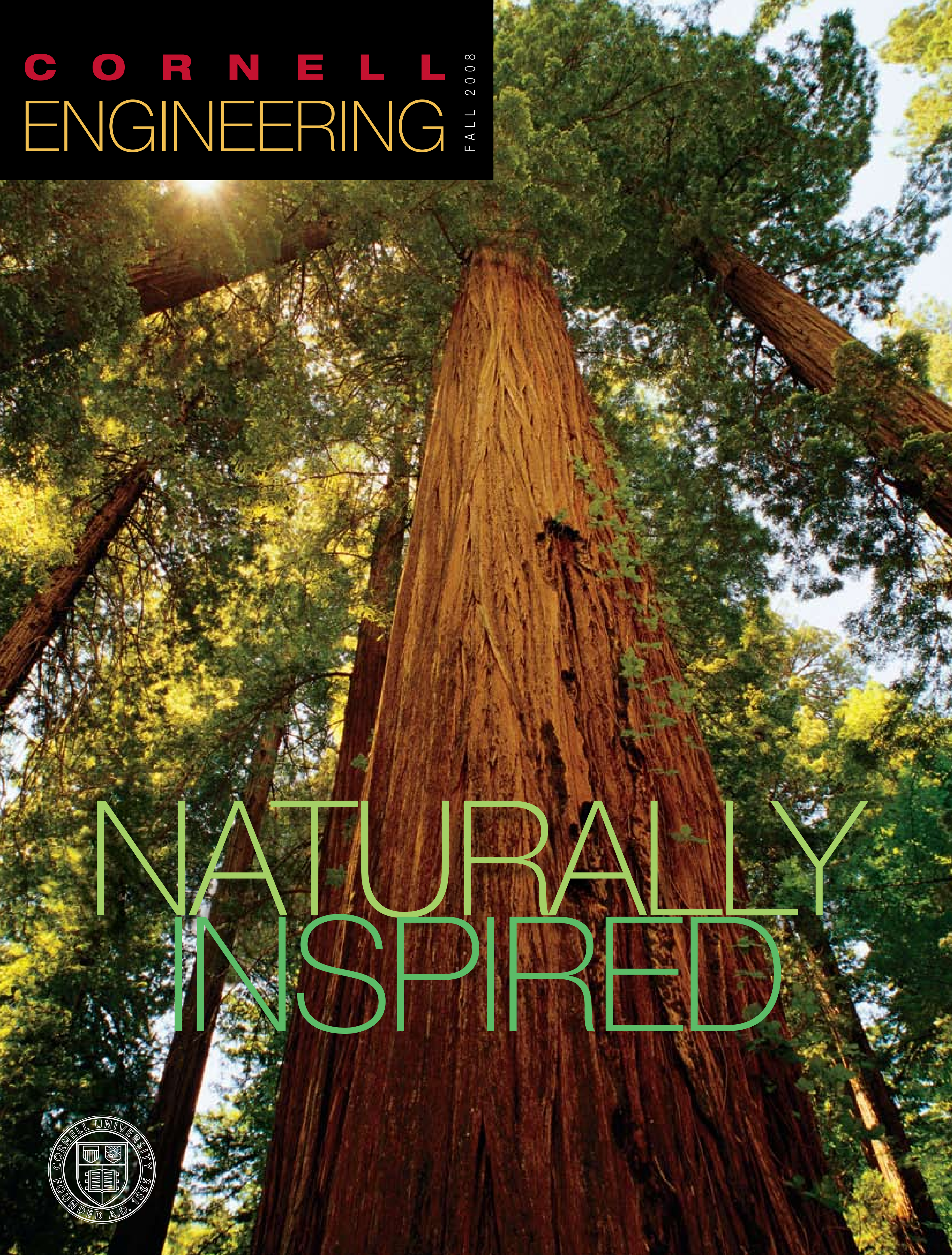
CORNELL ENGINEERING

FALL 2008



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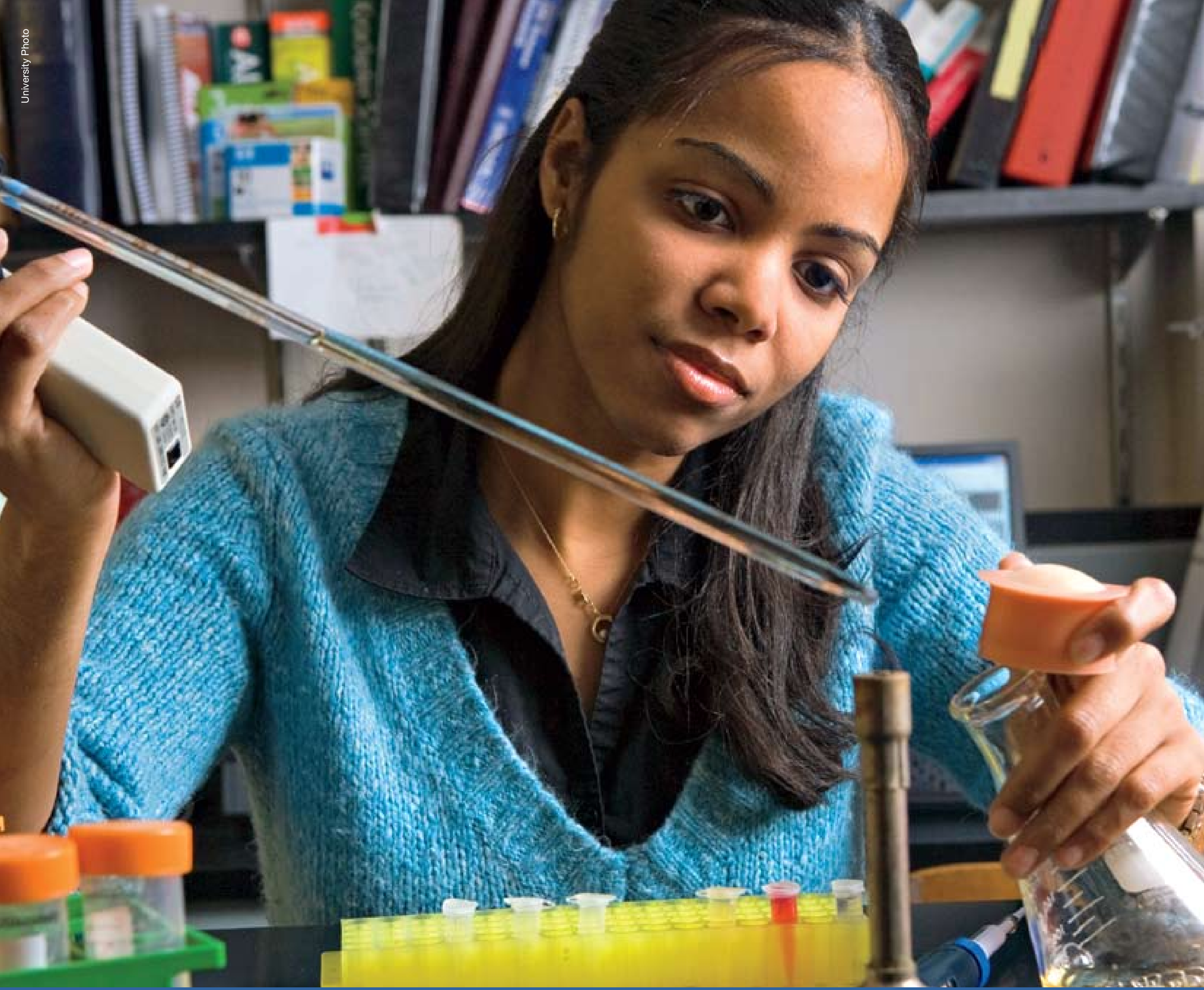

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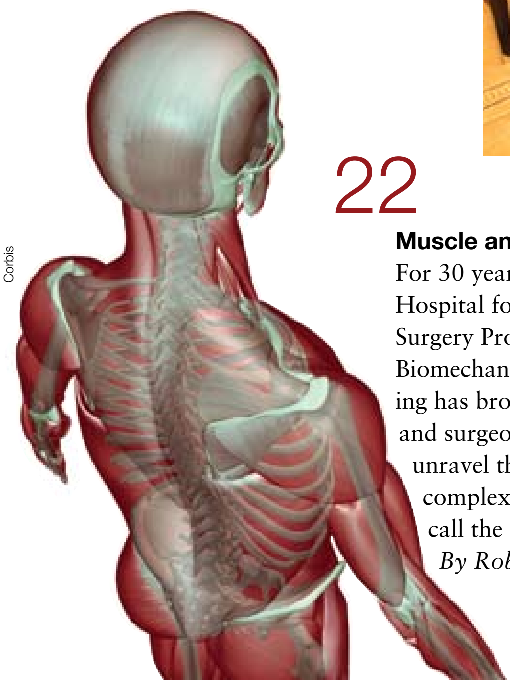
Model: Veronica Sudstedt, Patrick Ledda; Render: Kavita Bala, Bruce Walter



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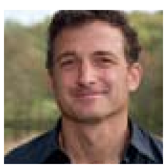
DEPARTMENTS



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SUSTAINABLE HAWAII

Semi-transparent photovoltaic panels are part of the designs in Palamanui. Provided

A planned community with plug-in hybrid cars, an electricity-saving microgrid, and many other green features will soon sprout up on the Big Island of Hawaii, thanks to a group of Cornell students and faculty members who have spent a year designing it.

The 13 students are members of CU Green, a group that links academia with industry. They are assisting developers in creating Palamanui, a 725-acre cutting-edge sustainable community on the Big Island.

CU Green was started last summer by mechanical and aerospace engineering assistant professor Max Zhang, who leads the project. Students from such varied disciplines as mechanical engineering, electrical engineering, earth sciences, architecture, landscape architecture, urban planning, and business are designing Palamanui around developer specifications that include a large residential sector, town center, business park, and hotel.

"This is a real development, and people are going to live in these homes," Zhang said. "It's not a showcase, so that's the most exciting part of it."

On May 28, the group traveled to Hawaii to present Phase I of their designs and recommendations to the developers, Palamanui LLC, a partnership between financier Charles Schwab, Hunt Development Group, and developer Guy Lam.

Martha Bohm, a visiting lecturer in architecture and project adviser, said she was especially impressed with the interdisciplinary nature of the work. "It's very important to the architecture profession to be able to work with structural engineers and lighting designers," said Bohm, who teaches a course in environmental systems.

Christina St. John, one of Bohm's students and a third-year architecture major, worked with mechanical engineering major Vinay Badami '08 to create models of two proposed home designs, complete with window choice and lighting structure. "We were able to generate a wider range of solutions for the home that were much more insightful than if either of us had tried to tackle this on our own," Badami said.

St. John designed a passive cooling system to eliminate the need for air conditioning. Using climate-specific data, she created a schematic house design using cross-ventilation.

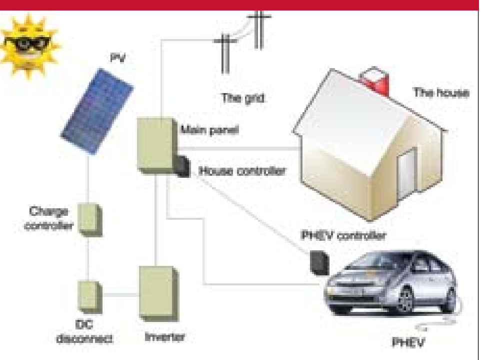
Students on the engineering side have faced challenges unique to the island, such as the high cost of electricity. In Hawaii, electricity costs about 30 cents per kilowatt hour, compared with 12 to 14 cents in the continental United States. Hawaii's transmission lines are often overloaded or near capacity, explained professor of electrical and computer engineering Robert Thomas, also a project adviser.

Two electrical engineering master's students, Bjarni Jonsson and Chimaobi Onwuchekwa, are recommending that the developers build an electricity microgrid to serve the community exclusively. Onwuchekwa has concentrated on the microgrid design, while Jonsson has worked on designs for plug-in hybrid vehicles for the community. Batteries for the vehicles, when not in use, could be used to store energy for the microgrid.

Such a small distribution system would open room for large amounts of such alternative energy sources as photovoltaics and wind energy, to be managed within the community, Thomas explained. "I think the era of demanding as much electricity as you want and getting it is going to end," Thomas said. "If we don't want prices to go higher, we need to be doing things more efficiently, and doing them better." This, he said, will include the prototypes designed into Palamanui, such as smaller generating sources, and more wind and photovoltaic sources.

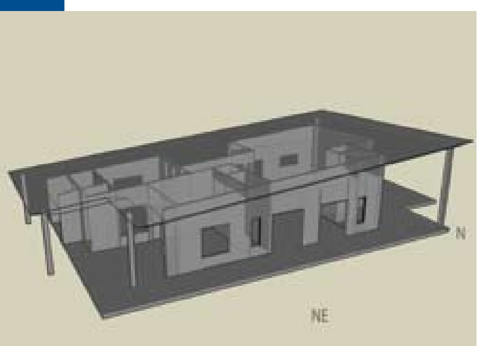
—Anne Ju

Provided



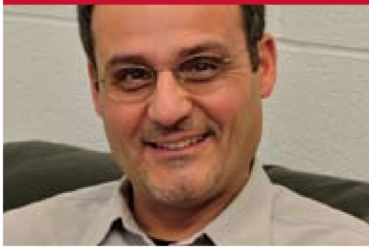
This sketch shows how the plug-in hybrid electric vehicles are integrated into the microgrid of Palamanui.

Provided



Houses are designed with passive cooling.

RESEARCH PARTNERSHIP



Emmanuel Giannelis

University Photo

Lynden Archer

G.Hodges/www.jonreis.com

A new partnership between Cornell and King Abdullah University of Science and Technology (KAUST) in Saudi Arabia promises to strengthen Cornell's research efforts in energy and sustainability.

The Cornell University–KAUST Center for Research and Education will receive an estimated $25 million over five years to establish what is hoped will become a leading research hub for nanomaterials science and technology.

Emmanuel Giannelis, Cornell's Walter R. Read Professor of Engineering and chair of the Department of Materials Science and Engineering, and Lynden Archer, the M. L. Hart Professor of Chemical and Biomolecular Engineering, will be co-directors of CU–KAUST.

The partnership will focus on a new class of hybrid nanomaterials recently discovered at Cornell. Termed nanoparticle ionic materials (NIMs), they hold potential for application in emerging technologies for water desalination, carbon capture, and solar energy.

KAUST, a research university whose core campus will be located on the Red Sea at Thuwal, is scheduled to open in September 2009. The $25-million award to Cornell will help create one of four KAUST centers for science research through the Saudi university's Global Research Partnership program. Other centers at Oxford, Stanford, and Texas A&M University will focus on applied mathematics, photovoltaics, and computer science.

Both Cornell researchers have worked for several years to promote NIMs research, and they say the center will give the field a major boost.

"A center of this magnitude will accelerate the research and put it into the public domain," Giannelis said.

Cornell officials also will support development of KAUST's proposed KAUST Nanoscale Facility, drawing on past success with the Cornell NanoScale Science and Technology Facility. They also will provide advice on curriculum and faculty development at KAUST.

