuel Reilly and Micael Duran, shows what Cornell's solar house will look like when completed, including its "light canopy" that surrounds it.

Provided

TSUNAMI SIMULATOR

Bill Steele/Cornell Chronicle

Graduate research assistant Yong Sung Park operates the wave simulator in Professor Philip Liu's laboratory in the basement of Hollister Hall. The hydraulic piston at right will be replaced with electric motors to drive a plunger that will generate larger and more repeatable waves.

Using a serendipitous $100,000 grant, Philip Liu, professor of civil and environmental engineering, will upgrade a wave simulator that is helping predict the effects of tsunamis on buildings and may contribute to the development of improved early warning systems.

The grant comes from California-based Spansion Inc., a major supplier of flash memory for electronic devices, which has been making major donations to tsunami relief and reconstruction efforts since the devastating Indian Ocean tsunami in 2005. Its grant to Liu is intended to help minimize damage in future disasters.

Liu did not apply for the grant. "They just called me out of the blue," he reported.

Liu, an internationally known expert on tsunamis, will use the grant to upgrade a wave tank in the basement of Hollister Hall to produce larger and more realistic waves. The tank, 120 feet long and about a yard wide, holds 3,500 gallons of water. At one end a hydraulically driven piston moves a plunger forward to generate waves up to about six inches high. At the other end, Liu places models to study how waves break over different types of coastlines and how they interact with buildings. Experiments in the tank verify the accuracy of computer-generated simulations. The upgrades will triple the height of waves generated and improve the repeatability of the system.

Liu was recently honored with the Kwoh-Ting Li Chair Professorship at the National Central University, Taiwan, the highest-level professorship at the university. Liu will help the university establish a joint graduate program in ocean sciences with the Academia Sinica in Taipei.

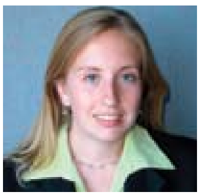
—Bill Steele, Cornell Chronicle

SEED GRANTS

Detecting cancer earlier, finding new materials for repairing bones and teeth, and controlling cortical epilepsy are just a few of the objectives receiving funding this year from Cornell's intercampus collaboration seed grant program.


Lara Estroff

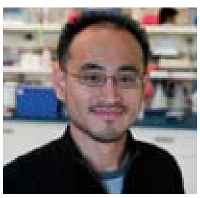

Emmanuel P. Giannelis


Cynthia A. Reinhart-King


C.C. Chu


Chris Schaffer


Lawrence Bonassar


Moonsoo Jin


Harold Craighead

Eight research teams from Cornell's Ithaca and New York City campuses each received $50,000 toward their projects, which draw on the strengths of faculty and students across the disciplines—and which could lead to medical advances in areas from genetics to organ transplants.

The seed grants, awarded annually since 2005, are administered by Steve Kresovich, vice provost for the life sciences; Harry Lander, associate dean for research administration at Weill Cornell Medical College; and by Cornell's Office of Corporate Relations. This year, half of the available $400,000 (to be divided into eight $50,000 grants) is provided by Johnson & Johnson. The eight winning collaborations were chosen from more than 30 applicants.

"We are very pleased to establish this collaboration with Cornell, given its outstanding reputation. We are committed to supporting innovative academic research groups worldwide to promote breakthroughs in medicine that contribute to significant improvements in human health," said Robert Zivin, corporate director of Johnson & Johnson's Corporate Office of Science and Technology.

This year's recipients are:

Lara Estroff, assistant professor of materials science in the College of Engineering, and Adele Boskey, professor of biochemistry at WCMC, for research to develop new materials for bone and tooth repair;

Emmanuel P. Giannelis, the Walter R. Read Professor of Engineering, and Yi Wang, professor of biomedical engineering (Ithaca) and professor of physics in radiology (WCMC), to develop nanoparticle-based tools for diagnostic and therapeutic applications for cancer;

Colin Parrish, the J.M. Olin Professor of Virology, and Moonsoo Jin, assistant professor of biomedical engineering (Ithaca), and Anne Moscona, professor of pediatrics and of microbiology and immunology, and Matteo Porotto, assistant professor of microbiology in pediatrics (WCMC), to study the roles of virus-receptor interactions in cell infection and disease;

Cynthia A. Reinhart-King, assistant professor of biomedical engineering (Ithaca), and Thomas Sato, the Joseph C. Hinsey Professor in Cell and Developmental Biology (WCMC), to study the use of stem cells for engineering organs in vitro;

Chris Schaffer, assistant professor of biomedical engineering (Ithaca), and Theodore H. Schwartz, associate professor of neurological surgery (WCMC), for the use of femtosecond laser ablation to understand and control cortical epilepsy;

C.C. Chu, professor of fiber science and apparel design and biomedical engineering field faculty member (Ithaca), and Bo Liu, assistant professor of cell biology in surgery (WCMC), to develop a new generation of synthetic biodegradable polymers as non-viral carriers for gene therapy;

Lawrence Bonassar, associate professor of biomedical engineering (Ithaca), and Roger Hartl, assistant professor of neurological surgery (WCMC), for work toward engineering human intervertebral discs to relieve back pain;

And Harold Craighead, the C.W. Lake Jr. Professor of Engineering (Ithaca), and Douglas Scherr, assistant professor of Urology (WCMC), to develop a microfluidic system for early detection of bladder cancer.

—Lauren Gold, Cornell Chronicle

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By Beth Saulnier

The credo of the title character in *The Prime of Miss Jean Brodie*, a teacher adept at molding young minds, is "Give me a girl at an impressionable age, and she is mine for life." Lena Fitting Kourkoutis was surrounded by science at every age—impressionable and otherwise—and the decision to study applied and engineering physics came naturally. Kourkoutis grew up in northern Germany, the daughter of a physicist and a thermal engineer. Now working on her Ph.D. at Cornell, she wants to make sure that other girls feel as comfortable as she does in the historically male bastions of math, science, and engineering. "There are still discrepancies between the numbers of males and females in science," says Kourkoutis, 27. "Girls are not exposed to it early on. Girls who don't have parents like me who were in engineering or science, they just don't know about it. There's a misconception that it's too hard, so they're scared to try it."

expanding Horizons

An engineering grad student gets girls interested in math and science.

Lena Fitting Kourkoutis demonstrates for a group of high school science teachers how she uses a kit to explain atomic force microscopy to students.

Shai Eynav Photography

Each year, Kourkoutis and dozens of her female colleagues—from undergrads to full professors—work to combat that stereotype through a program called Expanding Your Horizons. Held almost every year since its founding in 1978, the daylong, student-run conference is intended to pique interest in math, science, and engineering among girls in the seventh to ninth grades. "The idea is to give them hands-on experience," says Kourkoutis, one of the conference's three grad student co-chairs. "We try to point out what career opportunities there are, because a lot of girls don't know what's out there."

The event, which draws some 200 girls from around New York State, includes a keynote address and a panel discussion for adults, as well as communal meals, a raffle, and other activities like science demos and a book sale. But its most important element is a series of workshops on a wide variety of topics held all over campus and beyond. The girls choose three from a menu of three dozen, ranging from The Science of Soap to Babies, Babbling, and Brains to Fabulous Fossils. (Though they can rank their preferences, assignments are made by a computer program.) Participants parse the math behind the game Nim, wade through the waters of Cascadilla Creek, make ice cream without a freezer, mix chemicals to create their own perfume, explore the surface of Mars via computer simulation, even solve a crime with forensic science à la C.S.I. Parents tell us that they're blown away to see all the different things you can do with math and science, says nutritional science Professor Joy

Provided

EYH is just one of many outreach activities Lena finds time for. Here, she leads an activity on friction for Big Brothers Big Sisters at the Ithaca Youth Bureau.

Swanson, the conference's longtime faculty adviser. They themselves had no idea what possibilities there are for their daughters. And just the opportunity to be on the Cornell campus is awe-inspiring for the girls.

On any given day, the Human Power Lab in Kimball Hall seems more fun than your average engineering research facility, with its shelves full of motion toys and carcasses of mutant bicycles hanging from the ceiling. But on the most recent Expanding Your Horizons day last April, when the lab hosted one of the workshops, it had the heady air of a miniature carnival, complete with scientific sideshows. Step right up and see the robot walk down a ramp! In this corner, a fork and spoon teeter on the rim of a glass—balanced on a flaming toothpick! Across the room, a disk spins on a concave mirror; as if by magic, it gains speed rather than slowing down, getting louder and louder as it goes. Conference volunteer Megan Berry '07 ME coaches 14-year-old participant Kiki Jones as she tries to master an old-fashioned toy that involves twirling two red balls on a string.

"You've got perfect phase going there," says Berry, who's clad in a Cornell mechanical and aerospace engineering T-shirt that declares YES, I AM A ROCKET SCIENTIST. "How often you pull on it is going to change what the toy is going to do. Different frequencies give you different characteristics for a system. You have

Shai Eynav Photography

Lena uses Cornell's most advanced scanning transmission electron microscope to study the structure and properties of nanoscale materials.

Provided

to time everything—all the parts have to work together."

Jones may only be in the eighth grade, but the Binghamton resident is already fashion-forward; her jeans are artfully ripped, she has a stud in her nose, and her black-and-white jacket is adorned with diamond shapes and dollar signs. Her outfit isn't particularly outlandish for a young teen in the post-Britney age, but it illustrates one of the motivations behind Expanding Your Horizons: the desire to catch girls at a crucial developmental stage. "Boy issues start coming in, and they don't want to be looked upon as nerds or smarty-pants," Swanson says. "We target that age group to show, 'Hey, there are women who are in cool careers because we took math and science, and this is how we use them to have fun and be leaders and have interesting jobs.'" The conference doesn't aim to convince participants to focus on its subject matter to the exclusion of others; rather, she says, the message is, "Don't limit yourself—keep expanding your horizons by taking math and science through middle and high school, so you have choices."

Despite the professional advances that women have made since the conference began—back when Jimmy Carter was in the White House, the Bee Gees topped the pop charts, and hopes for ratification of the Equal Rights Amendment were fading—organizers say that encouraging girls to embrace science and math is still vital. "Things have changed a little bit," Swanson says. "But, in general, there's still a disparity in wages between males and females and in the number of women in leadership positions in math and science. People feel that there's equality, but in actuality there isn't. Even in industry, there are still glass ceilings."

Although the conference draws a significant number of girls from the Ithaca area, students come from as far away as Long Island, leaving home long before dawn to get to Ithaca in time for the 8:30 a.m. start. And the demand is acute: the 200 slots have been known to fill up in as little as three days. Organizers have been weighing the pluses and minuses of expansion; in the mid- '90s, Swanson notes, the event grew to about 300 girls and an equal number of chaperones, necessitating that it be held in cavernous Barton Hall. "The intimacy and collegiality were missing," she says. "It was just a big mass, without as much interaction. People were starting to get exhausted. It was getting so huge, there were communication problems." But then there's the pull on the other side of the equation: the desire to satisfy the enormous hunger for the program among the girls of New York State. When an event sells out in three days, in other words, it's clearly a hot ticket. "Whether to expand is definitely an internal debate," says Lindsay Batory, a Ph.D. candidate in organic chemistry and one of Kourkoutis' co-chairs. "There are a lot of factors we need to consider."

"Hey, there are women who are in cool careers because we took math and science, and this is how we use them to have fun and be leaders and have interesting jobs."

Funded by the deans of the Cornell colleges as well as grants from the National Science Foundation and National Institutes of Health, the conference costs some $20,000 to mount but charges participants just $10 each. Kourkoutis and her fellow organizers start planning for the April event the previous August—soliciting funds, scheduling workshops, arranging meals, and recruiting undergraduate "buddies" (female science and engineering majors who pair up with participants attending without a parent or teacher), among myriad other tasks. By the time the day itself rolls around, the event is a well-oiled, women-run machine.

The conference is headquartered in Kennedy Hall on the Ag Quad, where participants check in before downing a continental breakfast, getting matched with their buddies, and hearing a brief welcome speech. This year, the area outside Call Auditorium was filled with a whirlwind of activity and chattering teens and tweens. At one table, participants could shop for books with titles like *Cool Stuff and How it Works* and *Gutsy Girls: Young Women*

Astronomy grad student Sabrina Stierwalt helps Groton 8th grader Kate Davis prepare her rocket for launch during Expanding Your Horizons 2006.

University Photo

At an EYH 2006 workshop called "Colder Than Ice," girls blew bubbles concocted from frozen air.

Provided

Who Dare; at another, volunteers offered classic science-fair demos like the properties of magnetism and the creation of fake snow. Filling out a raffle ticket offered a chance to win a live butterfly garden. On the wall were posters of famous women scientists and a map showing participants' hometowns. Buddies mingled with their charges, chatting about the science the girls were studying in school. "We're hoping to get them excited," Batory says, "and let them meet women in the field so we can serve as role models."

Lena explains the principles of friction to a young girl and her Big Sister.

After attending their first two workshops, the girls have lunch at Trillium in Kennedy Hall. (One of the issues complicating the expansion debate is the fact that the conference already packs the dining hall to capacity, so more students would necessitate two lunch shifts.) Then the students take in their third workshop while the adults attend a panel discussion in which women scientists offer advice on encouraging the girls' curiosity long after the conference is over. The keynote address—this year's was given by Stacy Kenyon, a 1999 graduate of Cornell's vet college—is followed by closing remarks, the raffle drawing, and the all-important distribution of commemorative T-shirts. Participants and their guardians complete evaluation forms; the feedback, Kourkoutis says, has been overwhelmingly positive. "The students are excited about it and they ask very interesting questions," she says. "Most of them really want to be here."

