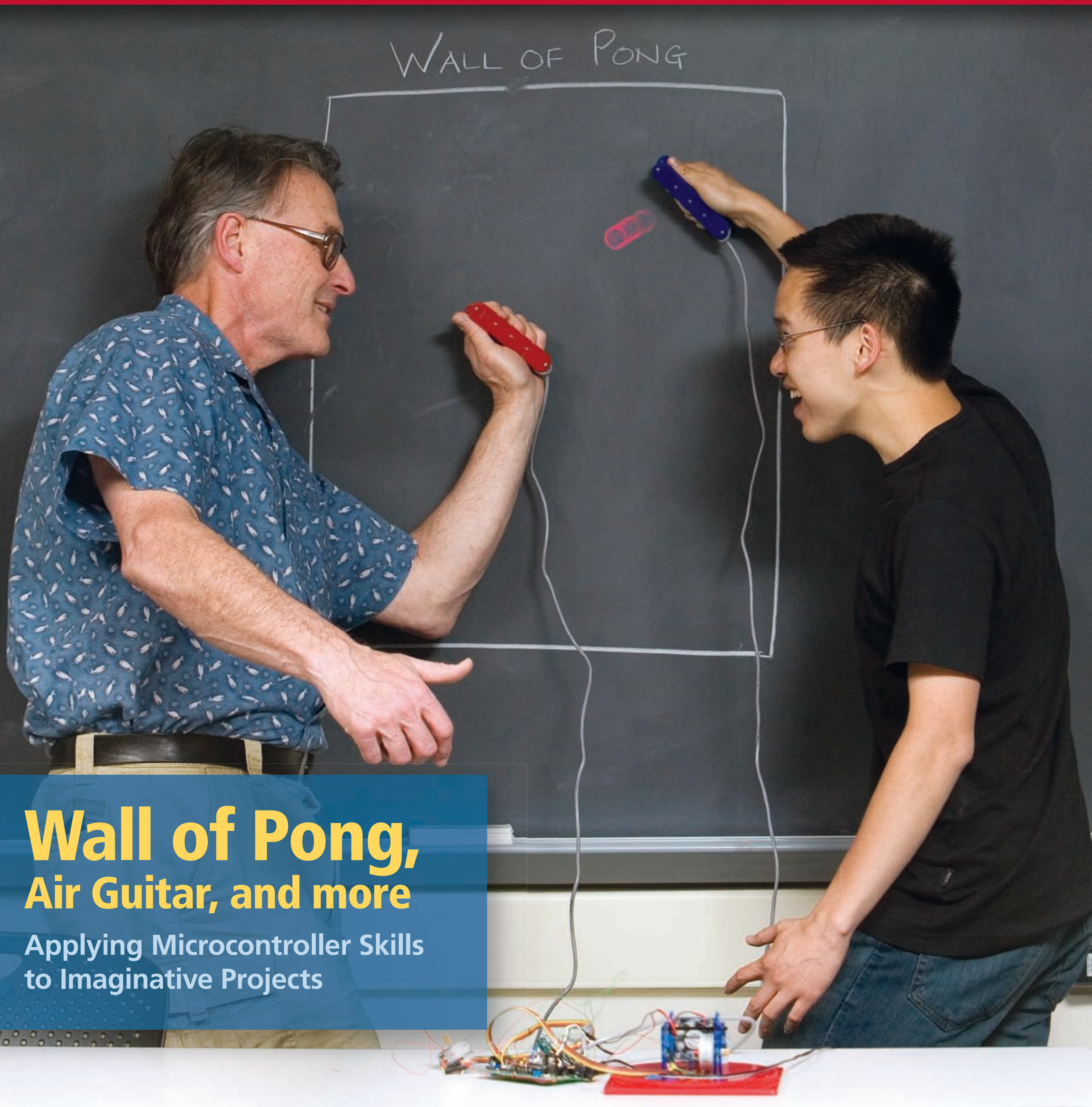
Cornell University
School of Electrical and
Computer Engineering

SPRING 2008

# ece connections

A Publication from the School of **Electrical and Computer Engineering** at Cornell University




## Wall of Pong, Air Guitar, and more

### Applying Microcontroller Skills to Imaginative Projects

## Inside This Issue:



# Far Above:

## Our Thanks for Investing in Those Who Will Invent Tomorrow

Whether you spent your days in what was then called Franklin Hall or in Phillips Hall, you know the life of an engineering student can be intense, focused on rigorous assignments, challenging labs, and open-ended projects, but also filled with wonderful interactions with professors, staff and other students. Like you, today's students benefit from superb teaching and an abundance of rich experiences.

