Creating nanoscale solutions to Global Problems
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M.Eng. degree holders start with higher salaries and earn more money over the course of their careers. The Cornell M.Eng. professional degree program can usually be completed in just two semesters. Cornell undergraduates who qualify for early admission may be able to complete the program in only one additional semester.

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meng.engineering.cornell.edu
CORNELL CHEMÉ CAR WINS NATIONAL COMPETITION

With their shoebox-size car powered by a hydrogen fuel cell, the 16-member undergraduate Chemé Car Team placed first at the American Institute of Chemical Engineers (AIChE) student car competition in Philadelphia Nov. 16.

Adrian Kami ’10 (left) and Perry Cerevel ’10 with Ben Stenson ’10 at the National Chemé Car Competition in Philadelphia, Nov. 16.

CORNELL ENGINEERING SPORTS NEW LOOK

Cornell researchers have developed a method to self-assemble metal complexes into complex nanostructures. Applications include making more efficient and cheaper catalysts for fuel cells and industrial processes and creating microfluidic surfaces to make new types of conductors that would carry more information than conventional wires do.

The method involves coating metal nanoparticles—about 2 nanometers in diameter—with an organic material known as a ligand that allows the particles to be dissolved in a liquid, then mixing the particles with a small molecule (a material made up of two different chemicals) whose molecules link together to solidify in a predictable pattern. When the polymer and ligand are removed, the metal particles fuse into a solid metal structure.

The polymer community has trouble with such reactions, said Ulrich Wiesner, Cornell professor of materials science and engineering, who, with colleagues, reported on the new method in the June 27 issue of Science. “But metals have a tendency to cluster into uncontrolled structures. The new thing we have added is the ligand which creates high solubility in an organic solvent and allows the particles to flow even at high densities.”

In addition to making porous materials, the researchers said, the technique could be used to create finely structured surfaces, the key to the new field of plasmonics, in which waves of electrons move across the surface of a conductor with the information-carrying capacity of fiber optics, but in spaces small enough to fit on a chip.

“This is exciting,” Wiesner said.

“It opens a completely new playground because no one has been able to structure metals in bulk ways. In principle, you can do anything you can do with mixtures of metals,” Stenson said.

FUCHS NAMED PROVOST; OBER INTERIM DEAN

W Kent Fuchs, the Joseph Silbert Dean of Engineering since 2007, has been named provost. In an announcement tendered to the university this week, President David Skorton said: “I am delighted to announce W. Kent Fuchs, the Joseph Silbert Dean of Engineering at Cornell, as the university’s next provost. He is a strong and important leader, and faculty member at Cornell,” said Skorton.

The selection of Fuchs follows an extensive search and is the result of considerable planning and discussion within the College of Engineering,” Skorton said.

“Dr. Fuchs is an experienced leader and faculty member at Cornell,” said Provost David Harris, who led the search committee that evaluated all candidates. Harris, who is about to retire from his position, added: “I am looking forward to working with my colleague the next provost.”

The press release was tendered to the university on Wednesday. Fuchs began his duties on July 1.

“Dr. Fuchs is a strong leader and will bring a steady hand to the provostial role,” Skorton said. “His leadership in advancing Cornell University and the College of Engineering is widely recognized. Under his leadership, Cornell Engineering has achieved a number of milestones: The College of Engineering was named one of the top five engineering schools in the country by U.S. News & World Report, and the university has launched a new strategic plan: Cornell 2020: Expanding the Boundaries of Possibility.”

The announcement for the deanship has been made effective as of the date the search committee met, May 22. The search committee, chaired by Provost David Harris, included Provost William Skorton, Dean Christopher C. Essex, Associate Dean for Research Robert S. Malcolm, and Associate Dean for Academic Affairs Sarah Bedair.

The selection of Fuchs was tendered to the university after the search committee met with potential candidates and the College of Engineering faculty, students, staff, and alumni over an extended period of time. The search committee conducted a series of meetings with Cornell Engineering departments, schools, and colleges to determine the distinctive characteristics that set Cornell apart from other engineering colleges. The search also included a visit to other institutions to see how leading-edge institutions are organizing the work of the engineering college.

The selection of Fuchs as provost was tendered to the university in consultation with the Board of Trustees, which has approved the appointment of Fuchs as provost.

“The search committee is pleased with the outcome of this search and is very excited about the leadership that Dr. Fuchs will bring to the college,” said Provost David Harris. “He is a strong leader who has a clear vision of the future for Cornell Engineering.”

Fuchs has been at Cornell since 1999, when he was appointed as Chair of the Materials Science and Engineering Department. In 2004, Fuchs was appointed as Associate Dean for Research, a position he will retain as provost. In 2007, he was named Joseph Silbert Dean of Engineering, a position he will retain as provost.

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Young Career engineers at Lockheed Martin are also earning engineering degrees at Cornell. The students are pursuing degrees in mechanical engineering, electrical engineering, and computer science.

Students pop balloon record

Career engineers at Lockheed Martin are also earning engineering degrees at Cornell. They are pursuing degrees in mechanical engineering, electrical engineering, and computer science.

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Cornell engineers show GPS can be spoofed

A group of Cornell researchers have shown that global positioning system (GPS) technology can be “spoofed,” or tricked by fake signals. The researchers, led by Paul Kintner, professor of electrical and computer engineering, and Mark Piskai, professor of mechanical and aerospace engineering, presented a paper on their findings at a meeting of the Institute of Navigation, Sept. 19 in Savannah, Ga.

To demonstrate how a navigation device can be fooled, the researchers programmed a briefcase-size GPS receiver, used in ionospheric research, to send out false signals. The researchers then tracked the movements of the “phony” receiver could be placed in the proximaty of a navigation device, where it would track, modify and retransmit the signals being transmitted from the GPS satellites. Gradually, the “victim” navigation device would take the counterfeit navigation signals for the real thing. “GPS is woven into our technology infrastructure, just like the power grid or the water system,” said Kintner, director of the Cornell GPS Laboratory. “If it were attacked, there would be a serious impact.”

By demonstrating the vulnerability of receivers to spoofing, the researchers believe they can help devise methods to guard against such attacks. “Our goal is to inspire people who design GPS hardware to think about ways to make it so the kinds of things we’re showing can be overcome,” said Piskai.

Read more on these and other stories at www.engineering.cornell.edu/news

Carbon nanotube ‘ink’ may lead to thinner, lighter transistors and solar cells

An atomic force microscope image of both metallic and semiconducting carbon nanotubes, before the cyclodaddition process of removing the metallic tubes. An atomic force microscope image of semiconducting nanotubes, after the cyclodaddition process of removing the metallic tubes (right). The research suggests careful control of the chemical reaction enables the complete conversion of metallic tubes without the degradation of semiconducting tubes. "Our work suggests that careful control of the chemical reaction enables the complete conversion of metallic tubes without the degradation of semiconducting tubes," Blanchet said. The work should lead to exploration of a wide range of devices, such as novel organic photovoltaic structures, Malliaras added.

Read more on these and other stories at www.engineering.cornell.edu/news

Cornell researchers seek to save precious minutes in deploying ambulances

A National Science Foundation grant of almost $300,000 is allowing three Cornell researchers to perfect a computer program that estimates how best to spread ambulances across a municipality to get maximum coverage at all times. Associate Professor of Operations Research Shane Henderson, Assistant Professor of Operations Research Hueyin T. Topaloglu, and applied mathematics Ph.D. student Almate Restrepo are working on a computerized approach to take such available information as historical trends of types and incidences of calls, geographical layout, and real-time locations of ambulances to figure out where ambulance bases should be, and where ambulances should be sent once finished with a call.

