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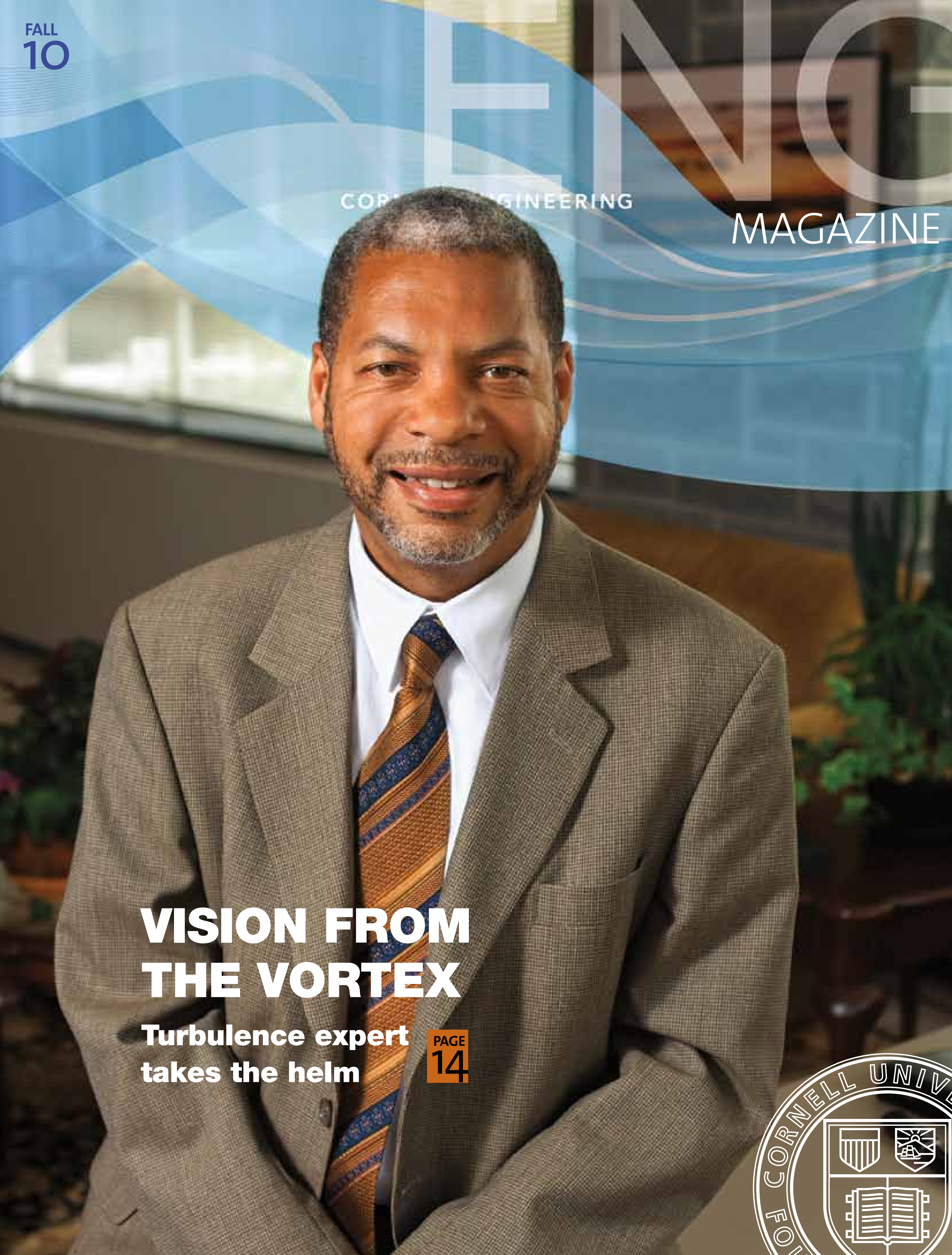
CORNELL ENGINEERING

MAGAZINE



VISION FROM THE VORTEX

Turbulence expert takes the helm

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DEPARTMENTS

CORNELL ENGINEERING MAGAZINE/FALL 2010

Features

'Smart Walker' patented

Cornell biomedical engineering students working with Weill Cornell Medical College-affiliated psychiatrist Dr. Eli Einbinder have designed an electronic braking system for walkers, with buttons replacing bicycle-style squeeze brakes. Their walkers also have automatic braking that can prevent slips, slides, and falls when a user grabs the handgrips.

For three years, a team of graduate students from the Department of Biomedical Engineering and undergraduate seniors from several departments in the College of Engineering worked with Einbinder and BME Senior Lecturer David Lipson on a prickly problem: how to prevent elderly users with limited mobility from falling when they use a braking walker.

The "Smart Walker" relies on handgrip sensors. The walker starts in the braked position, and low-strength users need only touch a button to electronically disengage the brake and begin moving. Once a user removes hands from the handlebar, the walker automatically resets to the braked position. The added stability and ease of operation for users with reduced hand strength promises to dramatically reduce accidental falls—a significant source of injury among the elderly with limited mobility. It can further reduce injury among the elderly by encouraging a more active lifestyle.

The braking system the team devised has a single highly sensitive button. The button runs to a microprocessor, which sends information to a linear actuator that in turn pulls on a mechanical brake to make the wheels come to a complete stop. That means this walker will brake safely for users with low strength or impairment in their hands.

This electrically assisted walker project, first reported in the Spring 2007 issue of *CEM*, stems from 16 years of work by Einbinder, who received a patent for his solution in June. Einbinder has been a consultant to the project since its inception, working with Lipson's team at least weekly via conference calls and e-mail.

LINDSAY FRANCE/UNIVERSITY PHOTOGRAPHY

The "Smart Walker" starts in the braked position, and low-strength users need only touch a button to electronically disengage the brake and begin moving.

100+ MPG Team withdraws from X Prize competition

Redshift, the Cornell X Prize car, passed technical inspection at Michigan International Speedway.

After passing a technical inspection and reaching the first knockout qualifying stage at Michigan International Speedway, the Cornell 100+ MPG Team was forced to withdraw from competition for safety reasons.

Competing in the Progressive Insurance Automotive X Prize, which offers a $10 million prize to cars that get 100 miles to the gallon or equivalent, the team experienced two separate failures in the electronic components that monitor the car's lithium-iron battery packs. Lacking the time to fully diagnose the problem, they chose to withdraw from the contest.

"We don't know if it was a design flaw or a manufacturing flaw," said Al George, team co-adviser. "There is a lot of energy stored in those batteries."

Cornell finished their run in the contest as one of nine teams in the mainstream, four-passenger vehicle class (judged separately from alternative-class vehicles), after being winnowed from a list of more than 100 qualifying vehicles back in April 2009. They were also the only university team representing mainstream vehicles.

The team arrived at Michigan International Speedway June 14 to prepare to race. They passed the final technical inspection near the end of the week, and they noticed the problem with the batteries June 17. After spending most of June 17 and 18 trying to figure out the problem, they decided to withdraw at about 1 p.m. June 18—just before their first endurance race.

"We just ran out of time, and I think if we were able to have a few days of testing we would have figured out what the issue was," said team co-leader David Zlotnick '11 ECE.

The team intends to get the vehicle running reliably to showcase new technologies and to use it as an educational and promotional tool for Cornell. The team is also working with a popular magazine to have a third party measure and publish the vehicle's overall efficiency in a series of real-world driving scenarios.

—Anne Ju

Baja team takes first

A land- and water-traversing vehicle built by the Cornell Baja Racing Team took first place against 70 other teams at a June 10–13 competition in Rochester, N.Y.

In its sixth year, the Baja racing team, which builds an off-road vehicle designed to withstand a variety of difficult terrains, took the top overall prize at the International Baja SAE (formerly Society of Automotive Engineers) competition held at Rochester Institute of Technology (RIT). It was their first overall first-place finish.

Also for the first time, the team took its vehicle, GP06 (named in honor of George Petry, an unofficial team adviser), to the water. The RIT competition required vehicles to drive through standing water as part of the endurance race. It was a chance for the team to showcase its first amphibious vehicle—no small feat, considering the engineering challenges associated with such versatility.

The Cornell students' design involved a hydrodynamic flotation system on the underbelly of the car, explained team co-leader Andrew Cypher '10 MSE, and two fenders that let the tires spin in the water and propel the car forward, much like a jet ski.

"A lot of compromises had to be made," Cypher said. "A lot of things that are faster in the water are slower on land."

During the four-hour endurance race, the Cornell students thought all was lost when the car nose-dived and flipped, setting them back a half hour to replace several parts and repair the engine. But thanks to some skillful driving by Connor Broaddus '10 ME and Alexander Kopache '10 BE, GP06 surpassed car after car and came in fourth—allowing them to earn enough points to win the competition.

"They just drove lights out," Cypher said.

As in years past, the team was also judged in such dynamic and static categories as design, maneuverability, suspension, and cost.

—Anne Ju

CORNELL RACING TEAM

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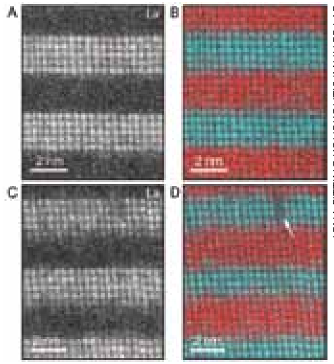
Researchers make ultra-thin magnetic sheets



LENA FITTING KOURKOUTIS/MULLER LAB

Spectroscopic images of alternating lanthanum strontium manganite and strontium titanate layers. A and C are lanthanum maps, and B and D are false-color maps with titanium (red) and manganese (green) extracted from the spectrum images. The layer grown with a smaller laser spot size shows less abrupt interfaces and a defect, marked by a white arrow.

Materials do funny things at the nanoscale. A metal oxide complex called lanthanum strontium manganite is ferromagnetic in large quantities. But scaled to nanometer thickness, it becomes an insulator and loses much of its ferromagnetism. Same material, different behavior.

Using cutting-edge spectroscopy at atomic resolutions, researchers led by David A. Muller, professor of applied and engineering physics, have figured out why this happens, and how to grow ultra-thin manganite films while retaining their magnetic properties. Perfecting such a technique could pave the way for manganites and other oxides to replace silicon in thin-film electronics, memory storage, and other technologies.

The work is detailed in a paper published online June 14 in the journal *Proceedings of the National Academy of Sciences*.

"A number of research groups have grown these thin layers before, and their results suggested that there is a 15-atomic-layer critical thickness, below which you could not get it conducting," said postdoctoral associate Lena Fitting Kourkoutis M.S. '06 AP, Ph.D. '09, the paper's first author. "But we show that we can go much lower to a handful of atomic layers and still keep it conducting."

The key is understanding how to grow perfect, defect-free manganite sheets. The chemical composition has to be exactly right, and even the slightest break in the crystalline lattice of the atomic layers can ruin the films' conductivity. These defects don't matter as much on a larger scale.

To examine manganite samples grown by their collaborators in Japan, the scientists used a technique called electron energy loss spectroscopy, performed in a scanning transmission electron microscope. They employed a technique (described in a 2008 *Science* paper) called aberration correction, which allows them extreme precision for imaging the composition of films only atoms thick.

Manganites have good potential for the emerging field of spintronics, which exploits materials' electron spin and magnetic moment for use in memory storage technologies.

—*Anne Ju*

Widetronix gets $2.2 million

A company that uses Cornell-developed technology to create low-power, long-lasting batteries has received a $2.2 million boost from the federal government.

Ithaca-based Widetronix Inc., co-founded in 2003 by Cornell professor of electrical and computer engineering Michael Spencer, has been awarded $1.2 million from The Solar Energy Consortium and $1 million from the U.S. Department of Defense.

U.S. Rep. Maurice Hinchey (D-22nd District), who helped secure the funding, visited Ithaca's South Hill Business Campus May 3 to announced the award, which the company says will create about 30 jobs in the next five years.

"This is a perfect example of how federal efforts can work together with local creativity and ingenuity," said Hinchey during the public gathering of company and Cornell officials.

Widetronix makes betavoltaic batteries, which are relatively low power and extremely long lasting, used in such applications as smoke detectors and pacemakers. Widetronix uses silicon carbide as a semiconductor material, which greatly increases the batteries' efficiency and addresses cost issues. The technology was developed in Spencer's lab at Cornell.

"The actual basic idea of a betavoltaic battery has been around for a while, but the material silicon carbide turns out to be an ideal match for this technology," said Spencer, who is no longer officially part of the company but serves as a consultant.

The Solar Energy Consortium is a nonprofit organization that Hinchey helped found in 2007 that supports energy independence and sustainability. In particular the consortium supports research for increasing efficiency of photovoltaic systems and boosting the cost effectiveness of solar energy systems.

U.S. Rep. Maurice Hinchey (D-22nd District) speaks with CEO Jonathan Greene '93, MBA '04, May 3 during a public announcement of federal funding for Widetronix Inc. Background: Don Tennant, interim director of Cornell NanoScale Science and Technology Facility; and Michael Spencer, professor of electrical and computer engineering.

