Almost an Oscar
Shaping DNA for drug delivery
MadSci: No question too weird

Making Tracks on Mars
How Rover learned to dig
Meet the Duffield Challenge

Duffield Hall, Cornell’s spectacular new facility for research and teaching in nanoscience and advanced materials, is opening this fall and you can be part of the Duffield Challenge!

There’s never been a better time to join the excitement. David Duffield ’62 EE, founder of PeopleSoft, will match all gifts to the building endowment on a 1:1 basis. Your gift will not only count for both reunion and giving-club credit, but will also create lasting support for the cutting-edge research conducted in this premier facility. Income from the endowment will fund the building’s operation forever.

The Duffield Challenge Campaign ends in 2005; commitments can be payable over five years, and corporate matching gifts count toward the challenge. Larger gifts will be recognized with named spaces or positions.


For more information:
Marsha Pickens
Assistant Dean
Engineering Alumni Affairs & Development
253 Carpenter Hall
Ithaca, NY 14853
ph. 607.255.6094
fax 607.255.9606
email: mp26@cornell.edu
FEATURES

Roll the Credits/6
BY BETH SAULNIER

Ithaca isn’t as far from Hollywood as you may think. A Cornell faculty member is honored for his contributions: the “science” behind science fiction.

Designing Molecules/12
BY GLENN SCHERER

Dan Luo’s work in nucleic acid engineering—a term he coined just three years ago—could help revolutionize biological engineering at the nanotechnology level.

The Little Dig/16
BY JAY WROLSTAD

Spirit and Opportunity scratch the surface of Mars to learn more about the Red Planet. Digging skills for the rovers were developed right here on the Engineering quad.

The Collective Cranium/22
BY MARK RADER

Got a science question? Tap into the brain trust at www.MadSci.org and ask the experts. You’ll get a fast, factual, friendly reply, quite likely from a fellow Cornellian.

SPRING 2004

Departments

News/2
From all over the campus map: a nano think tank, a nano experience for kids, a nano White House, a sensor networks project for disaster recovery, a fuel cell institute, a master’s degree program in biomedical engineering, a spot in the patents top ten, and even a pair of student-built satellites.

People/26
Meet the people who are visiting campus (Bill Gates), leading organizations (Constable, Tiwari) making news (Apsel, Campbell, Hammer, Hopcroft, Pingali), solving problems (ACM team, Lipson), and strutting their stuff (BOOM, Ithaca Beer) this spring.

Hometown Hero/32
She is only a Cornell sophomore but she’s often one of the first people on the planet Earth to see and manipulate the images coming down from Mars. Meet Stephanie Gil and find out how she “hit the jackpot” in undergraduate research.
Another Think Coming

A $7.5 million grant to Cornell from Fred Kavli and the Kavli Foundation of Oxnard, Calif., will endow the newly established Kavli Institute for Nanoscale Science, foundation and university officials announced March 10 in New York City.

The institute will be based on the Cornell campus in Ithaca, where there is a nationally recognized concentration of nanoscale-related research. The Kavli think tank will aim to address the major challenges and opportunities for science at the atomic and molecular scale; to bring together the world’s seminal thinkers in nanoscale science; to foster a collaborative, multidisciplinary research community at Cornell; and to define a path for progress in creating significant new science.

“When you’re working at the frontiers of science—as our faculty, researchers, and students are in the Cornell Center for Materials Research, the Nanobiotechnology Center, the Center for Nanoscale Systems, and the Cornell Nanoscale Facility—there’s not always time to step back and look to the future,” said Robert C. Richardson, Cornell vice provost for research, who will serve as founding director for the new Kavli Institute at Cornell. “This institute will give us the opportunity to engage multidisciplinary groups in exploration of emerging themes in nanoscale science and technology—at this institution as well as nationally and globally. It is a testament to the wisdom and foresight of Fred Kavli and the Kavli Foundation that they chose to focus significant resources in this important scientific field.”

Announcing several new institutes at a March 10 news conference in New York’s Carlyle Hotel, philanthropist Kavli said: “My goal in establishing these institutes is to support research at the frontiers of science. I feel that it is especially important to pursue the most far-reaching opportunities and challenges and to seek answers to the most fundamental questions.”

At Cornell, the new institute will work to define the directions and scope of the fields of nanoscale science by sponsoring seminars, symposia, and related activities, said Richardson. He noted: “We aim to provide leadership to the scientific community regarding current and future directions of research in nanoscience.” He said the institute will develop a flexible mix of programs, based on an annual research theme, to explore fertile research avenues in nanoscale science.

—Roger Segelken
Cornell News Service

FUEL CELL FUTURES

The U.S. Department of Energy (DOE) has awarded Cornell University $2.25 million over three years to establish the Cornell Fuel Cell Institute (CFCI). The institute will research new materials to kick-start the development of fuel cells that would be both effi-
cient and cheap to produce. The new approach to the electrochemical device, that in its traditional form converts hydrogen and oxygen into water and produces electricity and heat in the process, aims to make a significant improvement in the technology by discovering and exploiting new materials based on recent discoveries in Cornell laboratories. Indeed, some of the possible fuel cell technologies that could result from the research might not even involve hydrogen as a fuel.

“This is an interdisciplinary approach to good science with an obvious technological import,” says Cornell’s Francis (Frank) DiSalvo, co-principal investigator with Héctor Abruña, both professors of chemistry and chemical biology. “It is not often you can see such a close link between the basic research and a potential payoff.” DiSalvo is director of the National Science Foundation (NSF)–funded Cornell Center for Materials Research, which manages a group of shared experimental facilities that will provide many of the analytical tools for the fuel cell research.

Some of the research also will take place in two other NSF-funded centers, the Cornell Nanoscale Facility and the Cornell High Energy Synchrotron Source.

Although the CFCI initially will involve just six Cornell researchers and one from the California Institute of Technology, ultimately it could call on the expertise of many of the 100 faculty members involved in materials research at Cornell. The DOE funds primarily will support graduate and postdoctoral research.

—David Brand
Cornell News Service

MASTERING BIOMEDICAL

Cornell’s newly established master of engineering degree in biomedical engineering has been approved by New York State Department of Education.

The master’s program is recruiting for fall 2004 students, the first of whom will graduate in May 2005.

Michael Shuler, the Samuel B. Eckert Professor in Chemical Engineering at Cornell, director of the cross-campus BME program, says that the new M.Eng. degree will prepare students for professional practice in biomedical engineering. “Students in the program will acquire a broad perspective on the biomedical engineering discipline that complements their undergraduate training in engineering or science, and in-depth knowledge of an essential area in biomedical engineering,” he says.

The degree’s three areas of focus are: drug delivery and cellular/tissue engineering; bio-instrumentation/diagnostics; and biomedical mechanics and materials. Graduates will be equipped to design biomedical devices and develop therapeutic strategies within the bounds of health-care economics, the needs of patients and physicians, the regulatory environment for medical devices and pharmaceuticals, and stringent ethical standards of biomedical engineering practice.

“We believe that the breadth and depth of knowledge needed in biomedical engineering makes a four-year B.S. degree program impractical. By combining the M.Eng. in BME with a strong B.S. program, a student can obtain the knowledge and skills necessary to be an effective professional biomedical engineer,” Shuler says. Students will be able to link their undergraduate training to the new master’s program to create a five-year program in biomedical engineering.

In addition, an undergraduate minor in biomedical engineering, accessible to a broad range of students, was initiated in February 2003.

—David Brand
Cornell News Service

NEW KIND OF NETWORKING

A train has derailed at the edge of a city, spreading toxic chemicals and fumes over a wide area. Before rescue and decontamination workers can enter the danger zone, they need more information: How widespread is the contamination? Where are the hotspots? Where and how are toxic gases moving?

A helicopter swoops over the area, releasing a flurry of tiny devices, each about the size of a dime. They contain sensors that sample the air for toxins and tiny radio transceivers that allow them to communicate with one another and report to a van at the fringe of the disaster area. Inside the van, a screen lights up showing where the contamination is and how it’s spreading.

Such a system is the goal of a new research project at Cornell University that brings together molecular biologists, device physicists, telecommunications engineers, information and game theorists, and civil engineers to develop “self-configuring” sensor networks for disaster recovery. The project, involving researchers from Cornell and the Wadsworth Center of the New York State Department of Health, is funded by a $2.5 million, five-year Information Technology Research (ITR) grant from the National Science Foundation (NSF).

While initial research will focus on the detection of biohazards, the underlying principles can be applied to many other situations, including searches for earthquake victims (using audio and body-heat sensors) and monitoring of municipal water systems for leaks or contamination, according to Stephen Wicker, Cornell professor of electrical and computer engineering, who heads the research team.

In the aftermath of a disaster—whether it be an earthquake, fire, building collapse,
or terrorist attack—the most pressing need is for information, Wicker explains. Because often it would be dangerous or even impossible to collect data manually, the plan is to create an automated self-configuring remote sensor network. The idea grew out of studies of how such networks could be used on the battlefield, Wicker notes, but the NSF project focuses on civilian applications. "If they can save the lives of soldiers, you can use them to save the lives of civilians," he says.

—Bill Steele
Cornell News Service

SMALLER THAN SMALL

The world too small to see is revealed in a traveling science museum exhibition, “It’s a Nano World,” which was on view at Innoventions at Epcot in Lake Buena Vista, Fla., earlier this year. It was the first exhibit at Innoventions to highlight nanotechnology.

The 3,000-square-foot traveling exhibit is a result of a unique collaboration between Main Street Science (the education program of the Nanobiotechnology Center at Cornell), the Sciencenter in Ithaca, and Painted Universe, a design/fabrication team in Lansing, N.Y.

Innoventions at Epcot is a unique attraction filled with hands-on, interactive exhibits for guests to discover how cutting-edge science and technology can simplify and enhance life today and in the future. This interactive playground allows guests to be among the first to experience new products and services and to understand how these new methods will change the way we live.

The “It’s a Nano World” exhibit is part of a vibrant educational outreach program whose mission is to foster a lifelong interest in science and technology by teaching people of all ages about the nano world. Entering through the gateway of “It’s a Nano World,” visitors are transported into the wonders of biology at the nanometer scale, experiencing the scientific and technological discoveries of the Nanobiotechnology Center.