Kourkoutis herself really wants to be here; she's as fond of Ithaca as she is of Cornell. She sought a spot in the university's highly competitive applied and engineering physics program after doing post-college research at North Carolina State University, looking for "another good school in a very small town." The daughter of a German father and a Russian mother, Kourkoutis grew up in Rostock, located in the former East Germany. When she was seven, her parents moved their three children—Kourkoutis, her fraternal twin sister, and their younger brother—to Eritrea, where her father chaired a university physics department. They returned to Germany when she was 10, shortly before the Berlin Wall fell. ("I was young and didn't really understand what was happening," Kourkoutis says, when asked about her memories of the historic event. "You could see it on the TV—the wall fell and everyone was happy.") She earned a physics Diplom—roughly equivalent to an American bachelor's and master's rolled into one—from the University of Rostock, where her father is on the faculty, before heading to Ithaca via North Carolina. "She's a very good student," says associate professor of applied and engineering physics David Muller, Kourkoutis' adviser. "She's mature. The line that sums it up is that when she goes to conferences, she's frequently mistaken for a postdoc, because she has a good understanding of the material and she's very confident in how she presents it. She's hands-on, energetic—a natural leader. The work she's doing is going to have a big impact in the field."

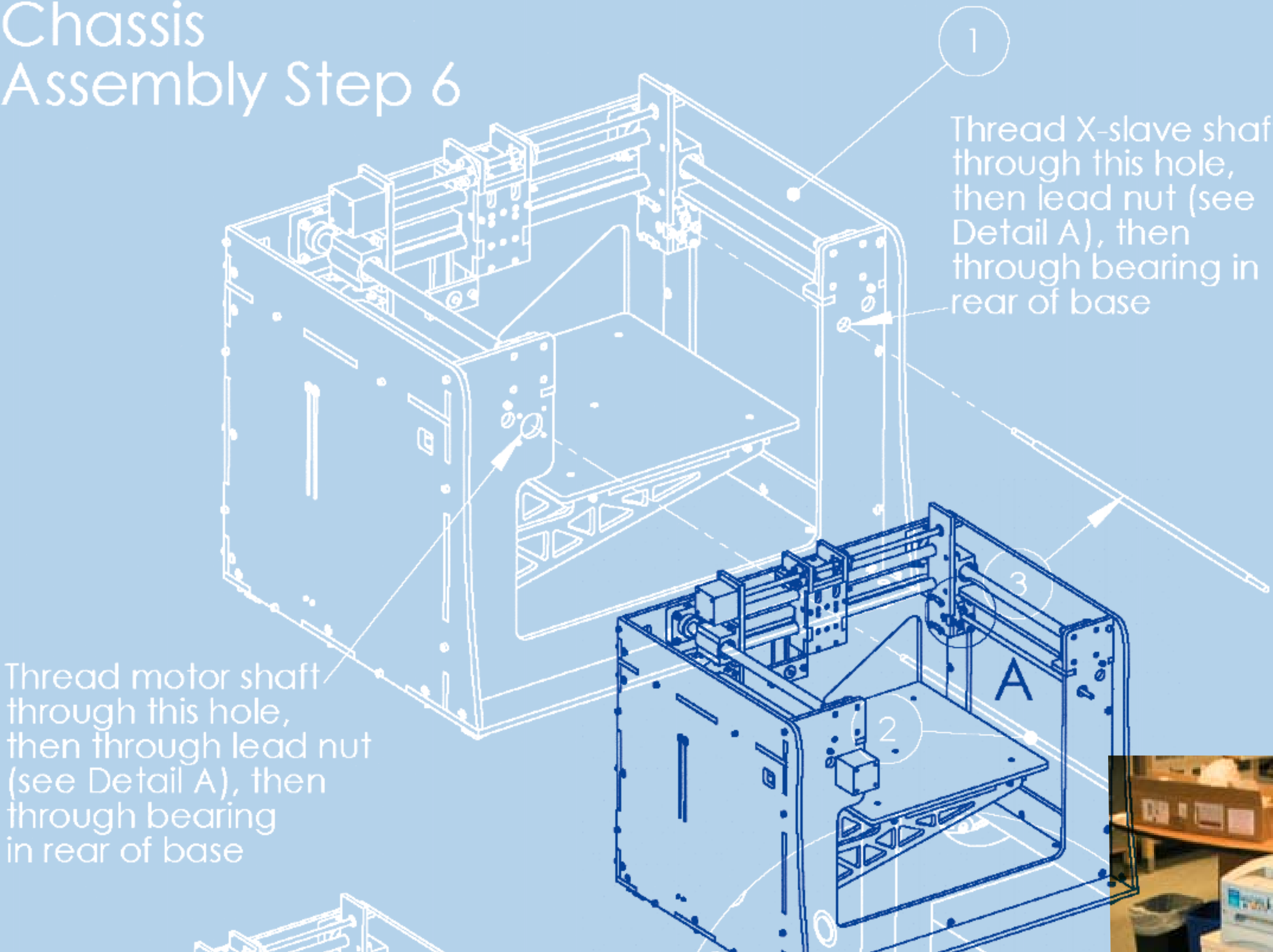
Kourkoutis' research is in electron microscopy, specifically its application to studying the structure and properties of nanoscale materials. Using Cornell's highly sophisticated instruments—which offer views at the atomic level—she has been studying the gate oxides used in computer chips. "The chips get faster and faster, but that means all the layers of components shrink," she explains. "But there's a limit, and we're getting there. We're looking for replacement materials, and ways to grow very thin layers." Kourkoutis has also been examining the atomic structure of the interface between insulators—a region that, though it may seem counterintuitive, can itself become conductive. "You start with two materials that are insulating, and you join them, and suddenly you get a layer that is conducting," she says. "Of course that would change the property of the device dramatically." Kourkoutis has already earned first-author credit on several papers, including publications in *Physical Review Letters*, *Ultramicroscopy*, and the *Journal of Applied Physics*.

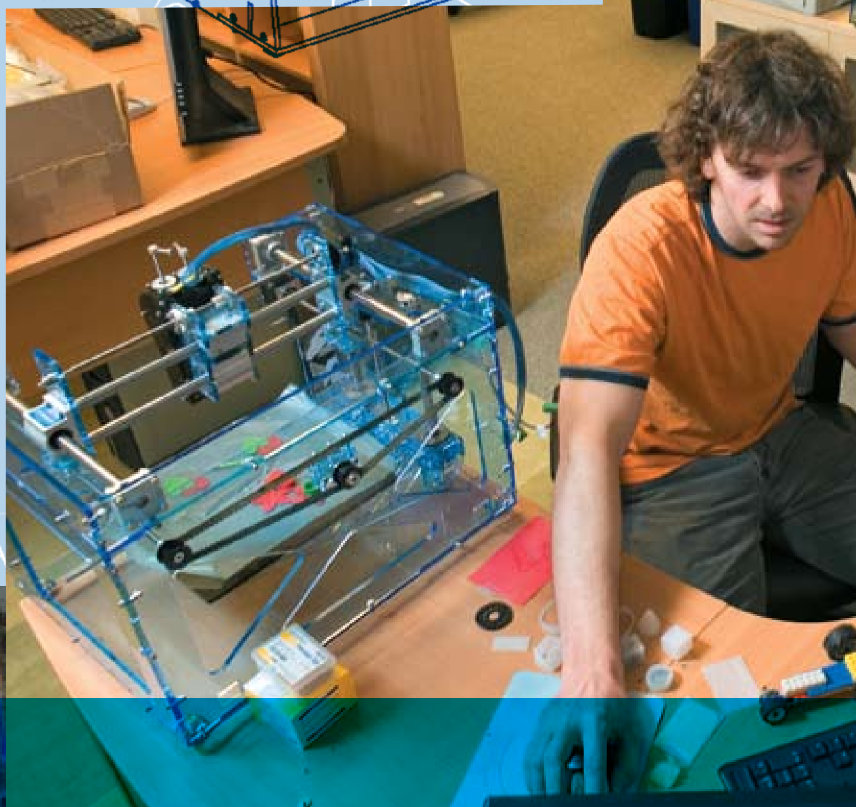
Even in 2007, female scientists can still face double-barreled bias: they're not encouraged to go into the field because they're women, and if they do they're assumed to be something less than feminine. Kourkoutis shatters the stereotype; she's nobody's idea of a geek. She's tall and athletic-looking, with big green eyes and wavy light brown hair cascading to the base of her spine; her flawless English retains enough of a German accent to make her sound distinctly exotic. Married to City of Ithaca firefighter Christopher Kourkoutis since November 2006, she hopes to find a position at Cornell or another nearby college after completing her degree.

Meanwhile, work on next year's Expanding Your Horizons conference is about to begin. Over the years, organizers have seen the percentage of minority participants rise significantly—from practically nothing to about 20 percent. Now, Swanson hopes to increase the number of students from underserved rural schools. "We get a lot from the Ithaca community, but in my opinion they don't need it," she says. "But Dryden, Newfield, Southern Cayuga [Central Schools], Candor, the Adirondacks—they need this type of program." Although the conference has long been open to repeat visitors, due to its limited capacity organizers may give preference to girls who haven't previously attended. "If someone already knows that they want to study science, it's great that they come," Kourkoutis says. "But to actually introduce someone to science…"

She doesn't finish the sentence. Her voice trails off and she smiles, green eyes lighting up.

Chassis Assembly Step 6





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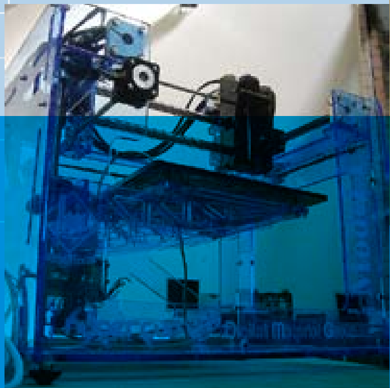


The Revolution is Now

By Michael Gillis

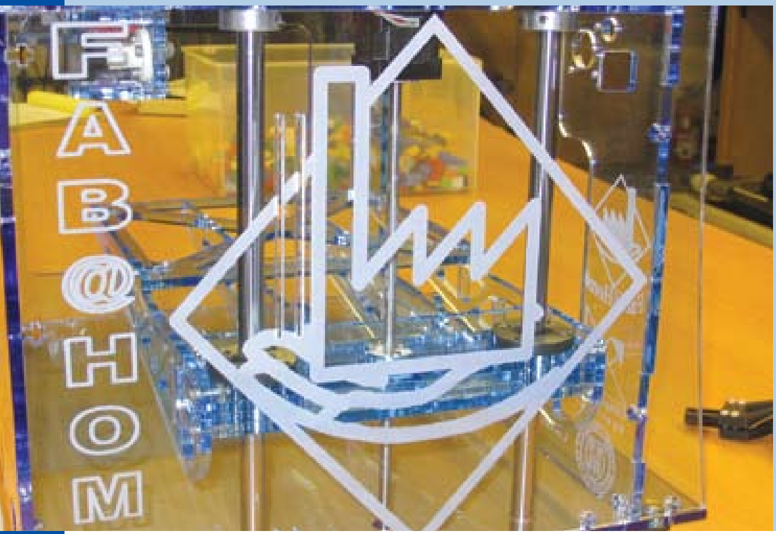
Fab@Home

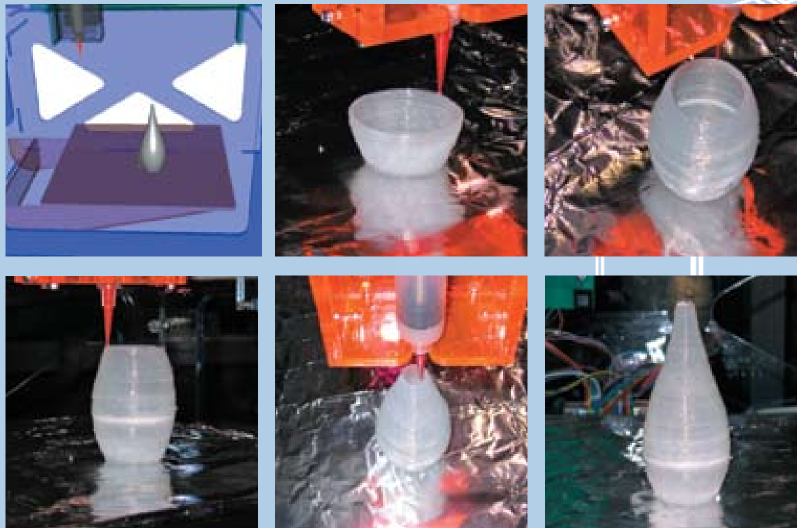
Graduate student Evan Malone and MAE Prof. Hod Lipson at work on their fabber design in the Computational Synthesis Lab in Upson Hall.

Toaster.
Coffee-maker. Blender.
Three-dimensional printer?

That's the kitchen of the future, according to Hod Lipson, Cornell assistant professor of mechanical and aerospace engineering, and graduate student Evan Malone, who see inexpensive fabricators, able to create objects on demand, one day joining the stable of well-worn home appliances.

