Finding the Forest Elephants

Robert MacCurdy makes recording devices to track and count the forest elephants of Ghana.
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A Vision of Excellence/6
BY DANIEL GROSS

As the ninth dean of the College of Engineering steps down, it’s a good time to take stock of the changes, challenges, and accomplishments of the past eight years with John Hopcroft at the helm.

Elephant Ears/12
BY BETH SAULNIER

You’d be surprised how hard it is to find elephants when they don’t want to be seen. But you can hear them if you know how to listen. That’s Robert MacCurdy’s role in the Elephant Listening Project.

The Most Tremendous Adventure/16
BY KENNETH AARON

Engineers are problem-solvers—which means they love a challenge. How’s this for a problem set: make a hot-air balloon that will fly around the world. Don Cameron found the answer in a piece of candy.

The Right Stuff/22
BY JAY WROLSTAD

ECE prof Kevin Kornegay knows what the communications industry needs from today’s graduates, and he’s put together a curriculum and laboratory to make sure Cornell students have all the right stuff.

News/2

Working well with others is the theme for the day: stories include a “virtual environment” for NASA collaboration; video-conferencing software by undergraduates; a symposium for sharing ideas among graduate students; joint research by an engineer and a chemist.

People/26

The fun never stops: students show off digital skills, race trucks, design a rollercoaster, explore the inner workings of PDAs, and face off against the annual dragon.

Hometown Hero/32
BY KENNY BERKOWITZ ’81

Sometimes the FIRST spirit is more important than first place. Freshman engineer Patrick Dingle works with budding engineers at Ithaca High School.
NASA and the state of New York will fund a $3 million, three-year program at Cornell and Syracuse University to develop a virtual environment that uses advanced information technologies to improve undergraduate engineering education. Most significantly for students at the two universities, perhaps, will be a collaboration with NASA engineers on the virtual design of future reusable space vehicles that could replace the space shuttle.

“We intend to raise the bar at the undergraduate level” in collaborative engineering design, said Tony Ingraffea, the Dwight C. Baum Professor of Engineering at Cornell, who helped unveil details of the course at a presentation at Syracuse University, March 12.

The program, to be called the Advanced Interactive Discovery Environment (AIDE) for Engineering Education project, was announced at a joint university event at the Syracuse Center for Science and Technology by NASA Administrator Daniel S. Goldin, New York state Gov. George E. Pataki and U.S. Rep. James Walsh (R-Onondaga).

In announcing a three-year, $2.5 million NASA commitment to fund the AIDE project, Goldin described the program as the agency’s “pet project.” It is aimed, he said, at projections of the need for scientists and engineers growing by 50 percent over the next decade, with about 2 million scientists and engineers due to retire. “If we don’t do anything different, we will only graduate 2 million, so we’re not going to be where we need to be,” Goldin said. “This is not about a social program; it’s not about an educational program. It’s about the future of our country and our economy and our vitality. We have to do things differently.”

New York state will provide $500,000 in state matching funds. Barry Davidson, a professor in the Department of Mechanical, Aerospace and Manufacturing Engineering at Syracuse, is principal investigator on the project and coordi-
GRADS COMPARE RESEARCH

Cornell engineering graduate students abandoned their laboratories to discover what kind of research their peers conduct at the inaugural Engineering Graduate Research Symposium in G10 Biotechnology Building, March 31. Five graduate students were chosen to present their research, focusing on such varied topics as engineering applications in biology, understanding the rowing stroke, and the creation of tangles in wires.

The five presenters were awarded $250 each. Another 28 graduates presented research posters, and 10 were chosen for $100 “best of show” awards. The event was sponsored by the College of Engineering and the Engineering Graduate Student Association.

Presenting the keynote speech at the symposium lunch, John Silcox, Cornell’s vice provost for physical sciences and engineering, noted, “Cornell can be proud of the high level of its graduate research.”

Andrew Spence, one of the oral presenters, said, “If you told me that when I came to Cornell I would be listening to an insect larvae’s thinking in a couple of years, I probably wouldn’t have believed you.” Spence, who is in applied and engineering physics, spoke on the topic of “Microfabricated Tools for Neuroscience” that can be used to study the information encoded in the firing of small groups of neurons in animals such as insects.

Cornell’s crew teams might want to examine graduate student David Cabrera’s “Optimization of the Rowing Stroke” study of why some coordination strategies are chosen over others. Cabrera, who is in theoretical and applied mechanics, said, “Competitive rowers seem to go through a series of actions. They are generally taught to row a certain way: Push off with your legs, then with your back, pull in with your arms, and then do the opposite.”

In order to make a dynamic stick figure model of the rowing stroke in his research, Cabrera had to account for the energetics that make the stroke optimal. If you lift an object up with your bicep, you do positive work, and when you release, your bicep is doing negative work, said Cabrera. The bicep is absorbing energy, “and that’s considered wasteful.”

In another student presentation, “Automated Construction of Genomic Comparative Maps,” Debra Goldberg, who is in applied mathematics, used her computer programming abilities to develop algorithms that speed up and improve the comparison of genomes—the sum of all the genes in an organism.

Grad student Cedric Langbort, who is in theoretical and applied mechanics, reported on “How Bifurcation Theory Can Help Untangle Your Telephone Wire,” by demonstrating the buckling and looping motions of a computer wire that are created by varying its tension and torque.

In his presentation on “Magnetic Nanospheres and Nanocylinders as Markers for a Biosensor Detection System,” Carlos Garcia, materials science and engineering, noted that disease detection should be easier in the future, as a result of the production of cylinders that can be attached to immune system antibodies, which normally bind to disease antigens.

Organizers plan to host the graduate research symposium as an annual event.

—Jeff Evans ’01, Cornell News Service
**Making Nanobumps**

A n engineer and a chemist, working together on a corporately funded research project at Cornell University, are reporting a fundamentally new way to fabricate nanoscale structures on silicon that promises the development of devices ranging from biological sensors to light-emitting silicon displays.

The new process, called controlled etching of dislocations (CED), has produced an array of features on a silicon surface with tiny columns—the researchers call them “nanobumps”—just 25 nanometers across (about 75 atoms), which is six times smaller than the width of the most minuscule component of a commercial microprocessor.

The Cornell researchers, Stephen Sass, professor of materials science and engineering, and Melissa Hines, associate professor of chemistry and chemical biology, believe that the new etching process will enable them to produce silicon structures as small as 10 nanometers, which is the distance between binding sites on a human antibody. “We now have the tools to make very fine-scale surface features at the length scale of biologically important molecules, such as human antibodies” says Sass. “We would hope to develop properties and applications we can’t even imagine today.”

Sass and Hines note that a process based on CED can potentially produce tiny structures across an entire six-inch silicon wafer, suggesting that the technique can easily be scaled up for industrial production. “I like to think of this as creating nano-Lego surface structures, which ultimately we can build on to make a variety of devices,” says Sass. The researchers report their findings in *Applied Physics Letters*, a publication of the American Institute of Physics.

The research was funded by a $2.8 million, three-year grant from Philip Morris Inc.

—David Brand,
*Cornell News Service*

**Team Studies Biocomplexity**

The National Science Foundation announced last fall a $3 million biocomplexity grant that will enable a five-year study of how physical, biological, and human interactions shape the ecosystems of Lake Ontario’s freshwater bays and lagoons. The study will be carried out by a team affiliated with the Cornell Center for the Environment consisting of biologists, engineers and planners from Cornell University, the State University of New York College of Environmental Science and Forestry at Syracuse and Syracuse University.

The faculty researchers and students at Cornell and Syracuse will be supported by one of 16 grants chosen from 300 proposals to the NSF, to foster a better understanding of the interrelationships that arise when living things at all levels interact with their environment.

“The connections among numerous processes and pieces that result in familiar environmental patterns are at the center of our work. This is a new, interdisciplinary team testing a new idea in a very complex ecosystem,” says Cornell’s Mark B. Bain, leader of the Lake Ontario project. Bain, a hydro-ecologist in the New York Cooperative Fish and Wildlife Research Unit at Cornell has been dubbed the “sturgeon general” for his studies of that endangered species in the Hudson River.

Other Cornell investigators in the Lake Ontario project are Asst. Prof. Edwin A. Cowen and Prof. Daniel P. Loucks of civil and environmental engineering; Prof. Stephen Ellner of ecology and evolutionary biology; Nelson Hairston Jr., the Frank H.T. Rhodes Professor of Environmental Science; and Asst. Prof. Jose Lobo and Asst. Prof. Rolf J. Pendall of city and regional planning. The biocomplexity grant also will afford research opportunities for students, including fieldwork and laboratory internships for undergraduates and fellowships for doctoral students in multidisciplinary studies at Cornell.

—Roger Segelken,
*Cornell News Service*
Videoconferencing programs—such as the one discussed—is based on a new video compression algorithm called CU30 developed by Toby Berger, the Irwin and Joan Jacobs Professor of Engineering and Professor of Electrical and Computer Engineering at Cornell. Eventually, CU30 can also lead to better video on web pages and even handheld videophones. CU30 is one of several developments from Berger’s Discover Lab at Cornell, a facility devoted to improving desktop and palm-top video.