Using their program, the researchers are recommending that ambulance organizations break the traditional setup of assigning ambulances to various bases and sending them back to the ambulance locations once finished with a call. Going back to base isn’t necessarily the best option for maximum efficiency, says the operations researchers. It might be better to deploy an idle ambulance to where coverage is lacking, even though no calls have yet been placed there.

"If everyone is constantly going back to the base assigned, they’re ignoring what’s going on in real time in the system," Henderson explained.

The concept is easy enough, but the solution is tricky, especially because of the enormous amount of uncertainty involved. The field of operations research that deals with making decisions over time in the face of uncertainty is called dynamic programming, in which Topaloglu is an expert. The key is coming up with what’s called a value function, a mathematical construction that estimates the impact of a current decision on the future evaluation of the system. In this case, it’s the impact of current ambulance locations on the number of future calls that are served on time.

"When you’re trying to make a decision, you have to select the locations of your ambulances so the performance predicted by the value function is as good as possible," Topaloglu explained. "But it turns out that computing that function is very difficult, especially if you’re talking about the scale of the problem we’re trying to solve."

—Anne Ju

Read more on these and other stories at www.engineering.cornell.edu/news

The Institute for Computational Sustainability has been launched at Cornell with a $10-million grant from the National Science Foundation, under a program designed to pursue "far-reaching research agendas that promise significant advances in the computing frontier and great benefit to society.”

Directed by Carla Gomes, Cornell professor of computing and information science, the institute involves 14 Cornell faculty members along with scientists at Ohio State University, Harvard University, Bowdoin College, the Department of Energy’s Pacific Northwest National Laboratory, and the Conservation Fund.

“Our vision is that computing and information science can— and should—play a key role in increasing the efficiency and effectiveness of the way we manage and allocate our natural resources,” Gomes said. Many of today’s problems in ecology and conservation involve juggling large numbers of variables, often to find the optimal way to balance them. Some are so complex, the researchers say that they will need new advances in computer science. Gomes and her team hope to create a new field of computational sustainability, analogous to computational biology, that will simulate new developments in the computer science areas of constraint optimization, dynamical systems, and machine learning. The researchers are also launching a new journal of Computational Sustainability.

The institute will collaborate extensively with the Cornell Center for a Sustainable Campus. But, said Gomes, “Our goal is to inspire people who design GPS hardware to think about ways to make it so the kinds of things we’re showing can be overcome.”

Read more on these and other stories at www.engineering.cornell.edu/news

Institute for Computational Sustainability launched with $10-million NSF grant

“Grizzly bears live in three widely separated areas in Idaho, Wyoming, and Montana. Computer optimization can balance distance and sustainability against the cost of the land to design a connecting corridor, as in the example above.”

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By observing the behavior of cancer cells grown in both two- and three-dimensional cultures, Biomedical Engineering Assistant Professor Claudia Fischbach-Teschl has demonstrated that a previously underestimated protein secreted by cancer cells could be a key factor in allowing cancer to grow and spread in the body.

The experiments, detailed in the Jan. 19 issue of the Proceedings of the National Academy of Sciences (PNAS: 106:3), looked at how cancer cells binding to the material that surrounds them, called the extracellular matrix, regulate the secretion of proteins called angiogenic factors. These proteins allow tumors to develop blood-vessel networks and eventually metastasize, or spread to other parts of the body.

Fischbach-Teschl found that when cultured in different ways, the cancer cells behaved differently, and the differences led to new questions about which angiogenic factors are more important in the progression of cancer. Notably, the protein called vascular endothelial growth factor (VEGF) was secreted heavily in two-dimensional tumor cell cultures. In fact, a cancer drug approved by the Food and Drug Administration works by specifically blocking VEGF secretions. But that samesecretion did not occur at the same rate in the more realistic three-dimensional culture systems.

The experiments show that VEGF, not IL-8, could be the more important chemical to signal blood vessels to grow around the cancer, allowing it to flourish in the body. The researchers further note that IL-8 may contribute to the spread of cancer.

The paper was also highlighted in the Jan. 20 edition of Science Signaling (2:54) as an “Editor’s Choice.”

---Anne Ju

Claudia Fischbach-Teschl (right), assistant professor of biomedical engineering, with students in the lab.

Grad student invents groundbreaking ultrasound device

A prototype of a therapeutic ultrasound device, developed by a Cornell graduate student, fits in the palm of a hand, is battery-powered, and packs a shock punch to stabilize a gunshot wound or deliver drugs to brain cancer patients. It is allowed to a ceramic probe, called a transducer, and it creates sound waves so strong they instantly cause water to bubble, spray, and turn into steam.

Ultrasound waves created by one of Lewis’s devices heat the tissue, submerge under water, causing the water to bubble, spray, and turn into steam.

Sharing Creative Passion

Medical device inventor Richard Newman ’68 ME returns to teach biomedical engineering

By Charley Hannegan

Richard W. Newman ’68 ME spent 40 years inventing medical devices that help doctors see inside the body. By any measure he had a successful career. He is the inventor of 13 patents, he won the 1994 Holley Medal from the American Society of Mechanical Engineers, and has nine patents pending. When he retired in 2008, his former employer, medical device maker Welch Allyn Inc., named its new research facility at Syracuse University the Richard W. Newman Innovation Center.

In retirement he’s consulting on a device for the early detection of Alzheimer’s disease. But, none of that compares with what he does now. At 62, Newman has just realized a lifelong dream: to teach.

“I wanted to teach in general, but if I could go back to Cornell, that’s a bonus,” says Newman, with the grin of a man who’s having the time of his life.

For Newman, being a lecturer in the Department of Biomedical Engineering is a return home.

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He went back as a boy he wanted to fix things like his uncle, Ronald E. Bowman, who graduated from the university in 1939 with a degree in agricultural engineering. Bowman married Frances Robbins, Newman’s aunt, also a Cornell grad. The Bowman and Newman clans grew up near each other in Cuyuga, N.Y.

“My dad (Paul Newman) was a businessman and if anything needed fixing he called Uncle Ron,” Newman says. “I could fix anything from the furnace to the lawnmower, he says.

By the time Newman reached high school his guidance counselor advised him not to go into agricultural engineering, but to make mechanical engineering instead because there were more opportunities there.

Newman tagged along with his older brothers, Robb and Larry, when they went out Lehag, Lafayette, and Bucknell universities, before both entered Cornell. When his turn to choose a college came, Newman toyed with the idea of going to Purdue University, his father’s alma mater.

Instead he sent only one application to the college where he had wanted to go since the eighth grade. He entered Cornell in 1964, one of 600 engineers. At the time there were two kinds of engineer that interested him, he says. You were an architect who designed and build bridges and roads, or you could be a mechanical engineer and make things. Newman wanted to make things.

“That’s always fascinated me. How do things work?” says the man who after retirement planned to take apart the hard drive from his computer to see how it works.

During the summers of his ju-

or and senior years, Newman worked for Welch Allyn, then a small manufacturer in Skaneateles. The Vietnam War was at its height. Many engineers who graduated at that time moved into jobs in the defense industry, Newman says. It was “the middle of Vietnam, everyone wanted to go to the aircraft companies.”

But defense work wasn’t for him. “I wanted to work on something that the better job it did, the more lives would be saved, not more lives would be lost,” he says. “I wanted to make a contribu-

tion to society, to make people’s lives better, and not design bombs and napalm, and bullets, and fights over countries.”