Cornell's Fab@Home is a project with that goal in mind. Developed in the Computational Synthesis Laboratory, it could transform manufacturing by eliminating the need for the mass production of common items.





Whether it's a toothbrush, a fork, a shoe or an action figure you need, Lipson said a trip to the store won't be necessary. Instead, it will be as simple as pressing "print" and waiting for your home fabber to build what you need, before your eyes, in the comfort of your own kitchen.

"It's a revolution about to happen," Lipson said. "You could fabricate relatively complicated objects on your desktop. That could change the way we design and consume products in an incredible way."

And Fab@Home is catching on fast. The blueprints, software, and drivers are available online at www.fabathome.org, and the components can be had for about $2,000. A New Mexico company, Koba, even sells all the parts ready to assemble for less than $3,000, and it is struggling to keep up with the demand.

> Instead of buying an iPod online and waiting for it to be shipped, for example, Lipson sees a future where consumers will download the blueprints and print it at home.

That has sparked interest beyond Cornell. Home "fabbers" are under construction all over the globe and scientists and hobbyists alike are experimenting with Fab@Home machines, pushing the project's boundaries. A high school student in Kentucky, Noy Schaal, recently used a Cornell-built fabber to build a chocolate replica of her home state, winning first place in her school's science fair. Biology researchers at Vanderbilt and Rockefeller universities are employing Cornell-built fabbers. The government of South Africa recently asked to see Fab@Home at work in local "fab labs," and the Science Museum of London has added one to its permanent collection, using it in an exhibit on the history of plastics. Fabbers have been built by computer-aided design and manufacturing instructors at the University of Washington, doctors in Austria, a fine arts student in Chicago, researchers in Japan, and hobbyists in Massachusetts and the U.K. Lipson stresses it was decided early on that Fab@Home would evolve as an open-source endeavor. Shifting production away from corporations and specialized engineers will "democratize innovation," he believes.

Anyone with a screwdriver, soldering iron, a little imagination, and a home fabber will be able to design and create items otherwise cost prohibitive to produce in small quantities.

Once that happens, printing a toothbrush or a shoe is only the beginning. That same toothbrush can be designed to fit the ergonomics of a specific hand. A shoe can be crafted to fit the contours of the foot. Malone has shown that fabbers can produce working batteries, artificial muscles, transistors, and even living biological tissues. Eventually this capability will trickle down to the home version, allowing more complex objects with working parts to be printed in the kitchen and emerge from the fabber fully functional.

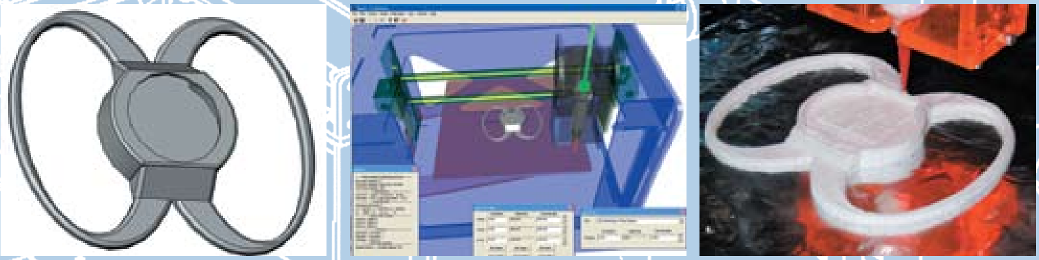
A prototype for change

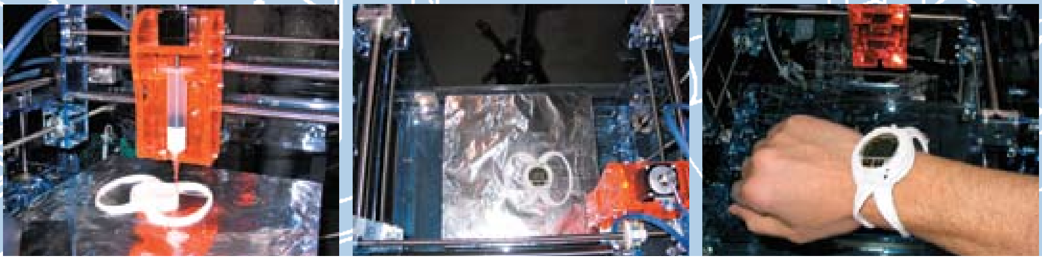
Lipson's earlier work in robotics, where machines were given the tools of evolution and motivation to self-replicate, is what led him to Fab@Home.

While experimenting with "autonomous adaptation in behavior and morphology of robotic systems," Lipson stirred up a "primordial soup" for machines, providing the building blocks of robotic life and letting machines build themselves—evolve. That happened in simulation, where oddly-shaped objects formed and strived for self-replication, the ultimate evolutionary reward.

Lipson said some of these strange machines were later constructed, but could not be assembled without manually adding individual components, unlike the simulations. That's when Lipson turned to rapid prototyping technology, which allows objects to be "printed" from raw material.

"I said, wouldn't it be great if I could have a rapid prototyper machine that could print the entire thing, if it could print the wires, the actuators, the batteries, all from raw materials?" Lipson explains. "That was the impetus to exploring this idea of multi-material rapid prototyping."

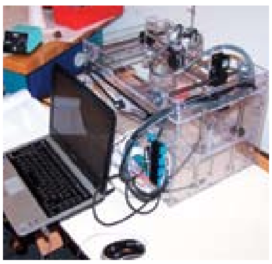


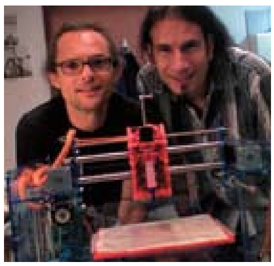


(Facing page) From a CAD model of a rubber squeeze bulb, the fabber creates one of silicone.

Here the Fab@Home Model 1 builds a watchband with an embedded watch.

Rapid-prototyping technology has been tapped in industrial and commercial labs for more than a decade. It is called upon to fabricate models of everything from cell-phone shells to car parts, but differs from the home fabber in both cost and size. Industrial machines are typically expensive and severely limited in the materials they can work with, usually one at a time. In addition, industrial and commercial applications call for more sophisticated and specialized technology, including high-powered lasers and accurate thermal processing, and discourage users from experimenting with their own materials.





Worldwide Fabbers: (clockwise from top left) University of Washington Prof. Mark Ganter's Model 1; Michael Verius and Ralph Huttary of Innsbruck, Austria, with their fabber; and Chicago Art Institute student Margarita Benitez's purple fabber, built so she could experiment with materials.

Home fabbers are intended to work more like an ink-jet printer, but instead of ink, they squeeze out a variety of substances—everything from cheese to silicone—to create three-dimensional objects, one layer at a time. Those substances are first poured into syringes, which can be swapped out of the fabber to alternate the material. Some home fabbers have already been customized to hold multiple syringes. Some day, Lipson sees people buying cartridges for their home fabbers the same way they buy ink now.

The future is now

Fab@Home may be following the path of a machine that changed the course of history, Lipson points out.

The 1975 edition of *Popular Electronics* introduced its readership to the MITS Altair 8800, which many people believe to be the first home computer. Although the Altair did require some expertise, it opened the door to a home computing movement. More importantly to Lipson, anyone with a little know-how could hack the Altair and make modifications.

Critics at the time doubted the machine would register at all, suggesting there was no interest or demand for a computer in the home.

But once people had access to the inner workings of the Altair and discovered how to modify it, there was suddenly a need for software, accessories, and games, and interest exploded.

Lipson hopes Fab@Home will catch on in much the same way.

“We need to nucleate this revolution by making a build-your-own rapid prototyping machine,” Lipson said.

For that to work, Lipson adds, it needs to be low cost, functional, hackable, and multimaterial.

“That's what we set out to do with Fab@Home,” Lipson said. “We just put it up on the Web—we didn't do any publicity—and it just exploded.”

In just a few months, the Fab@Home Web site logged 5.5 million page downloads from more than 350,000 unique visitors. Some are more driven than curious, and are working to expand the machine's capabilities. In addition, users are experimenting with a whole host of materials, including Play-Doh, wax, cheese, cake frosting, and gypsum.

“It's driven by hands-on people,” Lipson said.

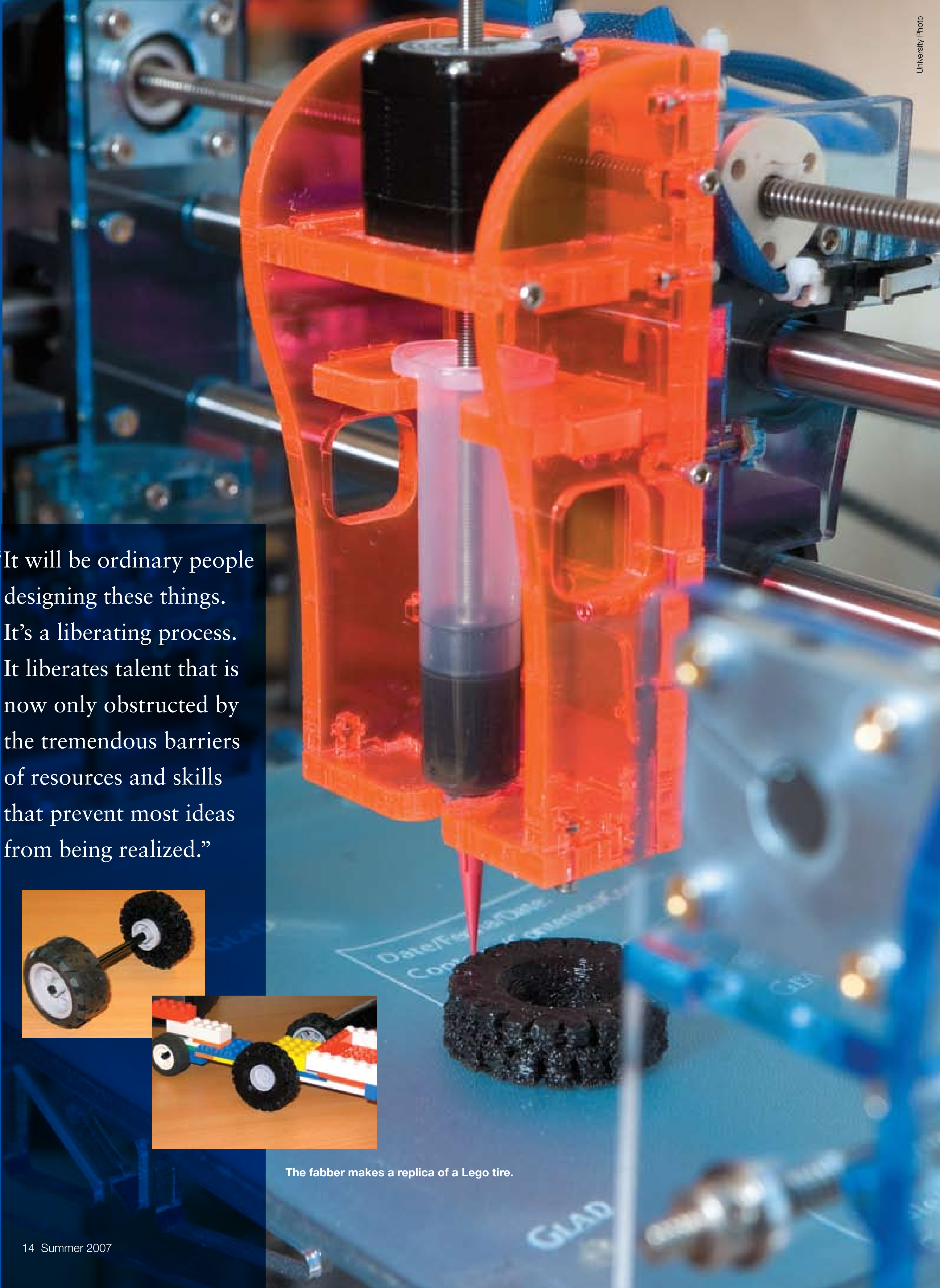
Proponents realize there is still much to do and the machine, in any version so far, is far from perfect, especially when compared to its industrial equivalent.

“It does not compare well, in terms of accuracy and speed,” Lipson said. “So our machine is slower and less accurate. It's a little like comparing the Altair 8800 to the mainframe of the day.”

The idea, Lipson adds, is to make Fab@Home accessible to all. “People will help perfect it,” he said.

One of those people is Malone, who designed and built the first fabber—the Fab@Home Model 1—in Lipson's lab in the summer of 2006.

Malone remembers being drawn to Lipson's vision of robots and self-replication. Malone hopes his fabber will



University Photo

"It will be ordinary people designing these things. It's a liberating process. It liberates talent that is now only obstructed by the tremendous barriers of resources and skills that prevent most ideas from being realized."

The fabber makes a replica of a Lego tire.

make a big leap toward that vision, which is how he intends to earn his Ph.D. He anticipates that by next winter, his research fabber will construct an entire robot able to emerge from the machine on its own accord, replete with circuitry, actuators, and batteries.

That lofty goal aside, Malone eventually found himself attracted to the idea of making multi-material fabrication technology available to everyone, which hit home on a trip to South Africa to demonstrate Fab@Home.

Managers at the Soshanguve FabLab in South Africa get to see a fabber in action.