The exhibition has a number of hands-on activities where visitors can view the nano world using a variety of tools. An important tool in nanobiotechnology, a cell sorter, is transformed into an interactive exhibit where visitors sort balls (representing cells) with a series of vacuum hoses and collect “cells” in hoppers.

Scientific content was not the only driver of the exhibit. "One of the most important perspectives that the collaboration brought to the exhibition was the idea that it should be fun for kids and informative for adults," said Anna Waldron, director of education for the Nanobiotechnology Center at Cornell.

The exhibition began touring in winter 2003 and will continue for up to five additional years.

—Cornell News Service

Salute To Nanotechnology

Cornell University researchers have etched the world’s smallest, full-color American flag on a silicon chip. The flag is part of an elaborate nanofabrication that includes six full-color flags and 15 White Houses, all etched on the chip. The size of a postage stamp, the chip has been placed in a Lucite paperweight that was presented to the White House on March 30 in Washington, D.C., by Joshua Wolfe, a 1999 Cornell graduate and managing partner of Lux Capital, a New York City venture capital firm specializing in nanotechnology. All told, the chip features 15 monochrome images of the White House flanked by six full-color American flags, embedded with microscopic features that reflect the colors of the stars and stripes. There are three visible White House images and a dozen nano-size ones, 500 microns wide and 225 microns high, that appear as dots without magnification. The flag and the White House images were produced using advanced photolithographic tools in the National Science Foundation–supported Cornell Nanoscale Facility.

—Blaine P. Friedlander Jr.
Cornell News Service

Cornell News Service
PATENTS PENDING

Landing a spot in the U.S. Patent and Trademark Office’s list, Top 10 Universities Receiving Most Patents in 2003, did not surprise technology-transfer specialists at Cornell Research Foundation (CRF), the unit that manages intellectual property for the university.

“This is just one measure of a successful technology transfer program, and all our indicators are on the increase. We’re on track to do even better in 2004,” said Richard S. Cahoon, senior vice president at CRF. With 59 U.S. patents issued in 2003, Cornell shared the No. 10 ranking with University of Florida. In 2002 Cornell was 21st on the nationwide list, with 35 patents granted.

No. 1 on the list with 439 patents in 2003 is the University of California, the public system with nine campuses, 201,000 students, and 160,000 faculty and staff members. By comparison, Cornell has three main campuses (in Ithaca, New York City, and Doha, Qatar), 20,225 students, and 11,835 faculty and staff members.

“If you consider the ratio of patents to employees, we’re more than twice as productive as the University of California,” Cahoon observed. “And we should do even better in the future. So far this year, we’re averaging more than one new invention disclosure each business day,” he reported, “and we expect to set an all-time high for the number of new inventions submitted to our office.”

Details on more than 360 Cornell-patented technologies are available for licensing on the web at http://www.crf.cornell.edu/.

—Roger Segelken
Cornell News Service

COOL SCIENCE

A group of some two-dozen engineering students this spring put the finishing touches on a space project that will deliver a pair of small-scale satellites into low orbit in an effort to examine a section of the Earth’s atmosphere and its effects on Global Positioning System (GPS) transmissions.

Dubbed ICE CUBE, the project is Cornell’s version of the CubeSat program run by Stanford University and California Polytechnic State University that seeks to engage students in the design, construction, and launch of “picosatellites.” While each CubeSat measures just 10-by-10-by-10 centimeters, they are being deployed for a variety of research tasks.

With ICE CUBE (IOnospheric CUBEs Experiment CubeSat), the team’s scientific mission is to measure disturbances in the ionosphere by sensing variations in the signal strength of GPS using GPS units in the satellites. The measurements will be recorded and sent to the ground station on campus for full evaluation.

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

Faculty sponsor Mark Campbell, an assistant professor of mechanical and aerospace engineering, explains that ICE CUBE brings together students in mechanical and electrical engineering and computer science. Not to be left out are members of the Cornell Amateur Radio Club, who will monitor the health of the satellite as well as the GPS scintillations measurements at a ground station in Barton Hall.

“We are finishing testing of the most recent prototype, which is identical to the flight units,” Campbell said in early March. To reach this point, students have spent three years, working in teams of 20 to 25 members, designing and building the satellites. “The educational experience for the students working in an interdisciplinary team on hardware that will fly in space is invaluable,” Campbell said.

Following test flights in April and May, the CubeSats will be shipped to Cal Poly, where they will be packed into deployment units that, in turn, will be placed on board rockets to be launched in the fall from a site in Eastern Europe.

If all goes according to plan, and Campbell has his fingers crossed, the Cornell students will be listening to and controlling two small satellites for several months, providing unique science data for the space weather community.

—Jay Wrolstad
ROLL THE CREDITS

Steve Marschner receives an Academy Award for his contributions to Hollywood’s most believable animations.

Marschner (above) at awards ceremony and (right) with colleague Pat Hanrahan.

By Beth Saulnier
THE CREATURE has pointy ears, fangs, a few sparse strands of scraggly hair. His chest is sunken, his skin a sickly shade of bluish gray. But he has wide blue eyes that tug at the heartstrings when he begs for mercy, or that glint with evil when he’s plotting to murder his only friends. He’s Gollum, the most intriguing character in the Lord of the Rings film trilogy, and he doesn’t exist.

It’s not just that the fallen Hobbit is a figment of J.R.R. Tolkien’s imagination; even on the set of the blockbuster motion pictures, he was nowhere to be found. Gollum is made not of flesh and blood but of ones and zeros and is widely considered to be the most sophisticated character ever to be created through computer animation. He owes his existence to a team of animators and computer scientists—including Cornell assistant professor and Ph.D. alumnus Steve Marschner.

While doing post-doctoral research at Stanford, Marschner was part of the team that discovered a way to make computer-generated skin much more realistic. Their findings have been incorporated into the digital palettes of
rather than translucent, a technique that made such renderings seem false to the human eye. A digital depiction of a marble statue, for example, would make it look like plaster. “Without accounting for translucency, it’s very hard to set things up so the skin looks like skin,” says the 32-year-old Marschner. “It looks too hard, or too smooth, or too shiny. But once you account for translucency, then suddenly you can get another level of realism. Subjectively, it looks like a soft material, like skin.”

The work grew out of a Stanford research effort directed by Marc Levoy ’76, M.S. ’78, known as the Digital Michelangelo Project, a marriage of art and science in which extremely high-resolution scans were made of several works including the famed David and the Slaves, unfinished statues that seem to be struggling to emerge from the rock. Although Marschner didn’t travel to Italy—he joined the project after the scans had been done—he worked on the data-crunching in Palo Alto. “The project was pushing the limits of three-dimensional scanning technology, but it was also creating an archive of data that’s useful for art historians and others who study these statues,” Marschner says. “They’re detailed enough so that with a large statue like the David, which is about twenty-three feet tall, over the entire surface you can see individual marks from the chisel that was used to make it.”

One of the project’s questions was whether, in the context of such detailed scans, marble’s translucency could cause problems with the data collection. The answer turned out to be no, but it sparked the team’s interest in the issue of subsurface scattering. Taking principles of physics into account and drawing on methods from medical physics, they created a simple model to describe the behavior of light in relation to translucent materials, then translated it into a method of rendering such materials via computer graphics. The researchers didn’t create a piece of software, but rather a tool for effects masters to use in their own rendering systems.

Computer renderings of a glass of milk: On the left the milk is modeled as an opaque material, making it look more like white paint. At center (skim milk) and right (whole milk), it is rendered with translucency, using data from measurements of real milk, and its appearance is correct, showing light bleeding through the edge of the milk and into the shadow.
And use it they have, in such films as *Harry Potter and the Chamber of Secrets*, which features its own entirely computer-generated character in Dobby the House Elf, Harry’s high-strung servant. And in *Terminator 3: Rise of the Machines*, in the form of the lovely—but-lethal T-X robot. And *The Matrix Reloaded* in which the technique was used for “digital replacement heads”—when a computer-generated version of a real actor’s head is used to replace that of a stuntman, or to top a digitally rendered body during tricky action sequences. “When they give these awards, frequently they go to the studios and the people who did the implementing for the films,” says Professor Don Greenberg, director of Cornell’s Program of Computer Graphics (PCG). “But enough studios were using this that they looked deeper and went back to the source, which is the research.”

Although Marschner and the Stanford team were honored for their work on translucency and its improvements in skin rendering, they’ve also contributed to research on another physical attribute: hair. “Hair is something that you need in renderings of animals and people and monsters,” Marschner says. “It’s also something that the cosmetics industry is very interested in the exact appearance of. But the models that have been used for how light scatters from hair are really quite simple.”

In work begun at Stanford (and which Marschner is continuing at Cornell), the researchers made a breakthrough in the study of how light interacts with human hair. Using samples from volunteers—including blonde locks from Marschner’s wife, Heidi—they suspended a single strand from a clip, illuminated it with a focused light beam, and recorded the reflection with a digital camera. Their discovery: that the standard method for rendering hair, industry is very interested in the exact appearance of. But the models that have been used for how light scatters from hair are really quite simple.”

In work begun at Stanford (and which Marschner is continuing at Cornell), the researchers made a breakthrough in the study of how light interacts with human hair. Using samples from volunteers—including blonde locks from Marschner’s wife, Heidi—they suspended a single strand from a clip, illuminated it with a focused light beam, and recorded the reflection with a digital camera. Their discovery: that the standard method for rendering hair,
known as the Kajiya and Kay model, didn’t take into account the fact that many hair types have a cross-section that’s elliptical rather than circular.

This phenomenon (commonly seen in people of European and African descent, less so in Asians) causes the hair to behave like a lens, focusing light in certain directions. “People who have elliptical hair will often have glints that you can see if it’s reasonably light-colored,” says Marschner, who presented the team’s findings in July at the 2003 SIGGRAPH computer graphics conference in San Diego. “They’re an important part of the appearance, and they lend a distinctive texture to the hair.”