The additional $1 million from the defense department will support its anti-tamper program, which aims to protect U.S. missile technology from being compromised. Spencer said the Widetronix batteries would be useful in applications such as continuous security monitoring and sensing networks.

The funds will also help Widetronix open a prototyping facility, according to CEO Jonathan Greene '93, MBA '04.

—*Anne Ju*

Faculty brief Congress on cybersecurity

Most information systems today are designed to lose, according to two faculty who briefed Congress April 30.

"We're in a situation in which we're basically always putting patches on security and always cleaning up after databases have been hacked into," said Stephen Wicker, professor of electrical and computer engineering. "The world doesn't have to be like this. It can be much safer if we follow certain design practices."

Wicker, the Cornell principal investigator for the TRUST Science and Technology Center, addressed privacy concerns and Andrew Myers, professor of computer science, tackled security issues.

Privacy concerns arise whenever data is collected unnecessarily, Wicker told congressional staffers. Besides presenting operational costs—when public uproar prompts the government to shutdown a company that mishandles private information—collecting unnecessary data can also have opportunity costs. "Certain systems like the cellular platform are not used in ways they could be used because they are recognized as being surveillance tools," said Wicker.

Wicker proposed a set of privacy-aware design practices. "When you apply these guidelines, interesting things happen and potential train wrecks are avoided."

Advanced Metering Infrastructure is one such looming train wreck, according to Wicker. AMI promises to cut summer peak electricity usage by as much as 20 percent by showing consumers their energy costs in real time. Studies show that with this information many more people will choose to delay power-hungry activities until evening, when electricity is less expensive.

But as currently proposed, AMI would collect data on individual power usage at a central location. "There's a lot of things I can tell about what's going on in your home based on minute-by-minute power consumption data," said Wicker. "And all of this wonderful information about what you do all the time in your home is going to be available to third parties, potentially for marketing purposes."

Myers, whose research focus is developing secure programming languages, pointed out that computer security costs billions of dollars annually. "The state of computer security is not so great. And the cost of security failures is high," he said.

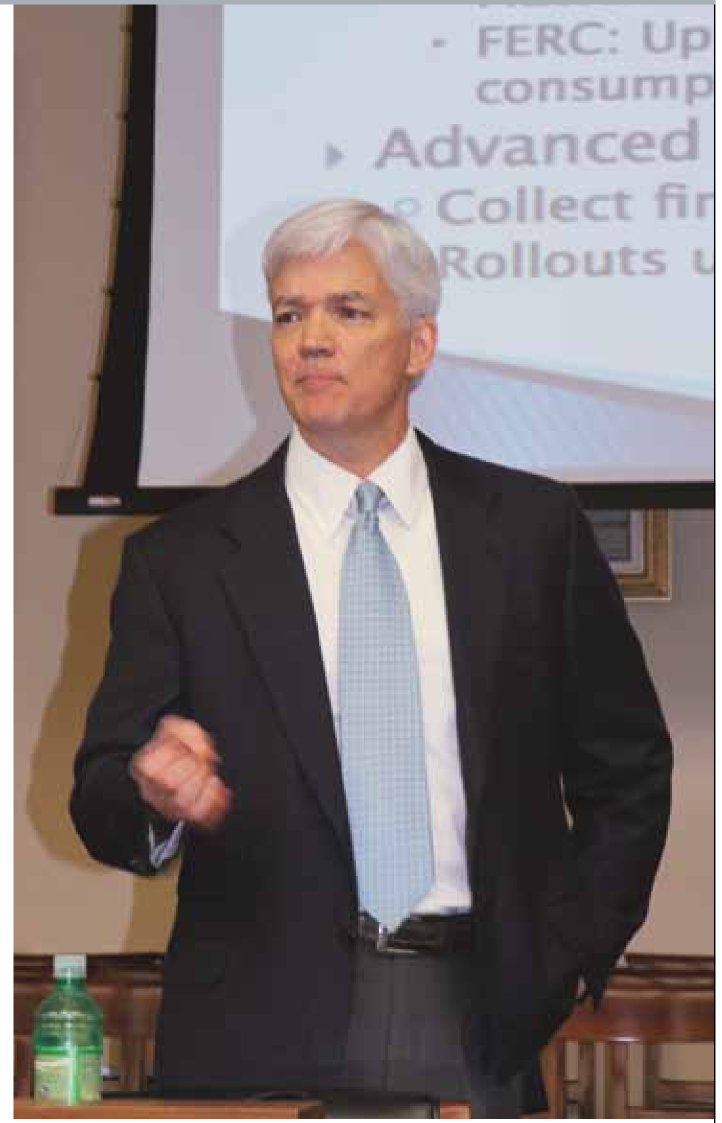
One reason security has become such an intractable issue is that computers have become so complex, said Myers. "The computer you use every day probably has more than 50 million lines of code on it," he said. "One error could allow someone to take over your whole computer."

Most of the effort that goes into computer security is reactive, said Myers. Security was not incorporated into the design of older, "unsafe" languages like C, leaving hundreds of potential loopholes for criminals to exploit. "Safe" languages like Visual Basic are better, but not a panacea, as shown by the 2000 "I Love You" virus.

Myers and his colleagues have been working on an even safer language called Jif, for Java information flow. Jif developers run their code through a compiler that checks that it adheres to their pre-established security policies. "The software construction process itself is checking security properties," said Myers. "So to a first approximation, you can't write code that's insecure."

Such code might enable Internet voting, but many fundamental security issues remain unresolved, said Myers.

—*Robert Emro*



JIM FABER/JFABERPHOTOGRAPHY

Stephen Wicker, Cornell professor of electrical and computer engineering, addresses privacy concerns at a Congressional briefing April 30.

Computer scientists create virtual smashing sounds

Cornell computer scientists are synthesizing the sounds of smashing computer-animated brittle objects. Their methods look at the computer model that underlies the animation, figure out how a corresponding real object would vibrate when fractured, and how that vibration would create sound.

For years, filmmakers have dubbed in recorded sound, but it is difficult to get it to match the action. And in a game or virtual reality, programmers can't know in advance how hard or far an object will fall.

"We'll compute motion and appearance and sound in an integrated way," explained Doug James, associate professor of computer science. "We won't just compute motion and appearance and have the sound as something you bolt on afterward."

James and graduate student Changxi Zheng presented their work at the SIGGRAPH 2010 conference in Los Angeles July 25-29. It follows previous work in which James and his students created sounds of water and such thin-walled objects as garbage cans and plastic bottles.

When a rigid object is struck or hits the floor, it can be deformed until the stress exceeds its strength, and then it shatters. The sound comes mainly from the way all the little pieces vibrate just after the break, rather than from the whole object in the instant of fracture.

The computer calculates how each shard will vibrate when given the amount of energy stored by the deformation. The calculation takes into account how far the object was dropped or how hard it was thrown. It assumes that more fracture will occur in areas that have been strained the most, creating more, smaller pieces.

In most cases, the initial smash is followed by the scattering of debris on the floor. To accelerate computation of those sounds, the sound synthesis program can treat each irregularly shaped shard as an ellipsoid of similar size and shape. Then it draws on preloaded "soundbanks"—computer routines for calculating the vibration of ellipsoids of various sizes and materials.

The researchers smashed real objects and photographed them with high-speed, slow-motion cameras and recorded the sounds, then compared the actual sounds with their computed simulations. To demonstrate the results, they created videos of smashing objects. See http://www.cs.cornell.edu/projects/FractureSound/ for examples.

All of this is still an approximation of the real thing, James admitted, but it's a start, he said, and one that needs to be done now to make ready for the coming of new, more powerful systems.

"This is the first time anybody's ever built computer-synthesized models of these events with sound," he said. "Everything after this will be better. The future's going to be very different. Computers will be a thousand times as fast. It will be insane."

—*Bill Steele*

Weatherspoon collaborates with IBM on cloud computing

Hakim Weatherspoon

More and more of today's computing is happening in "the cloud." Government agencies, banks and companies like Google, Amazon, and Microsoft maintain dozens of huge data centers all over the country and the world, all sharing data back and forth over high-speed fiber-optic lines.

But the data sharing doesn't always go smoothly; sometimes the short streams of ones and zeros known as data packets get distorted, delayed, or dropped altogether. "It is not unusual for network packets to travel 10,000 miles just to be dropped by the end-host," explained Hakim Weatherspoon, assistant professor of computer science, "but it is frustrating." Lost packets have to be resent, slowing down the overall data transfer.

Weatherspoon is collaborating with Hani Jamjoom, M.Eng. '97, a research manager at IBM's Watson Research Center, to study the causes of these distortions and develop ways for cloud computing applications to deal with them. Their work will be partly funded by a $20,000 IBM faculty award.

To find out what happens to data packets in their travels, Weatherspoon operates a testbed called the Cornell NLR Rings, which sends data on loops up to 16,000 miles round-trip around the National Lambda Rail high-speed fiber-optic research network. Network packets can be sent out and back through New York, Chicago, Denver or, in the largest loop, on a complete circuit around the country.

In order to understand packet loss experienced by the computer at the end of the chain and the associated reduction in performance, Weatherspoon's research group, collaborating with physics post-doctoral researcher Daniel Freedman M.S. '02, Ph.D. '08, has developed an apparatus that uses a very precisely modulated laser to generate packets of optical signals, then analyzes what comes back with sub-picosecond accuracy. "The instrument measures 'ground truth' on the wire," Weatherspoon explained. In other words, it shows what's really happening, not just a measurement from a distance. Software to operate the testing device was developed by Freedman and Weatherspoon's graduate student Tudor Marian M.S. '08 CS.

A surprise in early testing was that transmission problems show up on the uncongested Lambda Rail network, meaning they also may appear on private networks used by businesses and institutions. "I have discovered that contrary to the widely held supposition that such networks are largely stable, lossless, and jitter free, these networks can be rather unstable, prone to loss, and sources of significant jitter," Weatherspoon reported in his proposal to IBM. The longer the path, the worse packet loss experienced by the end-host, he added.

A key problem, the research shows, is that packets tend to bunch up en route and arrive in rapid-fire streams that the receiving computers can't process fast enough.

Other aspects of the IBM collaboration include developing software that parallelizes the incoming signals to make better use of multicore parallel processors, which may help in dealing with rapid-fire incoming packets, and finding ways to reduce energy consumption in large data centers by telling the systems when they can turn off disks that are not needed.

Overall, Weatherspoon said, there are "mismatches between abstraction and physical realities" in today's cloud computing. By removing these bottlenecks, he said, he hopes to facilitate the next generation of data centers.

—*Bill Steele*

Researchers make anti-inflammatory antibodies

Drugs that target chronic inflammation—associated with everything from rheumatoid arthritis to cancer—without suppressing the entire immune system could be the payoff of new Cornell research on lab-created antibodies.

Researchers led by Moonsoo Jin, assistant professor of biomedical engineering, made antibodies that block only specific immune cells that cause inflammation, but not the ones the body normally uses to fight infections.

The research was published online March 22 in *Proceedings of the National Academy of Sciences* (In print April 6, Vol. 107 no. 14).

The key to the experiments are integrins, which are proteins expressed by the body's immune cells—in this case, cells called neutrophils—that allow the cells to travel to a cut, infection, or other source of inflammation.

Integrins are receptor molecules located on the cell surface that are like Velcro that can be turned on and off. When they are chemically signaled to activate, they subtly change shape, called conformation, thereby exposing binding sites allowing them to firmly attach to receptors around them. This enables the neutrophils to stick to the inside of a blood vessel and invade into the surrounding tissue to a site of inflammation or infection.

"Integrins have these amazing, very dramatic conformational changes," said graduate student Sungkwon Kang M.S. '09 BME.

Inflammatory diseases like rheumatoid arthritis occur because the immune system has shifted into overdrive, with the body essentially attacking itself. Immune cells, which normally fight infection, flock to an area and cause painful swelling. Drugs now in clinical trials that block this immune response are indiscriminate, suppressing even those immune cells that are involved in healthy immune responses. That's why these drugs can make patients weak and susceptible to infections.

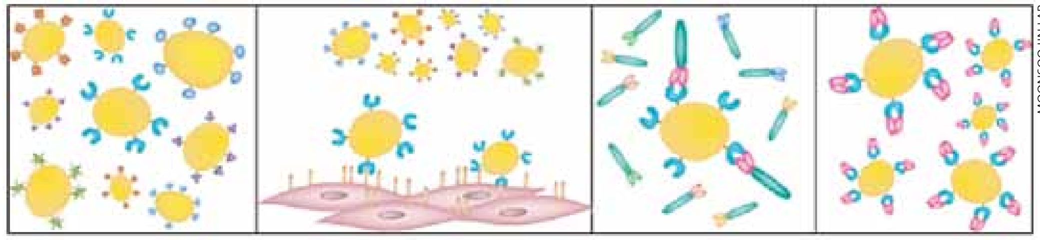
The researchers' antibodies block a specific integrin called Mac-1, but only in its active state—that is, in the conformation that allows it to bind to and move through tissue. The new antibodies leave alone the cells with integrins in a resting state—those that are just waiting to be needed for an immune response. This would greatly cut down on the side effects associated with immunosuppressive drugs.