Then a high school friend died in the fighting during Newman’s senior year at Cornell. June 1, Newman graduated with distinction with a bachelor of science in mechanical engineering. A day later he received notice from the draft board asking that it grant him a 2-A deferment. He was 1A.

“I didn’t want to die over there,” he says.

Newman intended to work on his Ph.D. degree, but by then the government had stopped granting deferments for graduate students. Instead, he took a job at Welch Allyn. The company got its start making ophthalmoscopes and otoscopes, devices that doctors use to look into patients’ eyes and ears. A small company offered him the opportunity to work on a product from its conception through to the marketing and manufacturing.

After he was hired at Welch Allyn, then company president Chuck Evans sent a letter to the draft board asking that it grant Newman a deferment because he had the necessary skills to benefit the health and welfare of the American people. Evans wrote that an endoscope Newman was working on would ultimately save 10,000 lives a year. “It was a great letter,” Newman said.

The draft board granted the deferment, and by 1983, that Welch Allyn endoscope, which he helped create, was indeed helping doctors save 10,000 lives a year.

The idea of working for a bigger company where you, as the designer of one small part in a larger product didn’t appeal to him, Newman says. He decided he wanted to continue his education too. At the time Cornell didn’t offer the opt- 

ical engineering degree so he went to work toward a master’s degree.

While he was interested in the new field of biomedical engineering, no local New York universities at the time offered such a degree.

Newman turned to Syracuse University, where a professor created a graduate mechanical engineering program that was essentially a biomedical engineering program.

For five years Newman worked at Welch Allyn in the morning and then drove 20 miles to Syracuse where he attended night school. He received his mechanical engineering classes at SU and medical classes at Upstate Medical University. During the day, he drove back to Welch Allyn to finish out his workday.

From filing cabinets built under the windows of a small room in the basement of a building in Auburn, Newman pulled out a several-inch-thick textbook with ragged yellow sticky notes to illustrate the kind of technical reading he did at night for class.

“I had zero social life for five years,” he says, with a laugh.

Newman graduated from SU in 1973 with a master’s degree in mechanical engineering. He moved up at Welch Allyn from project engineer to vice president of Advanced Solutions at the time of his retirement. Newman credits the academy and experiences he’s had for ways to make better medical products. It was not uncommon when his three daughters were at school that the family would go to High Schooling on weekends to see him reading an obscure sci-

entific journal while waiting for a school orchestra concert to begin.

“How’s always thinking, so he sees ap-

lications in science and technology that others do not,” says Allan Lasker, president and chief executive officer of Blue Sky Highway LLC, a newly cre-

ated Welch Allyn subsidiary dedicated solely to research.

“He has more enthusiasm and en-

ergy than some of the college kids I’ve seen. He didn’t lose his passion.”

Di Rienzo says.

If you’ve ever had a colonoscopy, then you’ve benefited from one of New-

man’s inventions. He was one of three people at Welch Allyn who developed the color video endoscopy. The device gave doctors the ability not only to see inside the colon, but to view it in color. Newman was one of the first people on whom a doctor tested the scope. The device was so ground-breaking that the team of Dominick Di Rienzo, William Moore, and Newman won the 1994 Holley Medal from the Ameri-

can Institute of Mechanical Engineers.

The society awards the medal to those who, by a great or unique act of engineering, have created something that has benefited the public. Henry Ford won a Holley Medal.

Even in retirement Newman can’t turn off his creative juices. “I was cur-

rently working on a different visual disorder.”

By the time he was winding down his career at Welch Allyn. He “was no longer working for money, I was working because I liked it. From that, I knew I liked teaching and I could be good at it,” Newman says.

Last March, Michael Shuler, the chair of Cornell’s biomedical engineering department heard Newman speak and offered him a position as a visiting lecturer.

He lectures in RME 5500, bio-

medical engineering design, and RME 5911, a fifth-year course for graduate students who want to work in teams to de-

velop new products from concept to market.

“He speaks with a lot of authority,” Shuler says. “He speaks about things he’s done and experiences he’s had. He knows what he’s talking about.”

Newman compares himself to a coach.

“There’s a big bridge between know-

ing what to do and doing it,” he says. “I have no knowledge to do it and now I want to teach them how to do it.”

The disposable ophthalmoscope invented by Newman, with an illumination system, eliminates the timedependence of sterilizing and reduces the chance of cross contamination.

The disposable original spectacles invented by Newman, with an illumination system, eliminates the timedependence of sterilizing and reduces the chance of cross contamination.

Welch Allyn's Klinik diagnostic set includes an otoscope and an ophthalmoscope designed by Newman.

Welch Allyn's Frequency Analyzer uses Welch Allyn’s Frequency Doubling Technology, which is in the early diagnosis of glaucoma and potentially Alzheimer’s disease.
By Robert Embo

KATHRYN DIMIDUK first director of the Teaching Excellence Institute

Fulfilling a strategic planning objective, the College of Engineering has established the Teaching Excellence Institute to enhance the educational effectiveness of the engineering faculty.

An advisory group of engineering faculty and staff led the creation of the institute, in the works for the last two years. It is funded in part by Mike Goggin ‘86, who created an endowment to support the institute, and James M. McCormick ’59, M.Eng. ’70, who provided additional start-up and continuation funding.

Kathryn Dimiduk ’79, formerly a senior lecturer in the Department of Physics and Astronomy at the University of New Mexico, was appointed director of the institute.

“Kathryn has been a leader in the promotion of effective and innovative teaching,” said Robert Embo, professor of mathematics at Cornell and interim dean of the College of Engineering.

Kathryn Dimiduk performs a demonstration designed to engage students in active learning. The class is asked to predict the effect of the collisions of two pendulum bobs of equal mass—one springy and one deformable—on the freestanding yellow blocks.

The institute’s launch coincides with that of the university-wide Cornell Center for Teaching Excellence. The Teaching Excellence Institute will focus mainly on engineering, but collaborate with the center on strategies, best practices, and coordination of services.

Cornell Engineering Magazine: Why did you want to lead the Teaching Excellence Institute?

KD: It’s an exciting opportunity to basically create a new program and to be able to work with faculty and courses beyond just what I was doing. Where I was, I was teaching three courses a semester and then on the side working with the faculty to show them how to incorporate active learning strategies. So I was already trying to do pieces of this and this was a chance to jump in and do a whole lot more of it.

C.E.M.: What is active learning?

KD: In a basic lecture the information is one-way. The instructor puts it on the board, talks about it, students take notes, and there’s a lot of info put out, but it’s very passive on the students’ part and it tends not to be very well retained. People have learned that way, but it doesn’t require the students to process as much, so what you try to do with active learning is get the student more engaged in the material so that they’re processing it, talking about it, and not just hearing it … If you can get them thinking about something and then guide their thinking through how to do something you can add a lot more value to the class time.

C.E.M.: What can you give an example?

KD: One of the simplest ways is to use the clicker system, where the students have individual response pads. And the instructor will pose a question and if it’s well done, it’s not a real easy one, it’s one you’ve got to puzzle over a bit. One of the nice things is, instead of one student, all 300 students get to answer it and then you can put up a graph of how many students picked each answer. At that point they’re much more vested in the answer. They had to think about it and they’re not just sitting and writing. And I found when I’m teaching, if I give a demonstration, I can visibly see the whole class lean forward instead of sitting back and relaxing thinking, “Oh, I don’t have to take notes.” Now it’s, “What is it? Did I get it right?” … Those are the easiest to implement.

C.E.M.: Why do we need these new types of educational strategies?