Marschner’s work on modeling hair, skin, and other materials doesn’t just have applications in the worlds of motion pictures and videogames; there are many other fields in which it’s vital to reproduce reality in exacting detail. Architects need realistic renderings of their designs to show clients; doctors to 1977 and the release of a little movie called Star Wars. As a child in suburban Chicago, he read everything he could get his hands on about how the filmmakers used intricately designed models and motion-controlled cameras to create the movie’s spaceship battles, set “a long time ago in a galaxy far, far away.” Years later, he would make a professional visit to Industrial Light and Magic, the effects house that director George Lucas founded to produce Star Wars; he chuckles when he ponders how he would’ve reacted if, as a young boy enraptured by the inner workings of the Death Star, he’d known that someday he’d be standing in the temple to Luke Skywalker and Darth Vader. “I was completely fascinated by Star Wars, and really excited about it,” recalls Marschner. “I had a video camera and played with trying to make little models and really accurate.”

Like many of his contemporaries, Marschner can date his fascination with computer graphics and special effects of that silk blouse or cashmere sweater. “One of the things that I think is great about computer graphics is that it’s an interdisciplinary area that’s at the boundary between computer science and other things—physics, animation, optics, the dynamics of how things move,” Marschner says. “I get to learn about new things, all the way from science to art, as part of my work.”

Marschner with graduate student Jacobo Bibliowicz

Steve’s both a scientist and a computer scientist, so he understands the need for experimentation and verification and physics and optics. He also has the smarts to be able to translate it into computer algorithms, and that’s a very rare commodity.
he calls among the best in the world. “Steve’s both a scientist and a computer scientist, so he understands the need for experimentation and verification and physics and optics,” Greenberg says. “He also has the smarts to be able to translate it into computer algorithms, and that’s a very rare commodity.”

Marschner is presently continuing his research, refining the models for depicting hair and skin realistically and expanding them to include other materials such as cloth. In addition to his research activity, he teaches undergrad and graduate courses as one of the department’s dedicated computer graphics faculty (with Greenberg and assistant professor Kavita Bala).

“The recent hiring of Steve and Kavita reflects our belief that graphics has an increasingly important role to play within Computing and Information Science and the larger circle of engineering and science,” says Charles Van Loan, chair of the Department of Computer Science. “Together with Don Greenberg, they have put together a world-class graphics curriculum that permits our wonderfully talented undergraduates to go deep into the subject.”

“He’s really a joy to work with one on one,” says computer science major Andrew Butts ’05, who took Marschner’s undergrad course last year. He received a research grant sponsored by United Technologies through the Learning Initiatives for Future Engineers program in the College of Engineering to work with Marschner over the summer. “It was a really enriching experience,” says Butts. “He always had lots and lots of ideas. It seemed like every time I had a meeting with him, he would leave me with five or six new paths that I had to choose from.”

Butts’s summer project involved writing software to simulate how light interacts with rough surfaces. He ran the simulation on the PCG’s computing cluster and collected and plotted “a really large amount of data,” but didn’t get as far as implementing a production-ready rendering; he’s continuing the research this semester as an independent study. “Especially in computer graphics, his math skills really shine,” Butts says of Marschner. “He pretty much knows all the mathematical theory behind any topic.”

Butts himself came to Cornell to study computer graphics after running across the program’s website while doing research during high school; he hopes to have a career in the field after graduation. How does he feel to be working under one of the people responsible for the striking realism of characters like Gollum? “It boggles my mind,” he says with a laugh. “What you see in The Lord of the Rings is definitely state of the art. You won’t find anything better than that right now. But there were people saying exactly that about the liquid metal guy in Terminator 2 when it first came out. ‘That’s amazing, we’ll have computer-generated humans in no time.’ But now we look back at that and say, ‘We could have the undergrads whip that out in a couple of hours.’”

The motion picture academy’s Edlund—who uses credits as a special effects master include all three Star Wars movies as well as Raiders of the Lost Ark, Poltergeist, Ghostbusters, and Die Hard—notes that as techniques get more sophisticated, so do audiences. “I always hearken back to my severest critic—that is, the ten-year-old who knows what reality looks like when it’s photographed and has seen many movies,” Edlund says. “If something doesn’t look right he says, ‘Hey, that looks funny,’ and you’ve lost him. These technologies that are developed by the supernerds—and I say that lovingly—are part of the creative force behind movie making. So the academy tries to seek out and applaud those who make it possible to make more convincing movies.”

At the Valentine’s Day ceremony at the Ritz Carlton in Pasadena, Marschner and his colleagues received certificates, not Oscar statuettes; clips from the event were shown during the main Academy Awards broadcast on February 29. Still, the honor puts him in the fraternity of Cornell-educated computer graphics gurus—including George Joblove ’76, M.S. ’79; Doug Kay ’76, M.S. ’79; Roy Hall, M.S. ’83; and Rob Cook, M.S. ’82—whom the Academy has honored for contributions to the field. As Van Loan points out, “The combined research strength of the PCG and the CS department makes Cornell one of the top places to study graphics at the graduate level.”

“It’s very gratifying to see the stuff being used, especially in films that I really enjoy,” Marschner says. “With Lord of the Rings, even as a computer graphics person, my attention was essentially focused on the performance of Gollum, rather than on the details of the rendering. Usually I’m always looking at all the little flaws. But that one was done so well that it’s the performance you’re seeing rather than the technology.” Edlund notes that in the case of the tortured Gollum—whose good and bad sides are at war with each other as he leads the Hobbits on their quest to destroy the evil Ring of Power—a computer-generated character was seen to convincingly argue with himself. “To me,” he says, “this was a historic moment in moviemaking.”

Beth Saulnier is a journalist and mystery author who lives in Manhattan. Her next novel, See Isabelle Run, comes out in March 2005 under her married name, Elizabeth Bloom.
N a stunning scientific advance, James Watson and Francis Crick in 1953 revealed the hidden structure of DNA. They proved that nature’s elegant and ingenious double helix is programmable and is the ultimate molecular building block of life.

Now Dan Luo, an assistant professor in Cornell’s Department of Biological and Environmental Engineering (BEE), is doing pathfinding work to extend DNA’s usefulness. He is looking beyond DNA’s purpose as genetic building block, showing it to be a versatile generic building block—an engineering material with near limitless potential.

Luo’s work in nucleic acid engineering—a term he coined just three years ago—could help revolutionize biological engineering at the nanotechnology level. In the short term, the sturdy twisted rope of the DNA molecule could be synthesized to build super-small nanomaterials and nanodevices with amazing biomedical applications, including precise multi-drug delivery systems to treat AIDS or cancer. Further in the future, such materials could be shaped into unimaginably powerful nanomachines and nanocomputers.

“Great potential exists beyond DNA’s use as a genetic material, in using it as a generic engineering material,” asserts Luo, “That’s because we now have the tools at the molecular level, such as enzymes, to design DNA molecules in a true engineering sense, with exacting control over their shape and architecture.”

Luo sees DNA as one of nature’s ultimate polymers, a large molecule comprising many smaller ones linked together, synthesized-to-order through the controlled repetition of those smaller structures. In the modern macro-world, long-chain polymers, such as plastics, revolutionized 20th century society, allowing for the fabrication of complex materials with tailor-made properties—everything from nylon to Plexiglas—to fit thousands of industrial and technological applications.

What is required to achieve such a goal on the nano-level, says Luo, is a change in perspective: We must view DNA not as a means of storing genetic information, but rather as a nano-sized LEGO block for building new molecules. “DNA through its natural evolution has become a material with self-programming ability. In other words, one DNA strand can recognize its complementary strand. The bonding between these two strands is very specific,” he explains. And these same qualities, which make DNA a perfect information storage molecule, also make it a versatile polymer.

There are, however, major hurdles to DNA’s use as nanotechnology building block: First, all DNA molecules in nature are made only in linear or circular forms, which greatly inhibits their design potential. Imagine, for example, how limited the engineering possibilities of LEGO blocks would be if they only came in stick or circle shapes. But if we were able to create other basic configurations, “Y” or “X” shapes for example, in a controlled manner, the engineering potential would expand exponentially.

The other two limiters to DNA’s use as a nano-polymer are low yield and purity. “When Dr. Nedarin Seeman of NYU first tried to use DNA for nanotechnology purposes in the late 1980s, he made some very impressive structures, such as DNA cubes,” relates Luo. “But while that provided a proof of concept, his yield was less than one percent,” making these structures impractical for immediate application. In a sense, Seeman was hand-making a Stradivarius violin. But what is needed for most biomedical and other applications is accurate mass production of new DNA nanoscale structures—like making Model-T cars on an assembly line.

In fact, Luo and his Cornell collaborators may be well on the way to becoming the Henry Fords of nucleic acid engineering. They have taken huge strides to overcome all three of the limiting factors.

The accomplishment gaining the most attention is the making of dendrimer-like DNA molecules by Luo’s team. A dendrimer (from the Greek dendra for tree) is an artificially synthesized molecule built up from many branched units called monomers. Creating novel dendritic architecture out of DNA is especially challenging since the researchers are working at the scale of nanometers—a nanometer is 10^{-9} meter or a millionth of a millimeter.

“All the molecules in the world can be classified into four different architectures: linear, branched, networked (like mesh), and dendritic,” Luo clarifies. “On the macro-level, dendritic structures are one of the most abundant architectures in nature. You see them in tree shapes, root shapes, leaf veins, and river deltas. But at the molecular nano-scale, there are no known naturally occurring dendritic molecules.”

In January 2004, Luo and his associates publicized their creation of the first-ever dendrimer-like DNA molecule synthesized in a controlled manner with a high yield that is very pure.

The structure is built from a novel, laboratory-designed, Y-shaped DNA molecule, with specific “sticky” ends that enable it to connect to other very specific Y-DNA molecules via their sticky ends in a highly controlled and enzyme-catalyzed fashion. These basic
designing molecules

Dan Luo’s new DNA structures could unleash the power of polymers in the fight against bacterial infection, cancer, and even AIDS.

By Glenn Scherer
Y-DNA building blocks can be “grown” into varied dendrimer-like structures that look like snowflakes and can be seen by the electron microscope. This achievement greatly expands the nanoscale LEGO building set that had only contained sticks and circles, giving it new design potential.

Since this success, Luo and his colleagues have gone on to synthesize “X” and “T” shaped DNA molecules, without any genetic purpose, but giving their nano-DNA architecture infinite design versatility.