Our famous Cornell education benefits greatly from the generous alumni who are our partners in excellence. And so we extend our grateful thanks to you for investing in our undergraduate and graduate students—young people whose insights, imaginations, and innovations will shape our world in the decades ahead.

You probably know that the university's ongoing $4 billion Far Above capital campaign includes $640 million for students. For our part, here in the School of Electrical and Computer Engineering, we continue to invest in building a great faculty and infrastructure, and especially in our students.

Here's what alumni gifts like yours are now helping to provide:

- Endowed fellowships to attract and support top graduate students
- Undergraduate scholarships that support need-blind admissions, so that gifted students can earn a Cornell education, regardless of their financial circumstances—scholarships recently enhanced to enable them to graduate without the burden of large student loans
- Discretionary funds to support undergraduate student projects and instructional laboratories
- Endowments for enhancing instructional development

To those who have generously supported us over the years, we extend our warmest thanks for making a difference to present and future ECE students. If you would like to learn more about how you can partner with us in enhancing and improving an already-great program, please visit **www.ece.cornell.edu/aad-donate.cfm**.


ece connections

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Director
Clifford R. Pollock

Director of Administration
Lynn P. Martin

Associate Director, Alumni Affairs and Development
Jessica C. Traynor

Editor
John C. Belina

ECE Photographer
Thomas P. Mitchell

Produced for the School of Electrical and Computer Engineering at Cornell University by

Iron Design, Inc., Ithaca, New York

Art Director
Todd Edmonds

Designer
Jennifer Infante

Writer
Laura McGrath

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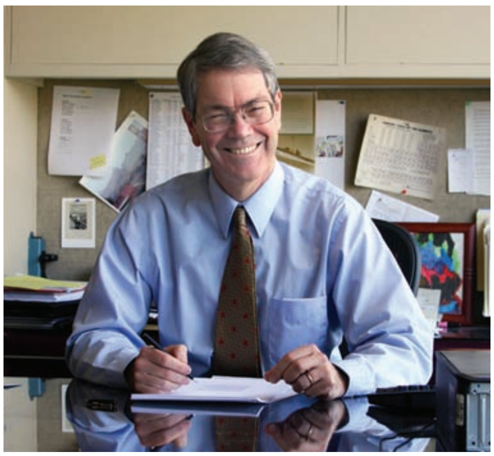
We welcome feedback from readers.



email: alumninews@ece.cornell.edu
Telephone: 607.255.4109
Cornell University
School of Electrical and Computer Engineering
224 Phillips Hall
Ithaca, NY 14853-5401

# Director's Message

This may be one of my last opportunities to communicate with you from the ECE Director's desk, as my term is coming to an end after seven years. I've really enjoyed serving as Director. It has truly been an honor to represent this great school and its superb faculty and students, but I have to admit I am looking forward to getting back into the classroom and my laser lab. Dean Fuchs and a faculty committee are looking for the next Director, to be named within the next few months. So this seems like an appropriate time to talk with you about the progress we have made over the past few years toward realizing the vision for ECE that the faculty developed.



**Clifford R. Pollock,** Director
School of Electrical and Computer Engineering

### The Future of the Field

Two years ago, we held a faculty retreat to explore the major issues that society would likely face in the next 20 years, the implications of those trends on the field of electrical and computer engineering, and how our school should prepare for them—and prepare our students for them. We identified these issues:

- Energy supply and demand
- Affordable and accessible health care
- Globalization and the shift of economic dominance away from the USA
- Human-machine interfaces and the impact of ubiquitous connectivity
- Control and security of information

### Goals for Cornell ECE

Our confidence that we can innovate solutions for the future comes from our remarkable legacy extending back to 1883, when Cornell University showed great vision by introducing the world's first degree in electrical engineering. Since then, our school has been at the forefront of many innovations and has been among a select few leading institutions that have pioneered and expanded the breadth, depth, and impact of electrical and computer engineering. Our leadership in research and our focus on superb teaching have earned us widespread recognition as one of the world's top schools. One meaningful ranking instrument—the Faculty Scholarly Productivity Index—has consistently rated our Electrical Engineering and Computer Engineering programs one of the nation's top three.