KD: The lecture style works well for a certain kind of learner and a lot of us were educated successfully with it, but it’s a very small slice of the population that thinks and learns that way. To increase science literacy, you need to broaden your ways of teaching and in doing that we find that the learners who do get a lot of lecture get even more out of the new style because they’re using different parts of their brain. And they learn the material more deeply. We’ve got to the 20 years of research on teaching and how the brain processes information that is being incorporated into these active learning strategies. Yes, you can certainly learn the old way, but why not use this research to improve that? We don’t ride in the same car in 20 years. A car today is more efficient and safer still it gets us to work, but it’s got other attributes as well. It’s the same with education. We’ve got more research and knowledge, why not use it to make a better product?

C.E.M.: How will you bring these strategies to Cornell?

KD: I’ve started working on a couple of areas. One is the multi-year project, it’s not going to happen right away. One of them, for example, is the use of clickers. A lot of our faculty know about it, but to introduce that in a new way. If you have to learn the system, you have to learn how to write questions. So I’ve got a system in my office that I can take to a professor’s class. I’ll offer to come beforehand and you can talk about the lecture and I’ll help write out questions. And I’ll run that part of it so it doesn’t interfere with your class. You can see what kinds of information you can get and how the students respond without it demanding a lot of your time. You can ask all sorts of questions and get that feedback so you can start adapting the course. And put in that context, the faculty seem much more interested and willing to try it themselves.

We’re going to have teaching workshops for new faculty and hopefully the time they save on the mechanics of teaching they’ll be able to spend thinking about incorporating some of this active learning. The idea is to do this in a way that works for the faculty. I want to let each of them find something that works for them and help them make their idea, their piece of it, work in that class.

Long term, we want to get some funding to help faculty redesign courses. A lot of NSF grants are expecting some education components now. We want to help make that part of the grant writing easier and showcase ideas that work so everyone doesn’t have to keep reinventing the same thing.

C.E.M.: What are some of the challenges you face?

KD: Faculty buy-in is one. They’ve got a lot of competing demands on their time, so how do they find time to not only teach their class but actually work with creating new components, in addition to all the other stuff they have to do?

They can’t just stop teaching to develop a course. So I’m looking at incremental changes that they can incorporate. Also, that’s been done in some courses, but there are others for which we only know basic strategies. In Intro Physics there’s a lot of data, but I don’t think engineering, or even the rest of physics, has been researched to the same level. You can’t just download a set of questions for upper-level courses … It’s this informal process that lots of people have put lots of time and effort on. The idea is to now take it beyond that. That’s one of the places where I’d like to see Cornell take the lead.

C.E.M.: What would give you the greatest sense of accomplishment?

KD: It would be when I can walk through a building and see that not every classroom has just one person at the chalkboard. If I walk past and see people engaged in different things, that would make me very happy.
"I made the material and I saw that it flowed at room temperature. So with the naked eye I had some proof. It’s the joy of discovery when you do something like that."

— THANOS BOURLINOS, NIMS CREATOR

STIRRING THE POT

RESEARCHERS AT THE NEW KAUST-CORNELL CENTER FOR ENERGY AND SUSTAINABILITY ARE COOKING UP NANOSCALE SOLUTIONS TO SOME GLOBAL PROBLEMS.

By Robert Emro

Graduate student Robert Rodriguez prepares polymer beads for use in novel nanocomposites under development at the KAUST-Cornell center as co-Director Emmanuel Giannelis looks on.

When you serve a bowl of soup, you probably stir the pot to get a good mix of vegetables and broth. Like soup ingredients, inorganic nanoparticles don’t want to stay mixed in organic materials, which is one reason why nanocomposites have yet to fulfill their potential. But Cornell researchers have found a way to evenly distribute nanoparticles in a polymeric broth. Varying the ingredients could make soups to soothe several of the world’s ills.

The new materials so impressed an international review committee appointed by the King Abdullah University of Science and Technology that it awarded $25 million to establish the KAUST-Cornell Center for Energy and Sustainability. Working with experts at other institutions and in industry, the center will apply the new technology to four critical problems: solar energy, water filtration, carbon capture, and oil production.

“Energy and sustainability, those are the questions of today,” says co-Director Emmanuel P. Giannelis, Cornell’s Walter R. Read Professor of Engineering and director of the Department of Materials Science and Engineering. “Those are the questions that scientists worry about; those are the questions that nonscientists worry about.”

Materials scientists have long been tantalized by polymer nanocomposites. By combining the processability, low-density, and light-weight characteristics of polymers with the functionality of inorganic structures like clays and carbon nanotubes, these hybrids offer unprecedented performance, design flexibility, and lower costs. Market forecasts estimate industry will use $500 million to $800 million worth of nanocomposites in 2011. But mixing problems have so far kept them from widespread applications.

“This is one of those once-in-a-generation type of projects. For the last 20, even 30 years, people in our community have recognized the benefits of hybrids, but the challenge had always been how do you make these systems reproducible, homogeneous, reliable.”

— Lynden Archer

CORNELL ENGINEERING 13

SPRING 2009
Playing with knobs

The researchers tried the process with other nanoparticles, including silicon dioxide, titanium dioxide, and fullerenes. They found that by altering the polymer, which envelopes the nanoparticle like a corona, they could create not just liquids, but glass solids, stiff waxes, and gels.

“What is really exciting about these materials is their tunability,” says Giannelis. “You have many different knobs that you can turn to give them a set of properties, and that makes us believe that there are hundreds of potential applications.”

Getting Out of the Way

Thanos Bourlinos first had the idea for creating NIMs in 2003, when he was a postdoctoral researcher working for Giannelis. His main research thrust at the time was modifying the surface of nanoparticles so that they could be used in photovoltaic cells. “Some properties had already been taken to the nanoscale so I was trying to figure out some new ones,” Bourlinos says.

Besides being perfectly mixed, NIMs have properties profoundly different from conventional nano-composites. They can behave as liquids at temperatures well below the melting point of either the polymer or the particle, undergo reversible phase changes, form solutions with other liquids, and act as solvents without evaporating.

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Materials Science and Engineering Associate Professor George Malliaras (left) discusses fabricating NIMs-based organic solar cells with graduate student Vladimir Pozdin.

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improvements. NIMs bring to solar panels could also boost energy conservation by producing more efficient LED lighting. “If you optimize it one way, it gives you good energy harvesting,” says Malliaras. “If you optimize it the other way, it gives you a good light source.”

**Big Beach Balls**

NIMs could also bring greater efficiency to oil production. Current oil drilling practices leave at least 50 percent of the ground. That’s because of a phenomenon called fingering that happens when water is pumped into the ground to drive the oil toward the well. “You can get preferential pathways—fingers of water—that connect the injection well to the production well,” explains Earth and Atmospheric Sciences Professor Lawrence Cathles, who leads the center’s oil production research. Because NIMs are much larger than most molecules, they don’t diffuse rapidly, making them useful as tracers. “They’re sort of like big beach balls that don’t leave their trajectory very much. They just go along with the flow,” says Cathles. “The first step is to tap this tracer capability to understand better where the fingers are. The second step is to develop a range of capabilities to deploy NIMs in a remediation fashion to reduce fingering’s impact.”

Surfactants, which, like soap, make oil and water more likely to mix, are the current solution to fingering, and NIMs could make them better. “To prevent fingering you try to get your injection fluid to have less distinction from oil so that it will displace the oil,” says Cathles. “It’s just very unusual that you get a new technology coming along that really lets you do some very established things in a new way.”

NIMs could also help with problems like groundwater pollution. “There are all kinds of environmental issues related to subsurface flow,” says Cathles. “Flow channels and diffusion are absolutely fundamental, and this technology is barking up exactly that tree.”