Luo’s team has already begun developing applications for dendrimer-like DNA. “It is very important to note that we can make our dendrimers ‘anisotropic,’ that is, we can make them different in a precisely controlled way,” says Luo. “Most branched polymers are ‘isotropic,’ so the branches must either all be exactly the same, or all different in a random manner. But we can precisely control which branch is which. That means that we can add molecules to the structure in a totally directed manner.”

If, for example, Luo wanted to bond three different drugs to a dendrimer-like DNA structure, he could design different-sized sockets or chemical hooks to hang each drug on, a process called conjugation.

Currently Luo is developing a nano barcode using dendrimer-like DNA to recognize specific bio-molecules in the human body or environment—a process that works something like a cash register reading barcodes on products in a supermarket. “With a DNA barcode we could detect thousands of different genes or pathogens in the body simultaneously. The DNA molecule used this way becomes like a gene chip in solution,” says Luo. Another promising application for DNA barcodes is in environmental detection, creating sensors at the nano-level to simultaneously detect many types of microorganisms in soils, a project Luo is working on with BEE colleague Professor Larry Walker.

Many diseases are caused and advanced by several factors. So drugs (including genes) that are aimed at a single target have limited success in treating complicated diseases such as cancers. Conceptually, it would be more effective to treat tumors with multiple drugs, ranging from small drugs to macromolecular drugs such as gene therapy, that are directed against not a single, but numerous targets.

The anisotropic characteristic of dendrimer-like DNA makes it an ideal structure for delivering multiple macromolecular drugs to a cell in precise doses. But it is extremely difficult for macromolecules such as DNA or proteins to enter the cell. There is no way to be certain that several DNA and protein drugs injected into the human body will enter the desired cells in the desired amount. “You must now treat a disease twice, or more, first with gene A, then anti-gene B, then antibody C. But whether drugs A, B, and C all enter the same cell is purely chance,” Luo explains. “It would be revolutionary if we could deliver gene therapy, anti-gene therapy, antibody therapy, and chemotherapy in a controlled manner within one delivery vector.”

But the greatest barrier to a multi macro drug delivery system is the human cell itself. “Cells behave much as a well-guarded building with many security measures to prevent suspicious macromolecules such as DNA from entering.” There are further defenses to prevent alien DNA from getting inside the cell nucleus. “It is harder to deliver DNA from outside of a cell to inside a nucleus than to get a man from Earth to Mars,” jokes Luo.

To develop a working multi-drug delivery vehicle, Luo is studying viruses. “They are the most efficient DNA and protein delivery machines,” he notes. “But of course, they cause disease and are dangerous. So we are dissecting different viruses, removing the components that cause infection, and isolating only those components that are important in delivery to the cell and nucleus. In essence, we’re constructing an arti-
ficial virus that is not a virus at all. Our dendrimer-like DNA serves as the architectural core, the scaffold to link those amazing viral delivery proteins onto one vector. So our nanoparticles are artificial and non-infectious, but powerful viral delivery protein assemblies. We call our delivery system Viral and Non-Viral Assembly, the VNA system."

Such a multi macro drug delivery system could one day be used to accurately convey drug combination cocktails to AIDS patients or to provide, at once, several chemotherapy drugs with antibodies to cancer patients in precise dosages inside the cell.

A designer-DNA multiple delivery system would also be ideal in gene and anti-gene combined therapy, where it is necessary not only to provide damaged cells with copies of good genes, but also to destroy defective genes at the same time.

Such a multiple delivery system could work for bacterial infection too. If a bacteria has developed resistance, an increasingly common problem in today’s hospitals, a DNA-vector could allow treatment of an infection with two or more antibiotics at once.

"We have already promising preliminary results in one DNA multi-drug delivery project," Luo reveals. "We have succeeded in creating a viral-protein-DNA hybrid and are seeing if it can enter a cell or not. It looks so far as if it can. That is a very striking phenomenon."

"We are also working on a nano-heater," Luo adds. "It is a means of generating [very localized but intense] heat using dendrimer-like DNA. We think it could be used to inactivate a virus in the body and to deactivate infectious microbes."

Luo has been intrigued by the mysteries of DNA since his undergraduate days. He obtained his bachelor's degree from the University of Science and Technology of China in 1989, doing his undergrad thesis on computer simulations that showed how antibacterial protein drugs could alter their structures to bind to DNA.

Working on his Ph.D. at Ohio State University, Luo studied topoisomerases, important proteins that can alter the topology of DNA. Topoisomerases are produced by cancerous cells in larger amounts, so they are major targets of cancer chemotherapies. "I was trying to understand the protein-DNA binding action with the presence of chemotherapy drugs," explains Luo. He also worked on a DNA network that could be used in cancer gene therapy, though such a network is currently too large to get inside of a cell and nucleus.

Luo did his postdoctoral training at Cornell’s School of Chemical and Biomolecular Engineering, focusing on synthetic DNA delivery systems. He joined the faculty of the Department of Biological and Environmental Engineering in May 2001.

"At Cornell, I started by studying a DNA delivery system that would protect the DNA inside the hostile environment of the cell. I worked with a controlled release polymer," which is, Luo explains, very much like a time-release drug. "We encapsulated the DNA into this polymer in a microsphere format, then it was gradually released, in a controlled manner. We found that the DNA was indeed protected before it was released, and it maintained its biological and genetic function."

Different medical situations require drug delivery systems at different scales. Luo has also worked on the nano-scale, micro-scale, and milli-scale DNA delivery systems that were based on silica nanoparticles, chemical dendrimers, nanofabricated electrodes, and other controlled release polymers. "Most of these systems are based on off-the-shelf and isotropic materials," Luo explains. "I would like to use anisotropic polymers instead to control the design."

Luo has more recently focused on dendrimer-DNA anisotropic patterning, an important design innovation. DNA, since it can be easily chopped away or dissolved, can act like a nanoscale mold or form. "You can create a DNA pattern, a honeycomb shape or surface, for example," says Luo. "You coat the surface with other chemicals, then treat it with enzymes, until all the DNA is digested away. The originally occupied pattern of DNA will remain there as a clean pattern, like a stencil."

Such patterning techniques would have many engineering applications, including the making of nanowires, nanoscale sieves, even nanomachines or nanocomputers that would use DNA "Y," "X," or "T" shapes in various controlled combinations to make circuits.

It is difficult, probably impossible, says Luo, to imagine the full scope of DNA nano-material engineering applications today, just as it would have been impossible in 1900 to guess at the ways in which plastic polymers would remake the 20th century with the then-unimagined wonders of nylon and acrylic fibers, polyethylene (used for plastic bags and bottles), and polycarbonate and polycrylamide (the material used in compact discs). Today’s ubiquitous plastics serve as spacecraft and computer components, as heart valves, and of course LEGO’s! Tomorrow’s dendrimer-like DNA applications may stretch across an equal number of mind-boggling horizons.

"What is demanded is a broad interdisciplinary approach to achieve the full potential," says Luo. "We are currently in a quite exploratory stage in biological engineering. In terms of our research and applications, we need to integrate an engineering component, chemistry component, biology and physics components, plus a polymer and drug delivery component. It’s a very rich and complex cross-pollinating process."

We need to integrate an engineering component, chemistry component, biology and physics components, plus a polymer and drug delivery component. It’s a very rich and complex cross-pollinating process.

"And of course this is one of the strengths at Cornell. There are almost no walls between departments, and multiple collaborations are easy," concludes Luo. "I’m very lucky to have so many fine collaborators in other departments, along with a supportive department, and the best undergrad and grad students." It is through such multi-branched, dendrimer-like linkages that Luo hopes the promise of nucleic acid engineering will be fulfilled.

Glenn Scherer <gscherer@sover.net> is a freelance writer in Vermont.
Lindsey Brock ’04 EP (left) and lab manager Tim Bond (right) worked with Harry Stewart (center) and Robert Sullivan on Mars rover wheel tests in Cornell’s Winter Laboratory.
Scooping a small hole on the surface of Mars could yield big news about the planet’s past.

SOMETIMES just spinning your wheels is more productive than it sounds.

Especially if those whirling wheels churn the virgin soil on a planet millions of miles from Earth. That is the premise promoted by two Cornell colleagues and approved by NASA as
worthy of inclusion in the Mars Exploration Rover (MER) mission.

In the experiments developed by Harry Stewart, a geotechnical engineer and associate professor in the School of Civil and Environmental Engineering, and Robert Sullivan, a planetary geologist and senior research associate in the Department of Astronomy, the wheels of the Spirit and Opportunity rover vehicles serve as tools to reveal what lies beneath the topsoil of the Red Planet.

The cutting-edge, high-resolution cameras carried by Spirit and Opportunity, which landed on Mars earlier this year, reveal the texture, shape, and angularity of the soil and mineralogy of the planet, but images provide only part of the story. “Pictures are useful,” Stewart says, “but having a physical measurement is something that’s very important.”

The rovers are essentially six-wheel-drive vehicles, with a motor and navigation system in each hub. Sullivan and Stewart, with enthusiastic support from key rover engineers at the Jet Propulsion Laboratory in Pasadena, Calif., devised a way to lock five of the wheels and rotate the sixth to create a small trench a few inches deep. “We want to delve into the third dimension and take a closer look at the subsurface,” says Sullivan. “You can only tell so much by rolling along the surface and taking pictures.” Digging would give scientists access to soil underneath the surface that may be significantly older than the top layer.

In scrutinizing the composition of the Martian ground, these experiments mesh with the $820 million MER mission’s main objective: to search for and characterize an array of rocks and soils that offer evidence of past water activity on Mars. They add scientific value to the mission without adding more of instruments on the rover vehicles, Stewart says.

“If the tracks made by a rover wheel in a variety of soil types found on Earth match those made on Mars, it’s possible to deduce that the soils there have the same textural characteristics as those on earth.”

Now he’s looking at soil that’s out of this world. In 2001 Sullivan, who has participated in NASA’s Mars research for several years, approached Stewart with the idea for a collaboration to study the physical and mechanical properties of Martian soils. The resulting proposal was one of 28 selected by NASA (from more than 80 submitted) for inclusion in the MER mission.

By now, most people are familiar with the images beamed back to earth by Spirit and Opportunity as the golf cart-sized vehicles cruise uncharted extraterrestrial territory. The rovers have provided panoramic views of the landscape, zoomed in on rock formations, and tested the atmosphere with sophisticated sensors.