"The personal interaction with the people [in South Africa] made the empowerment aspect of this project much more practical and immediate."

"The personal interaction with the people down there made the empowerment aspect of this project much more practical and immediate," Malone said.

Although Malone is looking forward to completing his doctorate and moving on, he does see a continuing role for himself with Fab@Home, at least as an adviser and possibly as a part of a business venture.

The inner workings

When Malone compiled a list of materials for the first Fab@Home, he said he wanted to make sure all of the necessary components were available to anyone eager to build one. Once all those materials are in hand, Malone estimates someone can build a Fab@Home over a weekend.

The "printer's" chassis consists of 40 acrylic pieces, laser-cut to specification, and a variety of linear stepper motors, bearings, rails, and fasteners. Mounted on this are several subassemblies, including a motorized table that moves up and down to accommodate layers of deposited material, the positioning system that controls the deposition syringe in the horizontal plane, and the "syringe tool" which holds the syringe and the motor that depresses it. Fab@Home uses standard syringe barrels, which are disposable and accommodate a wide variety of materials, according to Lipson.

After the table and positioning system are installed, the parts that process commands and help shape objects in the fabber are added: a 4-axis amplifier, a microcontroller, limit switches, and a breakout board and cables. The firmware for the unit's microcontroller can be downloaded from Fab@Home's Web site.

A few days and about $2,000 later, you have a fabber.

The simplicity of Fab@Home is one reason it continues to generate interest, but another strong component is the open-source philosophy behind it.

Some people, for example, have already suggested how to reduce the price by assembling the motors in house, although that admittedly requires some engineering skills.

Lipson and Malone created the software that imports an object's three-dimensional information and controls the fabber to build it. Lipson points out that the software uses standard computer-aided design formats to read information, which helps ensure compatibility. It is written only for Windows at the moment.

So what's been "fabbed" so far?

Everything from a squirt bottle, watchband, propeller, batteries, a working flashlight with printed wiring and switch, and even a Darth Vader head. Many other objects have been designed using chocolate, cheese, and cake frosting.

Lipson said another Web site, www.3Dprintables.org, will soon include downloadable blueprints for many objects able to be created in Fab@Home and other rapid prototyping machines.

Desktop future

Lipson and Malone see exciting possibilities for the future of desktop manufacturing.

The simple objects being created today will lead the way to more complex creations, they believe. In the same way the digital revolution allowed music and images to be downloaded and shared, Lipson sees home fabrication being as easy as downloading a design and printing it at home. As the technology evolves, and multiple materials can be printed in the kitchen fabber, objects of greater complexity will be feasible.

Instead of buying an iPod online and waiting for it to be shipped, for example, Lipson sees a future where consumers will download the blueprints and print it at home.

For Lipson, the most dramatic possibility for home fabrication is changing the way we invent and create. He said it harkens back, ironically, to a time of custom creation and manufacturing's soul. Convincing society that makes sense may take more time, however.

"It will take at least a generation of engineers to escape the idea that in order for something to be cheap, it needs to be mass produced," Lipson said.

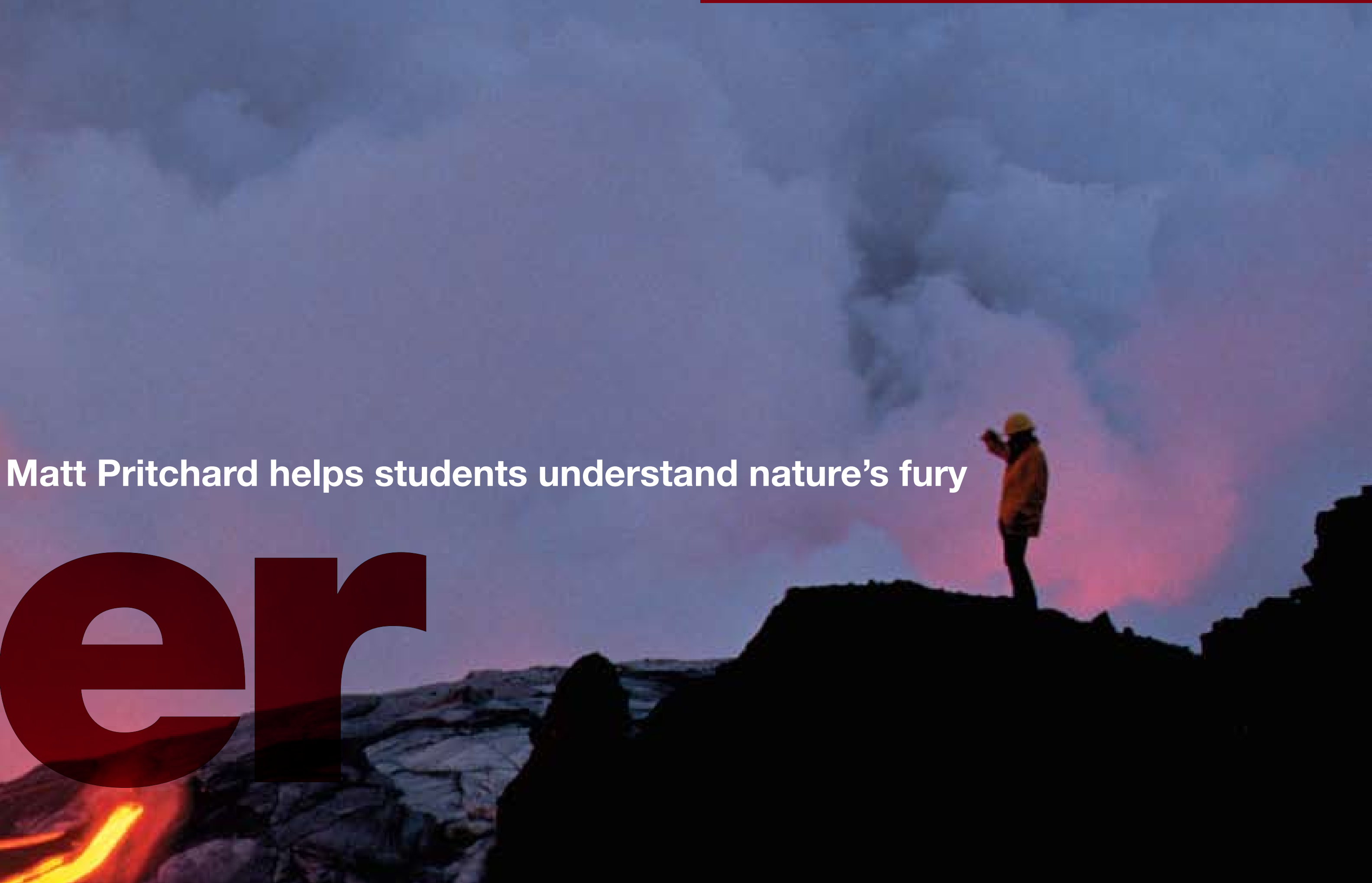
But perhaps that greatest hope for home fabrication is the imagination. That, Lipson said, could mean a new age of invention.

"Forget about companies designing these things," Lipson said. "It will be ordinary people designing these things. It's a liberating process. It liberates talent that is now only obstructed by the tremendous barriers of resources and skills that prevent most ideas from being realized."

All in the comfort of your own kitchen.

Master of Disast

Earth sciences professor



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Matt Pritchard helps students understand nature's fury

By Robert Emro

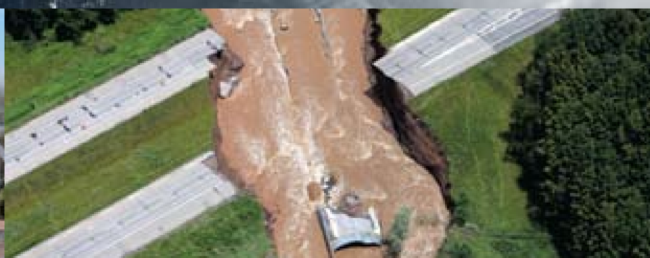
Universal Pictures

In a scene from *Dante's Peak*, a volcanologist played by Pierce Brosnan is trying to save the mayor, played by Linda Hamilton, and her two children from the imminent eruption of the mountain. They don't get far before the mountain explodes, sending a giant cloud of superheated gas, rocks, and ash rushing down the side of the volcano, destroying everything in its path "What is it?" screams one of the kids. "That," replies Brosnan's character, "is a pyroclastic flow." It seems the fleeing characters are about to meet their end, but Brosnan manages to outrun the cloud of death in the nick of time, crashing his pickup into an abandoned mine shaft, saving everyone, including the dog, Scruffy.

The special effects look real enough, but could that scenario really happen? A class of Cornell students must answer that question and several more about the validity of Hollywood calamities in EAS 122 "Earthquake! (and other natural disasters)" taught by Department of Earth and Atmospheric Sciences Assistant Professor Matt Pritchard.

Corbis

"You think the big disasters are going to be earthquakes and volcanoes but we learned that the most deadly natural disasters are floods and storms."



Hurricane Katrina-NASA / **2004 tsunami**-David Rydevik / **Washout of I-88 in New York, 2006**-AP Images / **Oklahoma tornado, 1999**-NOAA

With about 150 students, this is a big class. It's diverse too, with students from all seven colleges at the university, ranging from first-years to seniors. A few are EAS majors; for others, this is the only science class they will take at Cornell.

In the past, the class focused on geological disasters—earthquakes, volcanoes, and tsunamis—but Pritchard, who taught the course for the first time this spring, has expanded it to include all kinds of natural disasters, including tornadoes, droughts, and hurricanes. That may explain why enrollment shot up from about 90 students, but Pritchard thinks the increased interest may just be due to the 2004 Asian tsunami and the 2005 hurricane season. "I wonder if this generation of students' personal experiences have something to do with it," he says. "They were definitely very interested and had questions about things they had experienced."

Susan Riddick, a science of earth systems major (formerly geological sciences) from Middletown, N.Y., thinks everyone should take a class like this. "It's so useful to know about natural disasters and what to do when they happen because a lot of death and destruction occur because we aren't prepared," she says. "A lot of times we know how to get prepared but we don't do it."

One of the class assignments is to compile a top 10 list of natural disasters that occur during the semester, based on whatever criteria—loss of life, economic damage, number of people affected— the students choose. "I was actually really surprised by it," says Maxwell Royster, an engineering student who has yet to choose a major. "You think the big disasters are going to be earthquakes and volcanoes but we learned that the most deadly natural disasters are floods and storms."

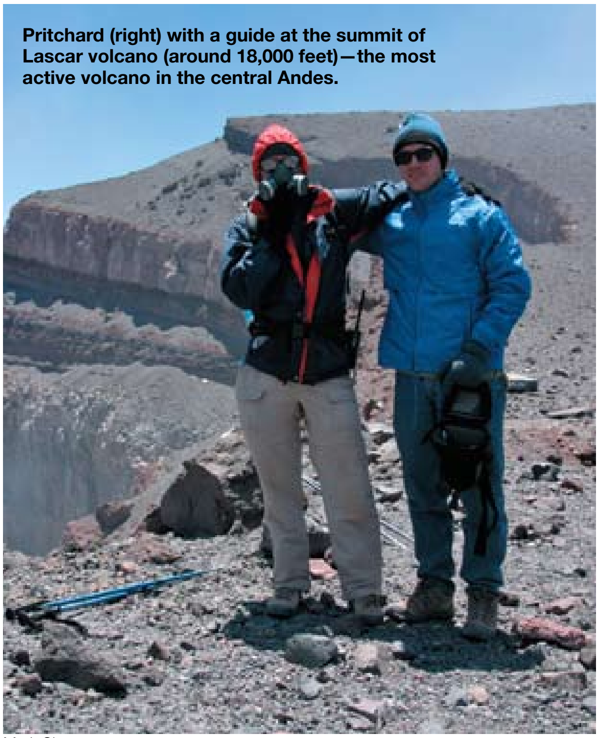
The purpose of the exercise is not to make the students depressed, but to give them a perspective on the types and frequency of disasters occurring around the world and what can be done to mitigate them in the future. "I want them to get an appreciation of what the different risks are," says Pritchard. "There's a huge difference between the developed world, where natural disasters mainly cause insured losses and economic damage, and the developing world, where 96 percent of the deaths from natural disasters occur."

"It's kind of morbid at times," says Royster, "but then you realize that we're getting much better at preventing loss of life and now the real problem is getting cheap, cost effective ways of making it safer in less developed countries."

The students must also complete several group projects, including a three- to four-page assessment of the earthquake hazard within a particular region, a five-page white paper for policy makers (topics include how to evaluate and announce an earthquake prediction, developing a world-wide tsunami warning system, and national funding priorities for earthquake hazard reduction), and finding the best place to live if you want to avoid natural disasters.

Some students found their hometown isn't as safe as they had thought. "I didn't know that the Northwest was such a volatile area," says Royster, who hails from Portland, Ore. "I thought we were pretty safe out here but we actually have the biggest risk for the highest magnitude earthquake."

Students also learn what to do—Pritchard squats on the balls of his feet with his hands on his knees and his head between them to demonstrate the "lightning crouch"—and what not to do in a disaster. "I heard a lot of things before about tornadoes, like open the windows or staying in the southwest corner during a tornado, and those are all false," says Riddick. "The windows don't help with the pressure difference, so there's no reason to even bother to open them."