**Carbon Rocks**

While enhancing oil production would provide a stopgap until more sustainable alternative energy sources could be developed, it would also result in more climate-warming atmospheric carbon dioxide. NIMs, however, could help here too, by providing new materials for carbon capture and storage.

Ethanolamine is a popular fluid for capturing carbon from power plant stacks, but it’s volatile, so the hot gases must be cooled first, adding considerable expense to the process. NIMs could do the job for less because they can withstand high temperatures without losing their organic components to evaporation. “The advantage of using the NIMs is that they have essentially no vapor pressure,” says Chemical and Biomolecular Engineering Professor Donald Koch, who heads the center’s carbon sequestration research.

NIMs made with ethanolamine coronas would have extra incentive for absorbing carbon because it would put the “fuzzy” long chain molecules in uncomfortable positions from which carbon could free them. “These chains have to fill the spaces between particles, since nature abhors a vacuum,” he says. “In some cases the hairs have to kink and squirm around in strange ways.”

Captured carbon could be removed and pumped underground, or it could be turned into rocks. “With the right nanoparticle catalyst, it could be combined with a mineral containing calcium or magnesium to form carbonates,” says Koch. “The other idea we are pursuing is to turn it into polymers that could potentially make useful products.”

**Goo-be-gone**

Applied to water filtration, NIMs could be used to create better reverse osmosis membranes. “We hope that with the composites based on these materials we will get to a level of pure size control as well as surface chemistry control that is unprecedented,” says Ulrich Wiesner, Spencer T. Olin Professor. Wiesner leads the team investigating a host of advantages NIMs-made membranes might offer, including faster filtration, salt rejection, better tolerance to pH changes, resistance to fouling, and self-cleaning capabilities. “Chemical oxidants, for example, can degrade the membrane. If they were more tolerant, they could last longer,” says Wiesner. “Or you could use chlorination as a means of preventing the growth of all kinds of goo on the membrane.”

Any improvements to the current technology would be welcome. “There’s a huge need for materials that can produce clean water at lower cost and at lower energy,” says Wiesner. “That would help everybody.”

While all the KAUST-CU Center researchers have high hopes for NIMs, they also point out that this is a brand-new materials platform. Some unforeseen stumbling block could stymie its application to real world problems, just as the mixing difficulties have thwarted most attempts to harness the capabilities of more conventional nanocomposites. It will be years before anyone knows what useful applications NIMs will yield, but it’s already certain they will help produce the next generation of engineers and scientists. “These materials are wonderful platforms to educate students in complex fluids, in polymers, and in composites,” says Giannelis. “Even if the technology fails—which I don’t think it will—we will still have produced a good number of students and experienced postdocs. And that, after all, is our primary business.”
students,” says Lisa Schneider, ELI director. “It does amazing things for their lab and research skills, as well as giving them confidence and a sense of their own capabilities. Then, too, these projects allow them to assess their interest in pursuing a research career, either in academia or in industry.”

ELI works with the Intel Foundation and others to fund undergraduate engineering projects. One of Intel’s goals is to retain students in science, technology, engineering, and mathematics disciplines and foster their interest in pursuing graduate degrees in these fields. “Our own self-interest is in ensuring that we have an ongoing supply of brain power to stay at the leading edge of the semiconductor and information technology industry,” says Intel Foundation’s Kimberly Sills. “But it’s much bigger than that. It’s about investing in a global future we all share.”

Part of that future is in the hands of Sarah Elizabeth Long ’09 CE, whose summer work Intel helped to support. “I didn’t expect to be involved in such big deal research,” says Long. She worked on a project run by Civil and Environmental Engineering Professor Christine Shoemaker for the U.S. Department of Agriculture titled “Integrating Sensor Network Design with Weather Forecasts and a Watershed Model to Predict and Manage Water Quality.”

“We are looking at sustainability issues,” says Shoemaker. “One of the major water quality problems facing central New York is caused by excess phosphorus. With a few big storms, you get more phosphorus in the water supply than if the rainfall is evenly spread out. So we are looking at thousands of weather files to understand not only the total amount of rainfall, but also the timing and magnitude of high-flow events.” Developing an improved model and computational analysis will enable Shoemaker and other scientists to better understand complex environmental systems and ultimately recommend the best practices to manage them.

The computational analysis is where Sarah Long fits in. Working as an intern with Surabhi Guar, a second-year master’s student, Long applied her programming and analytical skills. She ran massive amounts of rain data from the Cannonsville watershed—the third-largest of nine reservoirs that supply drinking water to New York City—through SWAT (a Soil and Water Assessment Tool). This powerful software is the USDA’s model for quantifying the impact of land management practices in large, complex watersheds. In this case, it extrapolated rain data taken near ground level to the higher amounts found at higher elevations, providing a more accurate picture of rainfall’s impact on the environment. Long then transferred those data into a spreadsheet in order to plot trends over time. Getting the software programs to work together proved to be one of her biggest challenges, requiring her to fix some of the code. “I didn’t expect to look at a stream and see so many numbers, over and over. I didn’t see the connection at first, but when I reached the end… well that was ooookay!” Guar was once a rarity, undergraduate involvement in faculty research has increased steadily over the past two decades, thanks to a National Science Foundation initiative. Cornell Engineering is at the forefront of this movement. Today nearly half of Cornell engineering undergraduates do hands-on research in faculty labs, working for a semester, a summer, or longer.

The college’s Engineering Learning Initiatives office makes it easy for students to connect with faculty by providing structured opportunities for undergraduate research. “Getting their feet wet in academic engineering research is really powerful for our students,” says Lisa Schneider, ELI director. “It does amazing things for their lab and research skills, as well as giving them confidence and a sense of their own capabilities. Then, too, these projects allow them to assess their interest in pursuing a research career, either in academia or in industry.”

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impressed—and grateful. “My work was coming along, but once Sarah came on board, we really picked up speed,” she says. Long found the work very rewarding. “It felt good to know I could contribute to results that will ultimately help people,” she says. The experience was beneficial to her personally, too. Doing some real world data analysis “will help me decide whether I want to go into the computational and theoretical side of engineering or do more hands-on, applied work,” she says. An experience like Long’s often begins at the ELI Web site, which gives students guidance on exploring opportunities, finding a mentor, getting a grant, and learning about a large number of research opportunities beyond those offered through the College of Engineering. A student looking for a unique summer experience can find information on scores of NSF-sponsored Research Experiences for Undergraduates programs at campuses around the world.

“Our large undergraduate research program sets us apart from many other schools,” says Chris Ober, interim dean and Francis Bard Professor of Materials Engineering. Ober himself participated in research as an undergraduate, and the experience influenced his decision to pursue a faculty position. Now he uses undergraduates in his own research every year.

ELI provides resources for research mentors, too. When targeted opportunities arise, Schneider contacts faculty individually to encourage them to involve students in their research and to inform them of the funding that is available. She keeps the grant application process simple for busy faculty members. “We ask for a brief proposal that tells us what they want to do, how they will mentor the student, and how the money will be used. There’s a lot of latitude; the grant funds can go toward a stipend for a student or can help cover project expenses.”

Ramya Tadipatri ‘10 BEE received support for her research expenses from the college’s Annual Fund. She came to Cornell fairly certain that she wanted to pursue medical research. By the beginning of her sophomore year, she was poring over descriptions of faculty projects and found herself particularly drawn to Biomedical Engineering Assistant Professor Claudia Fischbach-Teschl’s cancer research. She began helping out in her lab at the end of her sophomore year and applied for her first research project in the summer.