Sullivan and Stewart were confident that the rovers could go a step further, providing information about the texture and strength characteristics of the Martian soil by putting the wheels in motion.

To prepare their experiments, Sullivan and Stewart brought a Mars Rover wheel to Cornell’s George Winter Civil Infrastructure Laboratory and tested its interaction with various types of soils. Sullivan also visited the Martian terrain proving ground at the Jet Propulsion Lab (JPL), the lead laboratory for NASA’s robotic exploration of the solar system, to gather information on how the wheels interacts with different soil types and sand.

Each of the 10-inch wheels is fashioned from a single piece of aluminum, hollowed out to reduce the weight. Traction is provided by a paddlewheel-type tread that is machined onto the
outside of the circular frame.

Allowing the wheel to spin in the test bed layered with yellow, pink, and green sand, Sullivan observed how the wheel created piles of soil tailings and where each color of sand was concentrated in the tailings. With this information, scientists can see how deep the rover wheel is when it reveals a specific color and estimate, by comparison, which soils in the tailings come from various depths when the same process is used on Mars—since the soil there won’t be color-coded.

“By examining those tailings on Mars with a microscopic imager, we can determine the characteristics of the larger soil grains such as size and angularity,” Sullivan says.

At the same time, monitoring the motor current driving the wheel as it spins and digs can indicate the strength of the soil; if the motor struggles or spins easily, scientists can determine the relative strength of the soil.

Interpreting the results of the trenching tests is Stewart’s primary role. Stewart notes that if the tracks made by a rover wheel in a variety of soil types found on Earth match those made on Mars, it’s possible to deduce that the soils there have the same textural characteristics as those on earth.

“What’s interesting is that we may be able to expose more fresh soil on Mars in other ways as well,” he says, citing the rover’s rock abrasion tool that grinds off a layer of rock and exposes unweathered material, thereby offering a clearer view of Martian mineralogy for a spectrometer.

Another possible test involves locking the wheels on one side of the rover and rotating the vehicle so that it drags sideways through the soil, exposing fresh material. Then the rover backs up for a look at the exposed soil and employs other instruments to probe deeper into the skid mark.

What lies beneath the surface on Mars is anybody’s guess, although there have been some tantalizing hints. Data compiled from previous trips to the planet by the Viking and Pathfinder missions reveals that it is an inhospitable, parched planet blanketed by red dust. But previous probes have shown that the soil looks very different from red dust, leaving more questions than answers.

In the first weeks of exploration the two rovers detected a site with soil rich in hematite, an iron ore typically formed in the presence of water, that is a prime wheel-trenching target.

“By going deeper into the soil we don’t know what to expect,” says Sullivan. “One hypothesis, based on previous detections of a crusted soil, is that minute amounts of water known to be in the atmosphere have interacted with the soil over a very long period to give it cohesion.”

There is a consensus among scientists that the Martian soils consist partly of very fine-grained particles, in the two- to three-micron range, and should behave similar to fine-particle deposits found closer to home. The biggest difference, of course, is that there is no water on Mars.

“On Earth, it is how these very fine particles interact with water that gives them a wide range of characteristics,” Stewart explains. “On Mars they will...
behave like dry powders in many cases."

In early February, Stewart and Sullivan were still anxiously waiting for the trenching tests to begin. Software glitches with Spirit, the first rover to touch down in January at the Gusev Crater site, resulted in communications problems that pushed back all tests. The two men acknowledged that their experiments are low on the list of mission priorities but were nonetheless disappointed when a scheduled trenching test using Spirit was postponed.

“They are preparing for some long drives by the rovers, taking trips that can’t be simulated in a research facility, so other scientific endeavors will have to wait,” said Sullivan, who was spending time at JPL during the mission as a member of the science team. In addition to the wheel experiments, Sullivan has an operations role involving the evaluation of data collected by the rovers’ panoramic and microscopic imager tools.

Although Stewart remained on campus, he followed the mission with rapt attention. “I’m watching the daily briefings by NASA and JPL, and I’m getting tons of mail from those working on the project, although I’m still learning the jargon.”

For Stewart, whose specialty tends to keep him focused on terra firma, participating in interplanetary science is a new experience. “I’ve kept my work pretty much confined to Earth,” he says, “until now.”

Location notwithstanding, there are many aspects of this space mission that parallel civil engineering on Earth. “There are lab tests designed to characterize the Martian soil that we do all of the time,” says Stewart. In geotechnical engineering, he explains, it is common practice to evaluate soil for its stress, strain, and strength characteristics and to perform experiments using that soil to interpret the results. “Rob is working on a soil-structure interaction problem, with the structure being a wheel on Mars,” says Stewart.

Sullivan’s previous research has included studying Martian drifts and dunes, Martian avalanches, along with the geology of asteroids and Europa, a moon orbiting Jupiter. A principal investigator for NASA’s Mars Data Analysis Program since 1998, he served as a scientist in the earlier Mars Pathfinder mission. “I have spent my career in planetary geology, and I like moving parts, so this was a unique opportunity that I could not pass up,” he says.

Weeks of anticipation finally paid off for Sullivan and Stewart, when the first rover trenching exercise was completed on February 16, fulfilling their hopes to conduct soil experiments during the mission.

NASA decided that Opportunity, which is in the Meridiani Planum region on the opposite side of the planet from Spirit, would be used for the first trenching tests. Opportunity landed in a crater, with bedrock in close proximity, and has sent back intriguing images of layered and pebbled soil deposits.

The single-wheel rover trenching process actually involves a series of complicated maneuvers, conducted by remote control, before and after each step of single-wheel digging in order to coordinate the investigations of each depression and the pile of soil tailings created when the dirt is moved. Sullivan spent many hours at JPL before the landing, working with rover engineers to perfect the complex sequence of digging and rover maneuvers that result in a unique rover “ballet” that gets the job done.

The efforts were worth it. “The resulting trench exceeded our expectations,” says Sullivan, who was at JPL monitoring the test. Opportunity was situated on a slope in a crater, which required some last minute refinements to the trenching sequence. To Sullivan and Stewart’s delight, the entire science team was as fascinated with the result—a trench 20 centimeters wide, over 50 centimeters long, and 9 centimeters deep—as they were. The science team elected to stay two “sols” (Martian days) to study the floor and walls of the...
trench with the spectrometers on the rover arm. The composition of materials found at the bottom of the trench differs from the composition at the surface.

“It was very exciting to get the data back,” says Sullivan, “because the characteristics of the trench—how it all really turns out—depends partly on how cooperative Martian soil is. Thorough preparation is important, but if the soil is ‘hard as a rock’ we wouldn’t be able to dig. Fortunately, things turned out well and the science team was thrilled with the result.” Soon after, Spirit’s science team decided to trench and was equally thrilled with the results, also electing to spend two sols to collect data at their trench site. Final analysis of the soil will take awhile, but Sullivan describes the initial observations as revealing cloddy soil along the walls of both trenches and soil that is somewhat brighter at depth than at the surface. Soil compositions on the floors are different from the surface.

Stewart’s and Sullivan’s work in the laboratory at Cornell really are just beginning. “Depending upon what we learn in the laboratory, what we have uncovered could change the interpretation of data collected thus far by the rovers,” says Sullivan. Results from the trenching tests could put a whole new “spin” on what the MER mission reveals about Mars.

Jay Wrolstad is a freelance writer in Ithaca.
THE Antarctic weather station researchers were having beer issues. When they brought in a few bottles of beer from the spot outside where they kept them chilled and opened them, the beer turned instantly to beer slush. Beer slush was not beer. It was much less satisfying than beer. The problem was getting to be annoying.

So one of the researchers turned to the science question-and-answer website
MadSci.org in search of advice. Ten thousand miles away, from her home computer in Boston, Mass., Kieran Kelly, a 1990 graduate of Cornell’s chemical engineering program and a one-time process engineer for ice cream and soda manufacturers, read the question and replied with a three-paragraph answer. As MadSci.org’s resident beverage expert, she knew the issue was pressure. When a bottle was opened, the pressure on the beer inside was rapidly reduced but the temperature stayed the same, which caused the beer to change states quickly.

Kelly sent off a phase-change diagram, attached a humorous bit of trivia about the concept of hot beer in an Ursula LeGuin novel, and laid out a course of action.

“It was pretty simple,” she said. “I told them to let the beer sit inside for half an hour.” And the researchers were happy.

In the seven years she’s been an expert in the areas of chemistry and engineering for the MadSci website, Kelly, now a manager with The Nova Group consulting firm in Boston, has fielded hundreds of common and bizarre questions, from people all around the world. She has explained how Kool-Aid drink mix is made, why ice sticks to the top of a car in winter, why milk washes down peanut butter better than water, and what a major-league baseball is made from. She has advised children against trying to fire their ceramics in a microwave; she has provided help in mummifying a Cornish hen and has explained the mechanics behind an Etch-A-Sketch toy. As one of Madsci.org’s thirty-five moderators, Kelly also shares the considerable responsibility of screening the thousands of questions submitted each month. She weeds out obvious homework assignments and requests for medical diagnoses, pairs questions with the experts most likely to know the answer, and reviews each outgoing answer, ranking its helpfulness on a scale of one to five, and checking to make sure all attached web links are functional. Like all MadSci experts and moderators, she does all this for free.

“I really just think it’s a blast,” she says. “Each question is kind of like a little challenge.” And beyond being fun, Kelly says, volunteering for MadSci.org is wonderfully convenient.

“You can access the site at any time of the day, from anywhere there’s an Internet connection,” she says. “It’s great.”

MadSci.org was created in 1995 by a Cornell classmate and friend of Kelly’s—Lynn Bry, currently an associate medical director at Brigham and Women’s Hospital and instructor of pathology at Harvard Medical School. In the late eighties, Kelly and Bry were Risley Hall dorm-mates and members of the Cornell women’s crew team. A few years after graduation, when Bry was in the M.D./Ph.D program at Washington University in St. Louis and Kelly was working for Kraft Foods in Chicago, Bry called Kelly up to tell her about a new site she was planning to launch. Would Kelly take a peek to see if it looked all right and would she like to help answer questions related to chemistry? Kelly answered, Bry recalls, “Oh, I totally want to do this.”