The researchers used a novel screening method that eventually isolated only these specific antibodies. They started by growing random mutations of Mac-1 integrins on the surfaces of yeast cells. They screened the yeast cells against a sample tissue that expresses receptors identical to those that Mac-1 integrins would normally bind to in the body. After an extensive washing of the remaining yeast cells, they exposed them, now expressing only active Mac-1 integrins, to fluorescently tagged antibodies to discern which antibodies bound to the remaining integrins. The strategy allowed quick, error-proof examination of antibody binding.

Therapies and treatments that could result from this research are numerous, said research associate and first author Xuebo Hu. Mac-1 activation is known to cause inflammation that can lead to some cancers, for example. Also, the antibodies could be fluorescently tagged to image, for example, inflammation or metastasized tumors.

"Blocking Mac-1 or using the active Mac-1 for diagnosis or treatment of patients could be pretty significant," Kang said.

—*Anne Ju*



MOONSOO JIN LAB

The illustration shows the streamlined antibody selection strategy. From left, random mutants of Mac-1 integrins are expressed on yeast cells. The yeast cells are screened against a sample tissue that expresses receptors identical to those that Mac-1 integrins would bind to in the body. Remaining yeast cells, now expressing only active Mac-1 integrins, are exposed to fluorescently tagged antibodies. Final selection of specific antibodies is made.

Cornell Engineering Magazine goes paperless

Alumni and friends of the college can now sign up to receive an electronic version of *Cornell Engineering Magazine* instead of a printed copy.

The college is providing this paperless option as a convenience to readers and to reduce its impact on the environment.

Anyone who would like to receive an e-mail notification when we publish a new issue of *Cornell Engineering Magazine* online can do so at www.engineering.cornell.edu/paperless.

Robosub Team repeats win

For the second year in a row, the Cornell Autonomous Underwater Vehicle team took top honors at the international Robosub Competition.

The team's vehicle, Tachyon, beat out 23 others from five countries at the 13th annual contest (formerly known as the Association for Unmanned Vehicle Systems International competition) held July 13-18 in San Diego, Calif. With the win, Cornell took home a $6,000 prize.

The competition required the autonomous submarine to hit a targeted buoy, send torpedoes into specific windows, and drop markers in bins. The team hit a technical glitch with their hydrophone system, but their otherwise superior performance still earned them first place.

A webcast of the team's run can be found on http://www.Robosub.org and details about the team's work at http://cuauv.ece.cornell.edu/.

—Anne Ju

PROVIDED

The 2010 CUAUV team after their win in San Diego, July 18.

PROVIDED

Kevin Fuhr '12 ME prepares to test Tachyon's torpedo launcher at the competition as fellow team members look on.

Partnership to develop self-charging batteries

Cornell's Energy Materials Center (emc²) has signed a memorandum of understanding with Ithaca's MicroGen Systems LLC to develop "self-charging" batteries, which use background shaking and stirring as their energy source.

The battery will look like a microchip, but with a vibrating core, and it will harness energy from almost anything that shakes. Materials science and engineering professor R. Bruce van Dover is working with MicroGen to develop higher performance materials to enable the batteries to harvest more power from the same size vibrating core.

Applications for the self-charging batteries include smart energy systems for industrial equipment, lighting control, infrastructure applications for monitoring the structural integrity of bridges and roads, and energy for monitoring onboard vehicle systems.

The memorandum establishes the framework for MicroGen Systems to receive critical financial support from the New York state-designated Center for Future Energy Systems for the project, along with the Cornell NanoScale Science and Technology Facility and emc².

Paul Mutolo, Cornell researcher and director of external partnerships for the Energy Materials Center at Cornell, said that green energy start-up companies align with the goals of CFES and emc².

"Companies like MicroGen help our local community build and retain high-value jobs, and their technology will help us transition to a smarter, more efficient energy system. MicroGen is looking forward to strong growth, and we are delighted to have them as one of our collaborating companies."

Edward Reinfurt, executive director of NYSTAR, said: "NYSTAR is pleased to have a part in this special partnership between MicroGen Systems LLC and Cornell's Energy Materials Center, one of five designated Energy Frontier Research Centers in New York state. The story of MicroGen Systems involves many collaborations including work with the NYSTAR-supported Cornell NanoScale Science and Technology Facility and financial support from the Center for Future Energy Systems, a NYSTAR-designed Center for Advanced Technology."

The collaboration is the kind of cooperative work suggested by the Governor's Task Force on Diversifying the New York State Economy through industry-higher education partnerships.

"This is a critical component to the future of the innovation economy in New York state," Reinfurt said.

Robert Andosca, founder and president of MicroGen, said: "Overcoming the battery bottleneck is key. Providing a green, virtually infinite power source to replace traditional energy sources will significantly expand applications for wireless sensor networks and other technologies. Our micro-generator technology will enable the wireless sensor network industry to grow significantly."

Ranger sets record

A Cornell robot named Ranger has traveled 14.3 miles in about 11 hours, setting an unofficial world record at Cornell's Barton Hall on the morning of July 6. A human— armed with nothing more than a standard toy remote control —steered the untethered robot.

Ranger navigated 108.5 times around the Barton Hall indoor track—about 212 meters per lap—and made about 70,000 steps before it had to stop and recharge. The 14.3-mile record beats the former world record set by Boston Dynamics' BigDog, which had claimed the record at 12.8 miles.

A group of engineering students led by Andy Ruina, Cornell professor of theoretical and applied mechanics, announced the robotic record July 9 at the Dynamic Walking 2010 meeting in Cambridge, Mass. Ruina leads the Biorobotics and Locomotion Laboratory at Cornell. The research is funded by the National Science Foundation.

Previously, students in Ruina's lab set a record for a robot walking untethered in April 2008, when Ranger strode about 5.6 miles around the Barton Hall track. Boston Dynamics' BigDog subsequently beat that record.

One goal of Ruina's robotic research is to show off the machine's energy efficiency. Unlike other walking robots that use motors to control every movement, Ranger appears more relaxed and in a way emulates human walking, using gravity and momentum to help swing its legs forward.

Standing still, the robot looks a bit like a tall sawhorse, and its gait suggests a human on crutches, alternately swinging forward two outside legs and then two inside ones. There are no knees, but its feet can be flipped up and out of the way while it swings its legs so that the robot can finish its step.

Ruina says that this record not only advances robotics, but helps undergraduate students learn about the mechanics of walking. The information could be applied to rehabilitation, prosthetics for humans, and improving athletic performance.

Graduate student Pranav Bhounsule steers Ranger in Duffield Hall.

brainteaser

How long till the batteries die?

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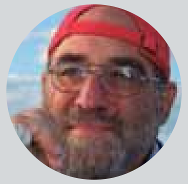


Professor Andy Ruina, Mechanical and Aerospace Engineering

ISTOCK

Suppose you have two cell phone batteries. They are both fully charged at the start with a charge of 1 amp-hour.

Solve this to win Cornell Engineering gear

We will draw three winners from correct entries submitted by January 1. They will receive a Garland gift pen, a stainless steel water bottle, or a Cornell Engineering car decal. Congratulations to Bernard Delarue Ph.D. '97 ME, Charles Henck '07 CS, John Judge '96 ME, Harold Wilhelm and Jimmy Zhu '14 for correctly solving the fall brainteaser! A prize also went to Richard Rosenstrom for building an experimental model the results of which approximated the solution. You can see the solution, pictures of Richard's model, and submit your answer at www.engineering.cornell.edu/brainteaser.

Your phone uses 1 amp. Immediately when the first battery is discharged you swap batteries and put the empty one in a charger. It charges at .5 amps. When the second battery goes dead you swap again, putting the second battery in the charger and the incompletely charged first battery back in the phone. You use it until its dead. You keep swapping and charging until both batteries are completely dead.

a. How many swaps have happened then?

b. How long does that take?

c.&d. What are the two answers if you started with 10 batteries?

Assume infinitely fast swaps, batteries that keep their capacity, and so on. Question unclear? Ask Andy: ruina@cornell.edu.

STIFF RESOLVE

By Lauren Cahoon

Biomedical engineer takes on two deadly diseases

Cynthia Reinhart-King's office and lab are located in Cornell University's new Weill Hall, a palace of sun-spilling windows and blinding white walls. Reinhart-King admits that, sometimes, the stark whiteness can be overpowering. Thus, hanging in her office is a colorful, 3-paneled abstract painting with generous splashes of yellow, red and, green—contrasting with the traditional white. One could say this contrast mirrors Reinhart-King's approach to science—an unconventional approach in a traditional setting.

An assistant professor in biomedical engineering at Cornell, Reinhart-King is also a lead investigator for a new, collaborative cancer center funded by the NIH, the Center on Microenvironment and Metastasis. The new center gives Reinhart-King a chance to explore her research on how physical and chemical cues affect tumor cell migration. Knowing how a cell behaves depending on its physical surroundings may be a robust new weapon against some of the most deadly diseases.

A Passion for Science

Early on, Reinhart-King was interested in science. She recalls being intrigued, and a little confused, as a young child, when she learned that her aunt was going to college for mechanical engineering. "I asked, why is my aunt driving a train?'" says Reinhart-King. "My mom told me no, an engineer is someone who takes something and makes it better."

This appealed to Reinhart-King, who excelled at math and science through high school and college. However, while she knew science was her calling, "it became fairly obvious I wasn't going to go on to become a doctor like most of my friends in college," says Reinhart-King. She explains that she likes to help people, but the emotional pressure of letting patients down on occasion was not something she felt she could handle. "I want to help people by doing basic science," Reinhart-King says.

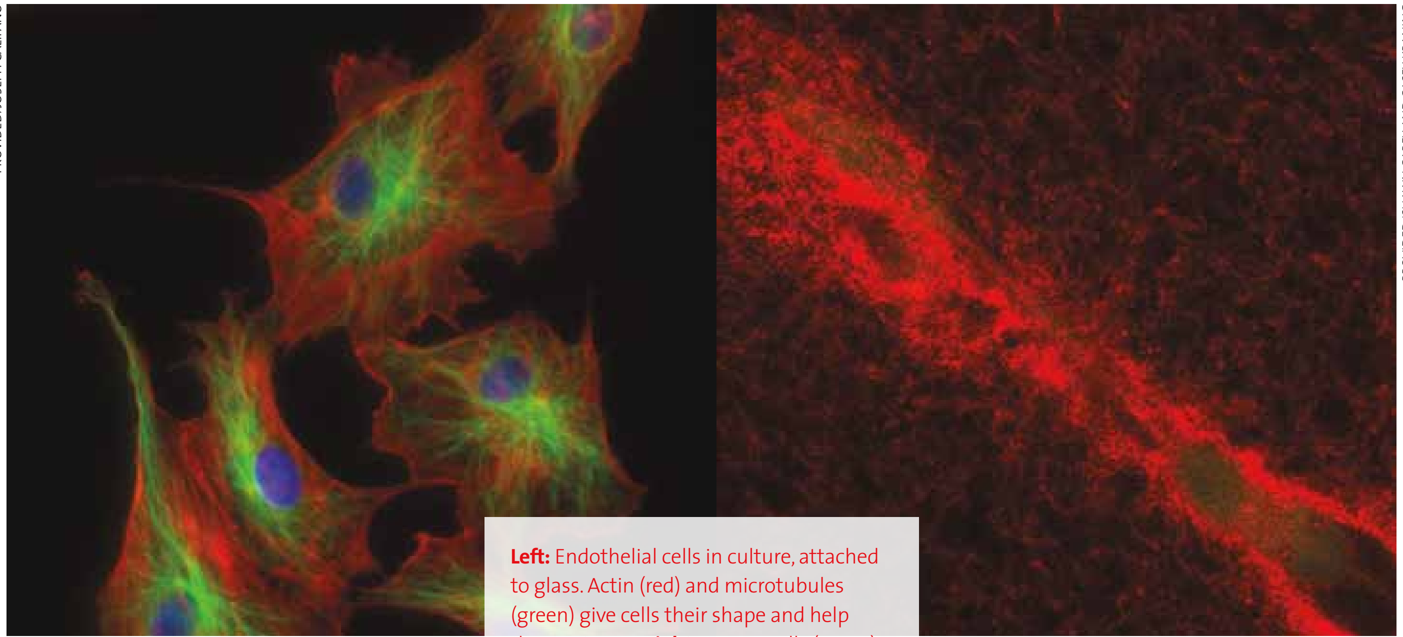
As an undergraduate at MIT, Reinhart-King was interested in doing lab research. She was diagnosed with scoliosis during this time, an experience that steered her towards Douglas Lauffenburger's lab. The Lauffenburger lab focused on molecular cell bioengineering, a field that contributed to discovering new therapies to induce bone cell differentiation. While she doesn't work on bones now, that connection was an influential one in her career path.