The application uses such a narrow bandwidth that the system will run with good quality over a cable modem or DSL (Digital Subscriber Line) Internet connection. These fast connections, which are becoming available in many areas, can provide much greater speed than a standard telephone modem.

In tests, the application has run successfully on a 200MHz Pentium PC, using only about 300 Kbps (kilobits per second) of bandwidth—about the same as is used by other desktop videoconferencing programs—but with much better quality.

The application is based on a new version of CU30 developed by Toby Berger, the Irwin and Joan Jacobs Professor of Engineering and Professor of Electrical and Computer Engineering at Cornell. Eventually, CU30 could lead to better video on web pages and even handheld videophones. CU30 is one of several developments from Berger’s Discover Lab at Cornell, a facility devoted to improving desktop and palm-top video.

Users can download qVIX from SourceForge at <http://cu30.sourceforge.net/main.html>, a clearing house for “open source” software, programs whose source code is openly available for users to test and improve.

The CU30 algorithm gets more information into less space by throwing away details that computer users don’t notice anyway. A common method of compressing video is to transmit only information about the pixels that change from one frame to the next. CU30 transmits those changed pixels only when the change is great enough that a human observer will notice it.

“Where we suffer is in the softer part of the picture, where there are slow changes in intensity over a large area, like light on a wall,” says Berger. “It doesn’t matter much on a wall, but it can show up in close-ups of a face. For videoconferencing this doesn’t seem to bother most people. But in TV or a motion picture, I don’t think you would like it.” — Bill Steele, Cornell News Service

SEEN YOU ONLINE

Videoconferencing on a desktop computer is usually a bumpy ride. Even with a good Internet connection, most desktop video displays 15 frames per second or less, jumping and jerking like an old movie that has been cut and spliced a few hundred times.

But in December, Cornell University undergraduate researchers started giving away qVIX, a videoconferencing application they have developed that provides full-motion, 30-frame-per-second video in full color. The application is only available, however, for computers running the Linux operating system.

The application uses such a narrow bandwidth that the system will run with good quality over a cable modem or DSL (Digital Subscriber Line) Internet connection. This is fast—about the same as is used by other desktop videoconferencing programs—but with much better quality.

The application is based on a new video compression algorithm called CU30 developed by Toby Berger, the Irwin and Joan Jacobs Professor of Engineering and Professor of Electrical and Computer Engineering at Cornell. Eventually, CU30 could lead to better video on web pages and even handheld videophones. CU30 is one of several developments from Berger’s Discover Lab at Cornell, a facility devoted to improving desktop and palm-top video.

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NYSTAR FUNDS BIOMEDICAL “CAT”

The state of New York, through its New York State Office of Science, Technology and Academic Research (NYSTAR), has awarded Cornell $2.8 million over two years to establish a new Center for Advanced Technology (CAT).

The new center, to be called the Alliance for Nanomedical Technologies, will utilize industrial backing to research and develop microscale optical detection devices—working at the molecular level—that could have significant impact in biomedical research.

Project director Carl Batt, the Liberty Hyde Bailey Professor in Cornell’s Department of Food Science, described the alliance as “a gathering of scientists and engineers from academia and from the private sector who will look at nanobiotechnology with a specific focus on applications primarily to medical diagnostics, as well as to medical research devices.”

An immediate result of the state grant will be the construction at Cornell of a $450,000 state-of-the-art fabrication facility—to be called NanoBioFab—in Kimball Hall in the College of Engineering. The facility will be built specifically for handling biomaterials and will serve as a model for satellite facilities that could be built around the state to support the private sector and as training facilities.

—David Brand, Cornell News Service
Leadership is the capacity to translate vision into reality.

—Warren G. Bennis

E

VERY morning, John Hopcroft walks from his home in Cayuga Heights across the Triphammer Bridge, along East Avenue, through the Arts Quad, and across Campus Road to his office in Carpenter Hall. Every evening, he makes the same trek back home. It’s a nice stroll, to be sure. But given the dawn-to-dusk schedule he keeps as dean of the College of Engineering, it’s largely a matter of efficiency. “I had to give up tennis,” he said. “So when I come in and go home, it gives me an hour of exercise.”

After nearly eight years in the corner office at Carpenter Hall, Dean John Hopcroft is preparing to step down. From his perch at the northwest corner of the Engineering Quad, Hopcroft has been at the forefront of a persistent drive to change the culture, curriculum, and physical appearance of Cornell’s 80-year-old College of Engineering.
“He was able, better than just about anybody else, to see into the future in scientific terms and predict which fields are going to be important, and in fact essential,” said Cornell President Hunter R. Rawlings III.

When he first moved into the corner office in 1994, Hopcroft’s challenge was to meld a coherent, nurturing whole out of a college that has 2,700 undergraduates, 1,000 graduate students, 200 faculty, 220 non-academic staff, and 150 academic staff—but no physical center. And in an era of budget constraints, he was compelled—but no physical center. And in an era of budget constraints, he was compelled to forge new links with rapidly changing high-technology industries, with alumni, and with other units of the university. By doing so, Hopcroft has substantially succeeded in repositioning the engineering college for the twenty-first century.

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In 1997, Hopcroft co-chaired a university-wide committee that identified genomics and molecular biology, information sciences, and advanced materials as three areas of research concentration for the university. “It had a big impact on what we did, and who we hired,” said James Thorp, Charles Mel- lowes Professor of Engineering, director of the School of Electrical and Computer Engineering, and a 39-year veteran of Cornell.

In the years that Hopcroft has been dean, interest in engineering has boomed. Applications have risen from about 3,000 in the mid-1990s to a record of 5,000 this year—up 14 percent from 2000. Last year, 38 percent of the applicants were admitted; that rate should fall to about 28 percent for the Class of 2005. “Engineering is starting to be seen as a degree that students can utilize to go into a variety of different fields,” said admissions director Betsy East. “Graduates pursue traditional engineering careers, go into consulting, business, or finance, or go to graduate or professional school in a variety of fields.”

The engineering college has also become a more diverse place. The proportion of women undergraduates has risen each of the last five years, and women constitute 25 percent of the class of 2004; 16 percent are international students; and 7.5 percent are underrepresented minorities, up from 5.5 percent several years ago.

The quality of the pool as measured by SAT averages, class rank, and extracurricular activities has likewise risen. “The graduates coming out of Cornell are highly sought after, and there is no better measure of quality of the institution,” said Neil Schilke ’62, B.M.E. ’63, M.M.E. ’64, general director of engineering, corporate staffs at General Motors, and chair of the Engineering College Council from 1993 to 2000.

As one might expect, Hopcroft is highly organized. Throughout the day, he refers frequently to handwritten notes on small cards. And he possesses the engineer’s typical affinity for systems and organization. But he has also shown an ability to think beyond the parameters engineers have been accustomed to using. “John has been one of the deans who has been most aggressive about seeking advice from deans and faculty members in other colleges about his appointments,” said Walter Cohen, dean of the graduate school and vice provost.

While the responsibility of hiring largely rests with departments, Hopcroft has had a strong impact on the process. When he first became dean, he attended a recruiting committee meeting in the School of Electrical and Com-
ticated laboratory space for which the existing quad buildings, constructed in the 1950s, were poorly suited.

Hopcroft established a committee, worked with faculty, industry, and executives, and presented a plan for a new building to the university. “The very first year I was here in the fall of 1995, he started asking me immediately about the possibility of having a new building, that would focus on nanofabrication and advanced materials,” said Hunter Rawlings.

But if Hopcroft wanted a new building, he’d have to pay for it. Resources were tight in the mid-1990s, and the college’s $110 million budget has remained flat for the last several years. “It has been a continuous struggle with the budget. I think we have cut out every inefficiency one can imagine,” he said.

Of course, the engineering college has a long tradition of strong fund-raising. “But John has really taken it to a higher and different level,” said Inge Reichenbach, vice president of alumni affairs and development. Hopcroft spent about 20 percent of his time fundraising—traveling as far as Hong Kong to meet with alumni and discuss the college’s prospects.

His journeys reaped several tangible results. Annual gifts and commitments have risen from $28.2 million in 1993–94 to $45.4 million last year. Alumni have endowed five new professorships. Nineteen teaching prizes have been endowed, at $50,000 each. “John is always willing to go anywhere at any time and talk to anyone in the interest of the college,” said Marsha Pickens, assistant dean of alumni affairs and development.

One of those he talked to was David Duffield ’62, B.E.E. ’63, M.B.A. ’64, the founder and longtime chief executive officer of PeopleSoft, Inc. In 1997, Duffield committed $20 million for a new research and instructional facility. (He offered an additional $7 million challenge grant in 2000 to help complete the funding.)