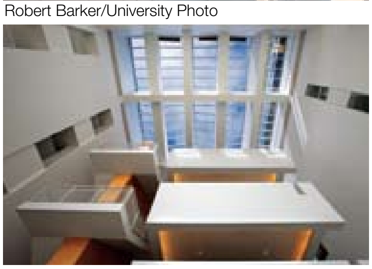
For more information, visit www.kaust.edu.sa.

—*Anne Ju*

WEILL HALL

This view looking toward the ILR School shows one of Weill Hall's green living roofs.

Robert Barker/University Photo



The atrium is Weill Hall's artistic centerpiece.

Robert Barker/University Photo

The Department of Biomedical Engineering has started to move into its new home in Weill Hall. With great expectations, the $162 million, 263,000-square-foot building, designed by architect Richard Meier '56, B.Arch. '57, will open officially in October.

Weill Hall is "important for intellectual and physical connections" within the life sciences at Cornell, said Stephen Kresovich, Cornell vice provost for life sciences. The research facility is a keystone of the New Life Sciences Initiative—Cornell's approach to providing national and international leadership to the genomics-led science revolution. The building carries the silver rating in Leadership in Energy and Environmental Design (LEED).

With work space for 400 to 500 people, Weill Hall provides faculty members and students with cutting-edge laboratories and meeting places for interdisciplinary research and teaching in the biological, physical, engineering, computational, and social sciences. It also houses the Department of Biological Statistics and Computational Biology and the Joan and Sanford I. Weill Institute for Cell and Molecular Biology.

The H. Laurance and Nancy L. Fuller Learning Center, a wing on the second floor, is designed to promote both formal and informal exchanges among researchers, faculty members, and students. The wing features two state-of-the-art video-teleconferencing rooms for distance collaborations. One room features tiered stadium seating for 30 people, microphones at each seat, and a curved projection-screen wall capable of blending images from three overhead projectors. The other video-conferencing room features dual high-definition overhead projectors and is designed for multipurpose use, with seating for up to 80 people.

The building's two-acre basement runs approximately 400 feet north to south and is twice as large as the above-ground footprint. Divided into four sections, it includes a 20,000-square-foot vivarium and a low-vibration space built on separate floor plates for imaging research.

—*Krishna Ramanujan*

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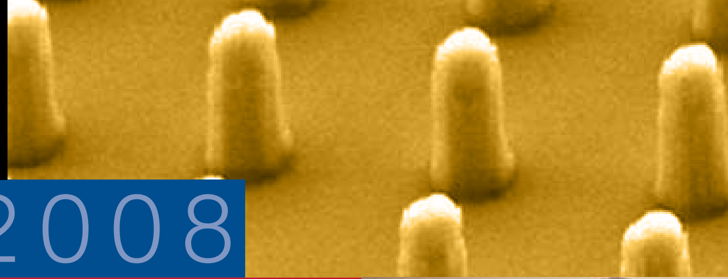

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PROJECTING SUCCESS

A high-tech Cornell startup business took the $100,000 grand prize at New York's Creative Core Emerging Business Competition, April 22, in Syracuse. Ithaca-based Mezmeriz Inc., founded by Shahyaan Desai '00 and led by Bradley Treat, MBA 2002, won for most innovative and growth-oriented emerging business in central New York state. This is the second year in a row that a Cornell-affiliated business has won the competition.

The firm developed a high-definition video display technology using tiny mirrors that can be used in cell phones, personal digital assistants, and MP3 players. Six investment funds have already provided Mezmeriz with $1 million in capital, and Desai and Treat are in talks with consumer electronics manufacturers to bring the technology to market.

The prize money will be used to hire electrical engineers, who will create prototype projectors to demonstrate the technology's potential to manufacturers. Mezmeriz's offices are in the Cornell Business and Technology Park.

—George Lowery

DIVERSE HONORS

Diversity Programs in Engineering held its annual awards banquet May 4 to celebrate the achievements of outstanding students, organizations, and faculty members. The celebration featured awards, dinner, and music in the Statler Hotel's Carrier Grand Ballroom.

A highlight of the evening was the presentation of the 2008 Zellman Warhaft Commitment to Diversity Awards. Established in 2007 in honor of mechanical and aerospace engineering professor Zellman Warhaft, the first associate dean for diversity in the College of Engineering, the award recognizes students and faculty members for commitment to diversity issues, as well as participation in DPE activities and programs.

Faculty awards went to Christopher Andronicos, associate professor in earth and atmospheric sciences, and Daisy Fan, lecturer in computer science.

Sarah Long '09, a civil engineering major, won the student award, along with a $1,000 scholarship sponsored by Lockheed Martin. Long, who is the incoming co-president for the National Society of Black Engineers, worked with Kobbina Awuah '07 to design and install two water-pumped wells in the Bawku district of Ghana.

Their "Development Project for Peace in the Bawku East District of Ghana" involved members of local, often warring tribes. Long is also a member of the board of directors for the Coalition of Pan African Scholars.

Other awards included: Freshman of the Year to Frances Padua '12, Undergraduate Excellence in Leadership Award to Diana Wu '10, Graduate Student of the Year to Marleen Kamperman, and Undergraduate Student of the Year to Jefferson King '10.

—Robert Emro

Provided

Diversity awards named for Professor Zellman Warhaft (third from left) were presented to (from left) Sarah Long, Kelly Andronicos (accepting on behalf of Chris Andronicos), and Daisy Fan.

SUSTAINABILITY WORKSHOP

Researchers from China's Tsinghua University traveled to Cornell for the third Cornell–Tsinghua joint workshop, April 29–30, focusing on Sustainable Development: Water Resources, Energy, and the Environment.

A collaborative relationship between Cornell and the Beijing university to strengthen science and engineering education was formalized in 2004 and has resulted in several such joint workshops.

The topic for the first workshop, held in Beijing in November 2005, was information science and computer engineering The second, in October 2006, featured nanoscience and nanotechnology.

Abstracts from the third workshop are available online: www.engineering.cornell.edu/workshop.

Robert Barker/University Photo

Wang Zhongjing (left) of Tsinghua University's Department of Hydraulic Engineering met with Cornell faculty members including Jery Stedinger, professor of civil and environmental engineering.

CORNELL RACER

The Cornell Racing team finished seventh in the Formula SAE World Championships, held May 14–18 at Michigan International Speedway outside Detroit. The competition challenges student teams to design, build, and drive a race car in a series of events that test the speed, endurance, and maneuverability of the car and the skill of the drivers. The Cornell team of 45 undergraduate and nine graduate students had been at work on the project since early fall.

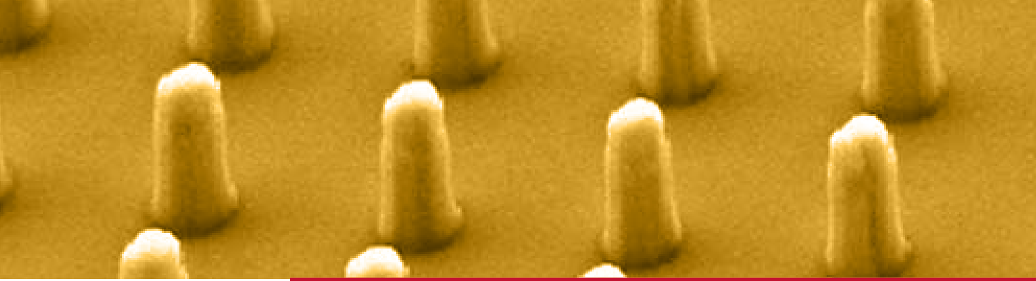
Cornell has won nine times out of the 22 years it has entered the competition, but the team is happy with this year's results nonetheless, said Jonathan Green '08, business team leader. "Being in the top 10 out of 120 entries is actually very successful," he said.

"Our car is certainly as fast as the competition," said David Porter '08, overall team leader. "We lost points on design and marketing and made some small errors in dynamic events." Many of the top 10 finishers were European teams who had more time to prepare, he noted, suggesting that future Cornell teams might start over the summer rather than in the fall.

—Bill Steele

Evan Berman

Driver Jason Smart '09 is congratulated by teammates as he finished the second half of the 20-lap endurance race.



GLOBAL FELLOWS

Provided

Kobbina Tuyee Awuah '08 ME, M.Eng. '09 (in red), was recognized as an Engineering Global Fellow for his work on water projects in Africa during summer 2007. Here, he helps residents of Bimbilla, in northwest Ghana, install pipes for a borehole.

The College of Engineering recognized nearly 60 undergraduate students as Engineering Global Fellows at a ceremony April 29 in Anabel Taylor Hall.

A new effort to highlight the accomplishments of students who work, study, conduct research, or perform service learning abroad, the first Engineering Global Fellows reception honored students who had overseas experience within the past three years. International students active overseas and outside their home countries are also eligible for the distinction.

"The college recognizes that engineering will involve the entire world, not only the city, state, or country that we live in," Kent Fuchs, the Joseph Silbert Dean of Engineering, told the students. "We're grateful that you've done something that's not only good for your education, but also increases our exposure overseas."

Several students spoke about their experiences, including Erica Mallare, a senior operations research and information engineering major who spent the spring semester of her junior year studying at the University of Nantes in France.

"What I got from studying abroad was really learning how to understand and appreciate a different culture, and learning how to appreciate and accept things that are different from what we know," she said.

Matt Perkins, a senior in materials science and engineering, completed a co-op in China working on wind energy for General Electric.

"It really completed my Cornell experience," Perkins said. "You learn a lot in the classroom, but the opportunity to apply that doesn't come until you do a co-op or internship."

Also a materials science and engineering major, Yuri Sylvester did research at the Royal Institute of Technology in Stockholm, Sweden, where he met students from all over the world.

"I realized how people in other countries don't have the same opportunities that we do," he said. "We need to be appreciative of what we have and how fortunate we are."

—*Robert Emro*

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Ideal Engineering

Anti-personnel devices in non-combat areas maim or kill someone—often a child—every 22 minutes somewhere in the world. For the MineSweeper team, designing a landmine detection robot is not just a competition; it's a humanitarian mission.

By Dan Tuohy

It was a boxy hunk of shiny aluminum, multi-colored wires and circuits, and knobby, little tires. But even a race car would look naked stripped to the chassis.

This vehicle, the Cornell MineSweeper, was in the capable hands of a student pit crew in May as Abraham Cantwell '10 ECE leaned over and deliberately tested the power source and checked each component against his laptop.

"It's a lot of work. But it's really great to see the whole thing come together," he says. "I like that we're doing something to really affect something. No disrespect to any of the teams here. I do like this because it did have an ideal, a goal."

The student engineering team has labored 20 hours a week for most of the first six months of this year to bring the Cornell MineSweeper blueprint to life. The initial goal was to build a vehicle for a contest. But team leader Hamzah Sikander '09 ECE says the competition immediately became just a waypoint on a journey to a higher ideal.

Like the DARPA challenge teams, Cornell MineSweeper is dedicated to constructing an autonomous vehicle, but one that can detect and remove landmines. Its intended use is for non-combat areas, targeting anti-personnel devices that maim or kill someone every 22 minutes somewhere in the world.

"I feel like we have a real mission," Sikander says as he oversees Cantwell building part of the team's solution. "This is not about a competition."

As a rookie team starting everything from scratch—and the latest team on the engineering scene at Cornell—the Cornell MineSweeper audited this year's Intelligent Ground Vehicle Competition held May 30 to June 2 at Oakland University in Rochester, Mich. The experience inspired the student engineers.

"We are going to be the big thing very soon. And we are very much in the path of our success," Sikander says. "The idealism of it is very important."

Engineering to Save Lives

The mission of this student-initiated project is to design and fabricate a landmine detection robot that is low-cost as well as autonomous. Doing so requires a diverse skill set, including understanding of machine vision, artificial intelligence, mechanical design, and landmine detection. Such a robot would become central to de-mining operations, benefitting military, commercial, government, and community interests. But Sikander underscores that Cornell MineSweeper is, first and last, a humanitarian endeavor. He became team leader earlier this year, succeeding colleague and friend Vikas Reddy '08 ME.

University Photo

Their mission reflects time-honored principles of the profession. The first value statement for the National Society of Professional Engineers is: “Protection of the public welfare above all other considerations.” Another touts the importance of “teamwork, unity, and fellowship of all professional engineers across all disciplines.”

The project’s cross-disciplinary challenges appealed to Cantwell. He was inspired to sign up after seeing a flier for the new team late last year.

Launched in 2007, Cornell MineSweeper has already swept in a few accolades. Based on his work on the project, Reddy was selected as a Cornell Presidential Merrill Scholar in May. In March, the Cornell Engineering Alumni Association named Cornell MineSweeper the Project Team of the Year. The team won $1,000 and was honored at the association’s annual banquet.

Also in March, Nobel Peace Prize co-laureate Rae McGrath delivered a lecture at Goldwin Smith Hall on his work to rid the world of landmines and cluster bombs. A co-founder of the International Campaign to Ban Landmines, McGrath met with Cornell MineSweeper and applauded the team’s vision and its research before launching development. McGrath said Cornell MineSweeper was valuable in its flexibility and he promised to stay in touch as a resource.

University Photo

Rae McGrath, 1997 Nobel Peace Prize co-laureate, speaks on landmines and cluster munitions in Goldwin Smith Hall in March while showing on screen a photo of a cluster munition explosion on a concrete street in Iraq.

Associate professors Ephrahim Garcia, of the Sibley School of Mechanical and Aerospace Engineering, and William Philpot, of the School of Civil and Environmental Engineering, serve as faculty advisers.

“In this project, no one discipline can solve all the problems so the students learn to work together and rely on one another,” says Garcia. “The real world is unforgiving. It is important for students to get to the crux of the problem as quickly as possible. There is nothing better than real machines and devices in order to learn these lessons.”

University Photo

The Problem

Researching current landmine detection and removal technology brought home to the team just how pernicious the problem is. Since their deployment in mass numbers during World War II, landmines have killed and maimed hundreds of thousands of people. Whether from a conflict that has simmered for decades or a war long since over, leftover antipersonnel mines kill indiscriminately in regions around the world. The International Campaign to Ban Landmines estimated that by the end of the 1990s there were between 15,000 and 20,000 new casualties each year.

"I was more shocked at just how bad we are at finding them and getting them out of the ground," says Cantwell. "Pretty much the most effective way of doing it now is to go out there with a metal detector."

Some of the most mine-contaminated places are Afghanistan, Angola, Burundi, Bosnia and Herzegovina, Cambodia, Colombia, Iraq, Nepal, and Sri Lanka, according to the campaign. Peace has come to many of these one-time hotspots, but like a bad memory, the landmines linger on. They do not distinguish between the footfall of a soldier or a child. In Afghanistan in 2006, 59 percent of an estimated 796 total casualties were children, according to the group.

Committed to an international ban on the use, production, stockpiling, sale, transfer, or export of antipersonnel landmines, the campaign led to the 1997 Mine Ban Treaty that now has 156 member states. But for various political and military reasons, as of April of this year, 37 countries have not signed the treaty, including India, Israel, Pakistan, Russia, Vietnam, and the United States. Still, the treaty is making a difference, McGrath has noted, though the organization is continuing its work and concentrating on a variation of the killer: cluster munitions.