Pritchard (right) with a guide at the summit of Lascar volcano (around 18,000 feet)—the most active volcano in the central Andes.

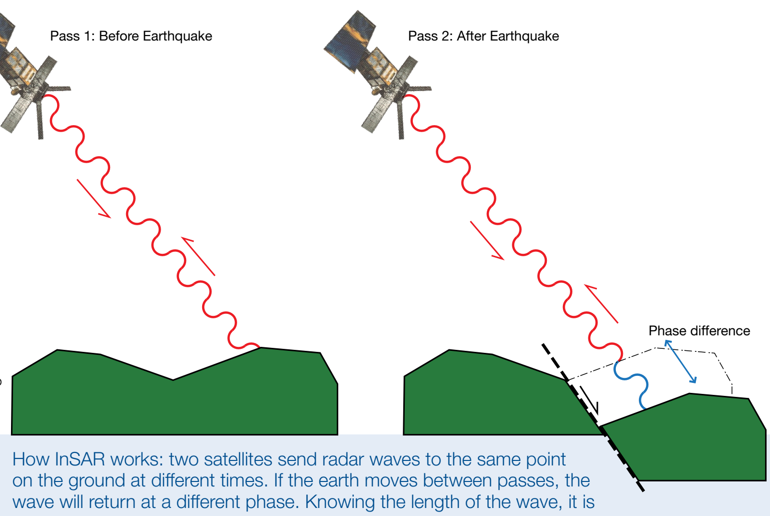
Mark Simons

For Pritchard, disasters offer a way to reach students who might not otherwise be interested in earth science. "We trick them into learning about these phenomena and the underlying science behind them because everyone is intrigued by disaster," he says. "I hope the students get some appreciation for what nature can throw at us. I also hope they come away with a realistic assessment of what we need to worry about, and what we don't—like that the threat of impacts from asteroids is real."

Pritchard says teaching such a large class, especially one outside his particular area of expertise, was a learning experience for him as well. "Teaching a class like that gives you a chance to really step back and look at the big picture," he says.

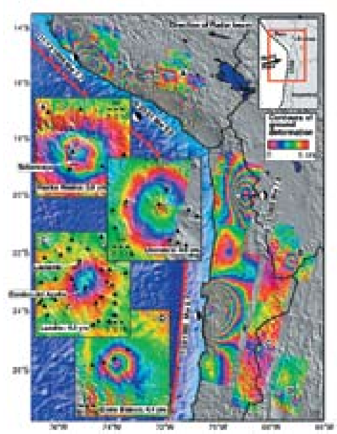
Pritchard is most familiar with how the ground moves in response to volcanoes, earthquakes, and landslides. Using satellites hundreds of miles in space, he can calculate centimeter-scale movements of Earth's surface. The traditional method for collecting this kind of data—survey crews—is labor intensive and dangerous. GPS changed all that, but the units are expensive, installing and maintaining them can be risky, and they don't fare well in lava or landslides. "Now we have these very dense maps of ground deformation from earthquakes," says Pritchard. "Being able to do it from space is a huge revolution."

To get such a precise picture of Earth's movements, Pritchard uses interferometric synthetic aperture radar. InSAR, as it's called, is an unintended byproduct of SAR, which uses microwaves to produce images of Earth, even in darkness or through cloud cover. Instead of using the amplitude of the wave to produce an image, interferometry uses the phase, which is the position of the wave within its cycle—trough, peak, or somewhere in between. As long as Earth's surface hasn't moved, the phase of a returning wave should be the same each time an InSAR satellite returns to a location. Because the length of the wave



Tim Wright

How InSAR works: two satellites send radar waves to the same point on the ground at different times. If the earth moves between passes, the wave will return at a different phase. Knowing the length of the wave, it is possible to calculate the precise amount of deformation.



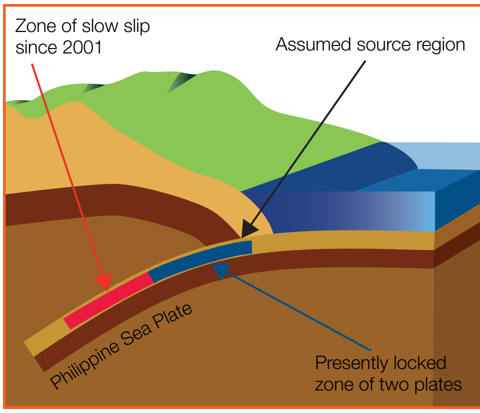
Matt Pritchard

Earthquake and volcanic deformation in the central Andes between 1992 and 2005. Each color cycle represents a change of 5 cm in the distance from the satellite and the ground between satellite overflights. Along the coast are the deformation patterns from four earthquakes.

is known, a phase shift can be used to calculate the change in the distance the wave has traveled.

In reality, of course, it's not quite that simple. Satellites rarely return to the exact same location, and that changes the phase in a couple of ways, but this can be compensated for using the known difference in satellite position and accurate topographic information. Vegetation and man-made changes to the landscape, like plowing, can also distort the returning signal. But when the "noise" is low or filtered out, Pritchard is left with an interferogram. A fringe pattern of alternating red and green bands indicates a change in the surface, like topographic lines on a map, except each band represents just 3 cm. "It's so fantastic," says Pritchard. "It's just a lot of fun every time one of these fringe patterns comes up; it's such a rush."

While a graduate student at Caltech, Pritchard worked with scientists at NASA's Jet Propulsion Laboratory to write the open-source software most commonly used to look at InSAR data. With this new tool, he and his Caltech adviser Mark Simons discovered that earthquake faults sometimes slip slowly, deep underground, without any violent shaking. Other researchers have found that one of these "silent earthquakes" happens about every 14 months in the Pacific Northwest. These events can increase the stress on locked plates at the surface. Eventually this stress overcomes the force that holds the plates locked and they slip suddenly. That's when the earth trembles and buildings fall. Silent quakes have been documented before giant temblors three times—in Chile in 1960 and in Japan in 1944 and 1946—but not every silent earthquake leads to a big one. Pritchard hopes InSAR will reveal more about the relationship between the two. "We're trying to understand where these silent earthquakes occur and what happens before and after," he says.



A "silent earthquake," an imperceptible slip of the crust not accompanied by violent shaking, has been detected in southeastern Japan where the Philippine Sea Plate is slowly being ground under the Eurasian Plate.

Geographical Survey Institute (Japan)

Precise earthquake prediction may not be possible, says Pritchard, but accurate earthquake forecasting may be. The larger timeframe of such a warning wouldn't allow mass evacuations, but it would let officials know where to focus preparedness efforts. "In theory, with this method, we can take measurements everywhere, all the time, to figure out if there are any precursory signals," he says.

InSAR can also show bulges or dips caused by magma deep underground. Pritchard and Simons studied 900 volcanoes in the South American Andes, where an arid climate and sparse population make for "fantastic" InSAR data. It would have taken years using GPS surveys, but in just a couple of weeks they found about 40 fewer active volcanoes than were previously believed to exist, allowing scientists to concentrate resources where they are most needed. They also found four volcanoes that had caused ground deformation that were not on the list of potentially active volcanoes. One is known as Untaruncu, which means "sleeping tiger." It's been sleeping now for many millennia, but Pritchard found that for the past 15 years it has been causing the ground to inflate about 1 to 2 cm per year. "Is this a super volcano accumulating magma for the last 300,000 years," he asks, "or is it a benign accumulation of a granite body?"

Pritchard has proposed more detailed field investigations that might help answer this question. "You still have to go do the field work," says Pritchard. "The remote sensing data allows you to ask questions that can't be completely answered by the remote sensing data."

He's also beginning to study some more mysterious movements revealed by InSAR, such as the sharp deformation at the edge of a salt flat known as the Salar de Atacama that showed up

Top 10 Disasters

Excerpted from Maxwell Royster's assignment

#1 Flood, Jakarta, Indonesia. February 2, 2007
Strong rains continued ceaselessly through the weekend, causing rivers to overflow in all regions of the low-lying city. Rain continued intermittently for two weeks afterwards. Over 340,000 people had to be evacuated, many remaining permanently homeless. Twenty-nine people died. There is no estimate for the monetary losses, but the floods affected not only the slums but the wealthy areas, thus increasing the economic damages.

#2 Tropical Cyclone Indlala, Madagascar. March 15, 2007
Indlala made landfall near Antalaha with sustained wind speeds reaching 120 mph. The storm caused numerous landslides and flooding. Whole villages were buried under mudslides and many roads washed out stranding those affected.

Sixty-nine people were killed and 13,000 homes destroyed. 40,000 hectares of crops were also destroyed. Madagascar has been hit by six cyclones since December 2006, the most on record. An estimated 200,000 people have been affected and an estimated three-quarters of crops have been destroyed, including 80 percent of the vanilla harvest, Madagascar's main export. Much of the rice crop was also destroyed leaving much of the country in danger of starvation.

#3 Flood, Central Africa. February of 2007
Many villages near the Zambezi River were completely submerged for several months.

There were few initial deaths, but subsequent disease outbreaks killed thousands. 100,000 people were displaced without adequate water supplies. In Angola alone more than 71,000 cases of cholera were reported with more than 2,800 dead.

unexpectedly in his study of Andean volcanoes and earthquakes. InSAR has shown the ground outside Seattle rising and sinking seasonally as well. Both deformations may be in response to groundwater withdrawal and recharge. Other applications include studying melting glaciers and monitoring the Retsof mine in western New York. It was the second largest salt mine in the world until it collapsed in 1994, causing 200-foot-wide sinkholes. Geologists expect 8 to 9 feet of additional subsidence over the next century. "Everywhere you look, there's something deforming," he says. "It's been surprising to a lot of people what we've found."

In June, the EAS faculty welcomed Rowena Lohman, another expert at using and interpreting InSAR data. She was a graduate student with Pritchard at Caltech and the two are engaged to be married. Her addition further augments Cornell's expertise in the study of earthquakes, a traditional area of strength, particularly in South America, where the Andes Project has been working for more than 25 years. "We will have a large group that uses this tool and hopefully expand the applications of it to different areas and different problems," says Pritchard. "We can compare our measurements with geological observations from the ground and determine if the patterns we are seeing are consistent over tens of thousands of years."

Pritchard's curiosity about geology was sparked by a rock collection he had as a boy growing up in Illinois. A family trip that included the Grand Canyon, Yellowstone, and Walnut Canyon National Monument in Arizona (shown here) solidified his interest.

Pritchard's curiosity about geology was sparked by a rock collection he had as a boy growing up in Illinois. The geology of the Midwest was less than inspiring, but a family trip to the Grand Canyon and Yellowstone solidified his interest. Similarly, a visit to Mt. Saint Helens in the eighth grade got his student Susan Riddick interested in volcanoes and led her to take his disaster class. Now she is working with Pritchard, supported by the NASA/New York Space Grant Undergraduate Summer Research Program. Using new, higher resolution data, she is studying volcanoes to better characterize their activity and potential hazards.

Thanks to Pritchard's class, Riddick came to the job knowing quite a bit about volcanoes, including the likelihood of Pierce Brosnan's character escaping a pyroclastic flow. "He definitely wouldn't be able to outrun it, because pyroclastic flows are really fast and they're also very hot," she says. "They're one of the most dangerous aspects of volcanoes."

#4 Storm Kyrill, Northern Europe.
January 17–19, 2007
The storm originated over Newfoundland and made landfall over Great Britain, continuing over Germany and Poland and finally into northern Russia. Wind speeds reached up to 140 mph. Forty-seven people died, most in Britain and Germany. Many homes destroyed or left without power. Damage estimated at almost $5 billion dollars.

#5 Flood, Afghanistan.
April 1, 2007
Heavy rains coupled with rapidly melting snow created widespread flooding affecting nearly a third of the nation. Avalanches also caused deaths and destroyed homes. Many bridges and roads were washed out making rescue efforts difficult over the rugged terrain. More than 80 people were killed and up to 10,000 homes were destroyed. 300 km of roads were washed out, including an important bridge linking Kabul to the southern provinces. Tens of thousands of hectares of agricultural land were lost as well as livestock.

#6 Flood, Central Argentina.
March 31, 2007
Widespread flooding, particularly bad on the Parana River. The country received nearly half its average annual rainfall in a few days. The province of Santa Fe received 15.7 inches of rainfall in 72 hours. In Santa Fe, 12 of 19 counties suffered flooding. 11 people died and 55,000 were evacuated. Three million hectares of harvest-ready crops were completely destroyed.

#7 Tornadoes, Central Florida.
February 2, 2007
A tornado touched down in Sumter County, leaving a 15-mile path of destruction into Lake County. About 30 minutes later, a second tornado developed in Lake County and continued on through Volusia County, leaving a trail 22 miles long.

Twenty-one people died. Many homes and businesses were destroyed. Property damage estimated at more than $80 million in Volusia County alone. More than 15,000 were left without power.

#8 Tornado, Enterprise, Ala.
March 1, 2007
A tornado with wind speeds reaching 170 mph cut a 7-mile swath, destroying more than 370 homes. A wall collapsed at Enterprise High School killing eight people and injuring 120.

#9 Earthquake, Japan
March 25, 2007
A magnitude 6.9 earthquake occurred off the Noto Peninsula, about 200 miles from Tokyo. More than 175 aftershocks occurred, including a 5.3 magnitude shock eight hours later. The earthquake resulted in one death and 160 injuries, most from falling debris. About 1,300 people were evacuated from their homes and 44 homes were destroyed, with around 200 others severely damaged. Water was cut off to 9,000 homes.