In context of these goals, how can we best position ourselves to anticipate and address the needs of the future? And how can we best prepare our students to help solve some of the important problems that lie ahead? These are our broad strategies:

*Establish two new research and teaching thrusts: energy and bio-electrical engineering.* This will require investment in additional faculty in these areas and developing strong programs that will make a national impact, as we currently have in the areas of nanotechnology, communications, and computer systems.

*Continue to strengthen the already-excellent quality of our faculty.* As we add new positions and replace retiring faculty members, we are determined to recruit and hire the best-of-the-best—individuals who are excited about their fields, poised to take advantage of emerging ideas, able to adapt their teaching to emerging

# Director's Message, continued

technologies, enthusiastic about working with students, and who can deliver a superb, leading edge education.

*Hone our curriculum to prepare the next generation of technological leaders for the changing world.* We can best achieve this by teaching critical thinking and innovation, based on a strong theoretical foundation including fundamental math and physics—knowledge that won't be out of date five years following graduation. We will deliver breadth in our undergraduate curriculum and focus on adding depth and advanced skills in the M.Eng. curriculum. We are committed to working with the college to address the larger issue of a liberal education for all undergraduate engineers.

## Making Progress

We have made headway on all fronts. As you'll see in this issue, this year we've hired two stellar new faculty members—Kevin Tang and Al Molnar—to join the excellent people we've hired in the last seven years. Kevin adds the critical area of networking to our strong communications program, and Al brings new expertise in bio-electrical engineering through his neuro-circuitry work. Meanwhile, other faculty continue to garner awards for their superb teaching. Three have won the national HKN teaching award—more than any other school in the nation—and three have received Cornell's prestigious Weiss Presidential Fellow awards—more than any other department on campus. Conversations with alumni always turn to their own personal experiences with faculty members who made a significant impact on their lives. I'm sure you have your own list and can only imagine you'll look at the current list of awards (Back Cover) with pride in this school.

We have made strides in our curriculum and are continuing these efforts. We are developing a curricular "stem" in green computing, integrating energy-savings and efficiency into many of our courses. We are adding two new courses in computer engineering. We have strengthened our foundation in quantum mechanics and physics, and introduced several relevant new courses in the M.Eng. program that incorporate entrepreneurship, program management, and technical management. We continue to make adjustments that enhance our innovative, relevant curricula and prepare both undergraduate and graduate students for present and future challenges.

## And You, Our Alumni

Particularly from my experience as Director of ECE, I am very conscious of the many ways that our alumni contribute to our success. So many of you generously offer valuable real-world perspectives, which we take seriously as we renew and enrich our curricula. You engage with our students, actively recruit our graduates, and help to fund the initiatives that help to make our aspirations and goals a reality. You are critical partners in Cornell ECE. We are deeply grateful.

I hope you will get a good sense of what's happening here at your alma mater as you peruse these pages. As always, we would be delighted to hear from you.

Clif Pollock

CLIFFORD POLLOCK, DIRECTOR

## Al Molnar
Assistant Professor

**B.S. Engineering with highest honors, Swarthmore College, 1997**

**RFIC Design Engineer, Conexant Systems, Inc., co-leading design of first generation Direct-Conversion GSM transceiver (sales now exceeding 20 million parts), 1998-2001**

**M.S.E.E., 2003; Ph.D., 2007, University of California at Berkeley**

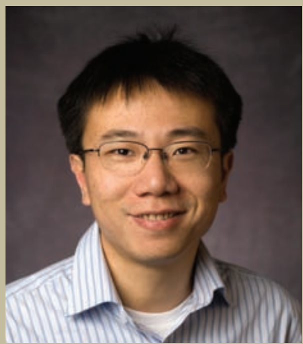
"There were only a few places I imagined I would want to be," says Al Molnar. All were top of the line engineering schools, and he had offers from several. But he chose Cornell ECE for several reasons. "It has a reputation as a very good place to collaborate." For someone whose research focuses on the intersection of silicon and neurons, that ability to cross traditional barriers is important. He's already found that collaborations within ECE occur easily. As for others across campus, he is confident they'll happen when he has time to pursue them.