Her project is one of several aimed at understanding how the bone microenvironment affects cancer cells—particularly the breast cancer cells that metastasize to bone. “People have studied how biochemical factors are involved in metastatic breast cancer. What we’re adding to the picture is to look at the matrix itself,” says Fischbach-Teschl. “We recreate biomineralized scaffold structures that mimic certain properties of bone and seed those with tumor cells, then we analyze how the tumor cells’ behavior is influenced by these conditions.”

The first part of Tadipatri’s project was to manufacture two versions of the scaffold: one incorporating hydroxyapatite, a calcium compound that makes up 70 percent of real bone, and one without the mineral.

Her next step was to expose both versions of the scaffold to macrophages, cells that turn into bone-dissolving osteoclasts. “The spread of cancer causes degradation to the bone, much like osteoporosis does,” she says. “That degradation is associated with higher osteoclast activity.” At the end of the summer, Tadipatri began to introduce live cancer cells into the scaffolds, grow the cultures, and finally cut up the scaffolds. She then treated them with chemicals to break up the cells and release the DNA, which allows her to estimate and compare the number of cells in each version of the scaffold. If all goes well, the numbers will give some indication whether bone’s physiochemical properties are a factor in cancer’s destructive process.

“Can a sophomore participate in such sophisticated research? Fischbach-Teschl, who consistently involves three or four undergraduates in her lab, gives them very specific assignments and has a system for using them. Her lab manager trains the undergraduates in the fundamentals of cell culture, sterile technique, and some specific aspects of the project. Then each undergraduate works directly with a graduate student or postdoc on an ongoing basis. Each research project team meets every two weeks, bringing their results, questions, and problems together and determining next steps. Fischbach-Teschl encourages undergraduates to co-author a publishable paper on their work. The whole process provides a path for students like Tadipatri to develop increasing levels of skill and knowledge, participate in a complete academic research experience, and earn some credentials that will serve them well in applying to medical or graduate schools.

THE SPREAD OF CANCER CAUSES DEGRADATION TO THE BONE, MUCH LIKE OSTEOPOROSIS DOES.”

—RAMYA TADIPATRI
In addition to corporate support and donations to the Annual Fund, designated alumni gifts also allow undergraduates to conduct research. “Some corporations who want to hire our students are eager to enhance their educational experience and encourage them to go on to graduate school. They can benefit, too, by enhancing their visibility with people they hope to hire in the future,” says Schneider. “Others—and this includes corporations and individual alumni—just see that undergraduate research provides very exciting and meaningful opportunities for students, and they want to help make them available.”

Jim Moore ’62, E’E, ‘64, funds several student projects each year. As an undergraduate, he worked with Electrical Engineering Professor Ralph Bolgiano Jr. ’44 EE, Ph.D. ’58 at the old radio astronomy lab next to the Tompkins County Airport for several summers. He also worked for Electrical Engineering Professor Simpson Linke, M.Eng. ’49 EE, devising a means to interrupt large DC currents. “I like to tinker and build stuff,” Moore says, “and I learned so much from working with these people on gadgets that were pretty important. They reinforced my interest in engineering.” So when Moore wanted to do something more philanthropic, funding undergraduate research projects seemed like the perfect match. Junior Goodwin “Win” Wharton was one of several students who benefited from Moore’s generosity last summer.

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Proteins, which account for about a fifth of our weight, are polymeric chains of up to 20 different amino acids. Each protein is hundreds to tens of thousands of amino acids long and performs a very specific function in our body; hemoglobin in our blood carries oxygen, and myosin in our muscles gets us moving. To perform such specific functions, proteins have to fold up in specific three-dimensional structures and sometimes toggle between different ones. A protein called VIVID, for example, found in a bread mold, changes its conformation when exposed to light to keep the fungus’ Circadian rhythms in sync with the sun.

A protein—forged as a linear chain—must find its correct structure from several billion possible folded forms. Counting on a protein to do that regularly is like expecting a mile-long yarn to knot up in precisely the same tangled ball every time—yet the protein usually succeeds. “Somehow the instruction as to how a protein is going to fold up is chemically written into the pattern of amino acids,” says Pollack, but it’s a writing that we haven’t learned to read yet. How a protein acquires its biologically active structure, and how it responds to stimuli—such as VIVID to light—have therefore been open questions in biology for several decades.

Proteins and their structural polka are half of Pollack’s research; interacting RNA and DNA strands make up the rest. What they have in common are the tools she builds to study them. “I love to find a problem that really needs to be solved, and ask, ‘Why has nobody been able to solve this before, and what’s been limiting progress?’” she explains. “And then I do my best to build a tool to solve that problem.”

No wonder, once you look at some of those problems. How does the flu virus fool our immune system every year? What controls our circadian rhythm? How do our cells decide when to make certain proteins?

Today, we know these to be questions at the forefront of molecular biology. Hard to believe, then, that Pollack slipped down this path perchance while flipping through a magazine, waiting to collect data for her real research, more than a decade ago.

Early Years

Pollack received her Ph.D. from the Massachusetts Institute of Technology, working with Thomas Greytak. In 1989, she came to Cornell to work with Physics Professor Robert Richardson as a post-doctoral associate. A low temperature physicist by training, she started studying nuclear spin ordering in 1995.

Her experiments with Richardson involved extremely long spin relaxation times; each run would take several hours, even days, to finish. During one such run, Pollack picked up an issue of Physics News and flipped to an article on protein folding. Within half a page, she had found her calling.

In 1995, the “energy landscape” picture of protein folding was just beginning to emerge. Each possible structure of a protein, the picture says, has a specific energy. Just as a ball will roll downhill to the point of lowest energy, a protein switches through many possible structures until it finds its lowest energy structure, which is also its biologically active structure.

What makes protein folding a hard nut to crack is that it’s impossible to see a protein
Pollack's group studies the dance that proteins like calmodulin (CALcium MODULated protein) perform when they change from being bound with calcium (CXL.pdb, left) to not being bound with calcium (QXS.pdb, right).

fold. Typical protein molecules—between a few and several hundred nanometers long—are too small to be seen with light microscopes. Instead, scientists look at how a protein scatters X-rays to paint a picture of its complex contortions. A change in pH initiates the dance. The first steps begin in just milliseconds, so the pH must be changed very rapidly. Otherwise the pH change's effects will show up in the painting. The scattered X-rays must be measured just as quickly. When Pollack first turned her attention to the problem, the pH change took longer than the folding. "Folding is in the blink of an eye," says Pollack. "They were too fast to be detected by the tools you could buy, and those were the tools that everybody was using." Pollack had an idea for building a much faster tool: a micro-flow mixer—a tiny device that everybody was using. "Proteins fold in the blink of an eye," says Pollack. "They were too fast to be detected by the tools you could buy, and those were the tools that everybody was using."