Designed by the Portland, Ore.-based Zimmer Gunsul Frasca Partnership, the three-story, 150,000-square-foot building will bring together faculty and students from across the campus. Professors from a variety of disciplines will be granted collaborative workspace for three- to six-year periods. Clad in glass and featuring a glass-walled atrium, Duffield Hall will have the effect of giving the Cornell community “a window into engineering,” said Clif Pollock, who serves as faculty program leader for the project.

Originally, planners thought Duffield Hall would be built outside the quad, on the present location of Hoy Field. But the site approved by Cornell trustees was inside the quad, adjacent to Phillips Hall. Once that decision was made, Hopcroft latched on to the notion that this new facility could be something more than state-of-the-art lab space. The atria connecting Duffield to Phillips and Upson will provide a common area for meetings and meals. “For the first time, the college will have social space, where people can get together regardless of the weather,” he said. When Duffield is completed in 2004, “it will change the social environ-

Hopcroft meets weekly with his executive staff, including Cathy Long (left) assistant dean for administration, and Deborah Cox, assistant dean for student services, and others.
C

hanging the environment—for students, staff, and faculty—has been a theme of Hopcroft’s tenure. The engineering college, after all, has long been famous for being tough on undergraduates. Building on efforts begun by former dean William B. Streett, Hopcroft and his team initiated several moves geared at reducing attrition. In 1994, the required freshman course load was reduced from five to four. Hopcroft also supported Engineering 150, a one-credit 18-student freshman seminar that allows students to interact with their advisers and introduces them to the college’s different majors. There’s also an intervention program to identify students who are having trouble early in the semester. “He’s had a strong vision that the College of Engineering should provide the best undergraduate experience in an outstanding research setting, with a particular emphasis on the relationship between students and faculty,” said Deborah Cox, assistant dean for student services. Hopcroft considers it a matter of pride that engineering is both “the most difficult undergraduate program” and “one of the most supportive colleges.” Of freshmen who enter the college today, 74 percent are likely to graduate from the college, and 90 percent are likely to obtain a Cornell degree.

He has taken pains to improve the environment for other members of the college community as well. In 1997, Hopcroft engaged Charles River Consultants to assess the workplace climate of the college for graduate students and faculty, with particular emphasis on issues affecting women and minorities. The final report, completed in April 1998, contained discussions of the existing climate and recommendations for improvements.

Hopcroft commissioned a college task force of faculty members and graduate students to meet over the summer to assess the recommendations and to develop detailed implementation plans. Among their recommendations was the appointment of an associate dean to manage the new initiatives and provide leadership in climate improvement strategies. Professor Mike Kelley, the James A. Friend Family Distinguished Professor of Engineering, was appointed to the post in 1998 and has worked with Hopcroft to build ties with graduate students and to plan programs for professional development of students—and faculty.

“We think of educating students. But we don’t think of developing faculty in the same way. We’ve kind of let them develop themselves, and that’s just not the most efficient way,” said Hopcroft. (Like a good engineer, he talks a lot about efficiency.)

In addition, this spring the college has begun “frontline feedback” sessions, gathering information from members of the administrative staff to examine what it’s like to be a part of the College of Engineering and to gather ideas about how to make the college a better place to work.

Hopcroft has also encouraged faculty to expand their interactions with industry, difficult in the past because of geographic circumstances, but becoming more feasible as the Internet closes the gap of physical distance. “John has led a major effort to reach out to Silicon Valley and other places and encourage the professors and others to do that, which has helped reconnect it,” said James Morgan ’60, B.M.E. ’62, M.B.A. ’63, chief executive officer of Applied Materials Inc., the chip-making company.

Increasing connections with industry is just part of the changing relationship the engineering college has with the private sector. Rather than simply make gifts and grants, companies are striving to connect with universities in ways that they perceive will help their bottom line. This trend has created new opportunities and challenges for the college and its many allies in corporate America. “One of the things that John has done well is use our corporate connections, usually through alumni, for advice on projects,”

Hopcroft and his wife, Judy, recently hosted a Cornell alumni trip to Patagonia. Here the group is returning to their ship, the Terra Australis, after a visit to Serrano Glacier.
said Jennifer Shea, director of corporate and foundation relations. The college has a database of more than 700 companies with which it interacts in some way each year.

Applied Materials, for example, is donating equipment for a lab in Duffield Hall, and supporting development of coursework for undergraduates in nanofabrication starting this fall. The course, geared toward first-year students, will be project-oriented, offering the opportunity for hands-on experience using professional-quality laboratory equipment. “Students will actually make something on the nano scale in this freshman lab,” said Hopcroft. The college will develop a series of laboratory courses in nanotechnology to attract prospective students and to encourage them to pursue studies in nanotechnology-related fields.

In response to industry needs, the college is also developing a systems engineering program that spans five departments. The program helped support the college’s entry in the Robot World Cup Initiative “RoboCup” for the past two years, bringing home the international championship title each time.

After this June, when the 62-year-old computer scientist steps down from his post after eight years, he’ll have more time for tennis and leisurely strolls. Hopcroft plans to take a year-long sabbatical, and then return to teaching and research. “I’ve started to revise an edition of a book, and I’ve agreed to give a few lectures,” he said.

But the college’s ninth dean is not coasting to the finish line. At a recent lunch at Banfi’s in the Statler, Hopcroft enthusiastically described new curricular efforts. “We recognize that molecular biology is going to be important in engineering in the future, so we’re planning how to introduce that into the curriculum,” he said.

The attributes that have characterized his tenure—a vision of the future in engineering research and education and a constant desire to improve the status quo—show no signs of abating. In mid-February, Hopcroft had dinner with Lewis Platt ’63, B.M.E. ’64, the legendary former CEO of Hewlett-Packard who now runs the Kendall-Jackson winery. Platt thought they might spend time talking about Hopcroft’s personal plans for the future. But several years ago, Platt had helped back a seed program to recruit more minorities and women to Cornell. “It got off to a shaky start, but John was pretty tenacious. He’s just stayed it, and stayed it and today you see a different picture of both women and minorities at the school,” said Platt. “We ended up talking quite a bit about that.”

Whatever Hopcroft’s next challenge may be, his vision—in strategic directions, in research and teaching facilities, in human resources and workplace climate—will continue to shape the college long beyond his years at the helm.

You may not see Ghana’s forest elephants, but you can hear them—if you know how to listen.

By Beth Saulnier

The African forest elephants in Ghana’s 300-square-kilometer Kakum National Park rarely reveal themselves. They’re so reclusive, in fact, that only one photograph of them is known to exist. And, to be specific... it’s a shot of one animal’s rear end. But there are elephants there, between 150 and 200 of them. Conservationists got that rough count through a laborious and unappetizing process called dung counting. But
recently, the presence of elephants in Kakum was confirmed because of another fact of nature: even if you can’t see the elephants, you can hear them—if you know how to listen.

And knowing how to listen (or, rather, to record) is the specialty of a 24-year-old electrical engineer named Robert MacCurdy. MacCurdy ’99 is a research associate in the Cornell Laboratory of Ornithology’s Bioacoustics Research Program, where scientists use sound to study animal populations that are difficult to observe the old fashioned way: whales, night-migrating birds, and those clever elephants. “Basically,” MacCurdy says, “I’m the design guy who takes care of all of the audio recording stuff for projects that come along.”

That recording stuff is both simple and devilishly complicated. The sounds—be they birds’ communicating chirps, whale songs, or elephant calls—are recorded with an analog microphone, then filtered and amplified for digital storage. The digital recorders, which store the information to a hard disk, were designed by Thomas Calupca ’91 EE; MacCurdy works on the rest of the system. And while that process may sound fairly straightforward, the circumstances aren’t.

MacCurdy has to design so-called “autonomous recording units” that work under battlefield conditions: hundreds of feet beneath the sea or in the blazing African heat. The elephant-sound recorders, for example, had to be light enough to carry, hardy enough to withstand changing environments, small enough to hide from both animals and poachers, and equipped with enough power to last for months. “It’s important,” bioacoustics research associate Katy Payne says of the effort, “because we need to find out how many forest elephants there are in the world, and what condition the populations are in.”

It was Payne who, back in 1984, first suspected that elephants use infrasound—sound below the range of human hearing—to communicate over long distances. That discovery may offer solutions to long-standing questions about elephant society, such as how males find mates, and how separated family groups coordinate their movements.

The Elephant Research Project, a cooperative effort among researchers around the world, bases its techniques on the Lab of Ornithology’s work with whales. Its first field effort, which looked at savannah elephants at Etosha National Park in Namibia, was conducted in 1999. The study in Ghana used MacCurdy’s microphones to collect two months’ worth of data, which were then compared to the results of a simultaneous dung count to see if the acoustic method was reliable. It was. “Rob jumped in to fill a need and did so with great competence and energy,” says Payne. “He made a tremendous contribution.”