The idea for the site, Bry says, came after she and a number of other M.D./Ph.D graduate students gave a science-related presentation to a local St. Louis public school as part of the university’s outreach program. “We showed them something about the brain, something about the heart, something about chemistry, and then we were gone,” she says. “But the kids had questions; they wanted to follow up. And it seemed if we had some kind of question-and-answer service, we could provide a bit more information than we could in just one session.”

Bry was already the webmaster for her department, so
she and a few colleagues decided to set up a forum on the Internet. Initially, there were three categories—biological science, chemistry, and “other”—and the experts were twenty-five people associated with the medical school. Soon after, other Washington University graduate students studying astronomy and physics were recruited. Then graduate students and professors from other universities began to notice the site and asked if they could answer questions. “It was literally this word-of-mouth thing,” Kelly says. “It was people searching the web, finding the site, thinking it was cool and wanting to help out.” Within six months, the site had become, what Bry calls “a global entity.”

Today Madsci.org boasts 26 subject categories, from Agricultural Sciences to Zoology, and more than 1,000 volunteer experts worldwide, hailing from academia, industry, and U. S. government agencies including NASA and the Los Alamos National Laboratory. The focus of the site is still its “Ask An Expert” service, which handles anywhere from 2,000 to 5,000 questions a month, but it also provides a wealth of other resources, including a database of edible and inedible experiments, a feature called the Random Knowledge Generator (which posts questions and answers from the tens of thousands of exchanges stored in the MadSci archives), MadSci FAQ (the most popular question is: Why is the sky blue?; perhaps the strangest is: could a frog survive being swallowed and vomited by a cat?), and the MadSci Library, a collection of links to science sites and information about careers in science.

Over the past eight years, the site has been recognized by a wide variety of organizations, including the U. S. Department of Education, Science magazine, New Scientist, and the BBC. It has also received awards from The San Francisco Exploratorium (Ten Cool Sites in general science) and Popular Science (winner of Best of the Web for three years in a row) and, in 2000, was nominated for a prestigious Webby Award in Science, presented by the International Academy of Digital Arts and Sciences.

Bry sites four reasons for the success of the site: it’s free, fast (questions are usually answered within two weeks), factual (answers are well-researched), and friendly (responses are personalized). Two-thirds of the questions submitted to MadSci.org come from K–12 students, but Bry says the site is intended as a resource for anyone with a question about science. Some of the questions adults submit relate to scientific topics in the news (SARS, bird flu, bioterrorism, and the Mars probe are a few recent examples); some are seemingly more random.

Sherri Kohr, a K–8 science specialist in northern Virginia, recently used the site to ask whether crayfish eggs are fertilized inside or outside the body of the female crayfish. One of the crayfish a student of hers had taken home had laid eggs and the student wanted to know if they might possibly hatch. “We were all thrilled to get such a detailed answer so quickly and with so much additional information, even more than we had asked for.”

Rebecca Kilde, a freelance writer in Glenwood City, Wis., first contacted MadSci.org on behalf of her daughter to find out how and where hollow-boned birds make their blood and found the answer listed in the archive. Soon after, Kilde turned to the site again to settle an argument. She thought a sloth could turn its head 270 degrees in either direction; her husband thought 135 degrees in each direction. “I lost,” she says, laughing.

The popularity of the site with the people who sign on to be experts, Bry guesses, stems largely from a desire in many scientists to be part of an outreach-oriented community. “With Madsci.org, people feel like they’ve found their niche on the Internet. Plus they get to say ‘I’m a Mad Scientist’.”

For Jeff Yap ’98 MSE, a volunteer in the areas of physics and engineering for the past three years, there are more tangible benefits. Yap, who is studying to be a physics teacher at the University of Buffalo, and who, oddly enough, found out about the site while doing volunteer research for the science program “Bill Nye the Science Guy,” says the experience of being an expert has given him invaluable practice in communicating effectively to young people. “The trick is to explain things with enough information but not too much information. You want to put your answer down in language kids can understand.”

Don Schaffner ’83, a food sciences professor at Rutgers University, agrees. His experience as a MadSci expert closely parallels his experience as an extension specialist, a job that demands a great deal of interaction with the public. “The really important part of being able to do any type of science is being able to explain your ideas clearly to people so it really doesn’t matter if you’re talking to a child, or a person without a science background, or another scientist. Einstein said you don’t really understand anything completely until you can explain it to your grandmother.”

The kinds of research experts do
in order to thoroughly answer questions varies. Schaffner and Yap both say they occasionally turn to books for answers but usually their first stop is the Internet. “More and more the answers do seem to be on the web, either on a faculty member’s website at a university or some other resource, like a government site,” Schaffner says. Joe Regenstein, a Cornell professor of food science, says more often than not he can find the answers by simply calling one of his fellow Cornellians directly. “That’s what’s wonderful about Cornell. It is amazing the wealth and depth and breadth of information that folks have around here. Often it’s just a matter of figuring out within one or two or three hops who on campus kind of knows enough about the topic.”

Kelly raves about the Internet as an educational resource, but she feels it’s important that the site do more than spoon-feed school children information. “We want to make sure that kids mine information for themselves, and not just expect that the answer will be on the Internet for them. We’ll point them in the right direction, tell them to do a web search, or look in an encyclopedia, or go to their local library.” Bry also sees a need for more education on methods to critically assess information gleaned from the web. “I don’t think that’s taught in K–12, and even at the undergrad level,” she says, speculating that most users learn on their own how to tell what’s genuine and what’s not. She adds, “We try to do our part by having our scientists say, ‘Here’s where I looked to find this information, so you know it’s valid.’”

Since its inception, the website has been running on what Bry calls “shoestrings and air.” The revenue brought in by the sales of MadSci T-shirts and paid to the site for housing links to science textbook vendors pays for the domain name and a few other small administrative items. But the lion’s share of the operating expenses—the server and the Internet connection—has been covered with money from a $30,000 federal grant given to the site in 1997 as part of an effort to make Internet resources available to school teachers. It’s money, Bry knows, that won’t last forever.

So as the site continues to service more and more people (the volume of questions has jumped at least ten percent every year), Bry says she’s looking for a more stable base of funding, so she can continue to develop and expand the site’s capabilities. She hopes to set up mirror sites in other regions of the country and abroad so MadSci can have a broader access to other people and also hopes to expand the website’s capabilities in handling questions in foreign languages. “We’ve had some limited capabilities to handle requests in French, Spanish, and Chinese, but it’s pretty much MadSci, the English version,” she says. “Which means we’re only reaching a small proportion of the population that’s out there.”

With the broad base of experts now volunteering, MadSci does a pretty good job of responding to all varieties of questions, though, Bry and Kelly say, the site is always looking for more volunteers. “The more the merrier,” Kelly says. “We’d be eager to have any Cornellians sign up,” Bry adds. “More brains for the collective cranium.”

Mark Rader <mark_rader@yahoo.com> is a freelance writer in Ithaca and a recent graduate of Cornell’s masters program in creative writing.

Classic chemistry: Place a candle under a jar in a plate of water. When the candle goes out, water is sucked into the jar.

Soda geyser: Warm a 2-liter bottle of soda. Remove cap and punch a hole in it. Drop in a wintergreen mint and replace cap.
Bill Gates has a cool new watch. He showed it off when he visited Cornell in February. It’s a black digital one that might look out of place on the wrist of the richest man in the world, until he puts it through its paces: It can pluck sports scores and stock quotes and weather reports from the ether, hold your calendar, send instant messages, do all sorts of nifty things.

That kind of connectivity is part of his big vision. What’s not so clear to him, though, is whether there will be enough computer scientists and engineers to make his vision come alive. So Gates, Microsoft Corp.’s chairman and chief software architect, went brainstorming in February, visiting five college campuses including Cornell’s to implore students to consider software careers.

“I think we need to do more to get the word out about the opportunities and the range of things that go on,” said Gates, speaking to a crowd of 1,000 Cornell students and faculty members who gathered at Call Auditorium in Kennedy Hall.

Many of these people were already sold on that notion: they began lining up to hear Gates more than an hour before he took the stage. But others aren’t convinced, and are turning away from computer science careers. In 2000, 24,000 students declared computer-science majors. By 2002, that number fell to 23,033, according to the Computing Research Association, a group of academics and other researchers.

The number has fallen at Cornell also, said W. Kent Fuchs, the Joseph Silbert Dean of Engineering.

Fuchs, who met Gates with President Jeffrey Lehman and others before the speech, said Gates came across as “a thoughtful and articulate spokesman for computer science and engineering.”

“We shared with him innovative changes that are taking place at Cornell in new majors for undergraduates that we believe will attract new students to the discipline,” Fuchs said.

One of those new majors is known as Information Science Systems Technology, which will be available to students in the College of Engineering beginning Fall 2004. It is aimed at students who are interested in applications of information technology, for example, learning how to harness huge data sets to analyze financial markets or the way pharmaceuticals interact with the human genome.

The cross-pollination between different disciplines in both research and education is something that Gates encountered particularly at Cornell. His three-day tour also took him to Harvard University, the Massachusetts Institute of Technology, Carnegie Mellon University, and the University of Illinois.

“With my dialogue with the faculty this afternoon, the emphasis on these multi-disciplinary approaches and the excitement around that was very impressive to me, because I think that’s going to be critical and allow for all the sciences to benefit from these tools,” Gates said.

He downplayed fears that the students who would take these jobs will find themselves displaced by foreign workers.

“I think for the U.S., I’d label it as more of an opportunity than anything else. We need to strive to keep our edge, which is by doing research,” he said.

Gates has long been familiar with Cornell. Mike Nash ‘85 is in charge of Microsoft’s security efforts. Steve Sinofsky ‘87 runs the company’s Office software project.

It was Sinofsky, in fact, who gets credit for focusing Microsoft on the Internet in the first place. On a visit to Ithaca in the mid-1990s, Sinofsky’s flight home was delayed. He decided to spend some time wandering campus and found students sending e-mail and checking course schedules online. The e-mail Sinofsky sent back to Microsoft headquarters: “Cornell is WIRED.” Gates credits Sinofsky’s account for causing him to finally take the Internet seriously.