Sikander, who is from Pakistan, says some team members have met some family members of mine victims in the course of their work. "For some of us, from our own countries," he says.

> Some team members have met some family members of mine victims in the course of their work, in some cases, from their own countries.

The interaction, so emotional and inspirational, cast their work in a new light. "Everyone should pay attention to it," he says.

The Challenge

The Intelligent Ground Vehicle Competition is designed to advance and promote intelligent mobility for civilian and military ground vehicles. Such driver aids will make possible the automated highways and intelligent transportation systems of the future, according to event organizers.

Bill Agnew, co-chairman of the 16th Annual Intelligent Ground Vehicle Competition and a judge in this year's design category, says faculty advisers praise the event as an excellent multi-disciplinary design experience for student teams. A number of schools also give credit for student participation.

"In the auto industry there is already movement to introduce lane-detection technology in cars, and inter-communication between vehicles and between the vehicle and the infrastructure is coming soon. Rangefinders to predict collisions and aid in parking are already in use. Industry will benefit greatly from having available engineers with experience in these kinds of technologies," says Agnew, former head of Research and Development at General Motors and a Society of Automotive Engineers Fellow, in an e-mail. "It may also benefit from some of the unique innovations created by IGVC teams. Also, the automobile and many other types of machines and mechanism are now controlled by electronics and computers, as are our IGVC vehicles; there is high demand for engineers knowledgeable in these areas of control."

Agnew says student benefits include the hands-on and real-world intensive engineering experience, including practical mechanical, electrical, and computer science work. "It is highly dependent on systems engineering, a subject where industry leads most engineering schools by a large margin," Agnew says.

And the team work is increasingly important in today's workforce, Agnew adds. He reports finding more women on

Standing row (from left):
Prof. Ephrahim Garcia (faculty adviser), Greg Meess, Sarah Leung, Karim Hamdoun, Hamzah Sikander, Michael Hsu, Saran Baskaran, Vaishal Patel, Evan Levine, Steve Gilson, Naveen Dasa, Felix Pageau
Top seated row (from left): Tanya Gupta, Harsh Chamria, Hung Dang, Jawwad Asghar, Steven Liu
Bottom seated row (from left): Jay Dev Mahadevan, Yong Sheng Khoo, Andres Mack

Vikas Reddy

University Photo

University Photo

David Heller '81 ME presents CEAA's Al George Award for best project team to Cornell MineSweeper members Vikas Reddy '08 ME, Hamzah Sikander '09 ECE, Andres Mack '09 (independent major), and Steven Liu '11 ME.

the teams than ever before and non-engineering majors, including business and liberal arts students.

Sikander says his 35-member team features a mix of majors, including students majoring in Spanish and economics.

The IGVC competition is judged on several categories, including design, autonomous function, and navigation.

Specifications for the small all-terrain vehicle mandate that it must be between 3 feet and 7 feet long, and between 2 feet and 5 feet wide. It cannot exceed 6 feet in height. Maximum vehicle speed is 5 mph. Each vehicle is required to carry a 20-pound payload, typically a cinder block. A team must demonstrate that its vehicle can detect and follow lanes, and avoid obstacles on an outdoor course. Vehicles cannot be remotely controlled by a human operator during competition. All computational power, sensing, and control equipment must be carried on board the vehicle.

Progress: A Game of Inches

Cornell MineSweeper is so new that it operated from vacant classrooms for several months before landing lab space at the start of this year in the basement of Upson Hall. Team members constructing the vehicle in May methodically worked on the project under tight deadlines. Without its aesthetic covering applied, the base of the vehicle looked like a heavy duty vacuum cleaner, though one designed to sustain a rough landscape.

Cornell MineSweeper is approximately 4 feet tall. It has a camera mount to add future sensors, and the vehicle system is waterproof. It is powered by a lithium battery.

"This thing is designed to be very solid," Sikander says. "We've given it a lot of punishment. If you strip off the expensive sensors, this thing can probably be made again for $5,000."

But the team upgraded its motors, so a rebuild would cost around $8,000. "The total price tag of this thing at this moment, if you were to rebuild the exact same thing with all the sensors would be around $50,000."

MineSweeper is not designed to last through a direct explosion. To test its durability, teammates dropped the vehicle randomly and from different heights.

University Photo

"In this project, no one discipline can solve all the problems so the students learn to work together and rely on one another,"

—Ephrahim Garcia, Sibley School of Mechanical and Aerospace Engineering

"We like to call this a modular design because we can take things apart pretty easily," he says.

Landmine activist McGrath, upon conferring with Cornell MineSweeper, spoke of the value of removing mines, not just detecting them, according to Sikander.

McGrath discussed functionality, such as the addition of clearing and cutting tools. As a result, the team intends to review the potential for a robotic arm with the Cornell Snake Arm team.

"It's basically whatever you want to do with it," Sikander says. The goal is to develop a method that is 100 percent accurate or, if less perfect, to achieve detection and removal without human consequence.

In constructing the vehicle, the team kept an eye on sustainable practices, as much as they could. The aluminum can be reused. And there are very few parts that cannot be recycled. In addition to the vehicle function, Cornell MineSweeper had to create the software to operate the vehicle and sensors.

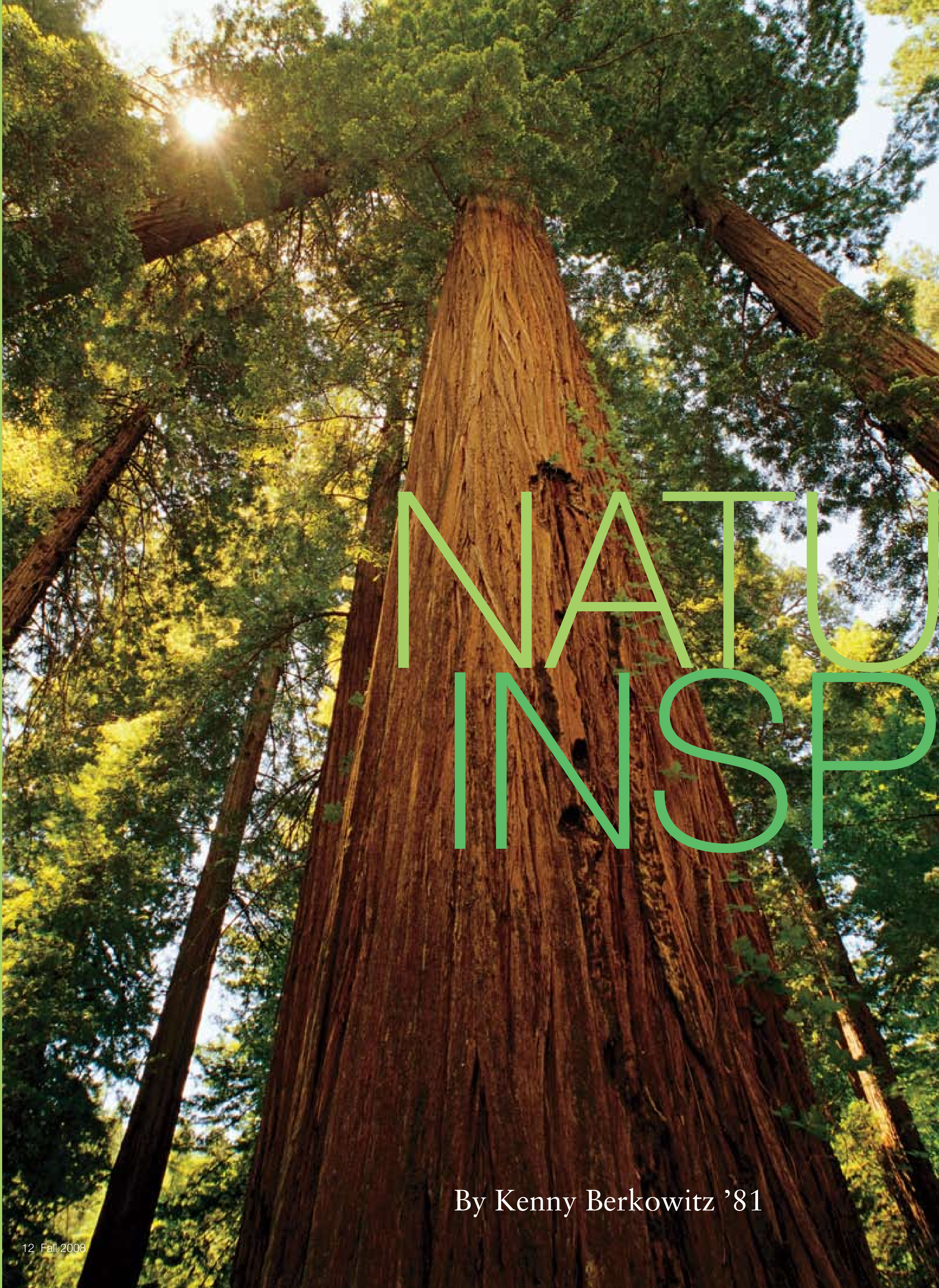
"It's making 10 decisions every second," Sikander says.

Sikander says money was the team's biggest challenge because motors and sensors are so expensive. Also, as a new team, it was required to buy tools and supplies. Cornell MineSweeper has a $13,000 budget, without gifts, from different departments and schools in the university.

The team runs like a business, with a chain of command for work on various parts of the vehicle production and operation. Sikander estimates team members have logged 8,000 hours, working according to task. The first semester, there were two team leaders, sub team leaders, and members, with much communication and file sharing online. MineSweeper also focused on interacting with other competitive teams to build relationships.

"We understand we are the new kid on the block," Sikander says.

At some point, the team plans to share its research, design, and development on the Web, embracing the open-source concept to advance its mission. "Here's everything," Sikander says. "Use it, upgrade it, whatever you like."



NATU
INSP

By Kenny Berkowitz ’81

University Photo

Abe Stroock examines his “synthetic tree,” which mimics transpiration in plants.

RALLY IRED

Searching for inspiration on a walk through Northern California’s Redwood National Park, Abraham Stroock stopped to look around him. But it wasn’t the physical beauty of the giant sequoias that left him transfixed; it was the beauty of the physics that allows these trees to transport water hundreds of feet in the air, pushing against gravity for a thousand years without expending any biological energy. And though Stroock continues to find his inspiration in nature, the thing that currently excites him is a small piece of polymer no bigger than a stick of gum.

“I’m not a naturalist, so the wonder of life doesn’t come as easily to me as the physical reality of it,” says Stroock, assistant professor of chemical and biomolecular engineering, as he slides his latest “synthetic tree” out of its plastic sandwich bag. “I wouldn’t have pursued this for the last five years, trying to get this to work, if there wasn’t good evidence that plants do this. If we hadn’t studied the physiology of plants, we wouldn’t have had the courage to launch into this project.”

With three days left of spring classes, as the trees on the quad come into full bloom, Stroock holds his synthetic tree up to the window, catching the sunlight in its two small circles etched side by side. After numerous attempts to build porous structures that could replicate the capillary action that gets sap to the highest twig—all unsuccessful—Stroock and his graduate student, Tobias Wheeler, abandoned conventional wisdom and devised a new concept: Instead of thinking of the leaf material that pulls the water to the top of the trees as porous material, like filter paper, they imagined it might be more like a gel, which can hold water at the molecular scale. That would explain why a leaf can remain water-filled even in extremely dry conditions. The polymeric tree in his hand, capable of wicking microscopic amounts of water at very great tension through its photo-lithographed channels, is the result of that breakthrough.

It’s been a long road, but with their work recently published in *Nature*, Stroock and Wheeler know they are on to something. “We flailed around for two or three years, unsure of what path to take,” says Wheeler, Stroock’s first graduate student, who completed his doctorate in May 2008. “No one had ever tried to tackle this problem before, and for a while it felt like we weren’t making any progress, which was tough. But once we switched from capillaries to this polymeric material, we had the first inklings this approach could in fact work. Things started to fall in place, and we wound up reaching the goal we’d set for ourselves five years earlier.”

If Stroock and Wheeler are right, the implications are enormous. The fundamental challenge—to engineer nanoscaled materials that reproduce the processes of living cells—is even more difficult than it sounds, and these trees represent the first synthetic system to mimic transpiration in plants, pumping water with enough power to reach the top of a giant sequoia.

In one of its narrowest applications, a collaboration with Alan Lakso of the New York State Agricultural Experiment Station in Geneva, this technology could be used to measure water pressure inside grapevines and apple trees, providing a continuous stream of data that would allow growers to quickly adjust irrigation.

"To have a collaboration like this between a plant scientist and a chemical engineer is very unusual," says Lakso, professor of pomology and viticulture, who sought out Stroock after reading a newspaper article about the synthetic tree. "It's been great to brainstorm with an engineer who is fascinated by plants, because the physics of plants tends to be extremely complex, which makes them very hard to describe and even harder to model as they change over time."

In its widest applications, this same technology could provide the foundations for a large-scale passive system for heat transfer, a microfluidic lab-on-a-chip, or an electrode for low temperature fuel cells.

"The synthetic tree is a real tour de force, but it's just one of the things that makes Abe so extraordinary," says Paulette Clancy, William C. Hooey Director of Chemical and Biomolecular Engineering. "It's this sense of innovation, this incredible boldness he brings to everything he does. He'll jump into a field that is already heavily populated, which is awfully difficult to do, and make a real impact. He brings a very thorough approach and a deep physical understanding to reach some very creative solutions—which is rare."

These trees represent the first synthetic system to mimic transpiration in plants, pumping water with enough power to reach the top of a giant sequoia.

In the five years since coming to Cornell, Stroock has published 16 papers covering a wide range of projects in microfluidics, which he's balanced with a teaching load of both undergraduate and graduate courses, winning a College of Engineering Excellence in Teaching Award in 2006.

"With Abe, we have somebody trained as a physicist, who teaches chemical engineering courses so well that he wins awards for teaching," says Clancy. "He took a standard course in heat and mass transfer, which is typically about the effects that come into play when you scale up to a large industrial process, and turned that on its head, asking 'What happens when you scale it down to microscopic length? What additional factors do you need to take into account?' That's the kind of innovative approach that really benefits our students. Even now, during his tenure year, when most academics would be concerned with themselves, he's been taking time to lobby for daycare facilities on campus, and I think that kind of selflessness speaks volumes about who he is as a person."

Stroock started exploring the world as child, growing up outside Boulder, Colo., as the son of a mathematician and an early childhood educator. (His father, Daniel, is an MIT professor best known for his work in diffusion processes; his mother, Lucy, is currently on the adjunct faculty of the Urban College of Boston.) When he was a teenager, the family moved to Cambridge, Mass., where his father began teaching at MIT and Stroock began his undergraduate career. Two years later, he transferred to Cornell, where he graduated cum laude in 1995 with a bachelor's degree in physics.

Unsure of what to do next, Stroock moved to France, where he had lived as a high school exchange student with the family of Laure Mougeot, who has since become his wife. After receiving a master's degree in solid state physics from the University of Paris—and getting married—Stroock returned to Cambridge, completing his Ph.D. in chemical physics from Harvard in 2002 while Laure began writing case studies for the Harvard Business School. Then, after his Ph.D. and a brief post-doc with Harvard's George Whitesides, who Clancy calls "the world's preeminent expert on microfluidics," Stroock returned to Cornell as an assistant professor, where he met the newly arrived Wheeler.