MacCurdy went to Ghana in May 2000 to work with an international team of rangers, conservationists, and scientists including Richard Barnes, the University of California at San Diego elephant researcher known as the father of dung counting. Since the recording units are custom-made, it’s often essential to have an engineer on site to deal with whatever technical issues crop up. MacCurdy did some additional design work there, with intermittent power and no diagnostic equipment beyond a laptop and a borrowed signal generator. “I wish I could clone him,” says Bioacoustics Research Program director Chris Clark. “Rob is just this wonderful combination of having a really good personality—easy to talk to, a sense of humor—and being very intelligent and well-educated in the engineering and physical sciences.”

MacCurdy is also a serious jock; he has a kayak, rock-climbing gear, skis, a snowboard, and two mountain bikes. And while that might not matter much at the worktable, it made big difference in the field. His enthusiasm for outdoor sports helped prepare him for the daily hikes into the Ghanaian forest, toting the recorders and their battery packs (totaling 50 pounds) along with an awkward homemade, two-meter bamboo ladder. “It was tough,” says MacCurdy. “In some places visibility was less than four meters. You couldn’t see the guy in front of you because it was so thick. Navigation was basically only manage-
able with a compass and a GPS. Without that, you could get totally lost."

The team typically hiked about a dozen kilometers a day, but the density of the forest made for slow going. "You have to either cut trails or else just try to meander through," he says. "And we didn't want to cut trails because they end up turning into poacher paths, so we tried just to move through with minimal effect." As for the dangers? MacCurdy shrugs them off, though they included giant scorpions, huge swarms of biting ants that crawled all over the hikers' legs, and an actual cobra. The snake encounter happened in a field outside the forest—which meant that, following ranger policy, it had to be killed. "They cut its head off," he says. "I felt kind of bad for it."

The researchers installed 11 recording units in Kakum, strapping some to trees four to five meters up and hiding them under leaves and sticks. "We were fearful that the poachers would try to cut the units because they might think they were for monitoring poaching activities," he says, "which hopefully, in the future, they will be." (An overlapping effort in the Central African Republic's Dzanga-Sangha forest clearing put in six recorders and captured the animals on video from a raised viewing platform.)

During the five-week project, MacCurdy lived near Cape Coast in what he calls "a regular, average, middle-class house" by American standards. "But there, it was luxury," he says. "I had a bed to sleep in, a cold shower, running water most of the time, power sometimes, phone lines half the time." He subsisted mostly on rice and vegetables, losing about 15 pounds. "That was tough for me," he says with a smile, "because I like to eat lots of red meat."

The Kakum site was chosen because it's a small forest area ringed by farms, which creates a conservation challenge. Elephants periodically wander outside the preserve and destroy crops; although farmers may want to retaliate, they can't, since killing elephants has been illegal there since the early '70s. "Small-animal poaching is a problem there," MacCurdy says, "and there's social pressure on the elephants because of the farmers."

Ultimately, conservationists plan to use the microphones to develop a warning system by which wildlife managers will be alerted to elephants encroaching onto farmland and can scare them off before any damage is done. "That's one of the quiet goals of the project," MacCurdy says, "but a very important goal."

Eventually, the Elephant Listening Project hopes to use bioacoustics to document the relationships between elephant calling patterns and their populations, composition, and behavior. The animals' infrasonic calls themselves may contain information about the size, makeup, and reproductive health of elephant groups, offering a window into the status of potentially threatened populations. The project has drawn support from (and inspired cooperation by) groups that don't always see eye to eye on specific goals: the International Fund for Animal Welfare, the Wildlife Conservation Society, the World Wildlife Fund, the U.S. Fish and Wildlife Service, and Conservation International.

At Cornell, MacCurdy works in a low cinderblock structure across the
“YOU HAVE TO KNOW HOW TO DEAL WITH THE NON-LINEARITIES OF LIFE.”

[Cornell engineering] textbooks all the time. They’re on my shelf and I refer to them almost daily.”

Last summer, there was so much work that he hired three engineering students to help him build the recorders—and involving undergrads happens to be one of bioacoustics director Clark’s priorities. The students, he says, need real-world experience to put their engineering education in context. “They need to know,” he says, “that all those horrid nights of homework and study sessions bear fruit.”

Consider the challenge of documenting the movements of elephant populations: Basic triangulation may be something out of a freshman problem set—but what about when you factor in issues like humidity, wind, temperature, tree height, and more? “There’s a nonlinear component that makes these math solutions useless in many cases,” says Clark, whose son, Iain, is a sophomore in agricultural and biological engineering on the Hill. “You have to know how to deal with the non-linearities of life.”

MacCurdy himself shares an apartment with an undergrad and a grad student on State Street on the edge of Collegetown. (“I love the college life,” says the young engineer, who could easily pass for a sophomore.) An Ithaca native whose mother teaches writing at Ithaca College, he graduated from the local high school in 1994 and entered a dual program that earned him a B.A. in physics from I.C. and a B.S. in electrical engineering from Cornell.

He joined Bioacoustics the summer after graduation, working on a Navy project that studies how supersonic shockwaves from military planes penetrate the ocean. In addition to the elephant research, he’s been heavily involved in the lab’s other bioacoustics efforts. He’s traveled to Argentina’s Peninsula Valdez for a study of southern right whales (he packed his bags on all of 12 hours’ notice) and worked on the equipment for a project on banded wrens in Costa Rica. The former used “pop-ups,” underwater microphones designed to rise to the surface and turn on a signal beacon after collecting one or two months’ worth of data at the bottom of the ocean. “Every project we do is conservation oriented,” says MacCurdy, who now plans to get a Ph.D. and teach at the college level.

It’s a far cry from the career MacCurdy expected; his senior year, he interviewed with companies that design satellites and microwave components for missiles. “I thought I’d end up working for a defense contractor,” he says. “I’m much happier here.”

There’s something gloriously old-fashioned about being an explorer in an age when there is so little left to explore.

By Kenneth Aaron
If you want to build a balloon to go around the world, Don Cameron’s the guy to go to. After all, he and his company, Cameron Balloons, are the only crew to build one so far. He’s “the dean of modern hot air ballooning,” publishing baron Tim Forbes calls him. He helped turn a going-nowhere U.S. military experiment with balloon technology into a civilian pursuit that quite literally stops traffic even today—30 years after he opened his doors and started selling weightlessness by the wicker basket.

Which is why, to some, it was no surprise that Cameron and his team were the ones to design the Breitling Orbiter 3, the first balloon to circumnavigate the globe. It took a feat of engineering to trick gravity, and it was at Cornell University where Cameron learned some of his chops. He received his master of engineering degree in industrial engineering in 1963; today, his company is the world’s largest balloon maker, as Cameron’s 100 employees turn out about one balloon a day from a three-story Victorian-era factory in Bristol, England.
BUT most of the balloons Cameron makes on a daily basis are fairly pedestrian, compared to the one that actually made it around the world. It wasn’t getting off the ground that was the problem, and getting back down proved inevitable. But the 19-odd days in between that the balloon would have to fly non-stop to make the journey, though, proved difficult to span. Pilots simply couldn’t keep their balloons aloft long enough. They lifted off during the day, relying on computer models to figure out where to best catch the jet stream, and helium gas and hot air would carry the orbs to jet-plane heights. And at night, when the sun’s heat disappeared, the gases cooled. Ballast had to be released to compensate for losing weight, until morning, when the sun’s heat rewarmed the gases and the balloons moved higher again.

“The problem was, it still wasn’t enough to get around the world,” says Cameron, for whom the round-the-world journey was, more or less, the final frontier in balloon flight. The day-to-night tug of war always took its toll, and flights drift back toward terra firma.

Cameron’s daughter, Hannah, recalls how the trick was turned. “It’s so obvious now,” Hannah says of the solution cooked up for the unsuccessful Orbiters 1 and 2. The team needed to know: How to keep helium cool during the day, and warm at night? The designers pored over the problem. “We almost locked them in a room,” Hannah says. And there the designers sat, crunching numbers and eating Kit-Kats, the chocolate-covered wafers.

It was the candy bars that led to the breakthrough the Cameron team needed.

The Kit-Kats were wrapped in foil. The foil seemed to do an admirable job of keeping the candy not melted, and not too cold. And then it dawned on Don Cameron: He would put an insulated skin, a foam layer a sixteenth of an inch, around the balloon (also known as the envelope). Above that he built a foil canopy, itself supported by another, smaller envelope.

The foam helped insulate the balloon; the foil canopy above further helped shield the balloon from the sun’s great heat, and helped keep it warm at night. And so the somewhat pointy-shaped Orbiter 3 made its 28,431-mile flight around the world. It left on March 1, 1999, in Switzerland and landed 19 days, 21 hours, and 55 minutes later among the pyramids in Egypt. Its pilots flew their Kevlar-and-carbon gondola across seas and mountains, taking it up to 105 miles an hour. “We knew that it was better than anything we had done before,” Cameron says, in typical British understatement, as the effort started. By the end, reporters stuffed flight headquarters in Geneva, and Don Cameron had cemented his reputation. Again.