While there, she was mentored by a graduate student, Anand Asthagiri—now a chemical engineering professor at Caltech. Asthagiri recalls how Reinhart-King stood out in the crowd as someone who could "cross the bridge fluidly from both camps" of biology and engineering. He adds that "she has something intangible, but very important—the drive that comes with rolling

"She has something intangible, but very important—the drive that comes with rolling up your sleeves and being perseverant. Science isn't just about low hanging fruit. It's about going for deeper and more challenging stuff. I think She does that really well."

— Anand Asthagiri,
Assistant Professor of Chemical Engineering, Caltech

Cynthia Reinhart-King and Ph.D. student John Huynh inspect a culture of cancer cells.



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Left: Endothelial cells in culture, attached to glass. Actin (red) and microtubules (green) give cells their shape and help them migrate. **Right:** Cancer cells (green) contracting and re-arranging a 3D matrix of collagen (red) as they migrate. Reinhart-King uses collagen scaffolds in the lab as a platform to mimic tumor tissue architecture. The cancer cell images were taken using a Zeiss 710 Confocal Microscope, the newest addition to the Cornell Life Sciences Microscopy Core.

up your sleeves and being perseverant. Science isn't just about low hanging fruit. It's about going for deeper and more challenging stuff. I think she does that really well."

Her time in Lauffenburger's lab, working with Asthagiri, solidified Reinhart-King's interest in pursuing research in an academic setting. Her husband and now colleague in Cornell's biomedical engineering department, Michael King, first met Reinhart-King while she was a Ph.D. student at the University of Pennsylvania, advised by Professor Dan Hammer. "She was very independent, and almost never really needed day-to-day supervision. She was almost thinking like a professor while she was a student," King says. "She's very creative, very passionate about science, and always has been since I've known her."

Old Problems, New Approach

Reinhart-King is getting plenty of academic freedom now, both as a project leader at Cornell's Center for Microenvironments and Metastasis, and running her own lab in the biomedical engineering department. Currently, her research focuses on two significant diseases: cancer and atherosclerosis. While at first glance the two may not seem related, Reinhart-King has discovered a compelling link between them. "Very few people have connected the two," she says, "but both are characterized by the overgrowth of cells." Reinhart-King has also connected the two via an unusual physical factor—tissue stiffness. In cancer, tumors are physically stiffer than healthy tissue. In atherosclerosis, the blood vessels become stiffer and less pliable.

In the case of atherosclerosis, this hardening of the arteries can be accompanied by plaque formation and the dysfunction of endothelial cells, the thin layer of cells that line the interior surface of blood vessels. This dysfunction can increase the permeability of the artery and allow increased uptake of cholesterol. This uptake of cholesterol causes the formation of plaques, which can clog blood vessels and increase the burden on the heart. This can spell bad news even for people who are diligent about eating a low-cholesterol diet and exercising regularly.

"Blood vessel stiffness occurs with aging and atherosclerosis occurs with aging, and we're trying to figure out that link," Reinhart-King says.

Whether or not the stiffening actually causes the atherosclerosis, or vice versa, is another question her group is addressing. While many scientists study atherosclerosis, examining stiffening as a therapeutic target is a new idea. Reinhart-King says that there could be two theoretical pharmaceutical answers to the problem—a drug that prevents the stiffening of the blood vessel wall, or drugs that prevent the endothelial cells' response to the stiffening.

Tissue stiffness may also hold answers to curing cancer. Tumorous tissue is stiffer than healthy tissue—a fact that Reinhart-King has looked into more closely. As part of a team of scientists, she has found that tumor stiffness can cause a change in a healthy cell's behavior, turning it into a cancerous cell. In turn, this can cause cell overgrowth. Stranger yet, a cell's behavior strongly depends on tissue stiffness—a healthy cell placed on stiff tissue will begin to look diseased, whereas a diseased cell placed on normal, soft tissue will begin to look healthy. Even more puzzling is the fact that malignant cells will cause the tissue they are on to gradually become stiffer. "It's really a chicken and the egg question," says Reinhart-King.

A key flaw of these cells-gone-bad is their wandering ways—a critical issue for cancer. "The problem for cancer patients is usually metastasis," says Reinhart-King. "We're interested in what about that cell's environment makes it migrate from the original tumor to form a secondary tumor." Her team has also investigated how much stronger these malignant cells are than healthy cells.

Malignant cells have to break free of the tumor itself, then make their way through thick, dense tissue, into the vasculature. Reinhart-King likens the difference between the ability of healthy and malignant cells to navigate through tissue to "walking on the street versus walking through the mud." Malignant cells are able to exert more force than healthy cells, making their way through the "mud" more effectively. Reinhart-King has proven this in her lab, where they've put malignant cells on a substrate that 'wrinkles' when the cells move—meaning they can tell how much they move and how much force they exert when they do it. Reinhart King says that this discovery can be helpful in curing cancer; there are a number of proteins that regulate cellular force, and finding the ones that have turned super-strong in cancer cells could help keep them from forcing their way through the body. Additionally, if Reinhart-King proves a stiff environment does induce or promote metastasis—any molecular elements that allow cells to sense stiffness could also be a therapeutic target.

Opening Doors

These questions about cancer are exactly what Reinhart-King and her lab is tackling at the CMM, the new NIH project that Reinhart-King is helping to spearhead. The entire center is funded for $13 million over five years, with $2.7 million devoted to Reinhart-King's project. The opportunity has opened a lot of doors for Reinhart-King, enabling collaboration with labs at the Weill Medical school in New York, N.Y. and access to samples from cancer patients, as well as easy access to state-of-the-art optical imaging. "There are 27 investigators on this grant," says Reinhart-King. "That means there's almost no experiment we can't run."

"Blood vessel stiffness occurs with aging and atherosclerosis occurs with aging, and we're trying to figure out that link."
— Cynthia Reinhart-King,
Assistant Professor
Biomedical Engineering

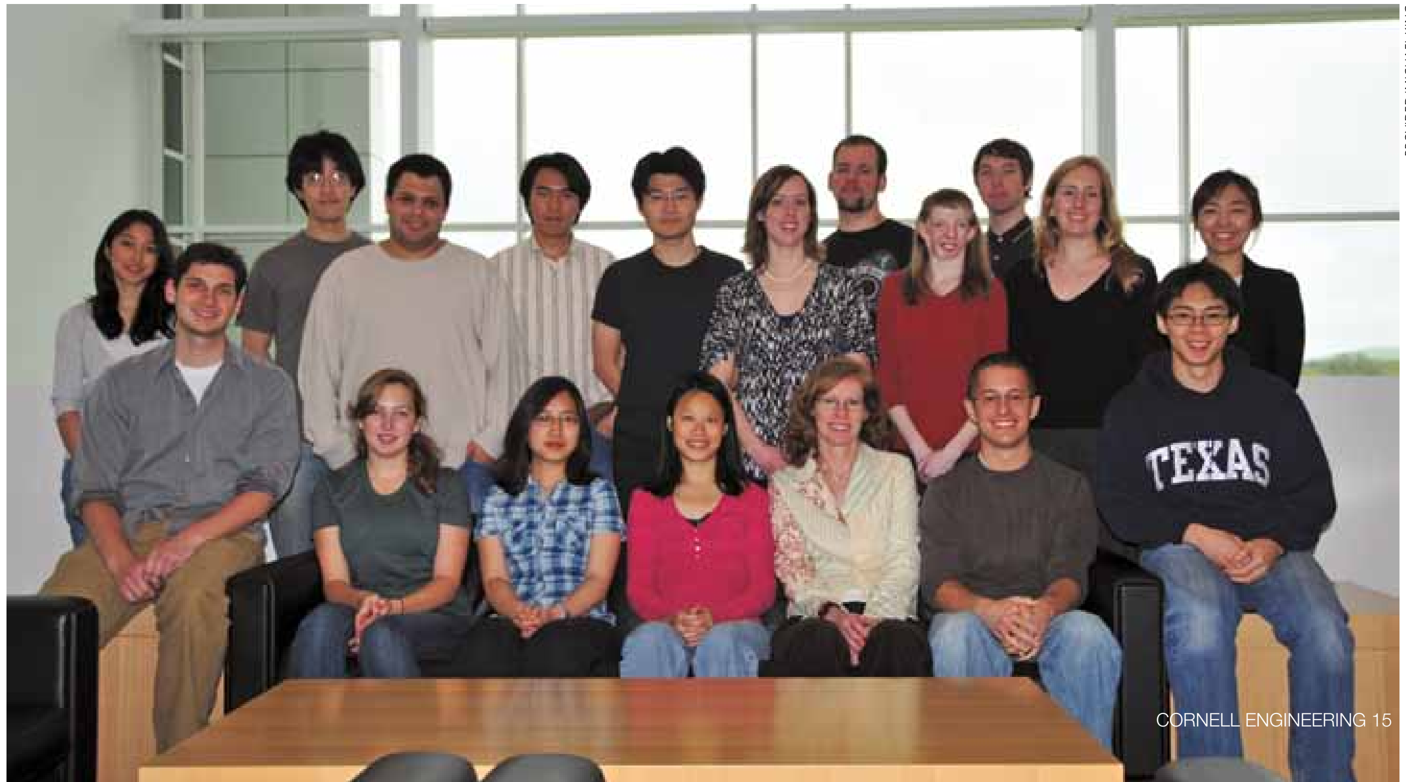
At the same time, the large number of collaborators from different scientific fields can also be a daunting thing to manage—with Reinhart-King overseeing nine other investigators with their own projects. "It's a level of responsibility that most assistant professors don't normally take on," she says.

Such a multidisciplinary effort can result in what Reinhart-King calls one of the biggest challenges of the CMM project—"getting everyone to speak the same scientific language." She tells of handing a late draft of the CMM grant to one of her biologist colleagues to review. Her colleague handed it back to her, saying it was "totally not understandable to a biologist," Reinhart-King recalls with a laugh.

Reinhart-King may laugh at this failed attempt at multidisciplinary communication, but she has a reputation for bridging fields. Asthagiri, her colleague and mentor during her undergraduate years at MIT, says that her combined understanding of biology and engineering is what made her stand out among crowds of other students. "What Cindy does is interweave biology with engineering," says Asthagiri. "In her case, she has realized that cell systems are themselves engineerable systems. We can poke at them and modulate and tune them, much the way we can with materials. We've got to have biologists that are thinking of these as designable substrates."

If her previous work is any gauge of what's to come, Reinhart-King will continue to weave science and engineering—and use her unconventional approaches to tackle age-old problems. CEM

The Reinhart-King lab studies how cells integrate multiple extracellular signals and translate them into either normal or diseased behaviors.