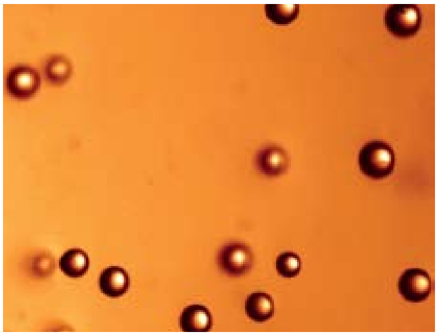
"The first summer I worked with him, he came to the lab almost every day," says Wheeler. "That says a lot about his approach, which has always felt very collaborative, very cooperative. My first impression was that he looked very young, and when we initially began meeting people to talk about the synthetic tree, they thought he was a graduate student and I was his undergraduate assistant. We were amused, but it's easy to see how people might have thought that, because he's so enthusiastic and open to new ideas. And that energy carried through my Ph.D., recharging me whenever we encountered a barrier in our research."

In a second, equally ambitious microfluidics project, Stroock is collaborating with researchers at Weill Cornell Medical College to develop a biodegradable bandage to transport fluid to and from a wound; and in a third, he's collaborating with Professor Lawrence Bonassar to engineer scaffolded, tissue-like, functional materials that could be used to either foster the growth of healthy cells for transplantation or restrict the growth of tumors.

"At its core, we want to make a device that can mimic the way the body delivers nutrients to its tissues," says Bonassar, associate professor of biomedical engineering with a joint appointment in mechanical engineering. "Tissues contain within themselves a network of channels—blood vessels—through which they get nutrients. What we did was to take this basic architectural feature of the body and superimpose it on a hydrogel, which is mostly water and polysaccharide, to make a better tool for culturing cells. It's a material that has a long history in medicine, but we're using it in an entirely new application.

"Abe has this wonderful combination of precision, creativity, and relentlessness," continues Bonassar. "We both knew very quickly that we had something special, and when you have lightning in a bottle, there's a temptation to share it as quickly as possible. But Abe was always very focused on the task at hand. He was the one who kept saying, 'We just need one more experiment to nail this down.' And as one turned into two, then ten, he kept going until he was 100 percent certain of what we had. In many ways, Abe is the kind of person I came to Cornell to work with: someone who would challenge me, send me in new directions, and do things no one had ever done before."

Tobias Wheeler



The microscope image (above) shows water-filled, spherical voids within the hydrogel that plays the key role in the leaf and root of the Synthetic Tree. These water capsules serve as miniature laboratories for studying the properties of water at large negative pressures (down to -220 atmospheres).

Taken together, the projects have earned Stroock a National Science Foundation Career Award, a 3M non-tenured faculty grant, an Arnold and Mabel Beckman Foundation Young Investigator grant, participation in the Frontiers of Engineering Symposium at the National Academy of Engineering, and membership in *Technology Review's* 2007 list of 35 top innovators under 35 years old. And for all their differences, the three projects share a common root in plant science, biomimicry, and fluid mechanics.

"In the phase diagram of water, there's a whole area that has never been exploited in manmade technology," says Stroock, quickly graphing the phases on a scrap of paper and darkening the lower left, where liquid water is at negative pressure. "Nobody has ever tried to accurately map out this region, and there's absolutely no reason it can't be done. In the mechanical sense, it could mean using water as a tensile element, like a rope. In the thermodynamic sense, it could mean pulling water out of seemingly dry soil.

"One of the extraordinary things that plants do is live as a hydrated system," he continues. "They live in liquid water, just like us. They use liquid water as their solvent, just like we use blood. And they can get water out of dry soil, where we have to dig a well until we hit the water table. Starting with a naïve curiosity—if plants can do this, why can't we?—we're taking water, which is arguably the world's most familiar material, and opening the door to a new, completely unexplored place."

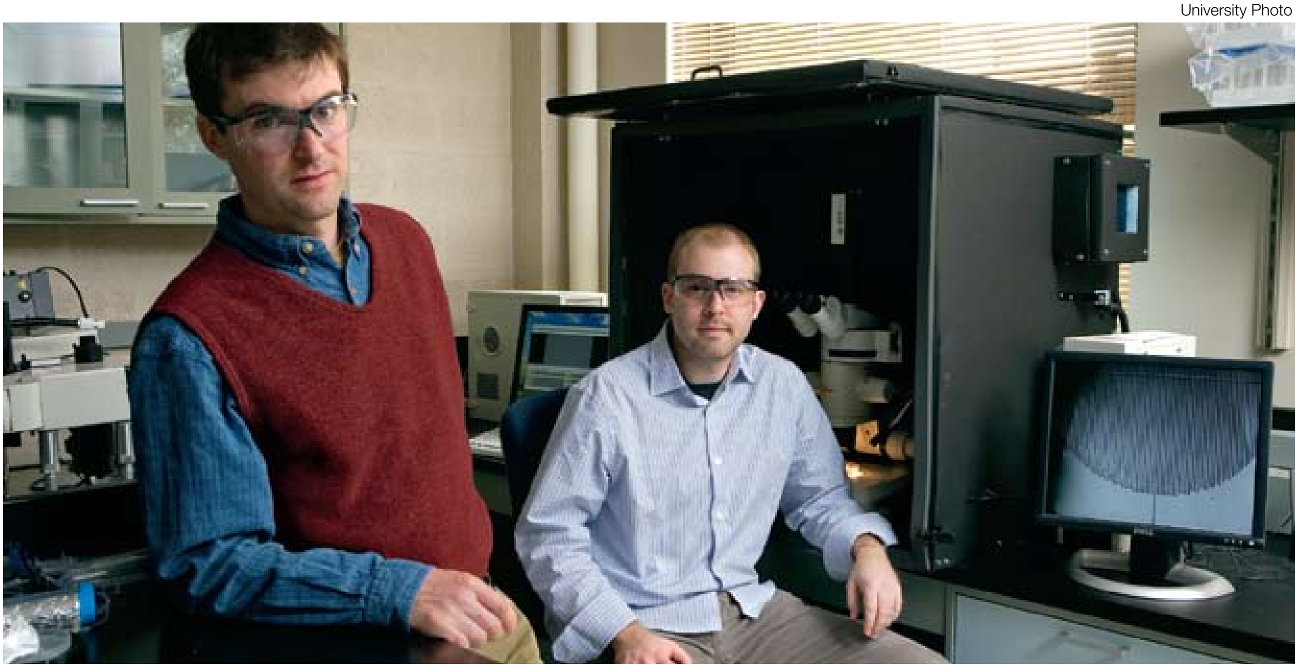
Stroock may find more inspiration in his Forest Home back yard, where he's begun to cultivate a garden, primarily for his three sons, Julius (seven years old), Elias (five), and Felix (one). Rising from his chair to draw another diagram, Stroock has the wiry frame of a cyclist and a freewheeling rush of words to go with it. On a good day, he bikes to work, and on a better day, the whole family rides into the country on their tandem and triple bicycles. He's talking about his family and their passion for the outdoors when something on the synthetic tree catches his eye.

"It cavitated," he says, newly excited. "Do you see this line here, down the middle? It failed, just now, as we were talking." He points toward the channel of water leading from the trunk, which has grown wider in its few moments outside the plastic bag. It's not the first (or the last) time one of his trees has failed due to exposure to extremely low humidity, and after being filled again with water, this one will likely recover. Really, it's not a setback at all — by its collapse, the tree actually proves the technology is working — and after a moment's excitement, he changes the subject back to the classroom.

"Teaching engineers is a pleasure," says Stroock. "As a professor, I'd like to give students more of a taste for what our excitement is all about. They should be developing the technology the world will be using fifty years from now, and I'd like them to think that the sky is the limit. I want them to know they're the luckiest people in the world, and that after being so talented, it's their obligation to change the world.

"Go ahead," he says, talking as if they were in the room. "Dream it. Then do it."

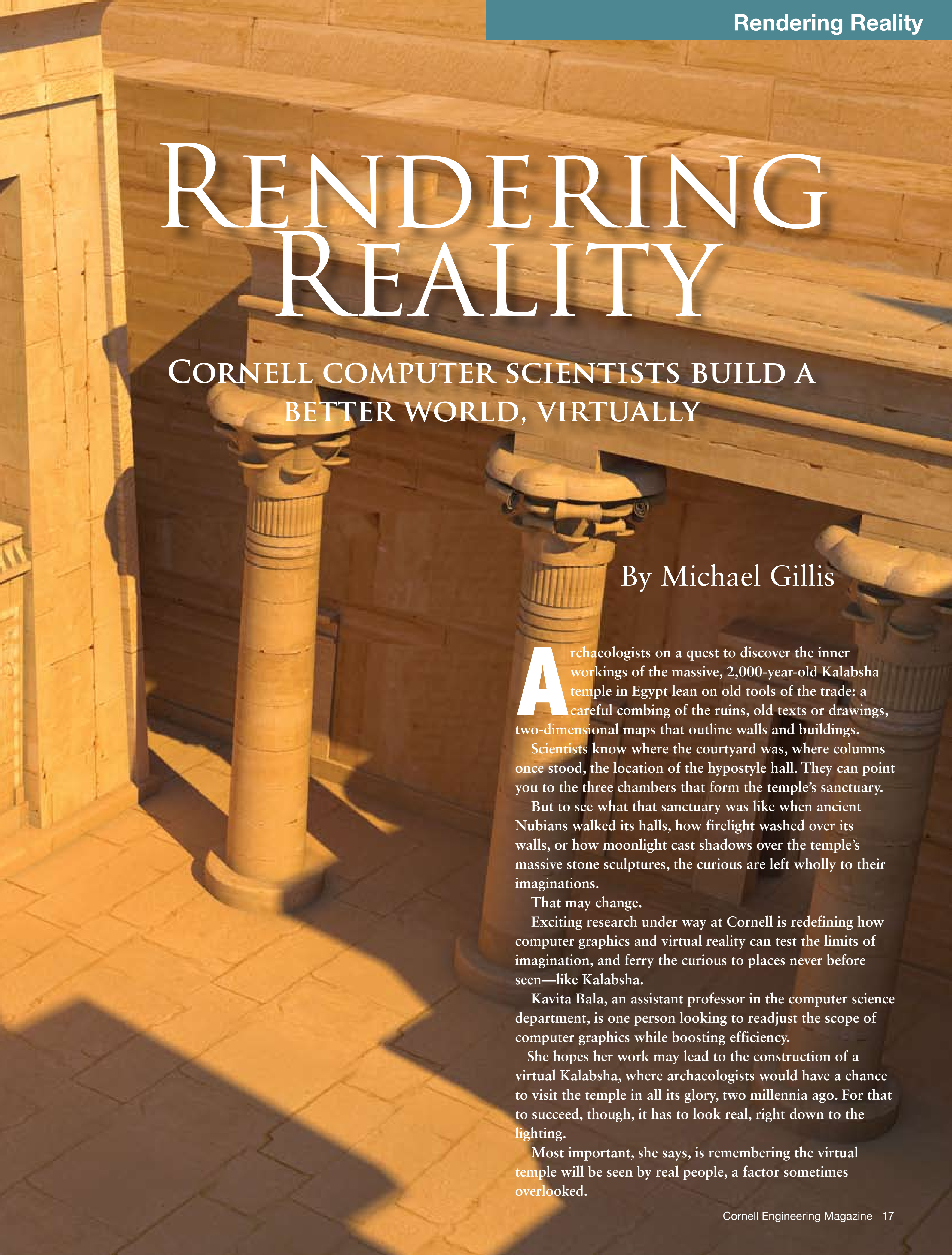
University Photo



Stroock (left) and Wheeler

Model: Veronica Sudstedt, Patrick Ledda
Render: Kavita Bala, Bruce Walter

This image of the reconstructed model of the Kalabsha temple uses perceptually accurate simulation of natural lighting. The scalable lightcuts algorithm uses knowledge of human perception to render this complex scene in a few minutes while evaluating only 1/10,000 of the lighting evaluations.



Rendering Reality

Cornell computer scientists build a better world, virtually

By Michael Gillis

Archaeologists on a quest to discover the inner workings of the massive, 2,000-year-old Kalabsha temple in Egypt lean on old tools of the trade: a careful combing of the ruins, old texts or drawings, two-dimensional maps that outline walls and buildings.

Scientists know where the courtyard was, where columns once stood, the location of the hypostyle hall. They can point you to the three chambers that form the temple's sanctuary.

But to see what that sanctuary was like when ancient Nubians walked its halls, how firelight washed over its walls, or how moonlight cast shadows over the temple's massive stone sculptures, the curious are left wholly to their imaginations.

That may change.

Exciting research under way at Cornell is redefining how computer graphics and virtual reality can test the limits of imagination, and ferry the curious to places never before seen—like Kalabsha.

Kavita Bala, an assistant professor in the computer science department, is one person looking to readjust the scope of computer graphics while boosting efficiency.

She hopes her work may lead to the construction of a virtual Kalabsha, where archaeologists would have a chance to visit the temple in all its glory, two millennia ago. For that to succeed, though, it has to look real, right down to the lighting.

Most important, she says, is remembering the virtual temple will be seen by real people, a factor sometimes overlooked.

VIEW MORE WORK BY KAVITA BALA:

Constructing the 3D Kalachakra Mandala
www.cs.cornell.edu/~kb/mandala

Kavita Bala's projects
www.cs.cornell.edu/~kb/projects/

Model: Jeremiah Fairbanks; Render: Kavita Bala and Bruce Walter

The kitchen includes complex illumination from lighting fixtures in the ceiling and walls and sun streaming in through the windows.

University Photography

Kavita Bala

"People who have looked at lighting have tended to not look at how we perceive it," Bala says. "The hardcore engineering perspective is measuring the light energy and trying only to evaluate that very accurately. Being accurate requires very time-consuming computations. But the algorithms that have been developed don't exploit the fact that there's a human observer at the end."

The challenge is knowing when the observer has enough information to perceive what's before them as genuine, even if some processor-hungry data is missing.

"My goal has been to produce graphics images that faithfully represent the appearance of the real world," she says. "One of the challenges is that the real world is complex."

To build a virtual temple by harnessing today's most accepted methods of complex computation and graphics would not only be unacceptably time consuming, but costly. Even for Hollywood, a virtual Kalabsha of the scale and accuracy Bala envisions would break the bank.

So how do you achieve virtual reality, with an emphasis on reality, on a budget?

A little sleight-of-hand.

> "I say, 'More is less.' What I mean by that is, the more complex the lighting is, as human beings, we're less able to perceive all of its complexities."
>
> *—Kavita Bala*

Rendering the forest for the trees

Much of Bala's work focuses on stripping some of the geometric and lighting complexity from graphics already too bogged down by their own computations. Such intensive graphics are a drain on a computer's processor and can be painstakingly slow to render, which is impractical. A lot of what the observer sees, Bala explains, doesn't even register.

"The complexity of the scene overwhelms our visual system and our ability to process all the information," she says. "Then the question is, 'What shortcuts can we take?'"