Because to Don Cameron’s name, “the first person to…” seems to be surgically attached immediately after.

As in, Cameron, the first person to cross the Sahara by hot air balloon.

Cameron, the first person to cross the Alps by hot air balloon.

Cameron, the first person to cross from the United Kingdom to the then-Soviet Union. (“First and only,” he says, “because the Soviet Union stopped existing.”)

And those are just the flight distinctions. Today, Cameron Balloons remains a pioneer in its field; besides building the first round-the-world craft, Cameron Balloons is pushing the envelope when it comes to balloons that aren’t round, specially shaped creations that run the gamut from a (super-sized) pint of Guinness to a flying cow. His company invented the non-spherical balloon, and today Cameron makes 75 percent of the ones produced. Cameron himself has been decorated numerous times: He won the Prince Philip Design Award in 2000, the Explorers Club’s Lowell Thomas Award, the Harmon Trophy for Aeronautics, the British Royal Aero Club’s gold, silver and bronze medals, the Queen’s Award for Export.

“It’s so hackneyed now to say somebody has genius, but he does,” says Forbes, whose late father, Malcolm, began a relationship with Cameron in the early 1980s. Forbes says that Cameron—who has built a flying castle and a sphinx, among other things, for the elder Forbes’s international jaunts—could have done anything with his talents.

Yet it was balloons that captured Cameron’s imagination. After Cornell, he took a job with the Bristol Aeroplane Company, but eventually, he strayed from the field and started working in operations engineering. How did he return to the skies? “I usually put it down to drink,” Cameron says now of his hot-air origins. He had started a gliding club with a few friends in Bristol, and he and his flying mates would sit in a pub at night discussing potential exploits. One night, they started talking about hot-air balloons, a strange new technology. “I think the balloon was originally developed for a military purpose, and it was no good for that,” Cam-
eron says. "But the people doing that realized it was a lot of fun."

So, in 1967, he and the club assembled their first balloon, kicking in several hundred pounds to build one from scratch. "After we finished building our own, we realized that the price of a military American balloon was fairly reasonable," he says now. The balloon’s fabric was taken from the spinnaker of a boat; they jerry-rigged a propane burner to heat it. "That balloon was called the Bristol Belle, and it was really quite beautiful," Cameron says. "In those days, no one had ever seen such a thing before."

Maybe not for the past century or two. Hot-air balloons were actually created in the late 18th century, when two French brothers pieced together a balloon and sent it 500 feet above Paris. Joseph and Etienne Montgolfier relied on the shaky chemical science of the day to create their first craft. Early experiments seemed to show that burning gases lifted upward, and even though their knowledge was tenuous, they refined their balloon over several test flights. Eventually they took it to the court of Louis XVI—who was so worried about the safety of human passengers that he refused to watch the first manned flight.

In fact, there was a pervasive fear about the effects of altitude on living creatures—apparently, the fact that
birds were suffering no ill effects from flight was not sufficient proof. So rather than people, a sheep, a duck and a rooster were the first crew to staff a balloon.

It was in 1783 that humans first flew, when the Montgolfier brothers’ silk-and-paper creation wafted 500 feet above Paris. More than 400,000 people reportedly gathered to watch the red and yellow orb take flight, which floated about a mile and a half before settling to earth.

Those early hot-air balloons, fed by burning straw, could not travel very far. Hydrogen-filled balloons were better, but the extremely flammable gas was dangerous. In fact, the first pilot to fly a balloon also became the first pilot to die in one, when his hydrogen balloon caught fire.

For nearly 200 years, then, the technology remained dormant. Hot-air balloons just couldn’t stay up long enough to be valuable. The invention of the oil burner was not much help, either, as it was too inefficient. The advent of rip-proof materials, though, made the envelopes more flight-worthy. And the development of propane burners provided a ready, constant source of hot air to get them aloft. By 1970, Cameron was convinced that he could make a living by selling balloons. It was a slow go at first; he typically financed balloon construction from the proceeds of the one he sold before. In those days, many of the world’s pilots were on a first-name basis, said Sid Cutter, who throws an annual balloon bash in Albuquerque that drew 1,000 balloons last year.

At the first world ballooning championship, in 1973, Cutter attracted 40
percent of the world’s balloons, he guesses. In the 1980s, though, the industry took off, and Cameron’s work has been a big part of the boom.

Big-time pilots, such as Brian Jones, the Orbiter 3’s co-pilot, turn to Cameron. “The pilots with the projects tend to come to Cameron and say, look we need the benefit of your skill and experience here, and Cameron sits down with them and discusses the type of balloon they want, the size they should have, they type of fuel system they ought to have,” Jones told CNN in 1999.

Corporations that want to build a flying trophy or other impossible-to-design creation also make their way to Cameron. Without using an internal frame—“we regard it as a bit of bad sport,” Cameron said—his company spins out some truly fancy flights. And even though they cost well into the six figures to create, they make up for their costs in publicity value.

“Balloons are, from a commercial perspective, about the only billboard everybody likes to see, and by creating the special shapes he made them all the more vivid and impactful,” Forbes says. Cameron’s daughter, Hannah, is 30, and the only one of his nine children involved with the business. “He’s a fantastic design engineer, but he has the imagination of a child,” she said. “The combination of the two just brings this tremendous enthusiasm.”

Today, the hardest engineering often revolves around those balloons that aren’t round, and computers do much of the heavy lifting. Cameron himself wrote the first balloon-drafting programs, in BASIC. “The development of the computer design is something that has made more things possible,” he said. Today, he said that his co-workers treat him as a bit of a dinosaur when it comes to computers. He’ll often sit down and write a program, when his younger cohorts might just go out and buy one.

“I’m always accused of being old-fashioned with my approach to computers,” Cameron says.

Of course, there’s something gloriously old-fashioned about being an explorer in an age when there is so little left to explore. “It’s like being the first person to walk on a field of snow,” he says of the sensation of going first.

“I remember, on the flight to the Soviet Union, once again we were in this isolated world,” he said. Floating above Sweden at 4 a.m., he watched the deserted wilderness below while his partner brewed coffee. “I remember thinking, ‘what am I doing here?’”

Now, two years after sending man around the world, an encore awaits. Finding something new to tackle is difficult. Cameron is organizing a race across the Atlantic, which he hopes attracts several teams; at about $350,000 for a balloon capable of making that journey, it could become a sport more accessible than trying to cross the planet.

“It’s the most tremendous adventure when you do it,” he says.

Kenneth Aaron writes for the Albany Times Union.
KEVIN Kornegay is like a kid in a candy store as he shows a visitor the cutting-edge integrated circuit design equipment recently received from corporate sponsors for the Cornell Broadband Communications Research Lab (CBCRL). A towering, production-quality radio frequency (RF) chip testing unit dominates the space in the characterization and testing lab on the fourth floor of Phillips Hall, down the hall from his office. “We’re running out of room,” Kornegay says with a smile, pointing with pride to the impressive Agilent Technologies hardware and a high-tech tabletop wafer probe station given to the lab by Cascade Microtech.

Kornegay, an associate professor of electrical and computer engineering, worked at AT&T Bell Labs before earning his Ph.D. at UC-Berkeley in 1992. After a couple of years on the research staff at IBM’s Thomas J. Watson Research Center, he joined the engineering faculty at Purdue, then came to Cornell in 1998. From both academic and industry perspectives, he knows what students need, and his lab is jam-packed with all the right stuff.

Down one floor there’s a larger room filled with 26 IBM RS-6000 high-performance computer workstations provided by Big Blue through the Shared University Research program, and each is loaded with circuit design software from Cadence Design Systems.

The equipment and software have a collective street value in the millions of dollars and will give Cornell graduate students the training they need to enter the fast-growing field of wireless communications.

“This setup is better than the equipment being used at most startups doing RF circuits,” Kornegay says. “The testing lab is the same as what you’d find on the floor at industry leaders like Qualcomm, and we are fortunate to have it.” For their part, the sponsors say the gifts are substantial, but so are the potential returns from RF-trained engineers.

The Right Stuff
Students in Cornell’s new broadband lab learn radio-frequency chip design using the best tools in the business.

By Jay Wrolstad
In the fall semester, the 33 students in Kornegay’s first-year graduate-level CBCRL program designed low noise amplifier circuits—a critical component of the transceivers found in cell phones and other wireless devices that process signals received through an antenna. Their designs were fabricated at IBM this past winter, and students will test the finished chips themselves this spring. While waiting for the results of their designs, Kornegay and his students were getting comfortable with the state-of-the-art testing equipment that will probe the RF circuits and provide data for interpretation and analysis.

Students were given specifications from IBM for the chips, Kornegay says, and if they meet these specifications, their chip will be good enough to use in a commercial cell phone. Because cell phone signals are small in amplitude, he explains, the challenge for RF circuit designers—and his students—is amplifying the RF signal without adding noise. “You are plucking signals out of the air, amplifying them, and then processing them after converting into digital signals,” Kornegay says.