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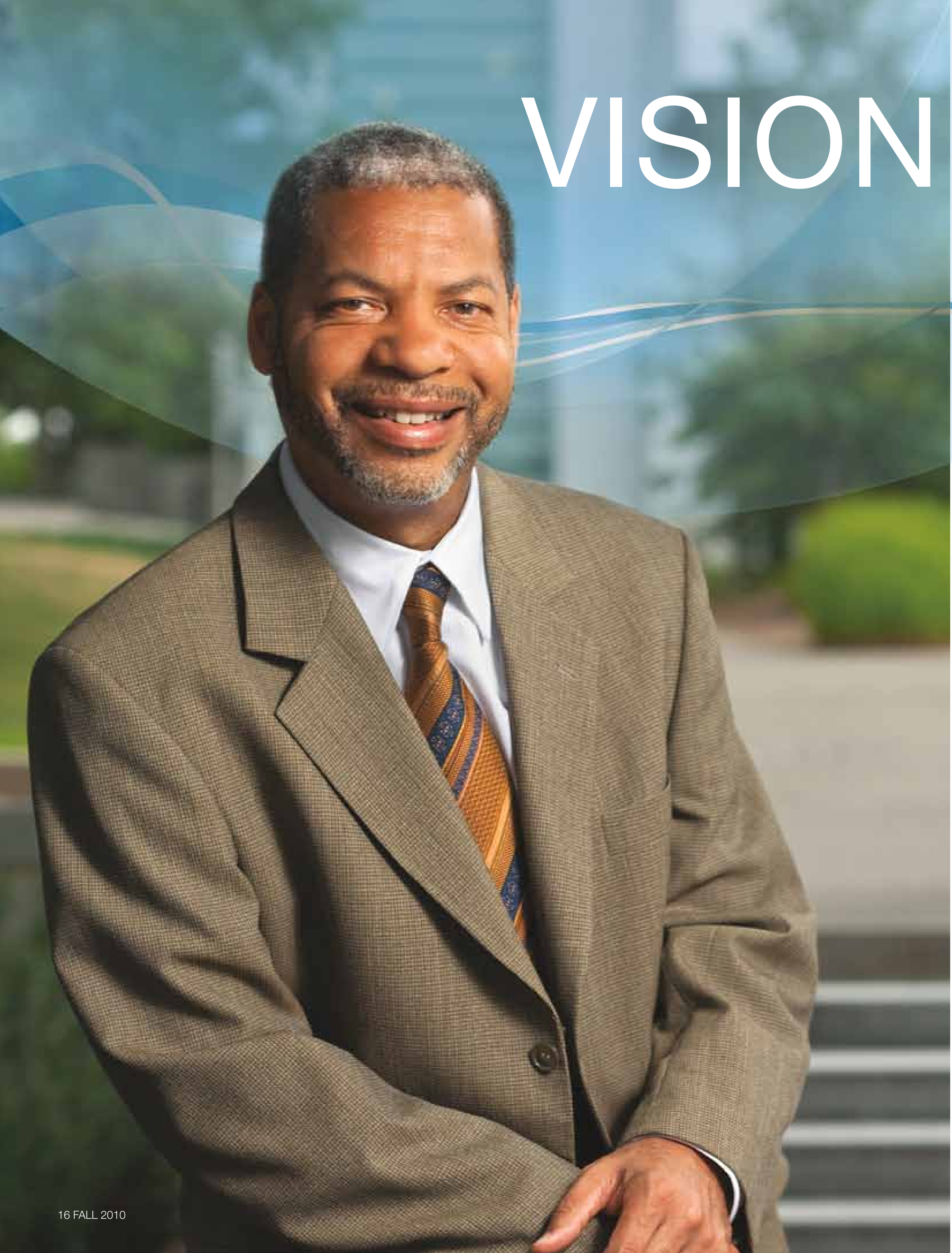

VISION FROM THE VORTEX

Turbulence expert takes the help

By robert Emro

Lance Collins knows a thing or two about turbulence—literal and figurative—which should stand him in good stead as Cornell Engineering's thirteenth dean. But the fluid dynamics expert and former director of mechanical and aerospace engineering feels the bumpiest patch is behind us. "While this has been a very difficult period, the College of Engineering is in great shape and is poised to move into a very exciting time," says Collins, who became dean on July 1. "I thank Chris Ober for having served in what amounts to the roughest interim deanship in the history of mankind. Normally an interim dean just keeps the status quo, but because of the extreme financial challenges that impacted us all in the last one-and-a-half years, he really had to make a lot of hard decisions and he made them well and I think the college is in really good shape."

Though optimistic that the economy is showing signs of recovery, Collins knows that, at least in the beginning, his biggest challenge will be continuing financial constraints. "But I don't see that stopping us," he says. "I see that as something we manage, so we will continue to hire. We have a significant portion of our faculty that is of retirement age and we must renew. There's no other option."

Even with limited resources, Collins says the college can continue its tradition of excellence by targeting strategic priorities. "If we focus ourselves on developing research in areas like bioengineering and renewable energy—create programs and have a long-term commitment—I think we can emerge as the leaders in these fields," he says. "The excitement is already there. The students at all levels are so interested."

Sustainability is a natural rallying point, says Collins, for the entire university. "That's probably going to be the dominant challenge for many decades and very few universities offer the comprehensive breadth and depth that we do with respect to this particular problem," he says. "If not at Cornell, then where? I don't know of any other place that can make it happen at the level that we can. Cornell is in a position to leave its mark and we must see that through."

The realization that science could make a difference is what drew Collins to engineering in the first place. As a rising high school senior from Long Island, Collins spent two weeks in the Minority Introduction to Engineering program at Lafayette College. He used a computer—a room-sized mainframe—for the first time, doing simple lunar landing simulations, and built

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Lance Collins and his wife Sousan, with their 10-year-old daughter, Ashley. Collins says, "She is the apple of my eye."

Popsicle stick structures. "I had never met an engineer—I didn't know what an engineer did. And I loved it," he says. "Really it was my first exposure to applied science. And the sense of science impacting society was really exciting."

That excitement carried Collins to Princeton University, where he earned his B.S.E. in chemical engineering in 1981. He then went to the University of Pennsylvania where he earned his M.S. in 1983 and his Ph.D. in 1987. Following a postdoc at Los Alamos National Laboratories, he spent the next 11 years at Pennsylvania State University, where he earned the rank of full professor and met his wife Sousan, a nurse originally from Iran. The two have a 10-year-old daughter named Ashley. "She's the apple of my eye," says Collins. "I spend a lot of time at work so I try to take the time I'm not at work and spend it with her and she's a fantastic distraction. She's probably the only person on the planet who can pull me completely away."

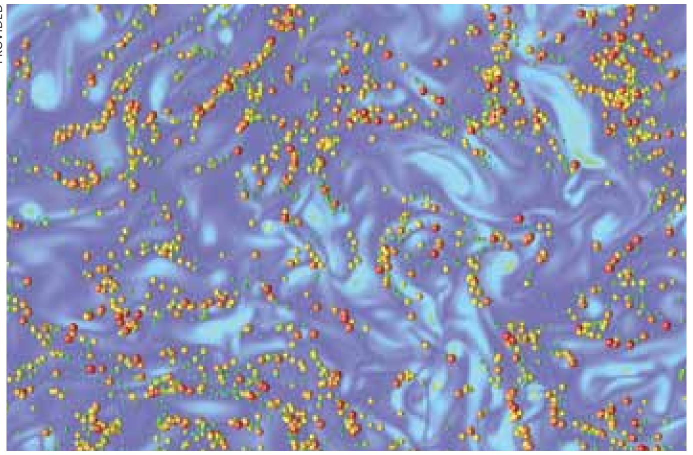
It was also at Penn State that Collins made a discovery in powder manufacturing that has generated a new area of study helping to refine climate models. DuPont wanted better control over the particle size distribution of titanium dioxide particles. The commodity chemical is used in a host of applications—a broad distribution of sizes makes highway paint more reflective, but a narrow distribution is needed for laser-based flow diagnostics. Previous studies had shown that vortices within turbulence act as centrifuges, causing particles to cluster around them. "If you put an initially uniform distribution of droplets in a turbulent flow and you turn on the turbulence they don't stay uniform. They actually clump up." Collins showed that this clustering could increase the collision rate of the particles up to 100 times.

"I try to listen for the great ideas. When you are surrounded by the kind of talent pool we have here, you don't need to be so unbelievably inventive; you just basically have to be turned on and listening and solutions are going to come."

After hearing one of Collins' grad students, Walter Reade, present these findings, a meteorology grad student, Raymond Shaw, thought the same phenomenon might explain why clouds always formed faster than predicted by modern weather models. Meteorologists use different empirical corrections to make accurate forecasts, but none of them agree when extrapolated to years, decades, or centuries. "We got together and wrote a paper that said, 'Aha! Maybe it's turbulence and this clustering phenomenon that's speeding up clouds,'" recounts Collins.

Researchers the world over now study the role of turbulence in cloud formation, gathering at international workshops to trade findings. "It's all driven by climate modeling," says Collins. "Clouds modulate the incoming energy from the sun, and their impact leads to the largest uncertainty in global climate models. That's the big problem that we want to have some impact on."

And Collins will continue to contribute to the field. "I'm not putting my research on hold. I am a committed researcher," he vows. "I have a new grant and I'm looking for a new student."



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Example of particle clustering from a direct numerical simulation of turbulence. Particles, initially uniformly distributed, spontaneously form "necklaces" outside of the vortices in the flow (light blue regions of the fluid). This clustering can increase particle collisions by a factor greater than 100.

Collins came to Cornell in 2002, serving as director of graduate studies for aerospace engineering from 2003 to 2005, when he became the S.C. Thomas Sze Director of the college's Sibley School of Mechanical and Aerospace Engineering. He made hiring faculty his top priority. "We've hired five faculty and I think they are all outstanding people," he says. "I'm also happy that two of those five are women and a third is an underrepresented minority."

Growing the graduate program was another major priority. "Really the reputation of the department is carried to a large extent by the quality of the research and graduate program," he says. "They were somewhat small when I first started and I'm amazed to see where they're at right now.

"Mechanical engineering is popular at the Master of Engineering and undergraduate level as well," continues Collins. "It's been the most popular undergraduate major in the last couple of years and that's driven largely by the outstanding student project teams that work on exciting, complex systems like autonomous underwater vehicles and solar-powered houses."

"Cornell has the gravitas to be able to create the Silicon Valley of the East. To me, you can't talk about economic development of upstate New York and leave Cornell out. Cornell has to be one of the drivers."

At Cornell, effective leadership requires a good ear, says Collins. "I try to listen for the great ideas. When you are surrounded by the kind of talent pool we have here, you don't need to be so unbelievably inventive; you just basically have to be turned on and listening and solutions are going to come," he says. "I'm not a fiery, bully pulpit type individual. I try to build consensus when I can but I'm willing to make the tough decisions when I have to. But even then, it's only after I've heard everyone."

Collins experienced turbulence of a different sort in 2009 when he was asked to fold the theoretical and applied mechanics faculty into his school. "The merger taught me an awful lot about how one should not underestimate the human element of the decisions we make," he says. "The mistake I made early on was to try to push this transition faster than everyone was ready to go. My colleagues needed some time to adjust to the cultural changes that accompanied the merger. That was a big lesson."

The human element will be crucial to one of Dean Collins' top goals: increasing collaboration with industry and spinning out more companies from Cornell Engineering research. With the caliber of its faculty, Collins thinks the college can expand the successes it has had with nanotechnology, if it can change its internal culture. "For engineering, interacting with industry and creating new entrepreneurial companies is really where we can have the largest impact on society," he says. "But this is not something that everyone has been thinking about. We want to develop programs that will facilitate faculty thinking in different ways and collaborating at a larger scale than we have historically."

Fostering a more entrepreneurial mindset among the faculty will not only help bring much needed solutions to market, but will also help a hard-hit region. "Cornell has the gravitas to be able to create the Silicon Valley of the East," Collins says. "To me, you can't talk about economic development of upstate New York and leave Cornell out. Cornell has to be one of the drivers." CEM

Cornell seats first African-American dean

When it was announced that Lance Collins would be the college's new leader, no mention was made of the fact that he would be Cornell's first African-American dean.

"We've changed so much that I think it's interesting how little was made of that," he says. "My community hasn't lost sight of it by any means. I've been contacted by the scientific African-American community in huge numbers. But ethnic firsts are far less newsworthy these days, which I think, in a way, is maybe the greatest statement that we really are making important strides on the historical racial problems. However, we will know for certain that these problems are behind us when we look at our demographics at all levels—faculty, graduate students, and undergraduate students—and see that it mirrors the society at large. In this respect, we still have a lot more work ahead of us."

As a young man, Collins' 88-year-old father Vincent, a retired carpenter who didn't attend college, certainly never could have imagined having a dean for a son. "My dad is someone I'm very close to," says Collins. "I called him as soon as I found out and he was ecstatic."

ISTOCK

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To augment existing sustainability efforts, the Verizon Foundation funded four student projects to reduce the telecommunication company's environmental impact and improve its efficiency.

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CALLING ON CORNELL CURIOSITY

By Sharon Tregaskis

Students find energy-saving solutions for Verizon

It's easy to talk in the classroom about the need to integrate economics into energy systems designs. It's another thing entirely to put that knowledge to the test consulting for a Fortune 100 firm grappling with energy-intensive operations, a volatile economy, stockholders with an eye on the bottom line, and looming policy changes liable to transform the economics of energy. This past year, the Verizon Foundation gave students the opportunity to put their education to the test with a $160,000 grant to fund a quartet of master's-level projects.

Brandon LaBrozzi, M.Eng. '10 ChE, analyzed using renewable energy to cool cell phone tower equipment buildings as part of the new Energy Systems and Engineering specialization in chemical engineering. In early April, LaBrozzi was one of a dozen undergraduate, master's, and Ph.D. students to present their preliminary findings to a roomful of top-tier Verizon Wireless executives, including CEO Lowell McAdam '76 ME, a former member of the Cornell Engineering Advisory Council. For the executives, the projects were more than an academic exercise: the telecommunications giant is looking for sustainable alternatives to increase energy efficiency and lower operating costs.

"It's not every day you give a presentation to a CEO unless you're in the business," says LaBrozzi, a 26-year-old native of Bradford, Penn., who worked as a high school chemistry teacher after earning his bachelor's degree in chemistry, math, and physics at Penn State, Bradford. "It was a personal challenge to make sure we had our ducks in a row, make sure we were giving the executives good information, get them excited, sell them on the idea."