Checking the Digital Pulse

Forget the dot-bomb; Bill Gates wants students to know that computer science is alive and well.
Now he’s exhorting those who would be his future acolytes with the message that there’s still some world-changing left to be done and software is the place to do it. “Computer science, I’m saying very explicitly, is the most fun and interesting field,” he said.

—Ken Aaron

ADVANCING SCIENCE

David Hammer, the J. Carleton Ward Professor of Nuclear Energy Engineering, was one of four members of the Cornell faculty named fellows of the American Association for the Advancement of Science (AAAS). They are among 348 researchers chosen to receive the prestigious award this year for their efforts toward advancing science or fostering applications that are deemed scientifically or socially distinguished.

Hammer’s current research involves pulsed-power-driven high energy density plasmas, plasma radiation sources, controlled fusion, high-resolution X-ray imaging, physics and technology of intense charged particle beams and their interaction with gases and plasmas and nonneutral plasmas.

A Cornell faculty member since 1977, Hammer has directed experimental research on the physics and technology of intense pulsed ion beams and their applications to magnetic and inertial confinement fusion.

In 1988 he began experiments to develop the X pinch as a point source of radiation for X-ray lithography and, later, with Lebedev Institute scientists, for high-resolution X-ray imaging. For the past few years Hammer has been involved in research on exploding-wire-initiated high energy density plasmas, conducting those studies since 2002 as part of the Cornell Center for the Study of Pulsed-Power-Driven High Energy Density Plasmas.

Others from Cornell named to AAAS fellowship were Donald Campbell, professor of astronomy; David Grusky, professor of sociology; and Ray Wu, professor of molecular biology and genetics.

—Cornell News Service

CU LEADS NANO NETWORK

The National Science Foundation (NSF) has designated a 13-member consortium as the National Nanotechnology Infrastructure Network (NNIN), creating the world’s largest and most accessible nanoscale “laboratory,” under the leadership of Cornell engineers.

The consortium will enable university students and researchers, as well as scientists from corporate and government laboratories, to have open access to resources they need for studying molecular and higher length-scale materials and processes and applying them in a variety of structures, devices, and systems.

Named to lead NNIN is Sandip Tiwari, director of the NSF-funded Cornell Nanoscale Facility (CNF), a national user facility on campus. NSF funding to the new network is expected to be $70 million or higher for five years, beginning in January 2004, with the possibility of a five-year renewal.

Other consortium members who will share their specialized facilities are Georgia Institute of Technology; Harvard University; Howard University; Pennsylvania State University; Stanford University; Triangle National Lithographic Center (operated by North Carolina State University and University of North Carolina); University of California, Santa Barbara; University of Michigan; University of Minnesota; University of New Mexico; University of Texas at Austin; and University of Washington, Seattle.

NSF Engineering Adviser Lawrence Goldberg said the new network is a significant expansion of the capabilities of the decade-old, five-university National Nanofabrication Users Network, which it replaces. “NNIN will implement, on a national scale, innovation in education that will impact all levels from professional through K–12, include outreach efforts to nontraditional users, reach underrepresented groups, and disseminate knowledge to the wider technical community and public. It will also develop the intellectual and institutional capacity needed to examine and address societal and ethical implications of nanotechnology,” he said.

Noting the need for discovery-driven research at a time when most industry research is mission- and profit-oriented, and the need for finding a balance, Tiwari, a professor of electrical and computer engineering at Cornell, observed: “In the experimental science and engineering research at the nano- and micro-scale, exciting interdisciplinary research depends on sharing the diverse resources, techniques, tools, and knowledge from various disciplines and institutions so that researchers can follow their own interests. This network brings together these resources for the overall good of the nation and is critical to the success of research in this new environment.”

—Roger Segelken
Cornell News Service
QUALCOMM FELLOWS

A $200,000 gift from Qualcomm Inc. will provide three new fellowships for graduate students in the Cornell Broadband Communications Research Laboratory (CBCRL). The selected students also will be paired with working Qualcomm engineers who will act as mentors and research collaborators.

The gift includes $150,000 for the support of three graduate students at $50,000 each, along with $50,000 in general research support. It is a one-year grant renewable on a year-to-year basis. It is slightly unusual in that Qualcomm asks that all of the money goes to support students and research, with no administrative overhead costs taken out.

“The intent is to recruit outstanding students and enrich their graduate experience at Cornell through interactions with researchers at Qualcomm working on topics of mutual interest to Qualcomm and CBCRL,” said Kevin Kornegay, Cornell associate professor of electrical and computer engineering and director of CBCRL.

The laboratory conducts research in broadband communication systems, with applications in cellular telephone systems, high performance networking, and optical communications. Among other goals, the research could lead to smaller and lighter devices with higher data rates and lower power consumption. The research group currently includes 13 graduate students, along with research support staff.

At least one of the new fellows will be selected from among current students, Kornegay said, noting that many of the students already have government, industrial, or university fellowships, and most already have some industrial experience. “One of the things I require of the students is that they do come in with industrial experience," he said. "I've been fortunate to attract some of the very best students, who are creative, independent, highly motivated, and focused.”

While Qualcomm may be best known on the Cornell campus as the maker of Eudora e-mail software, it is a major player in the world of wireless communications. Irwin Jacobs, founder, CEO, and chair of Qualcomm, is a 1954 Cornell engineering graduate.

CBCRL was established in 2000 with corporate donations of radio-frequency chip-design and test equipment, giving students the opportunity to work with equipment equivalent to that used in industry, according to Kornegay. In addition to Qualcomm, corporate sponsors include Agilent, Cadence, Cascade-Microtech, Compaq, IBM, and Intel. CBCRL also receives support from the New York State Office of Science, Technology and Academic Research, the Defense Advanced Research Projects Agency, and the National Science Foundation.

—Bill Steele
Cornell News Service

FIVE MORE YEARS

Robert L. Constable has been reappointed for a second five-year term as dean of the Faculty of Computing and Information Science at Cornell. Constable became the first dean of the new faculty unit when it was created in the fall of 1999. Previously he had been chair of the Department of Computer Science.

“The Faculty of Computing and Information Science is an important component of the College of Engineering's world-class excellence in computation, communication, and information,” said Kent Fuchs, dean of engineering. "It is a privilege to work with Bob and for our college to benefit from his leadership.”

“Under Dean Constable, the Faculty of Computing and Information Science has more than fulfilled its original mission of making computation and information sciences available to every discipline on campus,” said Provost Biddy Martin in announcing the appointment. “Bob’s intellectual curiosity and collaborative spirit have made a mark across the campus. The faculty’s imagination and expertise have combined to create new research tools and opportunities and to encourage previously unforeseen uses of computing, especially in the humanities and social sciences. We look forward to the continued success of the faculty under Bob’s leadership.”

The Faculty of Computing and Information Science (CIS) is an interdisciplinary program that, as Constable describes it, fits “sideways” over all the colleges and departments of the university. It was created in

Kornegay
1999 in response to the report of a university task force, which concluded that “Cornell University should undertake to become an institution where anyone can bring ideas from computing and information science to bear on any discipline.” CIS now comprises 53 faculty members, including many newly hired to expand the CIS program. All hold joint appointments in CIS and some other academic department.

“That’s the nature of computation today,” Constable explained. “It’s deeply involved with almost every discipline, and our job has been to recruit world-class professors into many departments and give them a second home in CIS.”

—Bill Steele
Cornell News Service

PROGRAMMED TO WIN

For the third year in a row, a team from Cornell has taken first place in the Association for Computing Machinery (ACM) Northeast Regional Programming Contest, held last fall at the New York Institute of Technology in Old Westbury, N.Y. Cornell also took first place in the regional contest in 1998 and 1999, but slipped to second place in 2000.

Several thousand teams of students compete in similar regional events worldwide, with about 70 regional winners advancing to the international contest. The northeast regional contest brought together 50 teams from colleges in New York, New England, and several eastern Canadian provinces. Contestants were given nine problems to solve by writing computer programs. Scoring was based, first, on the number of problems solved within a five-hour time limit and, second, on how quickly the problems were solved.

Simpler problems included simulating a bicycle odometer given the diameter of the wheel and number of revolutions, and a candy-sharing game for children. At the more difficult end were such tasks as plotting a route for a rook on an obstructed chessboard and comparing two logical expressions to see if they are equivalent.

Cornell sent two teams. The team known as Cornell 1 solved seven problems, edging out Columbia 1, with six, and New York University, with five. Cornell 2 placed 12th with four problems solved. Cornell 1 was made up of juniors Bill Barksdale and Pet Chean Ang and first-year Ph.D. student Xin Qi. Cornell 2 team members were freshman Alex Harn and juniors Dongjae Lim and Bo Wang. Cornell graduate students Martin Pal and Mark Sandler coached the teams.

The regional win allowed Cornell 1 to advance to the ACM World Finals, held in Prague March 28–April 1, where they received honorable mention.

ACM is an international scientific and educational organization dedicated to advancing the arts, sciences, and applications of information technology. The ACM collegiate programming contest, sponsored by IBM, is in its 28th year. This year’s Cornell teams were sponsored by Greenhills Software of Santa Barbara, Calif.

—Cornell News Service

LOCKHEED SELECTS TWO

Two professors in the College of Engineering have received prestigious $50,000 awards from the 2004 Lockheed Martin University Research Grants Program.

The two recipients are Alyssa B. Apsel, the Clare Boothe Luce Assistant Professor in the School of Electrical and Computer Engineering, and Mark Campbell, assistant professor in the Sibley School of Mechanical and Aerospace Engineering.

According to Nader Mehravari, senior technical staff member in the Advanced Technology Department at Lockheed Martin Federal Systems facilities in Owego, N.Y.: “It is very unusual for the corporation to award more than one grant to a given university per year. Moreover, this is the third year in the row that a Cornell faculty member has received one of these grants from Lockheed Martin.”

Thomas Ave-disian, professor of mechanical and aerospace engineering, was an award recipient in 2003 and 2002.

Apsel is an expert on merging high-speed CMOS (complementary metal-oxide semiconductor) circuits with photonics. Her research focuses on building high-performance optoelectronic computational microsystems. She received a Lockheed Martin award for her project “Resonant Monolithic Photodetectors and On-Chip Waveguides for Integrated Optoelectronics.”