That's where she weaves in a little psychology, specifically, how people perceive complex scenes.

"If you have this better understanding of how we perceive images, you can improve both the modeling and the rendering," she says. "In the modeling you can take shortcuts by not representing all kinds of details that would overwhelm any graphic system trying to handle all of them. They don't matter because there's so much information going around that the eye is tuning out."

When you determine what can go—how many trees in a forest, for instance—you can start to determine how many fewer polygons are needed to produce realistic images. Bala says her less-taxed graphics are subjected to a psychophysical test-run with viewers, the best judge of whether something seems off. These tests indicate viewers are convinced images with less graphical information are no different than more complex counterparts. Viewers see both images, Bala says, and simply can't tell which one is the original.

Much of Bala's work aims to realistically mimic light, while reducing resources needed to compute complex environments.

"You've heard the phrase 'Less is more,' right? I say, 'More is less,'" she says. "What I mean by that is, the more complex the lighting is, as human beings, the less we're less able to perceive all of its complexities. We throw away all of that information."

Bala's group has developed scalable rendering algorithms—lightcuts and multidimensional lightcuts—that exploit this insight to enable rendering of extremely complex lighting

Bala says the science has only scratched the surface so far, but is leading to better and more efficient algorithms that will help speed up the rendering of reality and will help graphics systems scale to handle the complexity of the real world.

Bala's work on reducing the computational heavy lifting of complex aggregates of objects and analyzing how viewers pay less attention to individual objects was presented recently at the 2008 conference for the Association for Computing Machinery's Special Interest Group on Graphics and Interactive Techniques (ACM SIGGRAPH). The published paper, which was co-authored by Ganesh Ramanarayanan, a Ph.D. candidate advised by Bala at Cornell, and Professor James A. Ferwerda, a perception psychologist from the Rochester Institute of Technology, explains the "more is less" concept: "Aggregates of individual objects, such as forests, crowds, and piles of fruit, are a common source of complexity in computer graphics scenes," according to the paper. "When viewing an aggregate, observers attend less to individual objects and focus more on overall properties such as numerosity, variety, and arrangement. Paradoxically, rendering and modeling costs increase with aggregate complexity, exactly when observers are attending less to individual objects."

The top image shows the Kalabsha temple but rendered at night, in foggy lighting conditions, and with complex effects like motion blur and depth-of-field. The kitchen (bottom), now smoke-filled, includes more complex shadowing and lighting effects. The multidimensional lightcuts algorithm computes these computationally expensive effects with a surprisingly small additional cost by exploiting the insight that "more is less": more complexity is less visually salient.

Model: Jeremiah Fairbanks; Render: Kavita Bala and Bruce Walter

Lord of the pixels

Many of the advances in computer graphics have incubated under the bright lights of the entertainment industry, and Cornell's research has played a leading role.

Hollywood has already tapped Steve Marschner, a Cornell associate professor of computer science, whose improvements to the rendering of skin were used to breathe life into Gollum in director Peter Jackson's film trilogy, "The Lord of the Rings." That work earned Marschner a technical achievement award from the Academy of Motion Pictures Arts and Sciences.

Marschner is also tackling a better algorithm for hair, which aims for a more natural look while reducing the rendering time to boot.

Hollywood isn't the only entertainment industry to profit from special effects advances. Computer gaming has long mined computer graphics research to lend a little more realism to games like *Doom*, and massive multiplayer online role-playing games like *Second Life*, where virtual interaction still depends more on imagination than good graphics.

Although computer graphics research will continue to notch up the gee-whiz factor in movies and games, that same research may one day take root in a host of other applications, including rapid prototyping, virtual archaeology and e-commerce.

Karen James

Doug James

Sounds like ...

Doug James, an associate professor in the computer science department, knows virtual reality is poised to capitalize on its enormous potential.

Surgical simulation is one example. What would it feel like to puncture a membrane during surgery? Being able to feel effects with haptic feedback, as well as see them, would be a big boost to education.

Which is why James, like others, recognizes that "virtual" without the "reality" can bring down the whole house of cards. In the same way Bala is looking to bring complex images to life, bathed in convincing virtual light, James understands that without authentic sound and feeling, even the best images can only tell part of the story.

"One whole area that's just coming out of the Dark Ages, so to speak, is realistic sound synthesis," he says. "There's been a lot of work on getting sounds to play back in some rich environment that sound like they could be real, but in the end they are essentially just canned sounds. . . . We fundamentally lack the ability to simulate physical sound sources for all sorts of different things, like even just crumpling a piece of paper, or making some tires skid across the ground, or crashing a truck into a stack of TV sets. Any of these things are just way beyond what we actually know how to do, for various reasons."

Even sounds we take for granted, like water pouring into a glass, are a challenge to mimic, James says.

"Nobody's really ever done that," he says, "even to get started and think, 'How does fluid make sound?' and when we know that, 'What kind of algorithms should we create to simulate it?'"

People's instinctual ability to detect false sounds adds to the challenge.

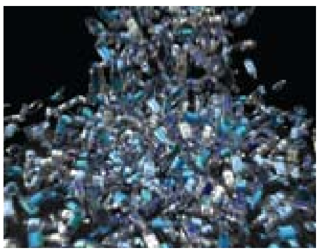
"For graphics, making physics look real isn't so hard, but actually making sounds seem real can be tricky," he says. "People have a very good ear for these things. Our brains have evolved to detect unnatural rustling in the bushes because if you didn't, you might not make it."

The challenge of creating realistic haptic feedback is compounded by the "chicken and egg" problem, James says. He and his associates don't have many existing applications or devices to work with because hardware isn't created without the technology to drive it.

"Building devices that can convincingly depict contact interactions is just hard, from a mechanical design perspective," he says. "Another reason is algorithmic. We fundamentally lack algorithms to display the multitude of contact interactions you take for granted. So how do you actually display, using a robotic device in a convincing way, picking up a piece of paper? We don't have devices that can reflect forces from your hand in a way that will make you think the subtle interaction is true.

"Even if you could," James jokes, "it would still be some sort of poor silent movie, right? Most of the graphics we have now are silent movies."

> "We fundamentally lack algorithms to display the multitude of contact interactions you take for granted."
>
> —*Doug James*



This still image is from an animation that visualizes the estimated rate (in 2005) at which plastic water bottles were not recycled in the U.S.: approximately 845 bottles/second. The bottle dynamics and sound vibrations are computer generated.

James's research into realistic simulated sound and haptic feedback has taken him and his associates down a path of interesting exploration, he says. That research has, like Bala's, pointed to a need to consolidate what data is processed during the first steps of any digital journey.

"If you want to compute physics, you can go ahead and do it. It's just, 'How long will it take?'" he says. "For interactive applications, in particular for sound and haptic rendering, the amount of time you have to go and compute something and display it to the user is very small. Preprocessing is a way to use an amortized computation to evaluate things ahead of time as much as possible."

It's like a drag race, says James. You could wait until the flag is dropped to step on the gas, but you'll go a lot faster if you rev up your engine first.

From big screen to living room

Bala sees a time, perhaps in the not-too-distant future, when people will be able to scan their living rooms electronically and rearrange furniture virtually.

More importantly, Bala points out that same technology can also be used to preserve sacred and historic objects that may otherwise be lost to the ravages of time.

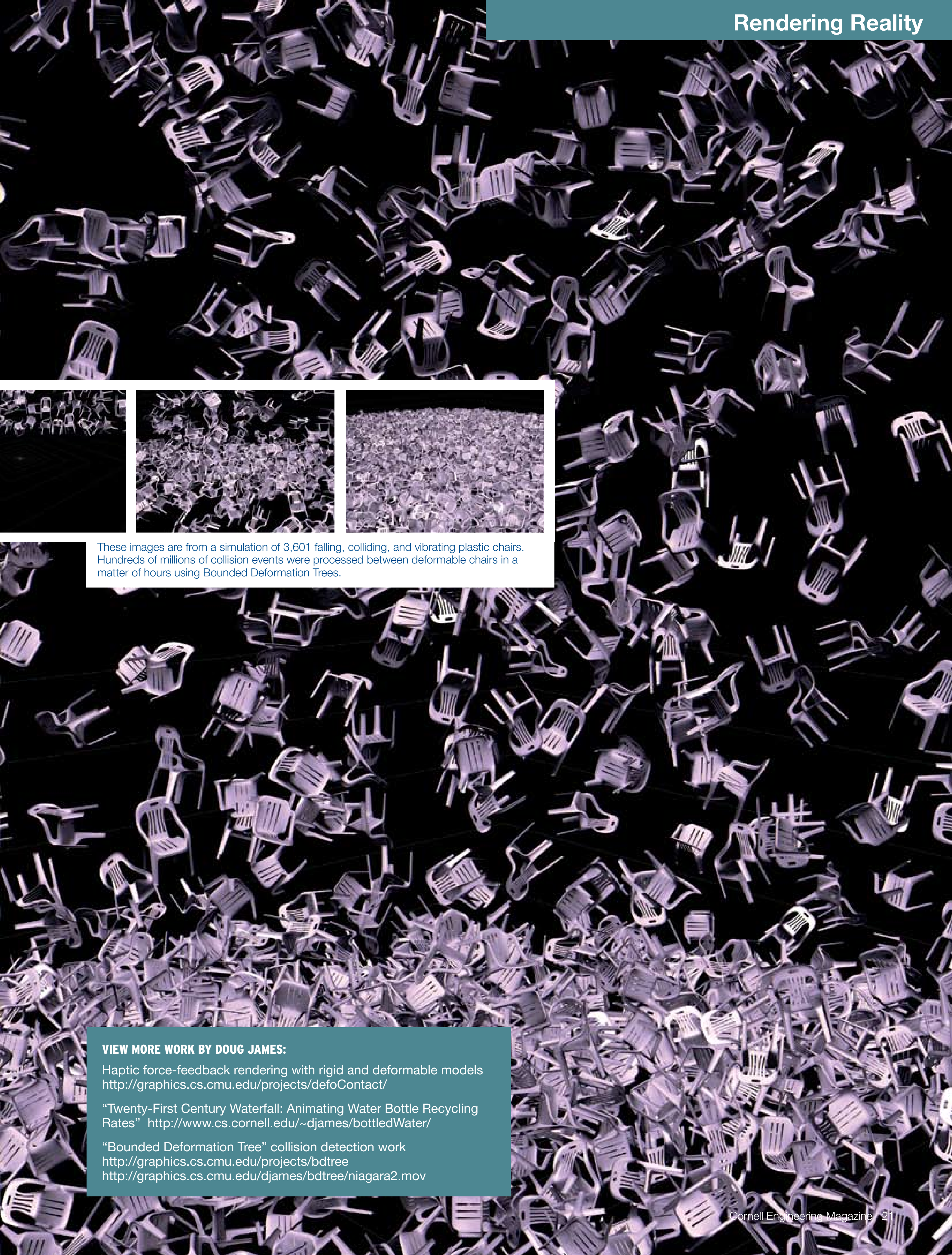
"We need digital representations of this kind of cultural information that is dying out," she says. "We need to archive and keep it. That's one of the applications that really excites me."

Both Bala and James say with so much still to learn, the research remains exciting as much as it is creative.

That's appealing to students, James points out. "Aesthetically speaking, it's really exciting for students who want to have a little of everything," James says. "To do computer science stuff, you need to know programming languages and how to design algorithms, but for these new research areas, you also need physics, and you need to be creative, and have various other skills."

Not to mention fun.

"I just love my job," James says. "It's great. You come in and try to figure out how to solve all these puzzles. And not only to solve the puzzles but to even figure out what the puzzles are, which direction you should go."



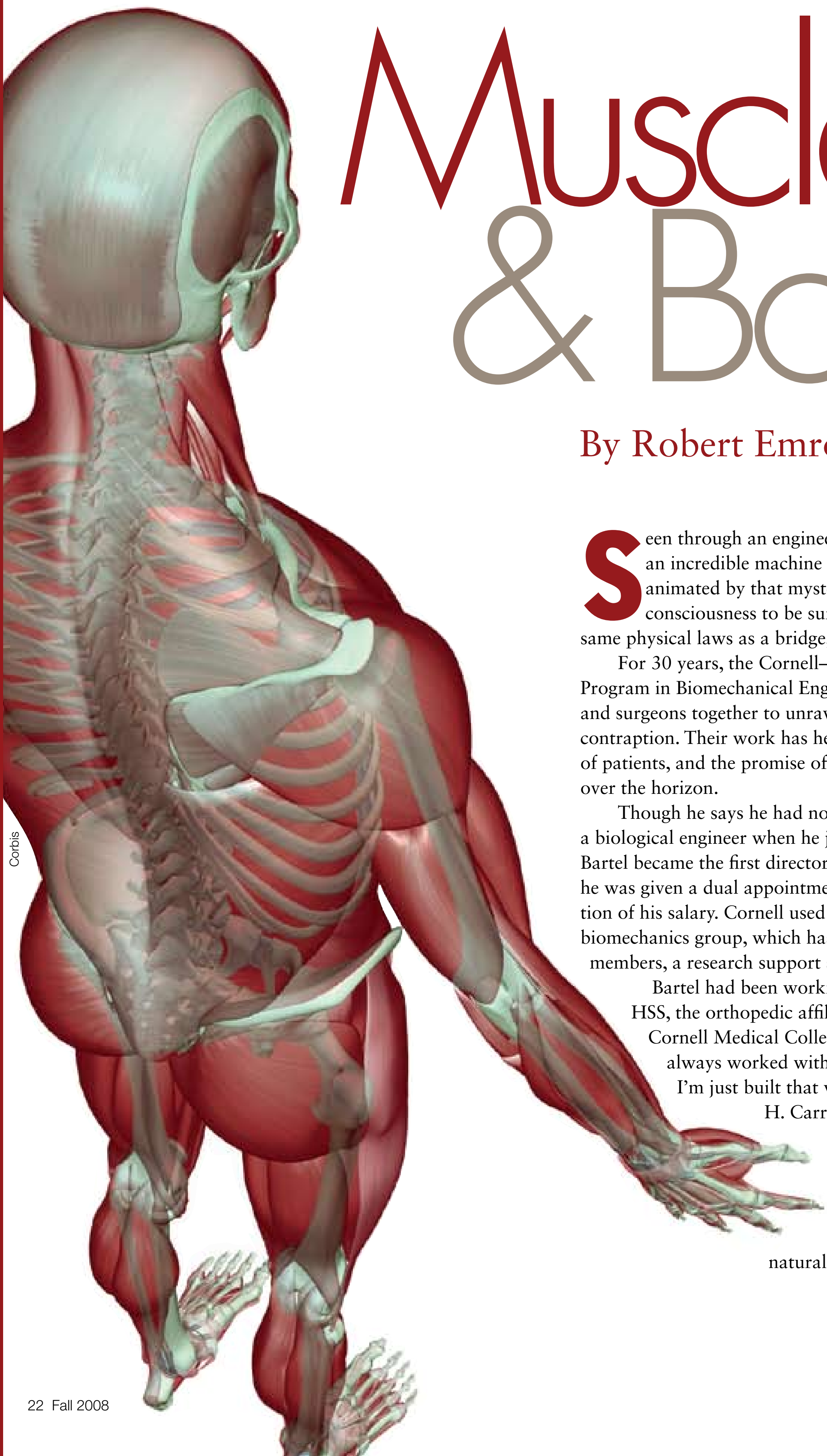
These images are from a simulation of 3,601 falling, colliding, and vibrating plastic chairs. Hundreds of millions of collision events were processed between deformable chairs in a matter of hours using Bounded Deformation Trees.