The demand for such circuits, and the people who can create them, is huge and getting bigger, especially with third-generation (3G) wireless technology being rolled out around the world. 3G wireless presents particular opportunities because it supports all manner of media, including wireless Internet access, audio and video streaming, global positioning, and voice activation applications in devices that can fit in the user’s pocket.

“The major challenge is to design a radio using the fewest number of components possible—to implement the entire radio on a single chip,” Kornegay says. “We also need to bring two competing wireless standards—GSM and CDMA—together, resulting in a device that can operate in any wireless environment.”

To get an idea of where this industry is headed, consider that market analysts at IDC, a leading provider of technology intelligence, predict the global market for wireless handset semiconductors will exceed $38 billion by 2004, while sales of 3G “smart” handhelds such as PDAs and cell phones will reach $26 billion. Market research by Dataquest reports there were 412.7 million mobile phones sold worldwide in 2000, a 45.5 percent increase over 1999.

None of this is lost on Kornegay’s students, who know that the demand for their services is creating six-figure offers from the wireless technology industry.

Drew Guckenberger, who holds a bachelor’s degree in systems design engineering from the University of Waterloo in Canada, says industry contacts have already intimated that a well-paying job is his if he wants it after completing the program. “That’s why they’re giving us the equipment; there is a real shortage of engineers trained to do this work,” he says.
Kornegay’s teaching assistant, Kyle Maurice, who enrolled in the Ph.D. program at Cornell in 1998 after finishing a master’s degree at Purdue, agrees. “Companies can’t hire enough engineers for wireless work—on cell phones and third-generation devices. There’s a lot of work coming down the pike, and businesses need to get into the schools and generate interest in this technology.”

“There aren’t many people going into hardware compared to software, and the companies are clamoring for RF-trained engineers,” says Sean Welch ’99 EE. “It’s great to have this equipment to work with; with the probe station and tester we can now do useful measurements at the frequencies we’re using. It’s hard to find this type of class.”

Guckenberger says he’s all for corporate involvement in student research because of the superior equipment and systems businesses supply. He came to Cornell specifically to work with Kornegay and plans a career in integrated microsystems. “As an undergraduate at the University of Waterloo, I designed chips, but this is the first time they’ve been produced,” he says.

“We put the technology in Kevin’s lab—technology that is years away from being used by other companies—because we know there is tremendous talent among the students and faculty at Cornell.”

—Bernard Meyerson, IBM

“It’s an unbelievable lab. People in the industry who have seen it told us it was better than their equipment, especially the probe station and the top-of-the-line tester,” Guckenberger says. “We do everything from learning the protocols to creating transistors. We’re using everything [we learned] from undergraduate courses in building a system.”

“We have placed in their hands the best technology, the best hardware, and the best software to train them to become RF circuit designers in one year,” Kornegay says.

In bringing together these industrial leaders, Kornegay developed an innovative proposal, which included a detailed course outline and a summary of the potential benefits of such a program to the industry. “I told them, ‘You have the technology and we have some experience in RF circuit design,’” he says. “They need RF integrated circuit design engineers with practical experience in the latest technology.”

After IBM signed on, the rest of the lab fell into place, says Kornegay. Cadence provided the design software, Agilent provided the measurement equipment, and Cascade provided a wafer probe station to access the chips. “Everyone wants students experienced in their technology, and this is a hands-on program,” says Kornegay. “We discuss RF circuit design theory in the fall, then apply the theory to a real chip design. They can say, when the class is finished, ‘I built this chip, which is as good as a comparable commercial part.’”

In addition to the hardware and software, industrial sponsors send their engineers to Cornell as consultants and advisers. The class has traveled to the IBM manufacturing plant in Burlington, Vt., to observe the chip-making process and spend time on the test floor talking with engineers and software designers. They also visited industry leader Tality to observe chip designers at work.

“Cornell has excellent people. This was a way to accelerate the learning process at the cutting edge of technology,” says Bernard Meyerson, vice president of communications, research and development center for IBM Microelectronics. “We put the technology in Kevin’s lab—technology that is years away from being used by other companies—because we know there is tremendous talent among the students and faculty at Cornell. We provided hardware, software for design, networking software, servers, workstations, and there will be more to come.”

Acknowledging that participation in the chip lab is a significant investment by IBM, Meyerson says the company wants to expand its relationship with Cornell. “The senior executive staff of the biggest division of the company spent the day at Cornell—that’s extraordinary,” he said. “Kevin has his priorities in focus. He wants to help the students and give them valuable skills.”

The lab is a recruiting tool, Meyerson says, but that is of secondary importance to IBM. “The wireless industry needs a generation of trained people who can drive this technology and Cornell is working on filling that need.”

Recently IBM has invited Cornell to
participate in their Program of Support for Broadband Communications. The program includes an IBM faculty award to provide summer research support for Kornegay, funding for operating expenses of the lab, two fellowships for graduate students working in the CBCRL, and the opportunity for CBCRL students to intern at IBM research centers worldwide.

All of the program’s sponsors concur that Kornegay is a convincing salesman. “He presented us with a sound proposal to create a lab at a school where we have had recruiting success, so we were ready to participate,” says Steve Fossi, vice president, RF semiconductor test division at Agilent. “The communications boom has driven a need for people with RF design background, and universities have had a hard time teaching it because the equipment is out of reach for most schools.”

Fossi is confident that Kornegay’s students will do meaningful research with RF circuits with the equipment they’ve been given by Agilent (a Hewlett-Packard spin-off) and others. “I’m looking forward to seeing great things come out of this lab,” he says. “We didn’t sign up to get more students. We have an established relationship with Cornell and are building on that.”

The Cornell connection at Cascade Microtech is a bit more personal in that company executive John Pence earned bachelor’s (95 EE) and master of engineering degrees (97 EE) on East Hill. “One aspect of our corporate culture is to support educational institutions. This specific program is one of the largest at an institution that is focused on a practical dimension—training people to work in industry,” says Pence, citing a critical shortage of RF and wireless engineers.

Cascade is recruiting at Cornell, Pence says, but the training offered in Kornegay’s lab has both direct and indirect benefits for the company since most of the firms who’ll be hiring these students, when they complete the class, will have no trouble finding jobs with us or anybody else in the industry,” Pence assures.

To support its contribution Cascade, like IBM, has sent engineers to Cornell to deliver guest lectures on wafer measurements for RF circuits. A similar visit will be scheduled when the manufactured chips come back for IBM and are ready to be probed, and Cascade plans to update its equipment at Cornell. “This effort is more than a donation. We want to engage the university in many dimensions. We are involved in the co-op program at the engineering school, we have offered internships, and we are talking to the Johnson School to have a presence in their MBA training as well,” says Pence.

Kornegay is convinced his lab is a model for future university–industry collaborations. “This technology is hot right now, because it’s relevant to all wireless applications. The best prepared students will be more attractive and this will give us an edge in research and development,” he says.

The course outline includes basic RF design concepts, wireless standards, transceiver architectures, and case studies. There is a communications component as well, with students required to deliver presentations on their results and to submit written reports on their research. Students will also participate in a design competition, with the lab’s sponsors judging the entries and cash awards providing additional incentive.

“’There isn’t anything like this at any other major research university,” Kornegay says. “It’s great for our students and I know it will bring in future research to Cornell. It was hard work to bring this all together but it’s beginning to pay off.”

Jay Wrolstad is a freelance writer and frequent contributor to CEM.
BOOM is a Blast

Fourth annual digital display draws 47 exhibits from across campus.

On February 28, BOOM (Bits On Our Mind) 2001 came to the Engineering Quad for the fourth year, and the rumble could be felt strongly on three stories of Upson Hall. Forty-seven computer science-related exhibits highlighted student talent from across the university to show current research and new applications in digital technology. Projects ran the gamut from an instrument to transmit images of Mars in color for NASA’s Athena mission, scheduled to launch in 2003, to an artificial intelligence prototype robot named Max, whose motor control is directed from the parallel port of an onboard laptop computer.

Sponsored by the Department of Computer Science and the School of Electrical and Computer Engineering, BOOM is a showcase of creativity from undergraduates and graduate students’ work from engineering, fine arts, psychology, space sciences, and—of course—computer science. “Every year, we’ve become more interdisciplinary, but that’s also because the interest in the event has grown tremendously all over campus,” said Charles Van Loan, chair of the computer science department.

Two benefactors, alumnus Philip Young ’62, B.M.E. ’63, and Microsoft Corp., donated approximately $9,000 to the event to add swanky catering to the ambience and free t-shirts for the participants. Though Van Loan said it would be impossible to guess how many of the projects were already being developed for commercial production, scouts from corporations were invited to attend to mingle with the students and browse their projects.

One project that garnered interest at the event will undoubtedly get more attention on East Hill later this spring. Three computer science undergraduates, working with the Human Computer Interaction research group in the Communications Department, have created a Cornell campus tour guide that fits in the palm of a hand. Taking advantage of a campus pilot project in wireless networking for which eight buildings have been equipped with wireless transceivers, the students created an interactive messaging and mapping program. Using a personal digital assistant (PDA) with a global positioning system (GPS) receiver attached, visitors can take a self-guided tour of the campus.