Molnar's interests include nanoscale circuitry of all sorts and the biological circuitry of the nervous system. His dissertation work involved dissecting the neuronal circuitry of the rabbit retina, using a combination of electrophysiology, pharmacology, and anatomy. He is convinced that the university—particularly Cornell—is the right place at the right time for research at the frontier of the biology-technology interface.

"The fact that they care about teaching here was a big attraction, too," Molnar says. After his stint in industry, academia was appealing because he also really enjoys teaching and mentoring. He'd mentored junior engineers and taught some courses at Orange Coast College while he was working in industry. He describes the students he's encountered here as "spectacular." One of them is graduate student Albert Wang, a Jacobs Fellow. (See article on page 11.) "Our mutual interests span all kinds of things. We're having a great time."

Molnar and his family are having a great time living in Ithaca, too. "I'd accepted that with a technical career, I was probably going to live in an urban environment." But he and his wife had dreamed of living and raising their family in a more rural area. And here they are. Their new home is just a 10-minute walk from Phillips Hall. They shop at the Ithaca Farmer's Market. What's not to love?

## Ao "Kevin" Tang
Assistant Professor



**B.E., M.E., Tsinghua University, 1999 and 2001**

**M.S., Ph.D., California Institute of Technology, 2002 and 2006**

**George B. Dantzig Best Dissertation Award from Institute for Operations Research and Management Sciences, 2006; Charles Wilts Best Ph.D. Dissertation Prize from Electrical Engineering at Caltech, 2007**

**Junior Fellow, Social and Information Sciences Laboratory, Caltech, 2006-07**

"In physics, atoms obey relatively simple laws, but when they impact each other, amazing things happen. In networking, each router and computer performs as it is asked to do, but when they interact through a network, amazing things may happen. We have a long way to go to understand why these things happen," says Kevin Tang. And that's exactly where he wants to be—in the midst of research that unlocks the important mysteries. "The whole networking field is quite unique in that it is very broad—it involves electrical and computer engineering, computer science, operations research, and information systems. It's a much younger field compared to electromagnetic field or information theory, so that implies there is a long way to go to reach intellectual depth."

For someone with Tang's interests in networks, Cornell ECE felt like the sweet spot. Here he could augment his expertise by reaching out not only to ECE colleagues with strengths in other aspects of communication but also to people like Eric Friedman in Operations Research, Steve Strogatz in Theoretical and Applied Mechanics, and others. As he had hoped, Tang is finding the interaction with other faculty members very rewarding.

Because he arrived in October, Tang did not begin teaching until spring semester. He's developed a new course, Control and Optimization of Networks, for seniors and graduate students. "I'm very happy here," he says. "The students are motivated, and working with them brings me a lot of fun."

Like Al Molnar, Kevin Tang had offers from several other top schools. They all strive for excellence. But after his interview, Tang says, "I could picture myself doing very well here. The department is very strong, the senior faculty are all very supportive," and he's in one of the world's best places to explore the "amazing things" that happen through networks.

# Irwin Jacobs

**Entrepreneur, inventor, professor, textbook author, husband, father, grandfather, philanthropist – the major strands of Irwin Jacobs' life are interwoven. In many ways, Cornell University is a loom on which they intersect.**

"I had an unusual start at Cornell," Jacobs says. "After three terms in the School of Hotel Administration, I transferred to the School of Electrical Engineering. Luckily, but I believe typical of Cornell, once the Dean of Students understood what I was requesting, he was very supportive of the change. I received a broad education in EE, but also was able to take math courses in Applied Physics and a course sequence in American Ideals from ILR Professor Konvitz." Most notable for Jacobs was Professor Henry Booker's course in electromagnetic theory, taught in an elegant and intuitive fashion. Many years later at Qualcomm, the second of two companies that Jacobs co-founded, the theory he'd learned in Booker's class led to an innovative truck-mounted satellite antenna enabling OmniTRACS®, which now provides communications and tracking on over six hundred thousand trucks. Qualcomm was one of more than 40 companies spun off from Linkabit, Jacobs' first fast-growing company.