VIEW MORE WORK BY DOUG JAMES:

Haptic force-feedback rendering with rigid and deformable models
http://graphics.cs.cmu.edu/projects/defoContact/

“Twenty-First Century Waterfall: Animating Water Bottle Recycling Rates” http://www.cs.cornell.edu/~djames/bottledWater/

“Bounded Deformation Tree” collision detection work
http://graphics.cs.cmu.edu/projects/bdtree
http://graphics.cs.cmu.edu/djames/bdtree/niagara2.mov



Corbis

Muscle & Bone

By Robert Emro

Seen through an engineer's eyes, the human body is an incredible machine made of muscle and bone—animated by that mysterious thing called soul or consciousness to be sure—but subject to exactly the same physical laws as a bridge, a motor, or a microchip.

For 30 years, the Cornell–Hospital for Special Surgery Program in Biomechanical Engineering has brought engineers and surgeons together to unravel the secrets of this complex contraption. Their work has helped hundreds of thousands of patients, and the promise of more improvements lies just over the horizon.

Though he says he had no intention of being labeled a biological engineer when he joined Cornell in 1969, Don Bartel became the first director of the program. Eventually he was given a dual appointment, with HSS paying a portion of his salary. Cornell used the money saved to build the biomechanics group, which has grown to include five faculty members, a research support specialist, and a postdoc.

Bartel had been working with the researchers at HSS, the orthopedic affiliate of what is now Weill Cornell Medical College, since the early 1970s. "I've always worked within a clinical setting and I think I'm just built that way," says Bartel, the Willis H. Carrier Professor Emeritus in the Sibley School of Mechanical and Aerospace Engineering. "I like working on things that make a difference in the short term. I guess it was natural I would seek out the others."

The partnership really flourished after HSS hired Albert Burstein, now famous as a co-developer of the Insall-Burstein knee implant, to set up its biomechanics department. "The whole idea was, we had a group of engineers that would be in a vacuum without a connection to an engineering school and at Cornell, there was a group getting into biomechanics that would have the ability to access a rich clinical and biomedical research environment down here," says current HSS Department of Biomechanics Director Timothy Wright, who was hired as a postdoc the same year the program was established. "And it's been an incredibly productive collaboration."

Besides stimulating research, the interactions between Cornell and HSS are an invaluable educational resource. "We have grad students in Ithaca working on computational models from which they learn an awful lot of medicine. And the orthopedic research fellows who collaborate with them down here learn an awful lot about engineering," says Wright. "It's exactly what the program is designed to do—get graduate students, medical students, engineering faculty, surgeons, all in the same room trying to solve a clinical problem."

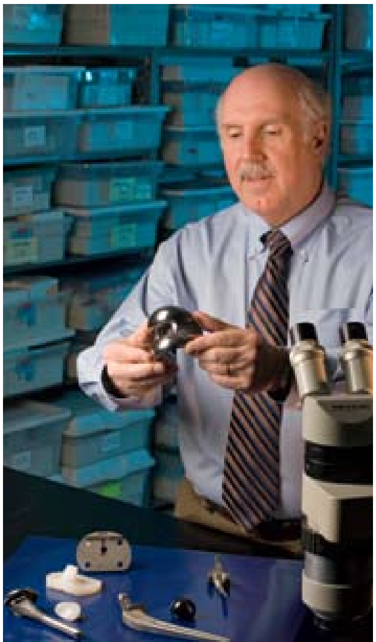
Uncontrollable Accounting

Working with Burstein and now Wright, Bartel's expertise in design optimization and numerical stress analysis continues to make him instrumental in the development of artificial joints. When natural joints wear out, replacements are either fixed to the bone with an acrylic or made with a porous metallic layer into which the bone can grow. Either way, the replacement must be able to withstand loads that can reach several times body weight during daily activities—ideally for the rest of the patient's life.

In designing joint replacements, certain variables can be controlled, like the shape of components, the materials used, and the desired surgical placement. But environmental variables that affect the performance of the device—like patient weight, bone properties, and small variations in actual placement—are beyond control. Bartel uses sophisticated statistical methods to estimate their effects.

The goal is to design a joint that can perform in the real, unpredictable world. "By using these statistics-based methods, you can now account for the variability that affects the system from patient to patient and in the same patient over time with disease and age," Bartel says. "By determining their relative influence, you can determine where you can get the most bang for the buck in improving the system."

Thirty years ago, "revision" of total knee and hip replacements was often necessary after just five to 10 years.



Provided

"It's just an amazing effort. The surgeons love having high-powered engineering behind them."

Timothy Wright

Today, these are some of the most successful operations by any measure, says Bartel, with replacements lasting 20 years or more in 95 percent of patients. And that's due in large part to putting engineers in a hospital setting. "The patient was never far from view and we were there to improve patient care," he says. "The only way you can do that is working directly with surgeons who know what the problems are."

Now retired from Cornell, Bartel continues to work on improving joint design at HSS, where he is a senior scientist. "It's been a great 30 years to work on implants," Bartel says. "I kind of got in on the ground floor. Nowadays, with biology, there's more to learn about the system and the research is longer term."

The evolution of biomechanics

With the explosion of molecular biology in the past 30 years, the Cornell–HSS Program in Biomechanics has found a myriad of new areas where mechanical engineering can shed light on the workings of the human body. Some of these go beyond studying structural mechanics to understanding the influence of mechanical stimuli on biological processes—termed mechanobiology. In addition to studying how the skeletal structure bears loads, current program director Marjolein (pronounced "mahr yoh L-EYE-N") van der Meulen wants to know how that loading influences the bone tissue.

Unlike man-made materials, human tissues are not static. They respond to a variety of environmental factors. Researchers have long known, for instance, that bone mass will increase in response to loading—a classic study in 1970 showed that the bone mass of tennis players was greater in their dominant arm. That's why Bartel designs joints that transfer their loads to the surrounding bone. If they didn't, the body would remove the unused tissue and the bone would weaken. It's also why women with osteoporosis are advised to exercise. But little research has been done to understand exactly how bone remodels itself. That information could aid in the development of drugs to treat osteoporosis.

"Bone is a very adaptive material but most people don't think of it that way," van der Meulen says. "I'm interested in understanding the adaptation process and also taking advantage of that process to some extent to form bone."

Working with Wright and Mathias Bostrom, an orthopedic surgeon at HSS, van der Meulen studies adaptation in animal models, varying the length, magnitude, frequency, and number of loading cycles to better understand the

University Photo

Don Bartel

process. "There's a perception that magnitude of the forces is more important than other parameters, but we don't fully know that," she says. "We're trying to tease out and elucidate which parameters are the relevant ones."

Aging and estrogen play a large role in changes in bone mass—bone loss spikes after menopause—and van der Meulen's group is also studying their effects on the tissue found at the ends of bones, called cancellous bone. "It's a challenge because there's a lot less of it, and there are fewer models for loading of cancellous sites," she says. "We're working on developing models for these clinically relevant locations. Half of all fractures in women with osteoporosis are in the hip, wrist, or spine—locations that are predominantly cancellous tissue."

Besides benefitting patients with osteoporosis, a better understanding of bone adaptation could lead to improvements in fracture healing. With Bostrom and others at HSS, van der Meulen is working to understand how forces applied to fractured bones can both enhance and inhibit healing. The team is focusing on the interaction between loading and biology, which come into play when surgeons use metal plates to immobilize broken bones. "The healing response is different when you put a plate over the bone," van der Meulen explains. "You bring the ends in close proximity and it heals well and more quickly, but in the long term, you start to lose bone under the plate because it's shielding the bone from the load."

While loading can restore lost bone mass, the architecture of the new bone may not be the same. The lattice-like internal structure of the new cancellous bone is different. Lost struts are not replaced because bone can only form on existing surfaces. This may explain why an increase in bone mass does not always correspond to an increase in bone strength. In fact, some drugs used to treat osteoporosis have been shown after long-term use to result in more fractures despite gains in bone mass, while another drug, which stimulates only a slight increase in bone mass, cuts the number of fractures in half. Van der Meulen's group is using computer models to better understand how bone mass and architecture relate to strength.

But just as the strength of a bridge is not only determined by the size of its beams and their configuration, there is a third factor to consider: the quality of the materials. The unexpected effects of some osteoporosis drugs are more likely due to different tissue properties and distributions, says van der Meulen. To find out how material properties contribute to osteoporotic fractures, she has teamed up with collaborators in materials science, civil engineering, and biomedical engineering at Cornell and with Adele Boskey at HSS. They are measuring the mechanical properties of bone at the tissue level, modeling them across multiple scales, and correlating them with bone microstructure.

"It's not really understood how the tissue bears the load, so we are working on how microscale properties relate to tissue and whole bone strength," says van der Meulen.

> "By using these statistics-based methods, you can now account for the variability that affects the system from patient to patient and in the same patient over time with disease and age."
> *—Don Bartel*

Working on All Levels

That approach illustrates a key vision embraced by the entire biomedical engineering field faculty at Cornell. "We need to—no matter the application, whether it's tissue or organs—think about these problems quantitatively at different length scales and how all the different levels relate to each other," says Lawrence Bonassar, an associate professor with joint appointments in mechanical and biomedical engineering. "There's a continuum that goes from molecules, to tissue, to organs. Biology tends to focus on the molecular level, and medicine is primarily concerned with organs, but the intermediate level, from 10 microns to the centimeter scale, gets neglected."

Bonassar is using a multi-scale approach to study cartilage, the importance of which is most apparent to those who have suffered damage to this crucial tissue. Just ask anyone with osteoarthritis, a bad back due to a damaged disc, or knee pain caused by a torn meniscus.

Like bone, cartilage is not a static material, although it's not quite as adaptable. Even so, it's incredibly durable. "Cartilage is an amazing tissue," says Bonassar. "It has some limited capacity to self-renew, but much more limited than other types of tissue, so essentially the same tissue survives 100 million cycles over 60 years."

Cartilage is not one material, but several working in concert, like carbon fiber reinforced plastic, but its behavior is

University Photo

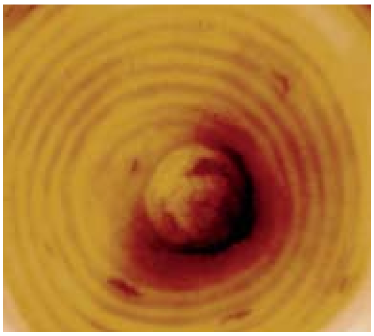
Graduate students in mechanical engineering Maureen Lynch (left) and Frank Ko work with Marjolein van der Meulen to determine how forces applied to fractured bones can both enhance and inhibit healing.

a lot harder to understand. “One can think of cartilage very much as a composite tissue made of collagen fibers embedded in a gel of mostly water and proteoglycans,” explains Bonassar. “The difference is that manmade composites are relatively simple. Biological materials are incredibly complex.”

Another difference with manmade materials is that their properties—even in composites—are usually consistent throughout. “In general, biological materials aren’t like that at all,” says Bonassar. “In particular, cartilage is not like that. Its properties vary with time, with position, and with development, and this is critical to the way that it functions.”

Cartilage has three layers—the surface, middle, and deep zones. Bonassar’s lab has been very excited by recent results showing unexpected behavior in the area that old anatomy textbooks call the transition zone, between the surface and middle zones. “The tissue has a weak or compliant region just below the surface,” says Bonassar. “It’s a great example of a case where there have been lots of hints in the tissue but until the experiments we performed, it was not all brought together.”

Provided



Using an atomic force microscope to examine a cross-section of a cortical bone osteon from an adult primate, van der Meulen’s research team can make measurements in the distinct layers that represent a gradient in tissue age. Osteons are the microstructural subunit of the shafts of long bones. Studying tissues from animals of different ages may help to determine the role of microstructure in the mechanical behavior of bones. (Samples are obtained from animals that have died from natural causes at the Southwest National Primate Research Center in San Antonio, Texas in collaboration with Dr. Adele Boskey at the Hospital for Special Surgery.)

With a new understanding of its properties, Bonassar thinks this area might be much more than a simple transition zone. “If you have a region that’s very compliant, that’s going to be good at absorbing energy,” he says. “Blunting cracks is also something we think might be important.”

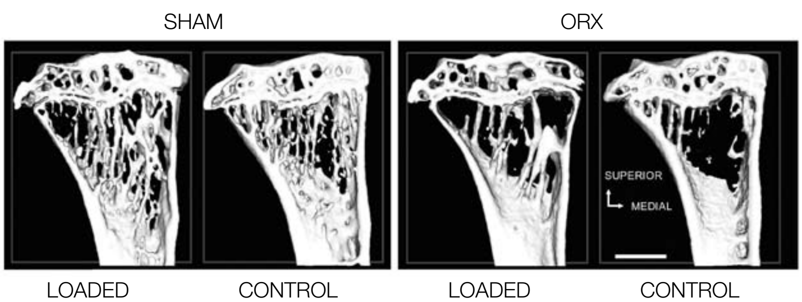
Arthritis is thought to be a top-down disease, starting at the cartilage surface and propagating downward, with deeper changes occurring as the disease progresses. Bonassar plans to work with HSS to look at human cartilage in various states of disease and look at lubrication performance and performance of the transition region to see whether that changes. “We think lubrication and mechanical behavior of the transition zone could be key in starting or stopping the degeneration,” says Bonassar. “We want to find out what goes on when things go wrong and connect that with function.”

That kind of knowledge could help Bonassar’s group create a cartilage substitute, whether it’s totally artificial or tissue engineered. He’s already demonstrated a process for tissue printing with mechanical engineering Associate Professor Hod Lipson. “We’re very lucky that it’s easy to see the connections to the therapeutic applications of what we do,” says Bonassar. “If we can identify special regions of tissue damaged early, and even specific molecular components that are damaged or enable the propagation of damage, that might inform therapeutic strategies for preserving function.”

Such strategies will be crucial in meeting the next challenge facing orthopedics. “The Baby Boomers are coming to arthritis at a younger age because they’ve been more active and more injured,” says Wright. “Now we see patients in their forties or fifties with the beginnings of arthritis.”

The HSS surgeons will meet that challenge working with Cornell biomechanics researchers. And with two new faculty members, Jonathan Butcher and Yingxin Gao, their interactions are sure to grow in coming years. “I couldn’t be more proud to be part of this thing,” says Wright. “It’s just an amazing effort. The surgeons love having high-powered engineering behind them.”