With her toolkit, Pollack hopes to see HA at work, literally, and demystify this unique protein. Proteins like HA catalyze structural changes, such as the fusion of the viral and endosome membranes. Others are molecular motors, such as myosin in our muscles and dynesin in bacterial flagella. Yet other proteins, such as VIVID and phototropins in plants, respond to external stimuli, such as light. The response of these proteins is very often a structural change, easily detectable by the suite of tools Pollack has at her disposal. Lately, she has trained those tools on two proteins that respond to stimuli. VIVID, a protein found in bread mold, controls the mold's circadian rhythm, the same physiological rhythm that makes us sleepy at night. The Pollack group, in collaboration with the Crane group, observed that two VIVID molecules merge when hit with blue light, starting a cascade of reactions that ultimately makes the mold's biological clock tick. Although VIVID itself is found in only a few organisms, it "is one of a larger family of proteins that is found in everything" including mammals, says Lamb. They thought it's not always a circadian rhythm, she clarifies. For example, a very similar protein NPH1 in Arabidopsis is responsible for the tendency of plants to grow towards light. Calmodulin, on the other hand, senses calcium ions. "The body works a lot like a circuit, and ions carry the currents in the circuit," Pollack explains. The flow of calcium ions across the cell membrane plays an important role in muscle contractions. Calmodulin senses these ions and converts their concentration into chemical signals, which trigger motor proteins in charge of muscle functions. Such proteins that convert "on and off" one kind of signal into another are fairly common in biology. Understanding how VIVID and calmodulin work, therefore, will provide insight into two of biology's most important processes: photodetection (how organisms respond to light) and signal transduction.

While protein functions kept her fascinated, Pollack realized quite early that studying them one after another had the danger of becoming monotonous. "It occurred to me that I could spend my entire life studying different proteins," she says. As a physicist, she craved diversity in the problems she tackled. "Instead, scientists look at how a protein scatters X-rays to paint a picture of its complex contortions. A change in pH initiates the dance. The first steps begin in just milliseconds, so the pH must be changed very rapidly. Otherwise the pH change's effects will show up in the painting. The scattered X-rays must be measured just as quickly. When Pollack first turned her attention to the problem, the pH change took longer than the folding. "Folding is in the blink of an eye," says Pollack. "They were too fast to be detected by the tools you could buy, and those were the tools that everybody was using." Pollack had an idea for building a much faster tool: a micro-flow mixer—a tiny device that everybody was using. "Proteins fold in the blink of an eye," says Pollack. "They were too fast to be detected by the tools you could buy, and those were the tools that everybody was using."

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The administrative point of view while also attracting a research star who can take the department in new directions," said interim Dean Chris Ober. Chen earned his B.S. from National Taiwan University and M.S. and Ph.D. from the California Institute of Technology all in electrical engineering. He worked at Bell Labs before Cornell and accepted the award at an October ceremony.

A student in Electrical and Computer Engineering Ph.D. student Lang Tong’s Adaptive Communications and Signal Processing Group, Anandkumar studies areas of inference on graphical models, networking, and information theory. Anandkumar is currently a visiting graduate student at the Laboratory for Information and Decision Systems at the Massachusetts Institute of Technology. She received her B. Tech. degree from the Indian Institute of Technology Madras, Chennai, India in 2004. Attracting and supporting more women into her field is “hugely important” to Anandkumar. “Although I have really good role models and a support system, I have heard from many women students that they could use a little more help or mentorship in the very beginning, when it’s most needed,” she said. “In that aspect maybe this award will help toward achieving that.”

— Anne Ju

STUDENTS GOING TO ACM WORLD FINALS

A Cornell team is going to the 2008–2009 Association for Computing Machinery (ACM) International Collegiate Programming Contest in Stockholm, Sweden, April 18–22. The team qualified with a second-place finish in the regional contest for greater New York in October. Eric First ’09 ECE, Vineet Chauhan ’08 CS, and Haden Lee ’08 CS made up one of three teams Cornell sent to the regional contest at St. John’s College in Pathaghy, N.Y. They were given eight complex, real-world problems, with a grueling five-hour deadline. The team that solved the most problems in the least time won. They solved seven and held first place until just 12 minutes before the end of the contest, when a team from SUNY Stony Brook solved their problem. In Stockholm, 100 world-festival teams will compete for awards, prizes, and bragging rights at KTH—the Royal Institute of Technology. Huddled around a single computer, competitors will race against the clock in a battle of logic, strategy, and mental endurance.

“These teams represent the best of the great universities on six continents—the cream of the crop,” according to an ACM fact sheet.

Dustin Tseng, a third-year Ph.D. candidate, coaches the teams. Overall standings were not last year. Tseng noted, even though the teams included many “rookies” who had never been in the contest before. A Cornell team took first place in the ACM regional last year and Cornell has placed in the top two for the last three years.

— Bill Shire

OR ALUMNUS STUDIES CRIMINAL JUSTICE

Alfred Blumstein ’71, Ph.D. ’80, self-described “missionary” of operations research to the criminal justice system, has spent 40 years offering a systems perspective for informing decisions and policies in crime-reduction efforts, incarceration, and cost effectiveness.

Blumstein, the J. Erik Jonsson University Professor of Urban Systems and Operations Research at Carnegie Mellon University, described his research at a recent meeting of the Institute for Operations Research and the Management Sciences Boston chapter.

Blumstein’s work over the past 20 years has covered such aspects of the criminal justice system as crime measurement, criminal careers, sentencing, deterrence and incapacitation, prison populations, demographic trends, juvenile violence, and drug-enforcement policy.

“Breaking his talk, Blumstein, who received his bachelor’s degree from Cornell in engineering physics and Ph.D. in operations research, described how feedback modeling of criminal careers has led to a number of policy insights in recent years, such as the notion that sentencing decisions should take into account the ‘residual career length’ of convicted lawbreakers to avoid wasting prison space.”

He noted that the primary factors driving growth in prison populations have not been increases in crime or arrest rates, but in length of sentences and in the proportion of arrests resulting in convictions.

He also discussed the unintended consequences of incarceration—an increase in drug offenders in prison, recruitment of young replacements by crack markets, the proliferation of guns to protect the markets, and the tendency of young people to “resolve disputes by fighting” with much more lethal weaponry in fact, Blumstein posited, the entire homicide rise from 1965 to 1995 can be explained by the increase in killings by young people with handguns, many in the drug trade.

Blumstein has served as president of the Operations Research Society of America, the Institute of Management Sciences, and the organization resulting from their merger—INFORMS. In 1998 he was elected to the National Academy of Engineering.

—Mark Eisner

KOZEN HONORED AS AAAS FELLOW

Professor of Computer Science Dexter Kozen M.S. ’86, Ph.D. ’77, was among five Cornell faculty members named fellows of the American Association for the Advancement of Science, the world’s largest general scientific society and publisher of the journal Science.

The members were recognized Feb. 12 at the annual AAAS meeting, held this year in Chicago. Kozen, who is currently a professor in Computer Science, is cited for outstanding contributions to the foundations of computer science, including the theory of computability, computational complexity, algorithms, and program logic and verification. Kozen is especially interested in the complexity of decision problems in logic and algebra, logics, and semantics of programming languages and computer security.

The other fellows were Thomas J. Burt, professor of plant pathology; Richard Durrett, professor of mathematics; Sally McConnel-Ginet, professor emeritus of linguistics; and John A. Schimenti, professor of genetics.

GOSSETT HONORED FOR LANDMARK PUBLICATION

Professor of Civil and Environmental Engineering James M. Gossett received the Outstanding Publication Award from the Association of Environmental Engineering and Science Professors. Gossett received the award with his former student David Friedman, who is currently a faculty member at Clemson University.

This award is given annually “to recognize the authors of a landmark environmental engineering paper that has withstood the test of time and significantly influenced the practice of environmental engineering.”

Gossett and Friedman were honored for their 1989 publication “Biological Reductive Dechlorination of Tetrachloroethene and Trichloroethylene to Ethylene under Methanogenic Conditions.”

They were the first investigators to report the complete conversion of chlorinated ethenes to non-toxic ethylene; for this work they were noted as using novel bioremediation technologies to address a common class of groundwater pollutants—chlorinated solvents.