The PDA, which visitors will be able to rent at Day Hall, uses GPS to determine the user’s
location and then makes a beeping sound to alert them when information related to that location is available. "But what’s cool about this program is that it creates social maps, so the user can then type in what they think about each of the various spots, rate them, and other users can then see those results," said Jenna Burrell, a senior in computer science and one of the exhibit’s creators.

Other better known projects on campus also debuted their latest research. Members of Cornell’s RoboCup team gave demonstrations of how their new omni-directional bots were able to capture their second robot soccer world championship title in Melbourne, Australia, last summer.

The Cornell Hybrid Electric Vehicle team displayed photos of their most recent gem: the 2000 Chevrolet Suburban that they’ve converted to use a large battery pack as its energy storage buffer. The team, in its eighth year of competition, is almost ready for their second Future Truck competition June 4.

Also, undergraduates from the Sibley School of Mechanical and Aerospace Engineering displayed the moonbuggy that they are readying for a NASA competition in Huntsville, Alabama, this spring. A team of eight students constructed the vehicle—a four-wheel drive bicycle—for NASA’s simulated lunar crater racing course. Junior Brett Lee explained that while the moonbuggy itself doesn’t appear to be a digital technology project, the steering and suspension geometry necessary to create its most essential parts are assuredly “the products of high tech computer design and programs.”

Whether the project is about designing an on-line coursework submission system, creating a program to instruct a computer to teach itself to play backgammon or checkers, or designing software to recognize human facial expressions, “this kind of forum gives the students a great opportunity to explain what it is they did and also get feedback on their work,” said BOOM faculty advisor and associate professor of computer science Stephen Vavasis.

Learning opportunities notwithstanding, for participants and observers alike, BOOM is a blast of entertainment and a resounding success.

—Missy Globerman

**CU SPIN DOCTORS**

In the fall of 1999, Cornell Presidential Research Scholars Neda Burapavong and Jaclyn Engelman began thinking about a new way of thrilling roller coaster enthusiasts.

And they started to devise a new kind of roller coaster car that would hang underneath a roller coaster track and would rotate in a somersaulting motion around the cylindrical track, spinning two side-by-side riders head over heels through an axis centered at the stomach.

Three semesters later, the design has been named Vertigo, an original and innovative car and seat assembly for a roller coaster. Next an actual...
working model will be built. “It will be just a prototype, so it’s not necessarily going to look exactly like the real thing,” said Engelman.

In the process, seniors Burapavong and Engelman have been joined by seniors Wilfred Lo and Chris Consolati and junior Brett Lee, who, like the two women, are mechanical engineering majors. The additions of three new members allows the team to divide up the research more evenly, allowing each member to focus on certain areas of the project. Andy Ruina, professor of theoretical and applied mechanics, advises the team by giving critical assessments of the design and occasional assistance with difficult calculations and problems.

“This project really does integrate a lot of different coursework—plus it’s fun, exciting and interesting,” said Engelman.

The two women became interested in the project when they decided to do something more applied, hands-on and less theoretical than they had been doing in prior semesters. They found that the Presidential Research Scholars program “paved a lot of connections and created a lot of opportunity,” said Burapavong.

The design consists of one chair on each side of a support that is attached to the roller-coaster track, with bearings that attach the seats to the support and permit the two seats to rotate around the track. “The question we’re working on right now is deciding how and when to make it spin as it’s going around the track,” said Burapavong. By doing this, the group can either let the twists and turns of the track create enough torque to spin the seats or decide where machines could exert control over the spinning seats.

“Our final goal is to build a working model of the car and a short section of the track so that we can actually take a very short, maybe five-second, ride on it,” said Engelman. Depending on how the working model of the car and seat assembly pan out, the group might take their design to the roller coaster industry to gauge its reaction to their ideas — and possibly to finance the working model.

In order to help the undergraduate team see how the car and seats would function on a real track, the group uses software called Working Model. The program allowed them to build the roller coaster in two dimensions and then analyze the forces created as the car and seat assembly goes around a track.

Safety also has been a concern in the design because sufficiently high G-forces (force measured as a multiple of the Earth’s gravitational force on a person) involved in the circular motion of the seats could cause riders to black out. The research team’s seats are designed, however, to rotate at a safe angular...
velocity of no more than one
revolution per second.

The research group pur-
chases materials through fund-
ing provided by the Bartels
family of Cornell, United Tech-
nologies Corp. and the Cornell
Presidential Research Scholars
program.

—Jeff Evans ’01,
Cornell News Service

INSIDE SCOOP
ON PDAs

E ver wonder what’s inside
those multifaceted
hand-held computers known as
personal digital assistants, or
PDAs? Last fall, a Cornell engi-
eering freshman class got to
find out by scratching, crushing
and even melting the tiny
devices.

The 52 students in Intro-
duction to Engineering 111,
“Electronic Materials for the
Information Age,” were learning
about the properties and design
of microelectronic systems, such
as a Visor PDA. “These types
of things are common in every-
day life and it’s good to know a
little bit about them,” said Man
Hoi Wong, a freshman electrical
engineering major who took the
course.

“The class is generally about
electronic properties of mate-
rials, and its lab component
was set up to practice what
was covered in the lectures,”
said George G. Malliaras,
assistant professor of materials science
and engineering,
who taught the
course. “The informa-
tion age we live in today
is made possible by the
ingenious use of advanced
materials—and a PDA is an
excellent way for the stu-
dents to learn first hand about
these materials.”

PDAs, from Visor to Palm
Pilot to Psion, are increasingly
ubiquitous on campus and par-
ticularly among students, who
use the palm-sized devices
mainly for storing personal
information, writing memos
and sending and receiving
e-mail.

In the labs, the students
formed groups, first to study
and then to irreparably damage
their Visor PDAs. Budget
administrators didn’t even
blink, because the Visors were
donated to the class by Jeff
Hawkins, chief executive of the
manufacturer, Handspring Inc.,
and a 1979 Cornell alumnus in
electrical engineering.

Much about the course was
also constructive. In the process
of destruction, the students
were able to familiarize
themselves with the prop-
erties of semiconductors.
Groups of students also
built single pixels of
an LCD, or liquid
crystal display. Each
pixel consisted of a
substance with the
properties of both
a liquid and a solid
sandwiched between two glass
plates. LCDs are used to display
graphics in devices like PDAs,
laptop computer monitors, dig-
ital watches and flat-panel
television.

At the end of the course,
10 of the students were so
fascinated by their explorations
that they expressed interest in
working in Malliaras’s lab or
with other professors in a sim-
ilar field. Freshman Wong, for
example, starts on a research
project in Malliaras’s lab this
summer.

“Cornell puts a lot of empha-
sis on getting students into labs
that give them great expe-
riences, as early in their careers as
possible,” said Malliaras.

“If you are interested in elec-
tronics, this course is a good
start for you,” said Wong.

—with Jeff Evans ’01,
Cornell News Service

PHOENIX (SOCIETY) RISING

Fantasy characters parade on
foot, followed by a slow-
moving and ominous orange
and black dragon. As the
dragon advances, he is met by a
fierce, coiled cobra—huge with
flashing red eyes and a span-
ning hood—protected by a
helmeted army. The second
chapter to Coleridge’s Kubla
Khan vision? No, Dragon Day
2001 as constructed by fresh-
men architecture students and
the engineering students that
make up the Phoenix Society. The Phoenix Society is well into its second decade, although it has an erratic history. Organized in the late 1980s, the original group of engineers came together to show the architecture students—who annually parade a dragon creation through campus—that they could be just as creative and constructive. The first creature was a giant plastic phoenix, then came a knight, and even a Viking ship. The society lapsed for several years, but now is back in full strength under strong student and faculty leadership.

Just days before the group’s project is unveiled, Michelle Engler ’03, president of the Phoenix Society, is keeping mum. After answering generic questions with noncommittal responses, the truth comes out: “I can’t reveal where we’re working from this year,” putting on her best poker face. In fact, there’s plenty that she won’t divulge: her secrecy seems proportional to just how good this year’s answer to the dragon will be.

On March 15, the secret was revealed. The group constructed a cobra—which measured well over 10 feet tall—in celebration of the Year of the Snake. About 15 students began the massive undertaking around Chinese New Year (January 24), putting in weeks of work, constructing the beast of chicken wire, mesh, cardboard, and lumber. A coat of black paint and a pair of brake-light eyes were the finishing touches.

Freshman Mike Brody, a mechanical engineering major and one of the dozen or so students serving as cobra security guards, found Dragon Day more civilized than he expected. “I was surprised to see that it’s not outright war,” he explains, despite the obligatory pranks. (This year, pranks included an extensive water balloon fight outside Rand Hall—the dragon’s lair—and a window treatment inside Rand to repel any paint applied to the panes, which are a traditional bulletin board of dragon propaganda).