The presentations—which also included smart-grid, fleet management, and inventory logistics teams—were such a success that a week later, a second team of executives came to campus to hear more from the students. "It's much better for students to do real-world work, interact with the people who have to deploy their findings, instead of just doing an academic exercise," says Croll Professor of Sustainable Energy Systems Jefferson Tester '66 ChE, M.S. '67, LaBrozzi's mentor. "It's like medical training in the emergency room —where the resident has to solve problems as they come through the door, not just talk about them."

When McAdam expressed interest in collaborating with the college in early 2009, Abby Westervelt, director of Cornell Engineering's Corporate and Foundation Relations, arranged for him to come to campus, give a public lecture, and meet Professor Tester. Later, she drafted a proposal to the Verizon Foundation, facilitated non-disclosure agreements, and coordinated meetings to refine parameters and review progress.

"This is a great example of a partnership that originated with a company looking to solve interesting problems," says Westervelt. "The relationship developed very flexibly and quickly, starting with the engagement of a high-level alumnus who saw the opportunity to harness the broad interest on campus in energy systems like geothermal, smart grid, and transportation to the real-world challenges of an operating company like Verizon."

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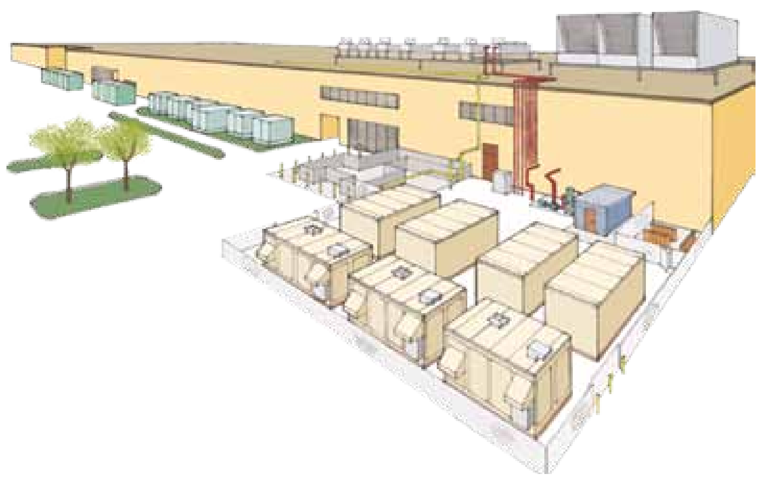


Verizon's fuel-cell powered call center in Garden City, N.Y., the largest project of its kind in the country, could be integrated into a smart grid developed by one of the student teams.

McAdam and his team met several times with interested professors to discuss which of Verizon's sustainability initiatives could provide an appropriate test bed for student projects, meeting both the educational needs of students and the research goals of faculty.

Twenty-one-year-old Kamil Bojanczyk '10 BE was the only undergraduate on the six-member team that developed smart grid technology based on a case study of the Cornell campus. The students collected data on the Johnson School's Sage Hall and Duffield Hall, Cornell's nanoscience facility, to inform development of a neural network algorithm. It would automatically adjust heating and cooling systems to reduce demand when energy supply is restricted and allow for increased consumption at times of increased supply. They were advised by Max Zhang, an assistant professor of mechanical and aerospace engineering; Bob Thomas, professor of electrical and computer engineering; and John Belina, the recently retired director of ECE's Master of Engineering program, who volunteered to help.

"Cornell's infrastructure is pretty far ahead of the curve in terms of energy systems," says Zhang, who encouraged the students to communicate directly with the university's utilities and facilities managers to understand each building's intricacies. "However, there are still a lot of other realms in which to increase efficiency and reduce carbon emissions. The smart grid provides a significant opportunity to achieve the carbon neutrality envisioned by the Cornell Climate Action Plan."

"It's much better for students to do real-world work, interact with the people who have to deploy their findings, instead of just doing an academic exercise. It's like medical training in the emergency room—where the resident has to solve problems as they come through the door, not just talk about them."

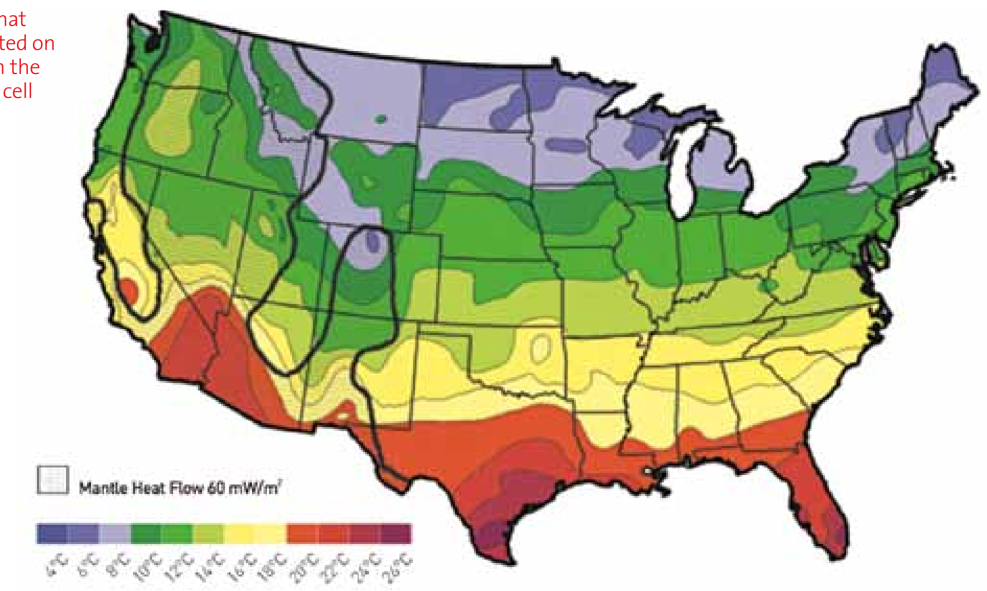
— Jefferson Tester,
Croll Professor of Sustainable Energy Systems

Bojanczyk helped to model the energy consumption of Duffield and Sage halls; worked with the team on strategies to integrate communities of buildings using a combination of photovoltaic, wind, natural gas, and hydroelectric energy sources; and participated in building a model residence and writing the algorithms to integrate renewable energy sources in a home. "I just love systems engineering stuff," says the Ithaca native.

In July, Bojanczyk started a job at Barclay Capital in Manhattan, but in the weeks following graduation he was still focused on his work with Zhang, laying out plans for future studies.

For his project, LaBrozzi needed a crash course in geothermal heat pumps—which embed a closed-loop heat exchanger in bore holes as an alternative to conventional air conditioning units—followed by visits to cell phone towers in the Ithaca area and a lot of modeling and spreadsheet time. He and Ed Dodge, a member of Cornell's research staff, also consulted regularly with professional geothermal heat pump installers and the trio of Verizon Wireless engineers who defined his project's parameters.

One of the student projects found that ground surface temperatures, depicted on this map, are a determining factor in the feasibility of geothermal cooling for cell phone tower equipment buildings.



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"They wanted to get an idea of whether it was a possibility to design a system for the worst-case scenario and install it all over the country," says LaBrozzi, who integrated data on soil geology, summer and winter temperatures, and geothermal system designs to assess cost variability across the lower 48 states. "In the worst case, the total number of bore hole feet required was 3,500 and in the best case it was 200. That adds up to a $20,000 difference in install price."

As a result, LaBrozzi urged the engineers to take a site-specific approach and developed guidelines to help them identify conditions in which the savings from geothermal installations would most briskly recoup the company's initial investment. Perhaps even more important, he analyzed the effect of installing air economizers—essentially, large fans—to take advantage of cool temperatures (in winter, for example, and at night) and reduce cooling loads, in combination with either geothermal or with the existing air conditioning systems.

Based on today's electricity prices, LaBrozzi estimated it would take more than two decades for the hybrid geothermal system to outperform hybrid air conditioning on cost, even when he accounted for savings of likely carbon emissions costs in the future. Only when he factored in the possibility of reduced equipment prices based on volume purchasing did geothermal become cost competitive. Ultimately, LaBrozzi says, Verizon's decision will depend on how the company weighs such goals as reduced reliance on fossil fuels.

Throughout his project, LaBrozzi got to work hand in hand with one of the country's leading geothermal experts. "Jeff and I met once a week, as often as we could," he says. "He just has so much experience—especially in geothermal, but also energy in general. To be exposed to that and benefit from all of his contacts in the industry was just great."

"It was a good lesson in engineering analysis for us," says Tester, who notes that with 30,000 towers in service, Verizon Wireless has an incentive to implement savings as soon as possible. "Energy management is the critical issue for them, particularly with uncertain future electricity prices. If you were designing cooling systems for their towers from scratch, you might do it differently."

Assistant Professor of Civil and Environmental Engineering Oliver Gao supervised two groups, each a trio of graduate students, developing new algorithms to help Verizon enhance its fleet and inventory management systems. "This is not only exciting academic research, but also has the benefit of seeing the findings applied to the real world and having real value," says the professor. "Nothing can be more effective in terms of exciting students than having them see that they can make contributions."

"This is not only exciting academic research, but also has the benefit of seeing the findings applied to the real world and having real value. Nothing can be more effective in terms of exciting students than having them see that they can make contributions."

— Oliver Gao,
assistant professor of civil & environmental engineering

Unlike other groups he's mentored, where data collection challenges can yield significant frustration, he saw both groups gain momentum as the Verizon Wireless engineers with whom they worked supplied concrete numbers. "Having access to real-world, complicated data made them more passionate," says Gao. "It gives students a chance to think new ideas, figure out how to deal with real-world data, incorporate it, and produce sensible results."

As his M.Eng. students delved into the gritty details of their projects, Gao found that his mentorship relationship with them was substantively different from any that had emerged with students in his lecture-based courses. "You have to work closely with students having technical difficulties," he says. "The adviser has to be a member of the team."

Working to solve some of corporate America's energy problems gave all six students a better appreciation for regular coursework, as well, says Gao, allowing them to recognize the value of what they've already learned and identify gaps in their expertise that might affect their future career success. He also saw tremendous growth in their ability to communicate their findings. "When they do homework, they get the answer and they're done," he says. "In this case, they had to interpret their final answers in terms of what it meant for Verizon. I was so proud of them." CEM

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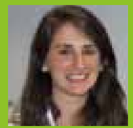
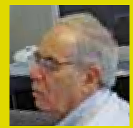
One student project drafted a management plan for Verizon's vehicle fleet, which added 1,600 alternative energy vehicles, like this natural-gas powered van, in 2010.


ENGINEERING PATHS TO SUCCESS

Four alumni show the versatility of an engineering degree

By Dan Touhy

As newly arrived engineering students take their first tentative steps along career paths that may go in unforeseen directions, a look at the professional journeys of four alumni shows that a Cornell Engineering education can take them just about anywhere they want to go.

One applies his skills to trading in the financial markets. One helps make better medical devices. One gives tomorrow's scientific leaders an early edge. And one makes big-name movies in Hollywood.

Each credits Cornell Engineering with giving them the critical thinking, creativity, and problem-solving that their job demands.

The Film Editor

An engineering degree, says Steve Shapiro '01 ME, opens doors.

"It's so wonderfully applicable to so many careers," says Shapiro, who has put his engineering skills to a different test. He is now a first assistant editor of feature films in Culver City, Calif.

Shapiro has worked on several movies for Adam Sandler's company, Happy Madison Productions. His credits include *Don't Mess with the Zohan*, *Bedtime Stories*, *Grown Ups*, and the tentatively titled *Just Go With It*. He tells people that as a freelance assistant editor, he is always getting hired and fired, because the work team dissolves upon completion of a film.

The young man who landed in Ithaca with a dream of becoming an astronaut or aerospace engineer has come a long way. After Cornell, he went to UCLA to pursue that dream. Upon further reflection, he decided to zero in on another mission: filmmaking.

Too, he owes Cornell for the inspiration. On campus, he created a class video called *The Future's So Bright* and the mockumentary of a day in the life of a student was a hit. A friend reminded him while he was in California about how much fun they had in making the film.

He sought out film professors and received his share of rejections. One professor was receptive and encouraging, even as she tried to convince him to hunt down an easier profession. After conferring with her, he decided to jump in and began working for free on low-budget horror films as a production assistant. He soon landed a post-production assistant job, and pay, and moved on to work with an editor and with Happy Madison Productions. When interviewed, he was overseeing four people, and described himself as a kind of office manager of the cutting room.

"It is something different every day," Shapiro said. "This is the greatest job in the world."

Shapiro said he has always liked solving a good puzzle and working with computers. "The reason I like editing," he said, "is that it's both technical and creative."

"[Engineering is] so wonderfully applicable to so many careers."

NAME: Steve Shapiro '01
CAREER: freelance film editor
DEGREE: Mechanical Engineering

The Entrepreneur

Charles Tall '78 OR is the chief executive officer of Archelon, a small international trading company.