**Irwin Jacobs**
BEE '54, M.I.T. MS '57, ScD '59

Another Cornell experience Jacobs found critical was his senior thesis, working in a small group to develop a digital differential analyzer. "We made use of vacuum tube logic elements and a magnetic drum memory salvaged from an IBM 650 computer. The experience I gained in organizing a team to solve a complex engineering project proved to be a good foundation for managing teams at Linkabit and Qualcomm."

After graduating from Cornell, Jacobs went on to MIT, completing a Ph.D. at warp speed. He credits Cornell with a strong education that enabled him to finish his graduate work in just three years. He spent the next seven on the faculty at MIT, where he coauthored, with Professor Jack Wozencraft, *Principles of Communication Engineering*. Published in 1965, it is still regarded as a fundamental textbook on digital communications. In 1966, he traded in Massachusetts' snow and cold for southern California's sunshine and warmth, leaving MIT to join Professor Booker at the new University of California, San Diego. He remained on the UCSD faculty for six years until becoming an entrepreneur.

## Digital Pioneer

Considered one of the world's best communication scientists, Irwin Jacobs pioneered and commercialized Code Division Multiple Access (CDMA) digital wireless technology at Qualcomm. This technology is the basis for all third-generation wireless networks which now carry voice and data traffic for more than 560 million subscribers worldwide. Jacobs holds 13 CDMA patents,

**Irwin Jacobs and his wife Joan Klein Jacobs (BS, Human Ecology, '54) have made significant philanthropic investments in Cornell University, the College of Engineering, the School of Electrical and Computer Engineering, and the College of Human Ecology.**

contributing to Qualcomm's portfolio of more than 6,100 issued and pending U.S. patents. His scientific prowess has led to a long list of awards and honors. He was elected to the National Academy of Engineering and the American Academy of Arts and Sciences, named a fellow of the IEEE and awarded its Alexander Graham Bell Medal, and in 1994 received the National Medal of Technology from the President of the United States.

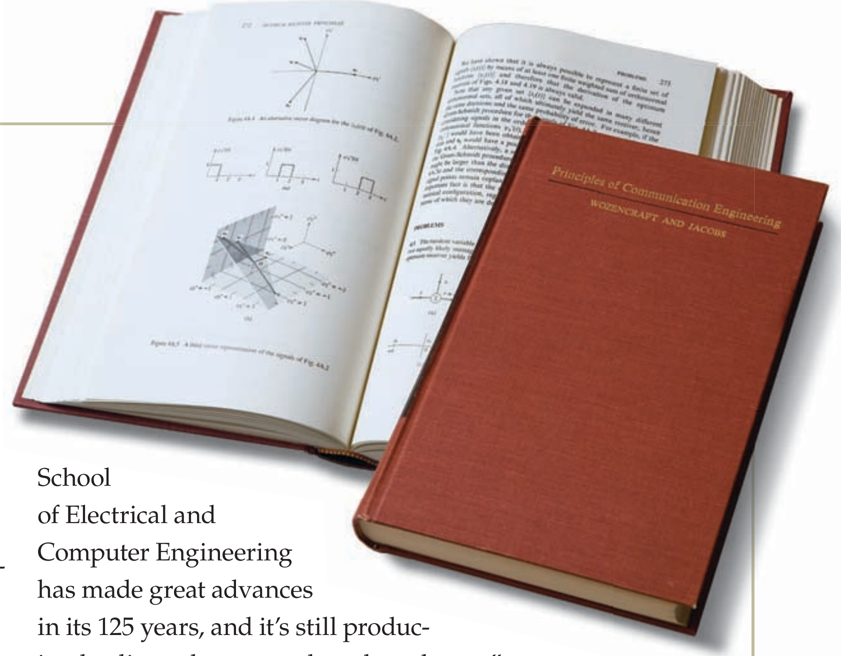
But Jacobs is also recognized for his business leadership. He built Linkabit from a great idea and a few part-time employees in 1969 to a firm with more than 1400 employees in 1985. Qualcomm, which he founded in July, 1985 just three months after his retirement, is a Fortune 500 company now led by his son, Dr. Paul Jacobs. The company continues to earn numerous business distinctions including *Fortune's* America's Most Admired Companies and Best 100 Companies to Work For (10 consecutive years), *Financial Times'* Top 10 IT Companies, and *CIO's* Top 100 Award.