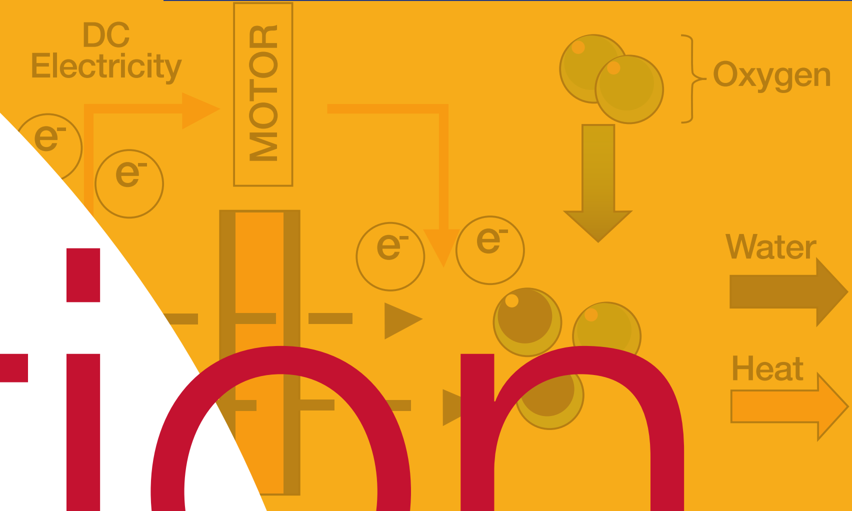
#10 Tropical Cyclone George, Western Australia.
March 2–10, 2007
Cyclone George formed over the northern coast of Australia's Northern Territory on March 2 and continued on a southwesterly path following the coastline. It moved out over the Indian Ocean where it increased in intensity, with sustained wind speeds of 125 mph and gusts up to 170 mph. It made landfall again March 8 near Port Headland. It continued inland, where it dissipated March 10. George resulted in three deaths and 28 injuries, many from the destruction of the Fortescue mining camp, where nearly all the buildings were destroyed.

Chem-E-Car

Comp

Cornell ChemE Car

"Bender" the Cornell Chem-E-Car entry and official logo



etition

By Dan Tuohy

As challenging as powering a small car by chemical reaction can be, this science experiment on wheels turns out to be a real blast.

Photos by Ariel Waitz '08

Safety First: Ka Yip '08 practices using a fire extinguisher at the Northeast regional Chem-E-Car competition last March.

"Bender," a shoe box-sized car powered by hydrogen, is carrying a team of Cornell engineering students to a national competition where they will vie for cash prizes and collegiate bragging rights this fall.

The students affectionately named their vehicle for the robot character in "Futurama," Matt Groening's animated television sci-fi comedy, because it has some bendable parts. But the nickname also tells the story of the annual Chem-E-Car competition: As challenging as powering a small car by chemical reaction can be, this science experiment on wheels turns out to be a real blast.

"It's purely for fun," says Yang Lu, Cornell's past team chairman, who graduated in May.

The American Institute of Chemical Engineers organizes the Chem-E-Car competition, in which students design and build a car powered with a chemical energy source that will carry a specified load over a given distance and stop. At the finish line, there is no checkered flag nor winner's circle. It's a competition, not a race. As the first T-shirt for the Cornell University team proclaimed, "Speed is not an option!"

The national competition in November kicks off the institute's annual meeting in Salt Lake City, Utah. University teams win a berth via regional conferences. Cornell qualified at the Northeast Regional Conference held at Northeastern University in March. In that race, Lu says Bender traveled only a short way, but the car was able to stop within the required two minutes and the team won a third place.

Stopping on time is crucial because it demonstrates precise calculation of the chemical reaction involved. "One of the toughest challenges is the cars have to start and stop within two minutes," says Lu, who hails from Brookline, Mass.

The competition time-line began in May with entry submissions and eligible teams completing their annual reports. There will be a maximum of 31 car entries in the 2007 competition. While multiple entries from a single school are permitted at the regional contests, only one entry per school via the qualifying procedure is allowed at the national competition.

The model car must fit into a shoebox with dimensions no larger than 40 centimeters by 30 centimeters by 18 centimeters. The cost of the contents of the box, including the chemicals, must not exceed $2,000. Chemical cars cannot be controlled remotely. Brakes, internal flames, and smoke are prohibited. And it may go without saying, but the rules underscore that the drive system have no commercial batteries and no mechanical or electronic timing devices.

Competition rules get tougher every year and Lu welcomed the challenge. "That's what the real world is all about, so it's good for students," Lu says.

Before the Cornell creation can zoom away on a straight track, judges will put the team to the test with a thorough technology review and environmental and safety checks. The event begins with a poster presentation in which each team explains the chemical reactions at play and details their attention to performance and safety issues.

A safety-first focus helps teams secure a first in the competition. According to the 2007 rules, a team must score at least 70 percent in the poster competition to advance to the performance session. Description of the chemical reaction, design creativity, and team member presentations each count for a maximum of 20 points. But the environmental and safety features account for a maximum of 40 possible points. Chem-E-Car models have been known to fail this test, thus blowing a shot at the title.

"It's a very practical application of chemical principles. It provides students an opportunity to experience the joy of accomplishment. These students really have fun."

Photos by Ariel Waitz '08

Cornell Chem-E-Car team members Yang Lu '07 ChE, Brian Weitzner '09, Parbir Grewal '10, Sheela Damle '08, Ka Yip '08, Michael Klees '09, Dan Lee '08, and Ariel Waitz '08.

Attention to detail and the ability to think fast pays off during competition. Lu recounted how during the Northeast Regional his team neglected to account for secondary containment for a dilute acid, as a precautionary backup. After the judges' scrutiny during the inspection phase, the team manufactured one out of a plastic lunch box and it worked just fine.

Such on-the-spot actions can make or break a team in the performance segment as well. The teams do not know beforehand exactly how far their car will have to travel or how much it will have to carry, only that the distance this year will be between 50 and 100 feet, while the load will be between zero and 500 ml of water. Once the teams learn the exact distance and load, they have just one hour to calculate the necessary adjustments to fuel or reactants.

Awards are given for the most creative drive system, the most consistent performance, and competitive spirit. There is also the "Golden Tire Award," a peer-elected award for the team with the most creative Chem-E-Car.

Cornell has participated in the competition for several years, experimenting with a variety of car designs and chemical reactions. The competition is so stiff that no university has won more than once since it was launched in 1999. Cornell has never won the national trophy. Adding to the challenge, the same car cannot be used from year to year.

Last year, Cornell entered a piston-based car driven by the production of oxygen gas from the dissociation of hydrogen peroxide. Bender is powered by a hydrogen fuel cell connected to a motor with a kind of acid switch in between. Hydrogen is stored at 20 psi and released into the fuel cell at 3 psi to generate power for the motor that moves the car. To close the circuit connecting the fuel cell to the motor, a magnesium strip is dipped into acid. Once the magnesium strip dissolves, the top of the car pops open, disconnecting the fuel cell from the motor. By adjusting the length of the strip, the students can control the distance the car travels.

Bender will undergo several modifications before the national competition, partly because it was the team's first attempt at designing and building a fuel-cell vehicle. The overhaul includes studying ways to drop its weight, acquiring a new motor, and adding new fuel cell stacks, according to the team's post-race review. In the days after the regional competition, the team set about trying to acquire a sponsor to help subsidize the costs of the fuel cells. The team has enjoyed the support of the School of Chemical and Biomolecular Engineering. Besides the Chem-E-Car materials and parts, travel expenses for the regional and national competitions are the big cost.

Many college teams are leaning toward the use of fuel cells, rather than a pressurized system or action, Lu noted. If the Cornell University team gets more members, it may choose to launch a second car for future competitions. Lu envisioned the team leveraging mechanical engineering students and support to improve the gear ratio of future cars.

Besides the increasingly popular hydrogen fuel cells, the 2006 competition saw some innovative chemical reactions to power the cars, including the use of vinegar and baking soda, beef liver and hydrogen peroxide, and a type of bio-fuel. The University of Minnesota used an enzyme from an insect to create the chemical reaction necessary to power its vehicle, taking home an award for using the most creative fuel. The 2005 national winner, Tennessee Tech University, powered its car with a zinc-air fuel cell.

The University of Puerto Rico won first place last year, followed by the University of Dayton and the University of Maine. The top three teams, in order of success, win $2,000, $1,000 and $500. The top three last year all used hydrogen fuel cells to power their cars. Of several ancillary awards this year, the Society of Biological Engineers sponsors a $1,000 prize for the best use of a biological reaction to power a car.

With America so focused on alternative fuels, the Chem-E-Car competition serves as an important avenue for college students to learn about the chemical reactions that can move vehicles, according to the American Institute of Chemical Engineers. The institute created the competition as a fun and practical way for students to apply their knowledge of chemical engineering principles.

A national competition also gives the public a better understanding of alternative fuels, says Tim McCreight, AIChE marketing director. For the mainstream media, it is an appealing news hook. For the competitors, McCreight says, "the benefits are they learn how to work as a team in a very real-world environment."

AIChE President-elect Dale Keairns is enthusiastic about the competition for its focus on energy as the grand challenge of our time. Students must work with process and systems integration, while experiencing the ups and downs of innovation, which Keairns called the reality of the real world.

"It's a very practical application of chemical principles," he says. "It provides students an opportunity to experience the joy of accomplishment. These students really have fun."

The other reality is that the industry, with its aging workforce, has a demand for young engineers in existing roles as well as emerging technologies, says Keairns.

Past competitors have pursued related endeavors after college. Students from Michigan Technological University, who won a regional competition in 2002, went on to launch their own company developing prototype hydrogen fuel-cell vehicles for a corporate client list that included Chrysler and John Deere.

Paulette Clancy, the William C. Hooey Director and Professor at Cornell University's School of Chemical and Biomolecular Engineering, says the student competitors may not be developing new technologies, but they are learning the issues involved in a moving vehicle, which the school hopes will generate enthusiasm for creating new systems for transportation.

"The human skills necessary to participate in, lead, and work cooperatively in a vehicle prototype design team are invaluable," Clancy, co-adviser of the program, wrote in an e-mail. She says the student engineers need to understand reaction kinetics, process control, and thermodynamics—part of the core chemical engineering curriculum.

They also need a level of cooperation students do not often experience in a classroom. Cornell's team leaders included a chairman, business coordinator, and design and construction experts. Further parallels to the private sector exist in the car design and manufacture. A design may take a few days or weeks to complete, while safety and environmental testing—the material and job safety analysis required in the real world—gets thoroughly examined and takes much longer. Lu says the analytical jujitsu required of teams under the hawk-eye of the judges is a practical representation of a workplace lab.

Northeastern University's Chem-E-Car emits vapor during the regional competition. Michael Klees '09 and Sheela Damle '08 make some last-minute adjustments to Bender. Brian Weitzner '09 celebrates the team's strong showing.

Students invest a lot of time—that precious spare time out of class—in the Chem-E-Car competition and its requisite preparations. A dozen students participated on the team last spring, including several women. "This is a unique program which enriches our educational experience," says Clancy, noting with pride the strong participation by women students.

Lu says the competition also builds camaraderie. "You can't do everything by yourself," he says. "What is really rewarding for me is to see guys develop."

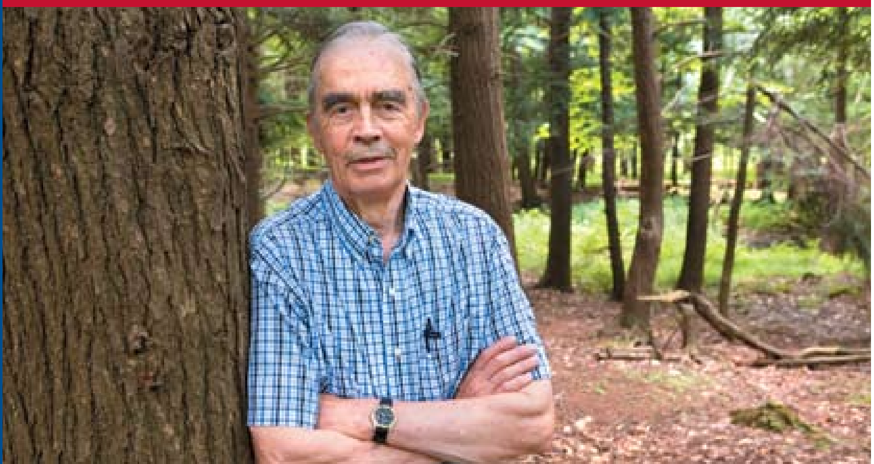
Before he graduated to put his chemical engineering degree to work, Lu named Ka Yip and Daniel Lee to serve as co-chairs as they start their senior years at Cornell.

The best part of the challenge at the national competition, says Lee, is the hands-on work and the immediacy. He sees it as a reprieve from the theoretical in the classroom, and relishes being forced to engineer around problems as they arise.

"The fun part," Lee says, "is that once we do something we can immediately see if it works."

URGENT PASSION

Professor Emeritus Peter Harriott wants you to know how to stop global warming.