Preclinical studies using mice indicate that cancellous bone mass loss can be prevented by mechanical loading, possibly offering a nonpharmacological treatment to prevent rapid onset osteopenia and associated fractures. The figure at right shows the midtibial plateau of paired tibias from 16-week-old mice. Experimental mice had surgery to remove the sex organs (ORX), which results in rapid loss of cancellous bone mass; control mice had simulated surgery to control for surgical effects (Sham). Forces were applied to the left tibias of both groups for six weeks. Comparison to the control (non-loaded) tibias showed that cyclic mechanical loading prevented bone loss that occurs as a result of withdrawal of the male sex hormones but altered the architecture of the cancellous bone.



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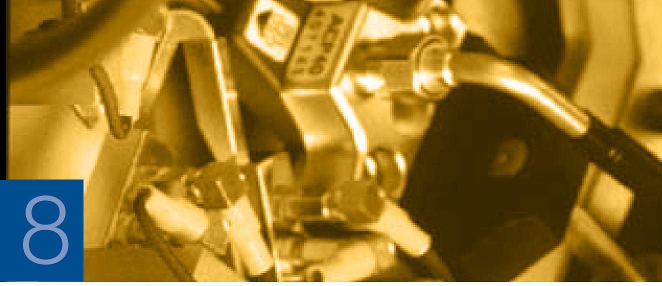


URBAN NANOPOLLUTION

University Photo

Max Zhang

As the world watched China prepare for the Olympic Games, Cornell researcher Max Zhang had his eye on less visible matters—the particles in Beijing's air that millions breathe every day and that many more were breathing when they descended on the city in August.

The assistant professor in the Sibley School of Mechanical and Aerospace Engineering is leading a project to study the air quality before, during, and after the 2008 Olympic Games.

Zhang's general research interests lie in what happens to the particles emitted from cars, trucks, and power plants.

"I am interested in how these particles are made and how they disperse—how they transport and transform in the air," Zhang said.

Although scientists have been studying the adverse effects of breathing urban air pollutants for years, Zhang notes that as combustion engines have become increasingly efficient, their exhaust particles have gotten smaller and more easily absorbed by the body.

Modern engines, he also notes, emit many more particles smaller than 100 nanometers than do older engines (a nanometer is one-billionth of a meter). And nanoparticles are rapidly transformed in the atmosphere, Zhang points out. When particles are emitted from the tailpipe of a car, they can be 50 nanometers. But after traveling just 100 meters (11 yards), the particles can shrink to about 20 nanometers.

"In that short distance, the particles you are breathing are very different from what's being emitted," said Zhang, who is originally from Qufu, China.

In 2006 the Chinese government began massive efforts to clean up Beijing before the Olympics by implementing emission controls and traffic restrictions. Zhang realized he could use the city as a laboratory to see if the efforts would work and to what extent.

Zhang and graduate student Xing Wang traveled to Beijing in the summer of 2007 to take initial measurements of airborne particles in various spots around the city, from heavily trafficked highways to residential communities—even inside restaurants. They used real-time analytical instruments to capture the changes in particle size and concentrations in a matter of seconds.

Zhang repeated tests in Beijing during the Olympics, and will test once again a year later. The study is supported by Cornell's Jeffrey Sean Lehman Fund for Scholarly Exchange with China and the U.S. Environmental Protection Agency.

Zhang also is collaborating in an air quality project in Syracuse, N.Y., helping to design a controlled ventilation system for a building to be placed at the intersection of Interstates 81 and 690—a major hub in downtown Syracuse. The building will house the Syracuse Center of Excellence in Environmental and Energy Systems, which is funding the study.

The ventilation's control system would turn up or down, depending on the quality of air around the building at any given time. To design it, Zhang is using cameras to measure traffic levels. He is developing computer algorithms to simulate how the plume of pollution would disperse into the building.

"I think it's novel in terms of linking the building to the surrounding environment," he said. "When people think about a building, they only think about the building alone. They never think, 'The building has to be somewhere.'"

Zhang is excited at the opportunity to work on such a project, because he has long studied traffic dispersion and how it relates to the air people breathe.

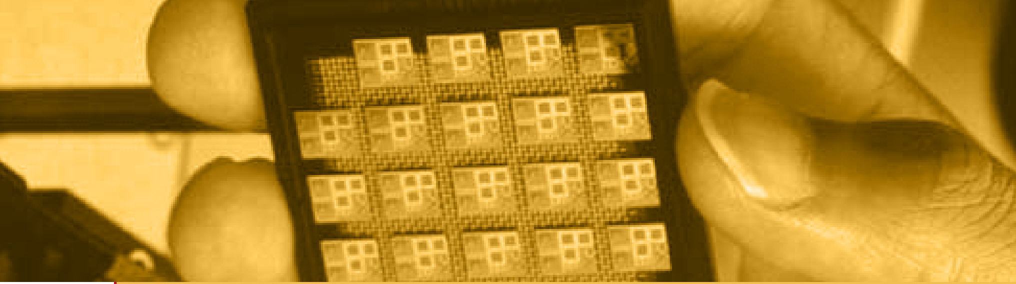
He also is working on air quality studies in Rochester and in South Bronx, N.Y., where high rates of asthma in schoolchildren are believed to be caused by heavy, prolonged traffic congestion.

"The cities are my laboratory," he said.

—Anne Ju

Provided

Graduate student Xing Wang monitors computer equipment that measures air quality in Beijing in August 2007.



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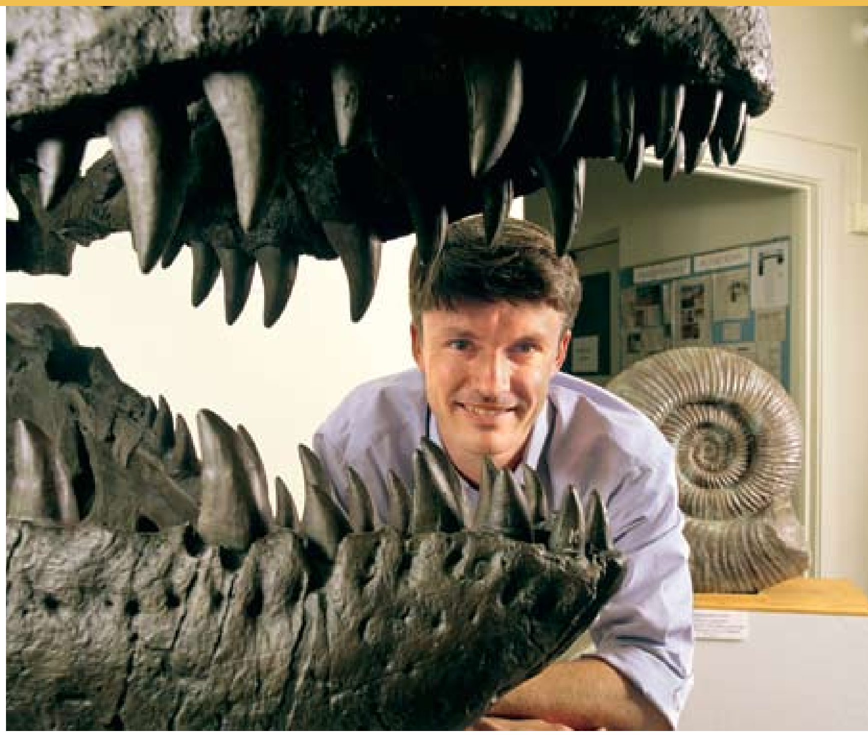
RAWLINGS PROFESSOR



Warren Allmon

The Cornell Board of Trustees has named paleobiologist Warren Allmon the first Hunter R. Rawlings III Professor of Paleontology in Cornell's Department of Earth and Atmospheric Sciences.

"Understanding the history of the Earth gives us a basis for understanding our current environment," said Kent Fuchs, dean of the College of Engineering, where Allmon's faculty appointment originates. "Warren has distinguished credentials, his enthusiasm is contagious, and his ability to communicate the science of paleontology is exceptional."

The new professorship is named for Rawlings, a Cornell professor of history and classics and the 10th president of Cornell, who served from 1995 to 2003 and as interim president in 2005–06.

"Warren is a remarkable scientist and acclaimed public spokesman for the values of understanding and protecting our planet in all its dimensions," said Rawlings. "He is also one of our most ardent and successful explicators of evolutionary theory, to Americans of every age and educational level."

To help Cornell students gaze back hundreds of millions of years, Allmon will teach such courses as Evolution of the Earth System, Paleobiology, and Advanced Topics in Paleobiology.

"Earth is a very complicated place," said Teresa Jordan, chair of the Department of Earth and Atmospheric Sciences at the time of Allmon's appointment. "In the context of current concerns about global change, the value of paleontology is that it records the outcome of Earth's previous changes. With paleontology, we can describe those environmental changes and their impacts on life. We realize that paleontology is vastly relevant to today's Earth."

Allmon has been teaching at Cornell for the past 15 years as an adjunct associate professor. He earned his A.B. in earth sciences from Dartmouth College (1982) and Ph.D. in earth and atmospheric sciences from Harvard University (1988). Director of the Paleontological Research Institution (PRI) in Ithaca since 1992, he was instrumental in the development of PRI's Museum of the Earth, which opened in 2003. Under his leadership, PRI has become a leader in public education about evolution, including Ithaca's Darwin Day, which celebrates the birthday of Charles Darwin annually.

"Cornell is of course more than a great research university," said Allmon. "It is also a great land-grant university, with the mandate for outreach that implies. Cornell is thus a place for sharing scholarly knowledge with diverse audiences beyond the campus. Especially with respect to climate change, this has never been more important than it is today. With this chair, I aim to continue that rich tradition."

—*Cornell Chronicle*

Paleontological Research Institution
Joseph L. Casciano

HONORARY DOCTORATES

University Photo

John Hopcroft

University Photo

Michael Shuler

Two members of the engineering faculty were awarded honorary doctorates last spring.

Professor **John Hopcroft** received an honorary doctorate from the University of Sydney. The IBM Professor of Engineering and Applied Mathematics, Hopcroft was recognized for his research contributions to theoretical computer science and his work in developing countries.

As a volunteer for the Vietnam Education Foundation, Hopcroft has worked to improve science and technology education in that country. Each year he travels to the Southeast Asian nation to help institutions develop curricula and to interview students hoping for one of 100 fellowships offered by the foundation to support study in the United States. Working for the World Bank, he has also helped Chile build its science program by making recommendations on research spending.

A former dean of engineering, Hopcroft offered brief advice to engineering students in Sydney at the May 16 ceremony. "When there's a time of change, it's a time of opportunity to position one's self to be a leader in a new direction," he said. "When I graduated in '64 from Stanford and started my career at Princeton, they asked me to develop a course in computer science. That made me one of the first computer scientists, so I didn't have to wait for the senior people ahead of me to retire."

Hopcroft's research centers on theoretical aspects of computing, especially analysis of algorithms, automata theory, and graph algorithms. His most recent work is on the study of information capture and access. He was honored with the A. M. Turing Award in 1986. He is a member of the National Academy of Engineering and a fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the Institute of Electrical and Electronics Engineers, and the Association for Computing Machinery.

Professor **Michael Shuler** received an honorary doctorate in engineering from the University of Notre Dame at its commencement.

The James M. and Marsha McCormick Chair of Biomedical Engineering and Samuel B. Eckert Professor of Chemical Engineering, Shuler was honored for his innovative, groundbreaking research in the biochemical engineering field—which has led to unprecedented advances in cell modeling and pharmaceutical production—and for remaining a committed teacher of young students entering the field.

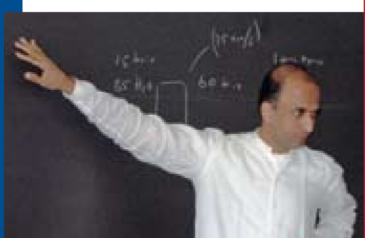
Shuler attended the May 18 ceremony as one of nine distinguished alumni. Interviewed prior to the trip, Shuler said, "It's the first time I've received an honorary doctorate, so that's special. It also will be a lot of fun for me to go on back. My younger son is working on getting a Ph.D. at Notre Dame too, but I'm going to beat him."

Shuler has been a member of the Cornell faculty since 1974 and has earned two teaching awards. He has received the inaugural James E. Bailey Award from the Society for Biological Engineering and the Amgen Award in biochemical engineering; he is a member of the National Academy of Engineering, American Academy of Arts and Sciences, and the American Association for the Advancement of Science.

—Robert Emro

INDUSTRIAL PRACTITIONER

Provided



Samir Somaiya

As part of walking the talk on the energy front, the School of Chemical and Biomolecular Engineering introduced a new course this year on ag-based renewable fuels, taught by Samir Somaiya '90, M.S. '92, MBA '93 (and MPA '05, Harvard), executive director of the Godavari Sugar Mills Ltd. in India.

Somaiya took time off from his job to teach the course, which focused on the potential of agriculture to provide renewable energy resources from the perspective of the Indian agricultural market and the Indian economy, both of which differ considerably from conditions in the United States and Western Europe.

For example, Somaiya looked at sugarcane as a feedstock, explaining how markets can create an environment that allows for innovation; he then discussed how successful implementation includes the need to extend innovation in areas of biotechnology, chemistry, engineering, agriculture, public policy, markets, and even microfinance.

The course was well received, and Somaiya will return in two years to offer it again. The course is a model for the College of Engineering to offer international perspectives in electives, in which speakers visit every two to three years to present a concentrated three-week course for "energy-hungry" students.

—Cornell Chronicle

BIG GIVER

A big idea from Oprah Winfrey meant big bucks for Stephen Paletta '87—big bucks to keep and to give away.

In "Oprah's Big Give," an eight-episode prime time television show that aired in spring 2008, ten contestants competed to give away money to complete strangers in the most creative and effective way to change that person's life. Each week each contestant was challenged to find ways to give big or risk going home. Stakes were higher than the contestants realized: unknown to them, in the final episode, the biggest giver would receive a $1 million prize, half of which must be used to continue helping others.

Paletta outlasted the nine other contestants as they traveled across the country, scrambling to find ways to impact the fates and fortunes of unsuspecting people; he was named the "Biggest Giver" on April 19.

A graduate of the College of Engineering, Paletta was also a four-year letter winner for the Big Red men's lacrosse team. He was a part of Cornell's 1987 national runner-up squad and was named a second-team All-American that season.

Paletta has spent the last several years on philanthropic endeavors and has established "Stephen's Journey" to continue serving others.

For more, visit www.stephenpaletta.org.

Provided

Stephen Paletta

MODELING SHIPS

The U.S. Navy's Office of Naval Research (ONR) has awarded Derek Warner, assistant professor of civil and environmental engineering, a $277,000 grant to help build better, more durable ships.

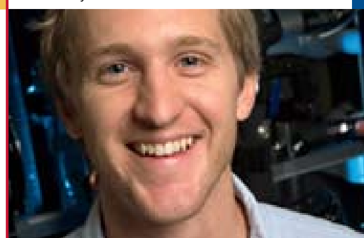
Warner was one of 25 scientists across the country who received ONR funding in the 2008 Young Investigators Program. His grant was awarded under the Sea Warfare and Weapons category.

With the three-year grant, Warner proposes to bolster research at the Naval Surface Warfare Center's Carderock Division by creating an atom-by-atom computer simulation that analyzes how stresses, load history, and temperature affect aluminum ship structures. Naval scientists are already working on a material model that can predict cracks and other damage in ship structures.