During the minutes preceding the approach of the dragon, Engler captured the final cobra preparations on

Who wants to be an engineer?

Kristy Graf ’01 ABEN helps Daniel Stackman, 9, measure ingredients for making a Silly Putty®-type compound. Engineering Day at the Mall kicked off Cornell’s celebration of National Engineers’ Week on Saturday, Feb. 17, at Pyramid Mall. Thirteen engineering student organizations offered interactive displays to teach children about engineering concepts. The event was coordinated by Women’s Programs in Engineering, Ithaca Science Center, and the Engineering Student Leadership Council and sponsored by Borg-Warner Automotive Inc. and Emerson Power Transmission Corp. Graf was staffing the Society of Women Engineers’ display in which participants were introduced to different kinds of engineering and learned how engineering is used in making substances like Silly Putty®.
The dragon made its appearance on March 15. According to Healey, the Phoenix Society members have carefully packed away materials and supplies and have already begun to plan for next year’s project. Healey will be back as well. "These students really want to do something for their college, and it’s hard to say no to a group of people like that."

— Emilie Dirks

Healey stresses the collaborative efforts of this year’s projects: "In the last two years we’ve tried to strike up a relationship between the freshman architecture students and the Phoenix Society. The officers of each group get together well before Dragon Day and meet with campus officials, campus security, and even Cornell’s claim adjuster. Look for the Phoenix to rise again next year.

Injuries have been a fact of Dragon Day for the past few years regardless of the Phoenix Society’s involvement. Past horror stories include the use of a variety of projectiles, including flour bombs and frozen fruit, as well as an all-out ambush of the other camp’s project.

This year, as the dragon confronted its rival, the cobra flashed it eyes and threatened to strike, but the dragon survived the encounter and continued on its path to destruction at the hands of its creators in a traditional funeral pyre in front of Rand Hall. (Unfortunately, a recent spring snowfall provided ample ammunition, and as the 2001 dragon made its way down Campus Road, a casual observer might have imagined that the snowballs pelting the beast originated in the vicinity of the E-Quad.)

“This is my second year with the Phoenix Society, and I really feel this year was a huge success,” said Tim Healey, chair of the Department of Theoretical and Applied Mechanics and faculty advisor for the Phoenix Society. “The students came together, and nobody was injured.”

**TERRIFIC TEACHERS**

Engineering profs are often famous for their research, but dean John Hopcroft wanted everyone to know that his faculty members were committed to excellence in undergraduate teaching as well. In 1995, he created an awards program to recognize faculty contributions to engineering education.

“The ultimate overall effect of a program of this magnitude will place the quality of teaching on an equal basis with the quality of research in evaluating the performance of each member of the college faculty,” Hopcroft said.

Hopcroft’s call for nominations describes a wide variety of teaching activities that merit recognition, ranging from course preparation and curriculum development, to classroom lecturing, teaching innovation, and interaction with students.

Candidates are nominated by their department chairs, and 20 winners are selected by a committee appointed by the dean. To support the teaching awards program, an effort was launched to create an endowment fund of $1 million. Fourteen alumni and friends of the college have funded the awards to provide annual cash prizes.

The winners for 2001 and their awards (named for alumni sponsors) are:

- Beth Ahner, agricultural and biological engineering, J.P. and Mary Barger ’50 Award
- Brad Anton, chemical engineering, Mr. & Mrs. Richard F. Tucker ’50 Award
- David Delchamps, electrical and computer engineering, Michael Tien ’72 Award
- Johannes Gehrke, computer science, James and Mary Tien Award
- Douglas Haith, agricultural and biological engineering, Abraham T.C. Wong ’72 Award
- Juris Hartmanis, computer science, Kenneth A. Goldman ’71 Award
- Mark Heinrich, electrical and computer engineering, Michael Tien ’72 Award
- Anthony Ingraffea, civil and environmental engineering, Daniel M. Lazar ’29 Award
- Leonard Lion, civil and environmental engineering, Stephen ’57 and Marilyn Miles Award
- George Malliaras, materials science and engineering, Fiona Ip Li ’78 and Donald Li ’75 Award
- Rajit Manohar, electrical and computer engineering, Sonny Yau ’72 Award
- Greg Morrissett, computer science, Ralph S. Watts ’72 Award
- Mark Psiaki, mechanical and aerospace engineering, J.P. and Mary Barger ’50 Award
- James Renegar, operations research and industrial engineering, Sonny Yau ’72 Award
- Jery Stedinger, civil and environmental engineering, Dorothy and Fred Chau, M.S. ’74 Award
- Steve Strogatz, theoretical and applied mechanics, Robert ’55 and Vanne ’57 Cowie Award
- Michael Thompson, materials science and engineering, James and Mary Tien Award
- Marjolein van der Meulen, mechanical and aerospace engineering, J.P. and Mary Barger ’50 Award
- Zellman Warhaft, mechanical and aerospace engineering, J.P. and Mary Barger ’50 Award
- Frank Wise, applied and engineering physics, Douglas Whitney ’61 Award
As a high school junior, Patrick Dingle knew he wanted to come to Cornell. There was just one problem: Ithaca didn’t have a robotics team. “That was the only negative thing about it,” he says, scanning through a series of robot photographs on his laptop. “So I decided I would start one.”

It’s almost a year later, and Dingle is sitting in his dorm room in U-Hall 5, resting after a rough weekend of competition in New York City. He speaks quietly, his voice tired and his eyes focused on the screen. For most of the past three months, he’s been working five or six days a week at Ithaca High School, mentoring a dozen students in Len Jordan’s pre-engineering class. For two years, Jordan dreamed about entering the FIRST Competition, a no-holds barred robotics tournament, complete with cheerleaders and referees, winners and losers. That’s where Dingle comes in. He’d already been to the competition twice, when he was a high school student at the Massachusetts Academy of Math and Science in Worcester. That first year, his robot’s lifting clamps failed during the qualifying rounds. The second year, his robot’s drive mechanism, with four wheels that could turn at any angle, was just too complicated. The lesson was clear: Design a robot that’s tough enough to make it through the competition without breaking.

Competing against schools that were better funded and more experienced, IHS’s RB^2 never made it past the second day of tournament. But they succeeded in building a robot that was faster than much of the competition, strong enough to drive across a ramp at the center of the playing field, and robust enough to sustain a pair of crashes without any significant damage. Most important, for starting a brand new team, they brought home a trophy as the team that best embodied “the FIRST spirit,” inspiring high schoolers to take an active interest in science and math. “I’ve got to give Patrick a lot of credit,” says Len Jordan. “Patrick was extremely dedicated—when he wasn’t in class, he was here working on the robot. He’s got this ability to motivate people, to get them working towards a common goal, and to see things through to the end. Without Patrick’s efforts, this would never have come to fruition.”

The work started in September, when Dingle first arrived on campus, and found Jordan. Together, they spent the semester building a team, lining up the funding they’d need from Cornell, Borg-Warner, and the local chapter of the Society of Manufacturing Engineers. Then at the beginning of January, Dingle traveled to New Hampshire for the FIRST kick-off weekend, his first chance to hear this year’s rules. Every year, the competition gets harder. For 2001, the robots had two minutes to race across a playing field, drive over a seesaw bridge, pick up a large rubber ball, and dunk it into a basket at the end of the court. To earn more points, the robots can grab the two goals, move them across the court, and balance them on the bridge.

From the time of the kick-off, the teams have only six weeks to design, build, and ship their robots. If that sounds like a lot to do, it is. And even though Dingle didn’t realize that at the beginning, by the time the competition rolled around, it was very, very clear. “The game was a lot more difficult than I imagined,” he says. “I think everyone was astonished at how much more harder it was than we’d thought.”

Of course, it’s a disappointment. But for Dingle, the end of this year’s competition means a chance to return to life as an ordinary Cornell student, without the pressures of leading the team, and a chance instead to concentrate on the simpler responsibilities of Chem 211, Calc 293, CS 280, and his freshman writing seminar. And like the Boston Red Sox, whose photos hang above his computer, Dingle knows there’s always next year.

“My goal from the beginning was just to get the team going, and whether we won or not really didn’t matter to me,” he says, looking ahead to 2002. “I know that some of the students are ready to start working on a new drive system. Next year starts now.”

—Kenny Berkowitz ’81
Who hasn’t had the experience of being interested in hearing about new engineering career opportunities, but only willing to move for the perfect position? If you value your current position and want to remain anonymous while searching, where can you turn?

Cornell is pleased to announce that now, as an engineering alumnus, you have immediate access to just such a benefit. It’s called Cornell eProNet, and it offers Cornell alumni free, lifetime access to services that will help them find exceptional job opportunities and make informed decisions throughout their careers.

Together with a résumé-posting feature, eProNet’s free career management service includes a private job board where the country’s top employers and most innovative new companies post opportunities for mid-level and senior management positions.

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