"For a little more than 30 years," he says, "I have been applying my engineering skills to trading in the financial markets. Initially it was just me using a simple programmable calculator on exchange floors where I was trading. It has now developed into a team of 100 people including 60 people in technology (developers and administrators) keeping our data management and models working in the U.S., Europe, and Korea."

When Tall's colleagues or friends learn of his engineering degree, he says he often gets one of two responses.

"Those who are familiar with today's financial markets immediately say, 'That makes a lot of sense,' and others say something like, 'I thought you needed a degree in economics to be involved in the markets.'"

"For a little more than 30 years, I have been applying my engineering skills to trading in the financial markets."

Tall, who for the past 15 years has lived in Bad Homburg, a town outside Frankfurt, Germany, fondly recalls visiting Cornell for the first time after growing up in a rural town in upstate New York. He says that he was convinced Cornell was the right place for him after a visit the spring of his senior year in high school. The different interests and backgrounds of fellow students caught his attention. The professors later challenged and inspired him.

Tall says he probably had too many inspirational professors to name, for fear of leaving anyone out. But Professor Narahari Prabhu teaching his "Prabhu-ability" was truly memorable, as was Professor Andrew Schultz for his accounting class. And he says Professor Robert M. Chase, in the Hotel School, introduced him to finance and opened his vision to entrepreneurship. And his adviser, Professor John Muckstadt, had a knack for bringing out the best of a student's abilities.

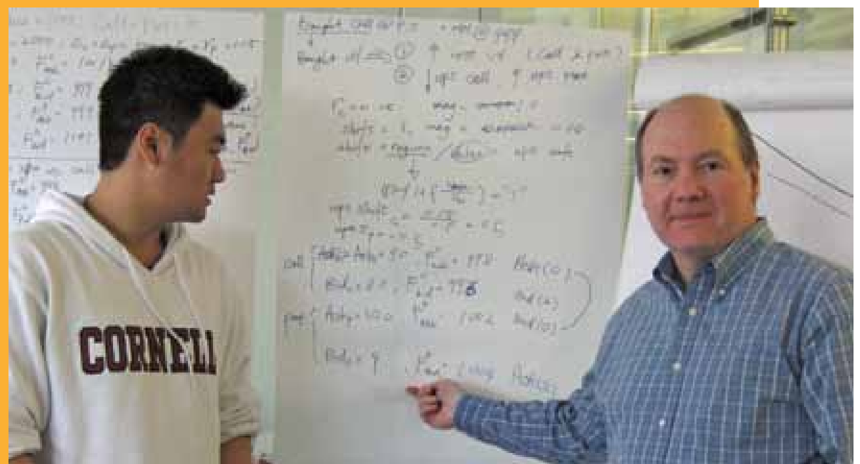
The critical thinking required in those engineering classes years ago has only accrued in value, according to Tall. "I believe it rings loudly in our work place," he said. "We are constantly confronting problems that arise from our activities, and looking to frame perceived opportunities into solvable problems."

In the not-so-old days, when Tall first started to trade on the floors, he says Wall Street had almost a prohibition on the use of technology on the floors. He says he was banned from using his HP-41CV with 64K of memory in the pit. Today, the biggest investment and cost to the firm is in its technological infrastructure.

Besides Archelon's core mission, Tall says he enjoys developing and mentoring the young people that the firm has been hiring recently.

"The best part for me is working with young, interested people who want to make a career in this crazy business of trading," he says. "The biggest challenge is to succeed in blending the technology and the people into a cohesive team that works."

NAME: Charles Tall '78
CAREER: chief executive officer Archelon
DEGREE: Operations Research



The Nonprofit Founder

After 20 years of service in the Navy, Vic Wintriss, '54 EE, started three different electronics and computer systems companies. In 2006, he launched Wintriss Technical Schools Inc., a non-profit in San Diego that trains grade and middle school students in writing computer programs using JAVA. He's focused on helping young people get competitive, high-paying jobs in the industry after college.

"It's terribly, terribly satisfying," Wintriss says. "Nobody else is doing this."

Even when he was a student at Cornell, Vic Wintriss was an engineer. He was engineering vice president for his father's company, Wintriss Controls. He worked with his father for a bit after graduation, then entered the Navy, where he flew patrols and was a flight instructor. The Navy saw that he was an electrical engineer and sent him to be an instructor at its first computer school.

"[The work we do] is terribly, terribly satisfying. Nobody else is doing this."

After the Navy, he put his engineering and computer expertise to work. At his last company, of which he still owns 25 percent, he designed a virtual golf room to help golfers improve their swing. After a business breakup with partners, he was inspired to give back. In 2006, he and his wife Diane launched Wintriss Technical Schools Inc., a non-profit, public-benefit organization. At the school, students learn computer programming while having fun, and volunteers from the private sector help teach. Classes are usually once a week for two hours, and Wintriss finds himself working seven days a week, partly to accommodate parents' busy schedules (and their children), and partly because it energizes him.

The Wintriss school, which currently has just shy of 30 students, is now self-sufficient, thanks to tuition and donations.

The idea, Wintriss says, is that these young people can not only get hooked on science, technology, and math, but can become the next generation of scientific leaders. The students are impressive in how quickly they learn, he says. Some short-term gains are already in the book: At least one of his teen-age students was given a summer job in a professional environment.

"Cornell was great for being hands on," he says, "and that's the work I do with the kids."

NAME: Vic Wintriss '54
CAREER: co-founder Wintriss Technical Schools
DEGREE: Electrical Engineering

The Research Scientist

Andrea Ippolito ’06 BE, M.Eng ’07 BME, works at Boston Scientific, spending most of her day in the lab. She says she’s found a professional home.

“I definitely consider myself a technical person,” she says. “I love science, I love engineering.”

Small wonder—both her parents are engineers. Her mother, Mary Valla Ippolito ’77, works at Raytheon; her dad Stephen at BAE Systems.

Ippolito says her job at Boston Scientific provides a regular stream of inspiration. She is in the lab most days, helping to improve existing medical devices and working on potential new solutions.

She performs experiments with cells to observe the interaction with various materials and instruments.

“It’s a great opportunity to work on medical advances,” she says.

Since 2007, Ippolito says she has been inspired by the company mission, to develop new potentially life-saving devices, and to help researchers and physicians. “Our country needs that now,” she says. “We need engineers.”

Ippolito leads the Women’s Network at Boston Scientific and serves as Vice President of Professional Development of the Society of Women Engineers and President of the local Biomedical Engineering Society Industry Chapter in Boston.

Cornell, she says, exposed her to different technologies, disciplines, and challenges. “Why,” she asks unprompted, “wouldn’t one pursue a degree in engineering?”

“There is no better career,” Ippolito says. “An engineering degree, you cannot go wrong. You can literally do anything.” CEM

“There is no better career. An engineering degree, you cannot go wrong. You can literally do anything.”

NAME: Andrea Ippolito ’06

CAREER: research scientist
Boston Scientific

DEGREES: Biological Engineering
M.Eng. Biomedical Engineering

people

Thomas W. Parks

Stephen B. Pope

PROVIDED

Narayana Murthy

PROVIDED

NAE electees

Professors **Thomas W. Parks** and **Stephen B. Pope** have been elected to the National Academy of Engineering this year, an honor counted among the highest professional distinctions for an engineer. Cornell trustee N.R. **Narayana Murthy** was also elected a foreign associate to the academy.

Parks, professor emeritus of electrical and computer engineering, was honored for “contributions to digital filter design, fast computation of Fourier transforms, and education.” Parks’ research interests include design of multirate signal processing systems, time-frequency signal analysis, and detection and classification of marine mammal sounds.

Pope, the Sibley College Professor of Mechanical and Aerospace Engineering, was recognized for his “contributions to the modeling of turbulent flow, including the development of probability distribution function methodologies for turbulent combustion.” Pope conducts research in the fluid mechanics field of turbulence, as well as computational methods for combustion chemistry.

Murthy, chair of the board and chief mentor of Infosys Technologies Ltd. in Bangalore, India, was honored for “contributions to the development of global information technology services.” Murthy founded Infosys in 1981 and served as its CEO for two decades.

–Anne Ju

New AA&D dean

Kathi Warren became assistant dean for Alumni Affairs and Development in the College of Engineering June 1.

Responsible for the college’s alumni affairs program, Warren will work closely with directors, chairs, faculty members, and staff to support major-gift fundraising.

Warren came to Cornell after serving as a major gifts officer at Johns Hopkins University’s Krieger School of Arts and Sciences and the Robert H. Smith School of Business at the University of Maryland. In 2005 she became director of corporate relations at Smith, and in 2008 she was promoted to campaign director.

Weiss guy

John A. “Jack” Muckstadt was named a Stephen H. Weiss Presidential Fellow by the Cornell Board of Trustees.

He received this award for excellence in teaching, advising undergraduate students, exemplary efforts to improve instruction on campus, and for striving to improve daily life.

“Engineering exists to improve the lives of all, and if you view it as your own personal enterprise, you’re missing the point,” says Muckstadt.

Muckstadt, the Acheson-Laibe Professor of Engineering in Cornell’s School of Operations Research and Information Engineering, joined the faculty in 1974. For more than three decades, he has brought the tools of real-life, private-sector experience to the classroom. “All coursework is about trying to teach students how to think about these problems,” he said. “It’s essentially the scientific method applied in a different way: You test the hypothesis, you revise it and you take action on it, and this is an ongoing thing.”

The award—$5,000 a year for five years—is named for the late Stephen H. Weiss ’57, emeritus chair of the Cornell Board of Trustees, who endowed the program. To date, 51 faculty members have been named Weiss fellows, including 15 engineering faculty members. Muckstadt was honored at a faculty recognition ceremony in May hosted by the Cornell Board of Trustees.

“The selection committee noted your love of teaching and your willingness to go ‘above and beyond’ to help students,” said Cornell President David Skorton. “Your clear, logical class presentations and your use of Socratic dialogue and experiential learning to develop critical thinking skills have had an impact on generations of Cornell students.”

In the nomination process, many former students recounted how Muckstadt personally placed students into internship-style experiences—with regional companies—that allowed them to analyze corporate manufacturing problems and develop solutions. Former students explained that he is famous for keeping his classes fresh by “continuously re-doing” exercises and labs—to keep up with modern demands and technology.

–Anne Ju

Kathi Warren

John “Jack” Muckstadt

people

Chekesha Liddell

David Muller

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Andrew Myers

Dan Luo

Distinguished scholars

Three engineering faculty members were among eight recipients of the Provost's Award for Distinguished Scholarship for 2010, announced by Provost Kent Fuchs in May. The $30,000 awards recognize outstanding tenured faculty members early in their careers for distinguished research and scholarly achievements, combined with their continuing commitment to Cornell.

Chekesha Liddell, associate professor of materials science and engineering, studies the synthesis and assembly of non-spherical colloidal particles. Her research program takes a calculated yet risky approach to address long-standing problems in the field, and her research group is now recognized as a leader in assembly of non-spherical particles.

David Muller, professor of applied and engineering physics, is being honored for his work in the atomic scale characterization of interfaces. In 2006 he received the Burton Award, which is given to the best electron microscopist under the age of 40. Muller is also co-director of the Kavli Institute at Cornell for Nanoscale Science.

Andrew Myers, professor of computer science, studies security, programming languages, and systems—a key area for national security. He is known for one of the most successful approaches to security—limiting information flow. His group has developed the Jif programming language and type system, the Jif/Split system and the Swift system, and the Civitas voting system for secure Internet voting.

The other winners were: Brian Crane, associate professor of chemistry; Laura Harrington, associate professor of entomology; Ted O'Donoghue, professor of economics; Eduardo Peñalver '94, professor of law; and Cynthia Robinson, associate professor of art history. Nominations for awards were made by the college deans, and a committee of vice provosts, chaired by Fuchs, made the final selections.

–Anne Ju

Award material

Dan Luo, associate professor of biological and environmental engineering, has been selected to receive the 2010 *Journal of Materials Chemistry* Editorial Board Award, which honors a younger scientist who has made a significant contribution to the materials chemistry field. Luo is the first recipient of the new award, which will be given annually.

In connection with the award, Luo is invited to contribute an article to the journal, published by the Royal Society of Chemistry in England, and to give three lectures at upcoming conferences describing his research. The award includes a stipend to cover the cost of travel to these events.

"I feel greatly honored to receive this award," Luo said. "I also want to thank my talented and dedicated postdocs and students, and wonderful collaborators, for their high-quality work; without them it would not have been possible."

The award cites Luo for his research in developing new materials for sensing, imaging, and biotechnology. He has innovated the use of synthetic DNA as a building block for self-assembling nanostructures, creating biodegradable hydrogels for drug delivery and tissue scaffolding, platforms for protein synthesis, and microscopic "barcodes" to identify pathogens.

–Bill Steele

Frontiersmen

Two Cornell engineering faculty members will participate in the National Academy of Engineering's 16th annual U.S. Frontiers of Engineering symposium. **Mark Campbell**, associate professor of mechanical and aerospace engineering, is an invited speaker, and **Jonathan Butcher**, assistant professor of biomedical engineering, is invited as a general participant.