Peter Harriott

Robert Barker/University Photo

Peter Harriott '49 ChE is 79 years old, and there's a walker parked in his Olin Hall office, but don't let it fool you: it's just to keep him mobile until he recovers from his second knee replacement. A founding member of the Cayuga Trails Club, the emeritus professor of chemical engineering is an avid outdoorsman who loves to introduce newcomers to Tompkins County's lesser-known hiking gems. "It's fun," he says, "to explore something where there's no steps and no hand rails."

Harriott's other great passion marries his abiding interests in science and the environment: he's determined to spread the word about the dangers of global warming. His mission is no passing fancy sparked after a viewing of Al Gore's 2006 documentary *An Inconvenient Truth*; Harriott has been advocating conservation for decades and taught a pioneering course on synthetic fuels during the first oil crisis of the mid-1970s. "I'm trying to make people aware of the urgency," says Harriott, who celebrated Earth Day '07 by giving a public lecture on the subject at an Ithaca church. "People who talk about alternative energy and sustainability say 'We've got wind and solar and ethanol.' But wind, for example, contributes only half a percent of our electricity, and it will only contribute a couple of percent in 10 years. We should be doing more conservation, which has the more immediate effect of changing people's habits."

Soft-spoken and good-natured, Harriott is no one's idea of a radical; he isn't aiming to ban cars and go off the grid. He's a realist who knows that to protect the environment over the long term, changes must be both meaningful and livable. He advocates tougher mileage standards for cars, regulations against energy-hogging appliances, and subsidies for Earth-friendly technologies like compact fluorescents. Voluntary conservation is all well and good, he says, but it has its limits.

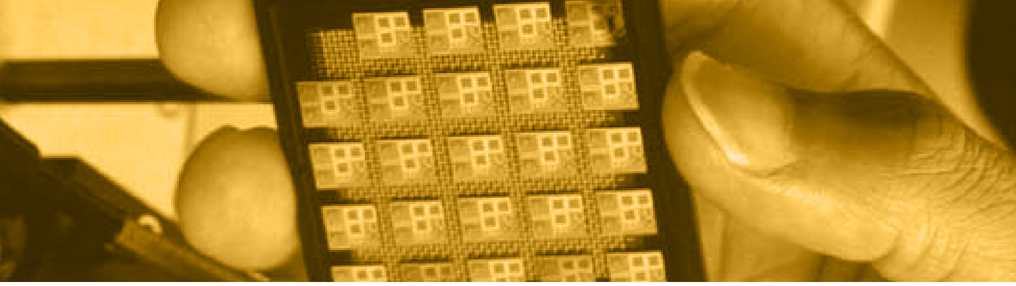
"The government has to take more steps," he says. "There are Energy Star appliances, but right next to them you can buy ones a little cheaper that use more electricity, and unfortunately some people look at the first cost rather than the long term. We are responsible for so much more CO_2 per capita than any other country, we have a moral responsibility to do more than let capitalism do its thing."

Harriott has been retired since 2001, but he still comes into the office three or four times a week and gives guest lectures in several courses, including the air pollution class he founded decades ago. He has written or co-written three books, including four editions of the textbook *Unit Operations of Chemical Engineering*, with Cornell Emeritus Professor Julian C. Smith.

Three decades ago, Harriott earned a bit of chemical engineering immortality by penning "The Reynolds Number Song," a folk ditty about the formula that characterizes the turbulence of a fluid. The chorus goes like this:

Take a D times a V, a rho by mu,
Put them all together with a little bit of glue,
Then you'll have a number that will see you through,
And tell you what the fluid's going to do

"There are four verses," he says with a smile, "and by the time I've gone through the first two, I can usually get the students to sing along."



Beginning this fall, fellowships in his honor will be available to Master of Engineering students in the area of sustainable energy systems and environmental protection.

Born in Ithaca to two Cornell alumni—his father studied agricultural economics, his mother home economics—he moved to Massachusetts as a child and returned to the Hill for the five-year B.S. program in chemical engineering. He earned his Ph.D. from MIT, bookending his graduate work with stints at Dupont and General Electric. "I didn't want to be a professor who was teaching engineering design but had never designed anything," he says. "I've always enjoyed the chance to combine the theoretical aspects of chemistry and engineering with the practical aspects of equipment design and operation."

Harriott and his wife, Mary Lou, met in the Adirondack Mountain Club; they've been married for 53 years and have five sons and seven grandchildren. All of their sons studied engineering—four at Cornell, a rebellious fifth at Princeton—and two are now medical doctors, while the others are engineers: one electrical, one mechanical, one chemical.

A guitar player and bass singer, Harriott seeks out a community chorus at each of his sabbatic locales. He's also a veteran woodworker, who helped build his family home. It isn't some ultra-efficient dwelling built into a hillside but a conventional house where he has installed extra insulation and compact fluorescent bulbs, with air conditioning in only one bedroom and a thermostat kept low in the winter. "We have a clothes dryer," he says, "but we also have a clothes line."

—Beth Saulnier

DISTINGUISHED CONTRIBUTIONS

Two Engineering professors were among five Cornell faculty members elected to fellowship in the American Academy of Arts and Sciences for 2007 in honor of their distinguished contributions to their professions.

Jon Kleinberg, professor of computer science, and Stephen B. Pope, the Sibley College Professor of Mechanical and Aerospace Engineering, will join Cornell colleagues Héctor D. Abruña, the Emile M. Chamot Professor of Chemistry and chair of the Department of Chemistry and Chemical Biology; Stephen T. Emlen, the Jacob Gould Schurman Professor of Neurobiology and Behavior; and Isabel V. Hull, the John Stambaugh Professor of History for induction ceremonies Oct. 6.

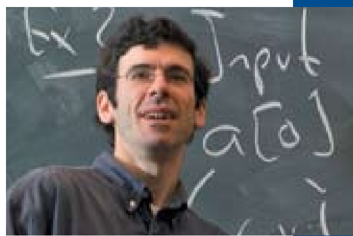
Kleinberg's research includes ways to reduce congestion on complex networks like the Internet, and methods for searching large, complex databases. A current project deals with the sociology of the Web. As a member of Cornell's computational biology research group, he has worked on protein folding and the databasing of proteins by their three-dimensional shapes. He is one of the developers of an algorithm that underlies the workings of major Web search engines. In 2005 Kleinberg, who received his Ph.D. from the Massachusetts Institute of Technology in 1996, received a MacArthur Foundation "genius" award.

Pope is an internationally recognized authority in the fields of turbulent flow and turbulent combustion. He has made major contributions to the field using the direct numerical simulation technique and is the world's leading expert in the development of the probability-density-function method for the prediction of turbulent flows. This method is increasingly used by industries requiring detailed knowledge of combustion processes in automotive and gas-turbine engines. Pope completed his graduate education at Imperial College, London. He was also recently elected a fellow of the Royal Society, the national academy of the United Kingdom.

AAAS fellows are nominated and elected to the academy by current members. The current membership includes more than 170 Nobel laureates and 50 Pulitzer Prize winners. The current membership list includes 70 present and former Cornellians.

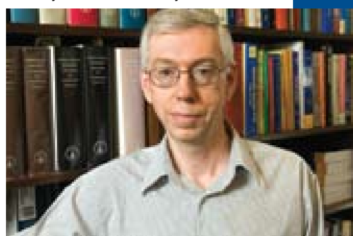
—Bill Steele, Cornell Chronicle

Robert Barker/University Photo



Jon Kleinberg

Lindsay France/University Photo



Stephen B. Pope

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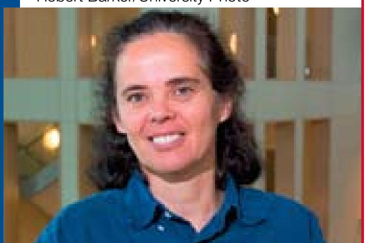
SUMMER 2007

SCHURMAN PROFS

Robert Barker/University Photo

Steven Strogatz

Robert Barker/University Photo



Éva Tardos

Steven H. Strogatz, professor of Theoretical and Applied Mechanics, and Éva Tardos, professor and chair of computer science, were among four Cornell faculty members recently named Jacob Gould Schurman Professors. One of the most prestigious chairs at the university, it is named for Cornell's third president.

Strogatz applies mathematics to real-world systems, ranging from physics to biology to social networks. He has studied the geometry of supercoiled DNA, the dynamics of the human sleep-wake cycle, and the topology of three-dimensional chemical waves. In recent years he has moved to studying the "small-world" phenomenon in social networks and its generalization to other complex networks in nature and technology, the nonlinear dynamics of language death, and the role of crowd synchronization in the wobbling of London's Millennium Bridge on its opening day.

Tardos' research focuses on algorithms that find close-to-best-possible solutions for problems on graphs or networks. Her recent work is on algorithmic game theory, an emerging area of designing systems and algorithms for users who are all seeking the best possible outcome. Her work is aimed at quantifying the inefficiency of the equilibria that such selfish users reach and designing systems where they reach close to efficient outcomes. For example, in a context of routing with delays (such as traffic on the Internet) she found that increasing network capacity is guaranteed to offset the inefficiency caused by the selfish behavior of users.

The other Schurman Professors are Andrew Clark, professor of molecular biology and genetics; and William P. Thurston, professor of mathematics.

—Bill Steele, Cornell Chronicle

TWICE HONORED

University Photo

Antje Baeumner

Antje Baeumner, associate professor of biological and environmental engineering, has been awarded a prestigious Alexander von Humboldt Foundation Fellowship from the Alexander von Humboldt Foundation and a Mercator Guest Professorship from the German National Science Foundation.

The Humboldt fellowship was awarded in recognition of her contribution to research and science. The Mercator guest professorship award for research and teaching will allow Baeumner to work during her upcoming sabbatical leave at the Institute of Biological and Chemical Microstructures and the Institute for Analytical Sciences in Dortmund, Germany, on microfluidics, dendrimers, surface chemistry, and detection (her area of expertise), to image cancer cells in vivo using nanovesicles.

Baeumner, who earned her Ph.D. in technical biochemistry at the University of Stuttgart in 1997, has been on the Cornell faculty since 1999.

—Susan Lang, Cornell Chronicle

ENGINEERING CYBERTOWER

CyberTower

Dean Kent Fuchs with Dean Glenn Altschuler on CyberTower

From nuts and bolts to nano-, bio-, and information technology, not to mention sustainable energy systems, engineering has come a long and amazing way since Cornell's College of Engineering was founded in the nineteenth century. Recently, Dean Kent Fuchs joined Dean Glenn Altschuler, of the School for Continuing Education and Summer Sessions, for a CyberTower discussion of engineering at Cornell today: what's taught, who the students are, what the faculty are doing, and where engineering is headed in the coming years.

CyberTower Forums are monthly videotaped sessions of leading members of the faculty discussing and debating current topics and issues. Moderated by Altschuler, each forum focuses on a different topic. You can tune in to Dean Fuchs at http://cybertower.cornell.edu/Requester/f/forumMain/jun07. (You will need a free password to get into CyberTower.)

Kent Fuchs has been dean of the College of Engineering since 2002. He was formerly the Michael J. and Catherine R. Birck Distinguished Professor and head of the School of Electrical and Computer Engineering at Purdue University. Before serving at Purdue, he was a professor in the Department of Electrical and Computer Engineering and the Coordinated Science Laboratory at the University of Illinois. Fuchs received his B.S.E. degree from Duke University, his M.Div. degree from Trinity Evangelical Divinity School, and his Ph.D. in electrical engineering from the University of Illinois.

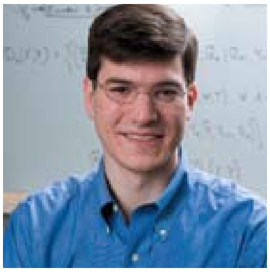
His research interests include dependable computing, testing, and failure diagnosis of integrated circuits. He is a fellow of the IEEE and a fellow of the ACM.

STIMULATING DISCOVERY

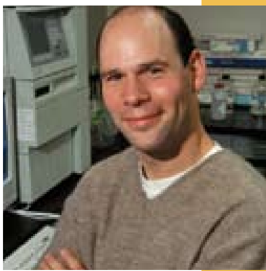

Kavita Bala


Wilkins Aquino


Robert Kleinberg


Aaron Wagner


Sunil Bhave


David Putnam

Six Engineering faculty members were among ten Cornell researchers awarded Faculty Early Career Development (CAREER) grants from the National Science Foundation this year. NSF established the awards to emphasize the importance the foundation places on the early stages of academic careers dedicated to stimulating the discovery process, in which the excitement of research is enhanced by inspired teaching and enthusiastic learning.

Kavita Bala, assistant professor of computer science, received a five-year, $450,000 grant to create a more realistic computer-generated "virtual reality." Bala's approach will take advantage of the limitations of human perception, supplying the features that an observer will notice while ignoring others. The method will produce visually realistic images of scale-complex scenes that include indirect lighting, motion blur, and light scattering.

Robert Kleinberg, assistant professor of computer science, received $400,000 over five years to develop algorithms that can make the best possible decision in situations where all the variables are not known. Kleinberg's approach aims to discover decision-making procedures with provable performance guarantees, using what he calls the "power of agency," i.e., the decision-maker's ability to go out and collect the information it needs in order to improve its choices.