A member of the Cornell civil engineering faculty since October 2007, Warner's research focus is understanding physical mechanisms that control the deformation and fracture of various engineering materials.

—Anne Ju

University Photo



Derek Warner

DIVER DOWN

The Cornell University Autonomous Underwater Vehicle team was in San Diego July 29–August 3 for the 11th International Autonomous Underwater Vehicle Competition, sponsored by the Association for Unmanned Vehicle Systems International and the Office of Naval Research. In a field of 25 teams, Cornell placed first in static judging, which evaluates technical design, craftsmanship, and safety of the vehicle. Teams are scored on a 15-minute presentation, a journal paper, and the team Web site.

The underwater portion of the event requires the vehicle to successfully complete a number of tasks. CUAUV's Triton had a successful qualifying round, advancing to the finals and ultimately placing seventh overall.

Find complete coverage of the competition and photos online at www.cuauv.org.

Provided

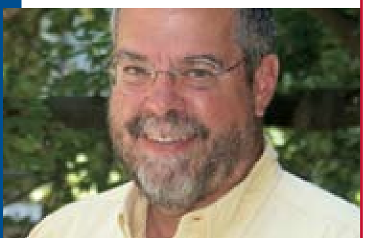
CUAUV team members in San Diego for the competition included (from left, back row) Conrad Petersen, Brad Factor, Sam Fladung, Brian Mittereder, Saurav Bhatia, (front row) Tommy Craig, Erin Fischell, Tracy Cheung, Peter Sullivan, J.B. Rajsky, and Ian Vaughn.

NEW LEADERS

University Photo

Daniel Aneshansley, BEE

Jeannette Little



Leonard Lion, CEE

University Photo

Philip Liu, CEE

University Photo

Larry Brown, EAS

The College of Engineering recently welcomed several new leaders.

Professor **Daniel Aneshansley** was appointed chair of the Department of Biological and Environmental Engineering. Aneshansley joined the department in 1984 after holding joint appointments in the School of Electrical Engineering and the Section of Neurobiology and Behavior at Cornell. He has also worked for National Cash Register Company and the electronics division of Borg Warner.

Professor **Leonard Lion** was appointed as director (for a one-year term) of the School of Civil and Environmental Engineering. After receiving his master's degree from Stanford University, Lion worked for two years with the U.S. Public Health Service. He returned to Stanford to obtain his doctorate, continued there as a postdoctoral scholar, and then joined the Cornell faculty in 1981.

Professor **Philip Liu,** will be appointed director of CEE, effective July 1, 2009. After receiving his B.S. in civil engineering from National Taiwan University in 1968, a S.M. in civil engineering in 1971, and a Sc.D. in 1974 from MIT, Liu joined the Cornell faculty in 1974.

Professor **Larry Brown,** Ph.D. '76 GeoSci, was appointed chair of the Department of Earth and Atmospheric Sciences. After receiving his doctorate, Brown continued at Cornell as a postdoctoral research associate and joined the faculty in 1977.

Professor **Alan Zehnder** was appointed chair of the Department of Theoretical and Applied Mechanics. Zehnder received his doctorate from the California Institute of Technology. He stayed on as a postdoctoral research fellow for one year and joined the Cornell faculty in 1988.

Cathy S. Dove was appointed as associate dean for administration for the college. As chief operating officer of the college, she will play a key leadership role. She was previously associate dean for M.B.A. programs and administration at the Johnson School at Cornell. She holds an Ed.D. from the University of Pennsylvania, an M.B.A. from Cornell, and a B.S. from Georgetown University.

Professor **Richard Allmendinger** '75 was appointed associate dean for diversity, faculty recruiting, and mentoring. He received his Ph.D. in geology from Stanford University in 1979. He joined the Cornell faculty in 1984.

Professor **Christopher K. Ober** was appointed associate dean for research and graduate studies. He is the Francis Bard Professor of Materials Engineering at Cornell University. Ober joined the Cornell faculty in 1986 after several years at the Xerox Research Centre of Canada. He received his doctorate in 1982 from the University of Massachusetts, Amherst.

University Photo

Alan Zehnder, TAM

Provided

Cathy S. Dove, Associate Dean for Administration

University Photo

Richard Allmendinger, Associate Dean for Diversity, Faculty Recruiting, and Mentoring

University Photo

Christopher K. Ober, Associate Dean for Research and Graduate Studies

MICROSOFT FELLOW

University Photo

Robert Kleinberg

Robert Kleinberg '97, assistant professor of computer science, has been selected as a 2008 recipient of a $200,000 Microsoft New Faculty Fellowship grant.

Kleinberg works on computer algorithms—the strategic plans on which programs are based—for decision making in situations where all the necessary information may not be available. Applications can range from choosing the best route for an Internet message to setting the optimum price for a product offered on eBay to deciding what movies to recommend to a DVD rental customer. These are the same sorts of decisions human beings make, but computers can make them faster and—at least theoretically—can be taught to make the best possible decision every time.

"Although I expect this research is more likely to be applied to computer systems," Kleinberg said, "one of the goals is also to enable people to make better decisions, with appropriate help from their software."

He plans to use the Microsoft funding either to bring in a new postdoctoral collaborator or to host an interdisciplinary symposium in his research area. "The most important resource that my research requires is interaction with gifted colleagues," Kleinberg said.

After graduating from Cornell with a major in mathematics, Kleinberg received his Ph.D. at the Massachusetts Institute of Technology in 2005 and joined the Cornell faculty in 2006. Along the way he developed network-optimizing algorithms at Akamai, a company that provides a mirroring service for online businesses.

Microsoft established the New Faculty Fellowship program in 2005 to identify and support promising researchers who "have the potential to make a profound impact in their respective disciplines." Five applicants were selected from more than 100 nominations from universities across the United States and Canada. Kleinberg has also received a National Science Foundation Early Career Grant and an Alfred P. Sloan Foundation fellowship.

This is the second year in a row a Cornell faculty member has received a Microsoft New Faculty Fellowship. Last year Adam Siepel, assistant professor of biological statistics and computational biology, was among the recipients.

—*Bill Steele*

GREAT PRIDE

University Photo

Biddy Martin

Cornell Provost Carolyn A. "Biddy" Martin has been selected as the next chancellor of the University of Wisconsin-Madison, her graduate alma mater.

Martin has been at Cornell since 1983 and has served the past eight years as provost, the university's chief academic officer. She will replace outgoing Chancellor John Wiley, who plans to step down in September.

"I'm delighted and honored to have been recommended for the chancellorship at UW-Madison, a world-class public university," Martin said during a telephone press conference. "The Cornell provost's position is one with broad and deep responsibilities and forms of authority that will stand me in good stead at a university with equal depth and breadth."

In a statement, Cornell President David Skorton said the news is "a source of great pride for the entire Cornell community and a great day for Wisconsin."

He said: "Biddy Martin will bring to her new responsibilities a deep academic sensibility and wealth of experience dealing with the many issues and constituencies that play such a critical role in the life of university."

A search is underway for the next Cornell provost; Paulette Clancy, professor and the William C. Hooey Director of the School of Chemical and Biomolecular Engineering, is a member of the search committee.

—*Daniel Aloi*

HOMETOWN HERO

Engineering With A HUMAN TOUCH

Noreen Rizvi '09 Combines Engineering Know-How with Personal Caring

University Photo

When Noreen Rizvi '09 ChE first walked into the room at Baan Nontapum, a government-run orphanage for more than 400 disabled children in Bangkok where she volunteered during summer 2007, she thought the young person in the bed before her was an 8-year-old boy. In fact, the person was a 25-year-old woman named Boom. Muscular dystrophy had contracted her muscles and severe mental disabilities made it impossible for her to speak. Seeing a young woman about her own age with such difficulties was hard for Rizvi.

"When I found out she was 25, it was very shocking for me at first, and it took me a few minutes to not react in a way that would be offensive," said Rizvi. "It was very hard for me to see the conditions of some of the children at Baan Nontapum. As I got to know each child, I became more accustomed to their handicaps. Toward the end of my trip, the same children that once intimidated me had become some of my closest friends."

Rizvi spent a lot of time with Boom, learning to feed her, care for her, and even managing to make a personal connection. It was a life-changing experience, one that challenged all of her intellectual abilities and also her heart. Her volunteer work in Thailand led her to be named one of Cornell's "Engineering Global Fellows," part of a new effort to highlight the accomplishments of students who work, study, conduct research, or perform service learning abroad.

It might at first seem surprising to see a chemical engineering student spending her summer working with disabled children, but Rizvi is not your average student. She's been drawn to medicine since she was a child, when she spent time with her grandmother, who was bedridden with severe rheumatoid arthritis. "My desire to help people stemmed from my feeling of helplessness," says Rizvi. "Seeing my grandmother's illness take over her lifestyle inspired me to do whatever possible to help others."

Rizvi, the daughter of Cornell food science professor Syed Rizvi, began her path excelling in math and science classes at Ithaca High School. In her senior year, she spent most of each school day at Cayuga Medical Center, rotating throughout the hospital as a member of its "New Visions" career exploration program. At Cornell, she has worked for Professor Jeff Varner's research group in the School of Chemical and Biomolecular Engineering, mathematically modeling prostate cancer cells, and also finds time to volunteer at Alterra, a local assisted living facility.

Rizvi understands that she may not be the most typical engineering student. She suspects she will be an "out of the box" engineer. She has a hard time imagining herself in a cubicle, working without people.

Provided

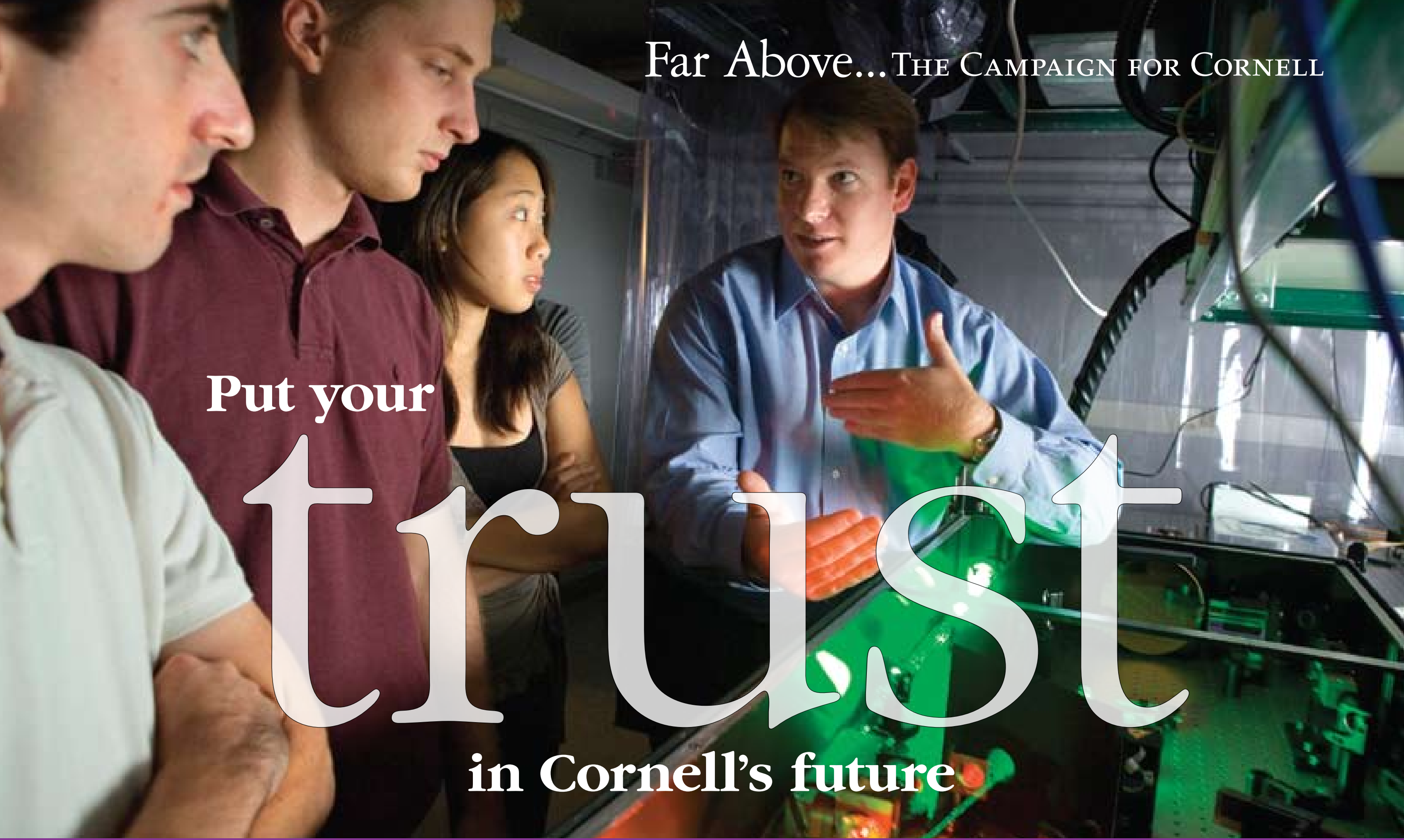
"I might not be designing energy plants," she says, "but the way engineers think is very applicable to working with patients and solving problems." She notes that chemical engineers are involved in the fields of pharmaceuticals, biomedical engineering, and prosthetics.

"My courses are very related to what I want to do," says Rizvi. "I'll learn about fluid flow in fluid mechanics class, and that can be modeled as the circulatory system in the human body, with the heart as a pump. The fields do overlap."

Rizvi has also been careful to explore other paths while at Cornell, to try out different things. In summer 2008, she tested out the world of business and industry as a research and development intern with L'Oreal in Clark, N.J., working on hair instrumentation. But while she's curious about business and has enjoyed her research with Varner, an M.D. seems much more likely in her future than a Ph.D. or an M.B.A.

"I love the concept of research and seeing how knowledge is created," she says. "But I would like to go into a field that has the human touch. What draws me to medicine is the combination of the human element along with fundamental science and groundbreaking engineering. In Thailand, that's especially what I learned about myself. Being with those children and seeing them smile is really what made me want to be there. Through volunteering, I have realized that the human element in such settings is irreplaceable."

—*Bridget Meeds*



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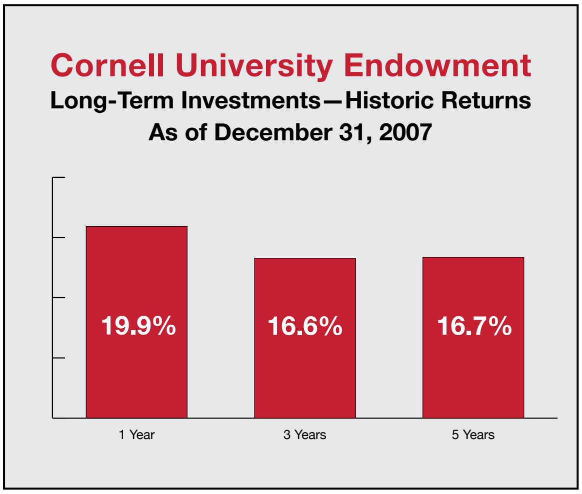

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