The symposium, to take place Sept. 23–25 in Armonk, N.Y., will examine cloud computing, autonomous aerospace systems, engineering and music, and engineering inspired by biology. Eighty-six of the nation's brightest young engineers have been selected to take part in the event.

Campbell's presentation will explore techniques for enabling intelligence in autonomous systems. He will talk about robots in complex environments, such as traveling over rough terrain or in the presence of moving objects, and connections between probabilistic perception and deterministic planning.

He also will address integration of humans into autonomous systems—an area with immense potential. Such concepts as formally modeling human opinions and combining this input with traditional sensors will be explored; for example, deep space rovers fusing scientist information from Earth with local terrain information from sensors.

Butcher's expertise is in the symposium topic area of engineering inspired by biology—in his case, development biology. His research focuses on understanding how mechanical forces drive heart muscle and valve formation and remodeling. He then applies novel design principles to engineer naturally derived regenerative strategies to target these vital tissues.

–Anne Ju

Early birds

Cornell faculty members **Jonathan Butcher**, **Hadas Kress-Gazit,** and **Matthew Pritchard** have received National Science Foundation Faculty Early Career Development Awards, which fund research and outreach projects for "junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education," and "the integration of education and research."

Butcher, assistant professor of biomedical engineering, has been awarded $400,000 over five years to study tissue assembly and remodeling, which occur at faster rates during embryo development and remain poorly understood. By better understanding the sensitive genetic signaling network that is active during the formation of heart valves, Butcher aims to develop new therapeutic technologies to treat heart valve disease quicker and earlier.

Kress-Gazit, assistant professor of mechanical and aerospace engineering, was awarded $512,000 over five years for research into high-level robotics. She is developing mathematical formalisms and algorithms to provide guarantees for the success of a robot's high-level task, such as driving autonomously in a real city. She hopes the research will pave the way for creating autonomous robots that will have a wide impact on society.

Pritchard, assistant professor of earth and atmospheric sciences, was awarded $530,000 over five years to use satellite sensing data to search for magma chambers and geothermal resources in the western United States and Mexico and to monitor changes to glaciers in Alaska. He will employ a relatively new technology for measuring the shape of the Earth—a science called geodesy—that uses satellite images to infer movements of the Earth's surface.

In addition, Pritchard has received a grant from the NASA New Investigator Program for $330,000 over three years to study volcanic activity at hundreds of volcanoes in South America. The NASA grant also supports exhibits and education programs at Ithaca's Museum of the Earth.

–Anne Ju

PROVIDED

Mark Campbell

Jonathan Butcher

PROVIDED

Hadas Kress-Gazit

PROVIDED

Matthew Pritchard

Medicine man

David Putnam, associate professor of biomedical engineering in the College of Engineering, has been named a fellow of the American Institute for Medical and Biological Engineering.

Also affiliated with Cornell's School of Chemical and Biomolecular Engineering, Putnam was cited for high-throughput pharmaceutical formulation and development of novel biomaterials used for controlled release of therapeutic compounds and for prevention of post-operative seromas.

A faculty member since 2002, Putnam's research is in the design and synthesis of polymeric materials with well-defined compositions and properties. His group is particularly interested in creating "functional materials," or materials with engineered characteristics optimized for specific applications ranging from drug and gene delivery to biodegradable packaging.

Trust brain

Kenneth P. Birman, the N. Rama Rao Professor of Computer Science, has received the 2009 Tsutomu Kanai Award, which recognizes major contributions to the state of the art in distributed computing systems. The award consists of a crystal model, certificate, and $10,000 honorarium.

Birman's research focuses on trustworthy computing in widely distributed systems, where many users interact with the same body of information. The most familiar example is the ATM system. In Birman's work, "trustworthy" means not only safe from attack but also correct and reliable.

His work in this area dates to 1985, and includes the development of software used by the New York Stock Exchange (NYSE) and Swiss Exchange, the French Air Traffic Control system, the AEGIS warship, and many applications in factory process control and telephony. Every stock quote or trade on the NYSE from 1995 until early 2006 was reported to the overhead trading consoles through software Birman personally implemented. Many network problems occurred, but the design always reconfigured itself automatically and kept the overall system up, Birman reports.

David Putnam

Kenneth P. Birman

The Tsutomu Kanai Award was established in 1997 by Hitachi Ltd. in honor of Tsutomu Kanai, who served as Hitachi's president for 30 years.

David Bindel

Craig Fennie

Good vibrations

David Bindel, assistant professor of computer science, has been named a 2010 Alfred P. Sloan Research Fellow for outstanding early career success.

The award is intended to enhance the careers of the best young faculty members in specified fields of science.

Bindel, who joined the Cornell faculty in fall 2009, received B.S. degrees in mathematics and computer science from the University of Maryland in 1999 and a Ph.D. in computer science from the University of California-Berkeley in 2006.

His research focuses on computer simulations that can be used by engineers and designers in areas ranging from microelectromechanical systems and photonic circuits to musical instruments.

"I do simulations of things that vibrate, and there's lots of the world that has things that vibrate that you wouldn't think of," he said.

Those range from the micron-sized tuning forks that vibrate at radio frequencies and generate signals in a cell phone to light waves in an optical waveguide and air in a music instrument. He also works on the computer science questions underlying these simulations, looking for ways to make the computations faster and more accurate.

In other work, he examines the tomography of networks. As with medical tomography, this involves trying to infer things about a network by looking at it from the outside.

Jiwoong Park, assistant professor of chemistry and chemical biology, was also named a 2010 Sloan fellow.

The Alfred P. Sloan Foundation awards 118 fellowships annually in seven scientific fields. Grants of $50,000 for a two-year period are administered by each fellow's institution; research fellows are permitted to employ those funds in a wide variety of ways to further their research aims.

–Lauren Gold

Med techs

Two Cornell graduate students have won the top CIMIT (Center for Integration of Medicine and Innovative Technology) Primary Healthcare Prizes—with awards that total $250,000—one for instant, accurate testing of sore throats and another for a portable, low-power ultrasound device that promotes healing.

Mark R. Hartman '07 ChE, M.Eng. '08 BEE, a Cornell doctoral candidate in biological and environmental engineering, received the $150,000 top honor for his instant-diagnosis test of sore throats, a project that applies DNA-based fluorescent "nanobarcodes" to provide accurate results on whether the sore throat is caused by strep, flu, or other diseases.

George K. Lewis Jr.

George K. Lewis Jr., M.S. '08 BME, a doctoral candidate in biomedical engineering, won the $100,000 second-place award with a low-power ultrasound device—the size of an iPod—to promote pain relief and healing.

A team from the Massachusetts Institute of Technology won third place and a $50,000 prize.

In announcing the awards, Ronald Newbower, chief technology officer and co-founder of CIMIT, said, "We are delighted with the passion this prize competition has elicited amongst engineering students. They are clearly eager to develop innovative technologies to address our national challenges in primary care. The winners of our major awards are headed toward terrific careers and may well serve as role models for others in their field. CIMIT is proud to be able to support their efforts."

CIMIT, a non-profit consortium in Boston, held the competition to encourage graduate and undergraduate engineering students to develop creative, technological solutions that could enhance the frontline of medical delivery.

Hartman graduated from Sayre High School, Sayre, Pa.

Lewis is a National Science Foundation Presidential Fellow and graduated from Andover Public High School in Andover, Mass. He earned a bachelor's degree in biomedical and mechanical engineering at the University of Miami (Fla.).

–Anne Ju

Atomic designer

Craig Fennie, assistant professor of applied and engineering physics, has received a Young Investigator Award from the Army Research Office Materials Science Program.

The three-year, $150,000 award will allow Fennie to conduct basic research into atomic-level design of materials known as multiferroic oxides, which have strong magnetoelectric responses. He will investigate how architecture, rather than composition alone, determines the multifunctional properties of inorganic materials.

Multiferroic oxides, in which a spontaneous magnetism coexists with and is strongly coupled to spontaneous electric polarization, are rare in nature, but could prove useful in computer electronics, Fennie said. Current computer storage technologies use energy-intensive electrical currents to read and write magnetic ones and zeroes that code information, but multiferroics could introduce a new low-power storage bit accessed through electric fields.

Blazes and Budgets

Accountant helps protect her community as a volunteer firefighter

Linda Smiley has two different kinds of suits—her business suit, which she wears to work as a research accountant in mechanical and aerospace engineering, and her firefighting gear, which she wears as a volunteer firefighter and emergency medical technician (EMT) for the nearby Freeville Fire Department. Thanks to a community-friendly policy at Cornell that gives employee volunteer firefighters paid leave to help out at emergencies that take place during work hours, Smiley even has days when she wears both her high heels and her fire boots.

Smiley, a single mother with two children (C.J., 11, and Angela, 23) had hoped to become a volunteer firefighter when she was younger. Family members discouraged her, worrying that it was too dangerous.

But two situations convinced Smiley that she had the courage and level-headedness needed to do the job. One day, she was in a grocery store when a person collapsed. Smiley, who knew CPR, jumped in and helped a group of people who had gathered to aid the man. He later recovered.

Soon after, while Smiley was at work in Clark Hall, she heard a man having a seizure in the stairway. Again, she rushed to assist him and her efforts helped.

"Those were a couple of situations that said to me, 'You can do this!'" she says. "So six years ago I joined the fire department."

Smiley trained as an EMT by taking a ten-credit course at Tompkins Cortland Community College. She is also an exterior firefighter. Her 32-member department answers about 400 calls a year, and most years, Smiley has been in the list of top ten responders.

She's left work to help at major fires and search and rescue operations, and really appreciates Cornell's policy enabling her to do so. "My management is supportive of me being away for my firefighting," says Smiley.

Her skills have even come in handy at Cornell. One weekend, when she was picking up something from her office, she noticed an older person sitting on the ground in front of her building. "I went over and starting speaking with him and realized he needed help," she says, noting that he told her he was a diabetic. She called 911 and stayed until they arrived.

"Our faculty and staff are part of the broader local community, a community that relies partly on volunteers for these key safety services," says Mary George Opperman, vice president for Human Resources, explaining the need for the long-standing policy supporting volunteers. "As a major employer in the area I believe it is our responsibility to support Cornell staff who volunteer as firefighters and EMTs by permitting them to remain on payroll during regularly scheduled hours when responding to a call. We are all very fortunate that faculty and staff like Linda Smiley are willing to help keep the rest of us safe."

Smiley, who was raised in Dryden, N.Y., has worked at Cornell University for ten years. In her position, she monitors the research funds of 40 professors, helping them meet their accounting requirements from pre-proposal to final report stage. Previously, she worked in the School of Applied and Engineering Physics and in the Department of Human Development in the College of Human Ecology.

"Cornell offers me a steady job with good people doing quality work," says Smiley. "I have the best of two worlds. I really enjoy accounting and I really enjoy the medical stuff. I get paid to do my accounting, and I volunteer to do the medical stuff. So I get to do two jobs!"

She also takes advantage of the continuing education Cornell offers employees, having completed the office professional, accounting, and research accounting certificate programs. "I always want to increase my knowledge," she says.

In her small amount of spare time, Smiley also demonstrates a strong sense of community responsibility by coaching Kiwanis youth baseball. "I have a busy life!" she laughs. "People ask me all the time when I'm going to slow down."

Whether it's helping a faculty member develop a proposal budget or aiding a person who has been injured in a car accident, Smiley lives up to her name, trying to bring joy and comfort into the lives she touches.

"I have a need to help people and I want to help people and I can help people," says Smiley. "As an EMT and firefighter, I've been in a couple of tough situations and afterwards I reflected, at least somebody was there to help them. It was me."

—By Bridget Meeds

Encapsulating Intuition

Operations research and information engineering Assistant Professor Peter Frazier is working with researchers at Cornell's College of Veterinary Medicine to find an alternative for antibiotics in the treatment of bacterial infections. "It's an operations research problem because you have this resource which is your time and money and the effort that you put toward doing these tests and you want to allocate that resource as efficiently as possible," says Frazier.

To help combat antibiotic resistance, the researchers are looking for viruses that kill bacteria. But these bacteriophages are among the most common life forms on Earth, so Frazier is using statistics to infer which ones might work. While subjective, Frazier says his method is useful. "If you don't make some kind of assumptions, you just won't be able to say anything at all and that's unacceptable," he says. "Bayesian statistics is a quantitative way of encapsulating your intuition about a problem. You're going through a haystack looking for the needle, so you want to be able to use the intuition that you have, even though it's not very reliable, to direct the search."

Frazier often commutes to campus on his mountain unicycle. "It's fun to be different. You ride down the street, and people will say 'Hello.' to you and say 'Oh that's cool! How do you do that?' and kids love it," he says. "Kids always smile and laugh and say 'Oh look, it's a guy on a unicycle!"

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