Aaron Wagner, assistant professor of electrical and computer engineering, with a grant of $400,000 over five years, will work on the way compression of such audio and video images as JPEGs and MP3 music files is handled in distributed networks, such as peer-to-peer file-sharing or wireless "mesh" networks where several users wirelessly share their Internet connections.

Sunil Bhave, assistant professor of electrical and computer engineering, received $400,000 over five years to study dielectrically transduced MEMS resonators for communication and computation. The project proposal focuses on the key challenges for solid and liquid, dielectrically transduced, high-quality factor, radio-frequency resonators, including tuning methods, electrode optimization, substrate isolation, and large array synchronization behavior.

Wilkins Aquino, assistant professor of civil engineering, won $465,000 over five years to develop an advanced simulation environment for modeling degradation of structures—a key challenge that engineers face today. The research will focus on corrosion-induced damage processes in reinforced concrete.

David Putnam, assistant professor of biomedical engineering and chemical and biomolecular engineering, received $400,000 over five years to investigate the predictive design of functional biomaterials, with an emphasis on bioadhesion. Putnam aims to create a library of polymer-based bioadhesives to study how their microscale composition correlates to their macroscale bio-adhesive characteristics.

Other Cornell faculty members receiving awards were Juan Hinestroza, assistant professor of fiber science; Adam Siepel, assistant professor of biological statistics and computational biology; Garnet Chan, assistant professor of chemistry and chemical biology; and Peng Chen, assistant professor of chemistry and chemical biology.

—Anne Ju, Cornell Chronicle

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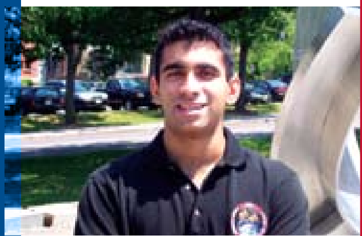
FIRST LUCE

Robert Emro



Sachin Desai

Sachin Desai ’06 ME, ’07 M.Eng. has been named a Luce scholar by the Henry Luce Foundation. Desai is the first engineering student from Cornell to win this award.

The Luce Scholars Program provides stipends and internships for 18 young Americans to live and work in Asia for a year. Dating from 1974, the program’s purpose is to increase awareness of Asia among future leaders in American society. Luce scholars have a record of high achievement, outstanding leadership ability, and a clearly defined career interest with evidence of potential for professional accomplishment, according to the foundation.

Recipients are chosen from 67 colleges and universities, including Cornell. The Luce Foundation, along with the Asia Foundation, will craft an internship opportunity unique to Sachin’s background and interests. He plans to work in Taiwan.

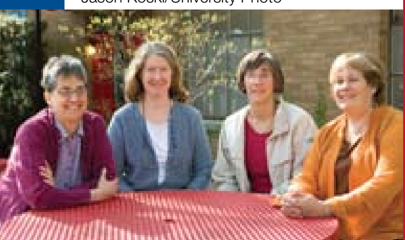
Desai was a member of Cornell’s FSAE team and a team leader on CUSat, a 100-member team designing and constructing a satellite mission in a two-year-long competition sponsored by NASA and the Air Force. He has also conducted research at Sandia National Laboratories.

Other Cornellians who have won Luce scholarships since 1996 are John Cochran ’00 (A&S) who went to China as a graduate student from the University of Southern California; Evan Frasier ’92 (Hotel) who won as a young professional; and Maureen Quigley MPA ’96, who went to Vietnam with the program.

—Susan Lang, Cornell Chronicle

ADVANCE’ING WOMEN

Jason Koski/University Photo



Cornell ADVANCE Center Research Initiative Award winners, at the Cornell Dairy Bar. From left: Abigail Cohn, Susan Quirk, Beth Ahner, and Jane Fajans

Beth Ahner, associate professor of biological and environmental engineering, was among four women faculty to receive the first Research Initiative Awards under a science and engineering program funded by the National Science Foundation.

The grants have been awarded through Cornell’s new ADVANCE Center, which was launched late last year through a $3.3 million NSF grant. The center seeks to promote leadership positions for women scientists and engineers and to institutionalize best practices, policies, and programs across colleges as they pertain to women faculty.

Ahner explores how organisms adapt to trace metals in the environment and influence the nature of metals in the environment. The grant is supporting Ahner’s project on bringing plant molecular biology tools to engineering applications.

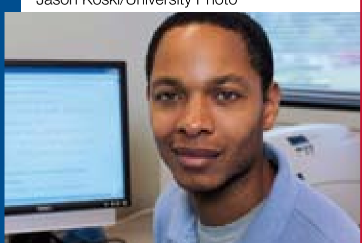
One environmental engineering application of Ahner’s research is in phytoremediation, or the use of plants to remediate contaminated soils. Successful application of this remediation lies in the ability to effectively transform plants. One key component of her current work is taking advantage of a biological mechanism to facilitate lead uptake into plant root tissues.

The other award recipients were Abigail Cohn, associate professor of linguistics; Susan Quirk, associate professor of animal science, and Jane Fajans, associate professor of anthropology.

—Anne Ju, Cornell Chronicle

FRONTIER ENGINEER

Jason Koski/University Photo



Mark Lewis

The National Academy of Engineering has selected Mark Lewis, Cornell associate professor of operations research and information engineering, to participate in its 13th annual U.S. Frontiers of Engineering symposium.

Lewis is one of 83 young engineers selected for the three-day event, which will bring together engineers between the ages of 30 and 45 who perform “exceptional engineering research and technical work in a variety of disciplines,” according to the academy.

Nominated by fellow engineers or organizations, participants come from industry, academia, and government.

Frontiers of Engineering will be held Sept. 24–26 at Microsoft Research in Redmond, Wash., and will examine trustworthy computer systems, safe water technologies, modeling and simulating human behavior, biotechnology for fuels and chemicals, and the control of protein conformations.

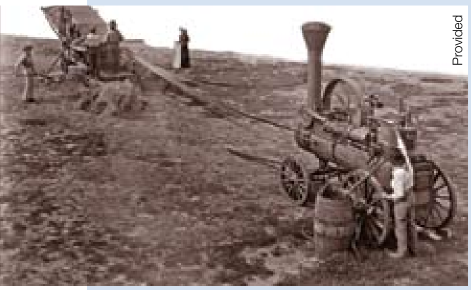
Lewis joined the Cornell faculty in 2005. His research interests are stochastic processes with an emphasis on queuing theory. He has also become interested in parallel processing and how resources are allocated dynamically in such systems.

—Anne Ju, Cornell Chronicle

BEE HISTORY

Provided

Vibration caused by this power laboratory in Stone Hall shook the botany microscopes on the top floor.



Provided

Cornell's BEE department has its roots in engineering agricultural technology, like this early belt-powered grain thresher.

John Chin '53 EE

Professor Ron Furry '53 Ag.Eng. (rear) with Bob Dellers D.V.M. Ph.D. '54, John Kleske '53 ChE, and Harry Homola '52 (A&S) in front of the West Avenue barracks dormitory in 1949.

Provided

Space was at a premium in the Farm Equipment Laboratory, c. 1918.

As Cornell's Department of Biological and Environmental Engineering enters its second century, a professor emeritus has chronicled its early roots in agricultural studies and its many changes over the years.

A Pioneering Department: Evolution From Rural Engineering to Biological and Environmental Engineering at Cornell University, 1907–2007 is a 176-page history written by BEE Professor Emeritus Ronald B. Furry. Published by the Internet-First University Press, the publication is available at the Cornell Library eCommons Web site at http://hdl.handle.net/1813/7642.

In short chapters, the publication traces the history of BEE, from its roots in agricultural mechanics, first taught in the College of Agriculture in 1900, to its present-day home in Riley-Robb Hall, named after Howard W. Riley and Byron B. Robb, the department founders and first department heads.

From 1988 to 2001, the department was called Agricultural and Biological Engineering. In 2001 it took on its present name because of its continued evolution into the integrated focus areas of biological and environmental engineering. The department currently focuses on ways to use biology as an engineering tool.

Shaped from studies in agricultural science and mechanics, the department also has deep historical ties with Cornell's land-grant mission, according to Furry.

"What began as a farm-oriented discipline, directed mainly by bright American men with rural backgrounds, has broadened into a theoretical and applied discipline made up of men and women from around the world who work to discover how best to make use of and preserve the resources of the Earth," Furry writes.

—*Anne Ju, Cornell Chronicle*

WARHAFT WINS COOK AWARD

Zellman Warhaft, professor of mechanical and aerospace engineering and associate dean for diversity in the College of Engineering, was among seven to receive Constance E. Cook and Alice H. Cook Recognition Awards April 17 for their contributions to improving the climate for women at Cornell. The awards were presented at a recognition luncheon in Becker House.

Warhaft was recognized for expanding the college's diversity efforts and bringing in $1 million a year to support diversity programs to hire faculty, and to recruit and support female undergraduate and graduate students.

The awards are granted by the Advisory Committee on the Status of Women, a campus group, and are selected from nominations by members of the Cornell community.

This year's other winners were Barbara Bartholomew, a reserves specialist in the Management Library at Cornell; Jacob (Jake) Benninger, a supervisor in the Electric Shop for 20 years; Hollis Nancy Erb, professor of population medicine and diagnostic sciences in the College of Veterinary Medicine; Amanda Erdman, a residence hall director at Balch Hall since 2000; Francine Herman, professor emerita of hotel administration; and Sabrina Stierwalt, a graduate student in astronomy.

The awards are named for Constance Cook, Cornell's first woman vice president, and Alice Cook, one of the first women faculty members at the School of Industrial and Labor Relations, both of them early advocates for women at Cornell.

—*Susan Lang, Cornell Chronicle*

C-ENG.

HOMETOWN HERO

ADVISING BELINA-STYLE

Vitamin P and proactive problem solving

In a big sunlit office where the door is always open, Assistant Director of Electrical and Computer Engineering John Belina expounds on his Vitamin P theory below a clock made of a real pizza and a poster of Ed and Ralph from the Honeymooners. It's a relaxed environment that undergraduates find very reassuring, and Belina has planned it that way. His avuncular manner and openness are the reasons he has recently been awarded the university's Kendall S. Carpenter Memorial Advising Award. The $5,000 award recognizes "sustained and distinguished contributions of professorial faculty and senior lecturers to undergraduate advising." Previously, he was named the 2006–2009 Rosenblatt Endowed Faculty Fellow for his sustained contributions to students outside the classroom and to the life of the residential communities.

"Advising is one of the most important things at Cornell because [the university] is very decentralized," says Belina. "Students really need help figuring out what's out there."

Belina helps students in many ways—by teaching courses, by serving as an adviser (and often having hour-long appointments with advisees), by serving as a faculty fellow in North Campus residence halls (where his Sunday brunch is popular enough to require two seatings), by leading discussions in the university-wide reading project, and by advising a vast number of student groups (from engineering honor societies to the co-ed Frisbee club).

> "I'm kind of an early warning system. I talk to them and make sure they understand the bigger picture."

Belina approaches advising as a form of engineering. When talking to a student, he gently asks questions to look for weak spots that need to be fortified. He encourages students to be as proactive as possible, especially when dealing with problems.

"I'm kind of an early warning system," he says. "I talk to them and make sure they understand the bigger picture. [I want students to] think about all the different pieces that go into deciding on a career—not just what major they're going to be, but also their values. I'm trying to get people to look at technical careers to go with what they want in their personal lives."

He not only solves problems, but also celebrates successes. Each year, he helps engineering seniors line up for graduation and marches with them. And he keeps in touch with alumni. He enjoys in particular when students who have gone on to medical school come back and tell him, "We hear how everybody is saying this is impossible and it's so difficult. I didn't find that at all. It seemed very doable."

"I think they were well prepared," he chuckles.

"John is extraordinarily attentive and generous with his time," says David Delchamps, the electrical and computer engineering advising coordinator, who nominated Belina for the Carpenter award. "[He's] willing to talk with any student about essentially anything, including academic interests; concerns about whether he or she is following the right path in school and/or life; and questions about majors, colleges, and special programs at Cornell. He has extraordinary success. His touch is truly magical."

"As a faculty fellow, John sponsors and attends a large number of programs that we do for residents," says resident adviser Branden Wells Buehler '08. "He's gone on a bus trip to New York City to see "Avenue Q" with residents, sponsored movie nights at Cornell Cinema, been to our study breaks, and so much more. John is everywhere!"

"John Belina is the best professor I've had," says Matt Haberland '07, the 2006 president of the National Society of Collegiate Scholars, which Belina advises. "Although John did not technically receive his doctoral degree, all of his students warmly call him 'professor,' and we certainly consider his long history of service with students more than sufficient tenure."

Belina, 55, is originally from Fairfield County, Conn. He came to Cornell in 1970 as a freshman in engineering. After completing his bachelor's and master's degrees, he worked on his Ph.D. but put it aside to take an advising position in the College of Engineering in 1982.

Belina's Vitamin P theory is his playful way of letting advisees know that to develop their whole person, they need to take care of themselves and have fun, as well as study hard. "Vitamin P," he laughs, "is a micronutrient that isn't quite discovered yet. It's responsible for keeping the immune system healthy and keeping the brain activated so you can do a lot of work. There are only two natural sources of Vitamin P—pizza and pasta. It's water soluble like Vitamin C so you have to replenish it two or three times a day if you want your Vitamin P level to stay high enough."

—*Bridget Meeds*

Shai Eynav Photography