Campbell is an expert in autonomy for complex aerospace systems, such as multiple satellites and autonomous aerial vehicles. He received his Lockheed Martin award for his project “Cooperative Information Seeking for Uninhabited Vehicles.”

—David Brand
Cornell News Service

GUIDING LIGHT

A Cornell researcher is developing techniques for making photonic microchips— in which streams of electrons are replaced by beams of light— including ways to guide and...
Michal Lipson, an assistant professor in the School of Electrical and Computer Engineering, described recent research by her Nanophotonics Group at the American Association for the Advancement of Science meeting in Seattle in February. Her talk was part of a symposium on “21st Century Photonics.”

Lipson suggested that one of the first applications of nanophotonic circuits might be as routers and repeaters for fiber-optic communication systems. Such technology, she added, could speed the day when home use of fiber-optic lines becomes practical.

Researchers already have built nanoscale photonic devices in which wires are replaced by square waveguides that confine light by total internal reflection. This works only in materials with a high index of refraction, such as silicon, where there is a loss of light intensity and sometimes distortion of pulses. Lipson described a way to guide and bend light in low-index materials, including air or a vacuum. “In addition to reducing losses, this opens the door to using a wide variety of low-index materials, including polymers, which have interesting optical properties,” she said.

Connecting photonic chips to optical fibers can be a challenge because the typical fiber is vastly larger than the waveguide. It’s like connecting a garden hose to a hypodermic needle. Most researchers have used waveguides that taper from large to small, but the tapers typically have to be very long and introduce losses. Instead, Lipson’s group has made waveguides that narrow almost to a point. When light passes through the point, the waveform is deformed as if it were passing through a lens, spreading out to match the larger fiber. Conversely, the “lens” collects light from the fiber and focuses it into the waveguide. Lipson calls this coupling device “optical solder.” Based on experiments at Cornell, the device could couple 200-nanometer waveguides to 5-micron fibers with 95 percent efficiency, she reported. It also can be used to couple waveguides of different dimensions.

Some of the work has been done in collaboration with researchers working under Alexander Gaeta, Cornell associate professor of applied and engineering physics.

—Bill Steele
Cornell News Service

BIG BOOM IN UPSON

With soccer-playing robots downstairs and computers that can play chess upstairs, this year’s eighth annual BOOM (Bits On Our Minds) exhibition looked like something out of “The Jetsons.”

Some 120 presenters with a total of 64 projects crowded three floors in Cornell’s Upson Hall on March 3 to take part in the eighth annual expo hosted this year by Computing and Information Science at Cornell University.

“We have this expo every year for two reasons,” said Emin Gun Sirer, assistant professor of computer science and faculty coordinator for BOOM. “We want to reach out to undecided majors and to people who are not in college yet to show them the opportunities computer science holds. We also do it as a teach-in, to show colleagues what the cutting-edge research is.”

Irene Chung’s project is an example. Chung ’04, college scholar, displayed her web concept-managing tool, a program that allows the user to generate many different web-site styles for the same information. Chung already has sold her program to Production IG, a prominent animation firm in Japan.

“I have a lot of work to still do with this program,” Chung said. “But I think what is going on right now with the project could couple 200-nanometer waveguides to 5-micron fibers with 95 percent efficiency, she reported. It also can be used to couple waveguides of different dimensions.

Some of the work has been done in collaboration with researchers working under Alexander Gaeta, Cornell associate professor of applied and engineering physics.
Math major Lorraine Pace ’05 demonstrates her computer game and graphics project for Geri Gay, professor of communication, at BOOM.

is awesome, and I’m glad a company likes it.”

Not all projects came from the computer science school of thought. Lindsay Lyman-Clarke, a graduate student in textiles and apparel, displayed her project, which uses body scan data to design clothing sizing systems. She uses lasers to acquire body scan data, in conjunction with computer patterning programs, to design clothing.

“It is wonderful to see what students are doing,” said Kathy Okun, wife of President Jeffrey Lehman. “There are lots of interesting things going on in computer science, and it’s so great that students have the opportunity to do these things.”

BOOM was sponsored by Bloomberg and Credit Suisse First Boston, which now has sponsored BOOM for three years in a row.

—Rachel Einschlag ’04 Cornell News Service

CHEERS FOR THE CHAIRS

Two faculty members in the Department of Computer Science have recently been named to endowed chairs.

John E. Hopcroft, former dean of the College of Engineering, has been elected the IBM Professor of Engineering and Applied Mathematics.

The IBM chair was established at Cornell in 1962 with a grant specifying it be given to an eminent faculty member in the College of Engineering. It was the first corporate-sponsored chair at Cornell.

Hopcroft’s research centers on theoretical aspects of computing, especially analysis of algorithms, automata theory, and graph algorithms. He has co-authored four seminal textbooks with Jeffrey D. Ullman and Alfred V. Aho. His most recent work is in the area of information capture and access.

Hopcroft was previously the Joseph C. Ford Professor of Computer Science from 1985 to 1994 and the Joseph Silbert Dean of Engineering from 1994 to 2001.

Keshav K. Pingali, professor in the Department of Computer Science with joint appointments in the Faculty of Computing and Information Science and the School of Electrical and Computer Engineering, has been elected as the India Professor of Computer Science.

He is the first person to hold the chair, which has been endowed by an anonymous benefactor of Cornell in India. The donor requested that the chair be given to a full professor in early or mid career and that the holder travel periodically to India to lecture on computer science.

Pingali’s research focuses on the improvement of compilers, the software that turns code written by programmers into machine language that can be executed by a computer. He and his research group work to create compilers that “optimize” the output so that programs run as fast as possible. Advances the group has made have been incorporated into software products from Intel, IBM, Hewlett-Packard, Silicon Graphics, and Digital Equipment Corp., among other companies.

—Cornell News Service

Hop To It

Jeff Conuel ’92 ChE, a brewer at Ithaca Beer Co., pours a Double India Pale Ale for reporters attending a February press conference at the brewery. The ale was brewed with 100 percent New York-grown hops. Agricultural researchers at Cornell are working with the Northeast Hops Alliance to re-introduce commercial hops production in the state.

Agricultural researchers at Cornell are working with the Northeast Hops Alliance to re-introduce commercial hops production in the state.
Planetary Attraction

Stephanie Gil was drawn to Cornell for the research opportunities; what she found was out of this world.

She is only a Cornell sophomore but she’s often one of the first people on the planet Earth to see and manipulate the images coming down from Mars.

That’s because Stephanie Gil covers one or two shifts a week for the Mars Exploration Rover (MER) project in the Space Sciences Building at Cornell, calibrating the images as they’re beamed down from Mars. She knows what she’s doing because she’s been involved with the Cornell team that’s heading up the mission’s science payload since she was a first-semester freshman. In fact, although she was one of the youngest members of the team last year, she’s already worked at NASA’s Langley Research Center (last summer), attended a Rover launch, and worked at the Jet Propulsion Laboratory (JPL) in Pasadena for three weeks when the first rover landed.

How has someone so young and seemingly inexperienced gotten such opportunities so early in her college career?

Gil started right away: her first week on campus, she knocked on Jim Bell’s door in the Department of Astronomy; his panoramic cameras (pancams) are now sending those glorious images of the Red Planet down to Earth.

“I told him I wanted to get involved any way possible,” says Gil, a mechanical engineering major. Her interest in engineering had been kindled at Woodlands High School in Hartsdale, N.Y. (where, by the way, she played competitive billiards). “Before physics, I didn’t know what the purpose was of all that math, ironically, my least favorite subject at the time. Physics was the link that was missing, the link that showed me how math and science together form the media through which we can predict and use natural phenomena to do things that may seem like science fiction.”

On the MER team, Gil learned how to use Interactive Data Language (IDL) scripts and the UNIX operating system to view, manage, and create files of images from the pancams. Over the summer, she participated in the Cooperative Education Program at Langley Research Center, learning additional computer skills. Since co-op students alternate periods of full-time study and full-time work, Gil will return to NASA next fall after she takes her fall courses at Cornell this summer.

So far, the highlight of Gil’s short career was the night at JPL when Spirit, the first rover, landed. “The whole MER team had been planning and envisioning this moment for so long; they had invested so much of their time and their hope. That moment, waiting for the tones from the rover, was intense. It was unbelievable; the anticipation was like New Year’s Eve—times a thousand,” Gil recalls.

As an assistant at JPL, Gil attended all the Science Context and Science Assessment meetings, trained to use Science Activity Planner (SAP) to view data products, worked on the Spanish MER NASA web page, and interviewed with Spanish-speaking journalists. Her fluency in Spanish is thanks to her Colombian-borne parents who immigrated to the U.S. about 25 years ago.

Her current task is to calibrate the images streaming down to Cornell from Mars before sending them to JPL. She views images as they arrive from Mars, screens and reports image anomalies, and uses scripts to obtain spectral data from the calibration target mounted on the rovers to serve as a reference point for interpreting the image data.

She was at JPL when Spirit sent back images of its first RAT (rock abrasion tool) target, a football-shaped rock dubbed Adirondack, and on duty at Cornell when the RAT was used on Adirondack.

Gil, who recently received a National Society of Collegiate Scholars Merit Award, one of only 50 granted nationwide, says the primary reason she came to Cornell was because of its potential research opportunities for undergraduates.

“I really hit the jackpot by having the opportunity to be a part of this mission,” acknowledges Gil, who has made Dean’s List every semester. She plans to study in Australia in the spring of her junior year and then pursue a doctorate, perhaps after gaining some “real world” work experience.

“I’m seeing firsthand what you can do with what you learn. It gives you inspiration to want to learn,” she says. “It’s just amazing how much we don’t know when it comes to aerospace and planetary science. There’s so much to discover. The problems are infinite and that stimulates my curiosity more than anything else.”

—Susan Lang
Imagine the impact . . .
people, knowledge, leadership

Advisory Boards
Classroom Presentations
Cooperative Education
Curriculum Support
Distance Learning
Distinguished Lectures
Diversity Programs
Equipment Donations
Fellowships
Mentoring
Outreach
Recruiting

Research

Student Design Projects
Student Organizations

Find your vision for the future at Cornell!

A strategic investment in university research and education is a strategic investment in your company’s future.