CHEN LEADS SCHOOL OF ELECTRICAL & COMPUTER ENGINEERING

Tsuhan Chen, an expert in visual computing from Carnegie Mellon University, joined the Cornell faculty in January as director of the School of Electrical and Computer Engineering.

Chen succeeds Clifford Pollock, the Ilda and Charles Lee Professor of Engineering, who had served as director since 2001.

“Cornell’s depth and history immediately got my attention,” Chen said. “But what really impressed me is how the faculty have stayed so dynamic over the years, constantly finding new ways to do things—staying out in front.”

Chen joined Carnegie Mellon’s engineering faculty in 1997 where he served as associate department head of electrical and computer engineering and co-director of the Alberta Chung Technology Research Institute Laboratory, a collaborative research program with ITRI in Taiwan. His group worked in the area of visual computing, which Chen leads School of Electrical & Computer Engineering

Tsuhan Chen

Ph.D. student wins IBM award for women in engineering

Engineering Ph.D. student Asimaan Anandkumar has received the 2008–09 IBM Fran Allen Ph.D. Fellowship, which promotes the advancement of women in technology fields. The award, named for an IBM fellow emerita, includes a $50,000 grant to Cornell to encourage participation of women in engineering and computer science, according to the award letter. Anandkumar accepted the award at an October ceremony.

A student in Electrical and Computer Engineering Ph.D. student Lang Tong’s Adaptive Communications and Signal Processing Group, Anandkumar studies areas of inference on graphical models, networking, and information theory. Anandkumar is currently a visiting graduate student at the Laboratory for Information and Decision Systems at the Massachusetts Institute of Technology. She received her B.Tech. degree from the Indian Institute of Technology Madras, Chennai, India in 2004. Attracting and supporting more women into her field is “hugely important” to Anandkumar. “Although I have really good role models and a support system, I have heard from many women students that they could use a little more help or mentorship in the very beginning, when it’s most needed,” she said. “In that aspect maybe this award will help toward achieving that.”

— Anne Ju

STUDENT RECEIVES OUTSTANDING UNDERGRADUATE AWARD

Tal Rusak ’09 CS is the 2009 winner of the Computing Research Association’s Outstanding Undergraduate Award. The award includes $1,000 and a plaque. He will also receive financial assistance to attend a major computing research conference.

The Outstanding Undergraduate Awards are given to one male and one female undergraduate in North American universities who show outstanding potential in an area of computing research. Rusak has been involved in research since freshman year, resulting in seven first-authored publications and presentations. His current research focuses on understanding the structure of low-power wireless networks by deriving novel properties of the time variations in network links. This work was advised by Assistant Professor Philip Levis of Stanford University. Concurrently, he has focused on building a computerized system to audit major requirements in collaboration with other Cornell undergraduate Professor David Freedman, associate dean for undergraduate education.

He has served as a teaching assistant and peer tutor for undergraduates and serves on the Student Library Advisory Council. He also volunteers at an after-school program for elementary school students in Ithaca.
SEVEN RECEIVE HEART ASSOCIATION GRANTS

Three biomedical engineering faculty members were among seven Cornell researchers to receive new grants from the American Heart Association to help fight heart disease and stroke, the No. 1 and No. 2 causes of death in the United States. Six Cornell researchers already have funding from the AHA. Cynthia Renhart-King, assistant professor of biomedical engineering, received a scientist development grant for $198,000 over three years for her research, “Regulation of endothelial cell function by extracellular matrix elasticity.” Moonsoo Jin, assistant professor of biomedical engineering, received a scientist development grant for $198,000 over four years for his research, “VLA-4 (aβ1 integrin) activation-specific antibody in inflammation.” Jonathan Butcher, assistant professor of biomedical engineering, received a scientist development grant for $198,000 over four years for his research, “The biomechanical regulation of valvulogenesis.”

Richard Rand, professor of theoretical and applied mechanics, was among four Cornell faculty members chosen for the 2008 Stephen H. Weiss Presidential Fellowships for excellence in teaching and advising undergraduate students and outstanding efforts to improve instruction on campus. The awards—$5,000 a year for five years for each faculty member—are named for Stephen H. Weiss ’87, the late executive director of the Cornell Board of Trustees, who endowed the fellowships in honor of his late mother. The committee wrote, “Letters from undergraduates emphasize his kindness and patience and his willingness to meet with them outside of regular office hours.”

When fellow rocket scientists are asked to describe their colleague F. Landis Markley Jr. ’61, B.E.P. ’62, it usually comes back to brainpower. “He’s the brightest person I ever met,” says John Cressidis, a former student of Markley’s. “He would solve stuff in five minutes that would take another person hours upon hours.”

The praise isn’t unwarranted. Markley has a list of accomplishments that have garnered him awards and a symposium in his honor—and he is absolved at all the interjections of “Dr. Markley” by his peers. “I feel that there are probably many other people who are equally deserving,” he says.

At age 69, Markley has built a successful career in astronautical engineering, still working as a lead mission engineer for NASA’s Goddard Space Flight Center in Greenbelt, Md. His expertise in physics and engineering has enabled breathtaking snapshots of galaxies, data on global change, and proof of dark matter and energy. However, this wasn’t the realization of a childhood dream—in fact, Markley claims he simply “fell into” the field. After teaching physics for six years at Williams College in Massachusetts, Markley failed to get tenure—he left to take a position with a software company writing computer programs for spacecraft. “That’s when I got interested in space—because it was a job,” says Markley, with a laugh. “It isn’t very inspirational.”

Despite this modest debut, Markley soon made his mark on the world of space engineering. His contributions to a NASA mission determined the recognition. “It feels humbling,” says Markley. “I feel that there are probably many other people who are equally deserving.”

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Discovering new materials is a laborious process of trial and error. From hundreds of thousands of possible combinations of elements, scientists choose one they think might have the properties they are looking for, determine how to synthesize it, and then test for the desired properties. More often than not, they’re wrong. But with advances in computing power, a deeper understanding of physics, and the ability to manipulate individual atoms, scientists are beginning to design materials they know will have the desired properties. Cornell’s Craig Fennie, assistant professor of applied and engineering physics, is working to make materials by design a reality. By using first-principles quantum mechanical techniques he gains insight— not easily obtained through experimentation, if at all—into the physics of complex oxides in order to predict new properties. Superconductivity, ferroelectricity, and magnetoelectricity are just three of the exotic properties of complex oxides. They could someday be used in multipurpose semiconductors for hard drives, sensors, and other applications.

As a graduate student, Farley attended a small seminar in which Professor Bill Gordon first presented ideas that led to the building of a giant radar at the Arecibo Observatory in Puerto Rico. Farley has been involved with the theory and study of space plasma physics, using this and other giant radars, ever since.

“Most of my retirement savings are in tax-deferred accounts, so I would normally have to pay federal and state income taxes on any withdrawals before donating—not an appealing prospect,” said the J. Preston Lewis Professor of Engineering Emeritus. “I learned of a provision that allows for tax-free distributions from IRAs; I decided to take advantage of this, and the paperwork turned out to be very simple and quick—just a couple of phone calls.”

Read more about Professor Farley’s gift and discover the benefits of the many gift options like the charitable IRA rollover online at www.alumni.cornell.edu/gift_planning

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Once again, you can redirect your required minimum distribution to Cornell—tax-free. Consider joining other alumni and friends who are taking advantage of this unique opportunity to meet their charitable goals. Please note the following:

• You must be 70½ years of age or older.
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• The provision expires December 31, 2009.
• The gift must be outright to Cornell.

1-800-481-1865
One of Cornell’s gift planning specialists can explain the benefits.