### An Engineering Backbone for Business

So how does a professor engaged in research, teaching, and heady academic pursuits transform inventions into highly successful business ventures? "High tech business is similar in some respects to academia," says Jacobs. "As a professor working with grad students, you may suggest projects; they go off and work on them, returning periodically for review and suggestions. The end product for a student is a thesis. In business, the objective is a useful product, but the process is often similar."

He adds, "An executive of a high-tech company needs a clear understanding of engineering to evaluate when an innovation may be commercialized in a reasonable time and cost. An engineering background encourages a systems approach, framing business and marketing decisions as well, and supporting decision-making with incomplete information."

Jacobs believes that excellent engineering schools are necessary to produce skilled engineers who are open to innovations. "I can't stress enough the importance to our economy of the research university," he says. "Cornell's School of Electrical and Computer Engineering has made great advances in its 125 years, and it's still producing leading-edge research and graduates."




### Gifts Built on Hope

Irwin Jacobs and his wife Joan Klein Jacobs (BS, Human Ecology, '54) have made significant philanthropic investments in Cornell University, the College of Engineering, the School of Electrical and Computer Engineering, and the College of Human Ecology. They have funded Jacobs Scholarships for undergraduate engineering students, Jacobs Fellowships for ECE graduate students (see Page 10), the Dean's discretionary fund and Cornell Tradition Fellowship and Scholarship programs in Human Ecology, and the Irwin and Joan Jacobs Professorship in Engineering, a position now held by Dr. Lang Tong (see Page 12).

There's personal experience behind their generosity, too. Irwin and Joan Jacobs watched their parents and grandparents set aside hard-earned coins for local charities. And Irwin Jacobs attended Cornell with the help of several scholarships. "I benefited greatly from support as an undergraduate at Cornell and as a graduate student at MIT," he says. "Without such assistance, I might not have completed my schooling and gone on to teaching and running a company. It's made a marked difference in my life. I hope our help will make a similar difference to many students and their ability to be productive and lead exciting lives."

As some of the stories in this issue reveal, Irwin Jacobs' "hope" has already become reality.

# Course 476 Demands That Students Integrate All They've Learned...

"You are going to program in the equations of motion for the Lander. Your controls will be attitude and thrust, so you will need to relate acceleration, velocity and position."

Hello, Mission Control? Nope. Phillips Hall, Room 238—the digital lab for ECE 476: Designing with Microcontrollers. For this Week-4 lab assignment, small teams of students are challenged to produce a version of the classic 1973 Lunar Lander video game. They must write a program in C and assembler (a utility program that translates computer instructions) for the microprocessor, incorporating multiple parameters. By the end of two three-hour lab periods, they'll be required to manipulate controls to demonstrate all the Lunar Lander functions and successfully land the on-screen spacecraft. In addition, of course, there's an extensive written lab report, complete with details of their integration algorithm and a heavily annotated list of their code.

While Rebecca Slovak and Matt Meister look over his shoulder, Daniel Bermudez tests the work they've done together, manipulating a tiny screwdriver to control the potentiometer that manages the thrust values. The tough part, these senior lab partners agree, is getting the software to work with the hardware. "It's different from any coding we've done before," says Slovak. "The picture won't display right if we don't get the timing correct." Meister adds, "This is one of a few courses that allow us to do the whole hardware/software interface. Here, we're getting a sense for what's better handled by hardware and what's better handled by software."

### ECE 476: A Capstone Experience

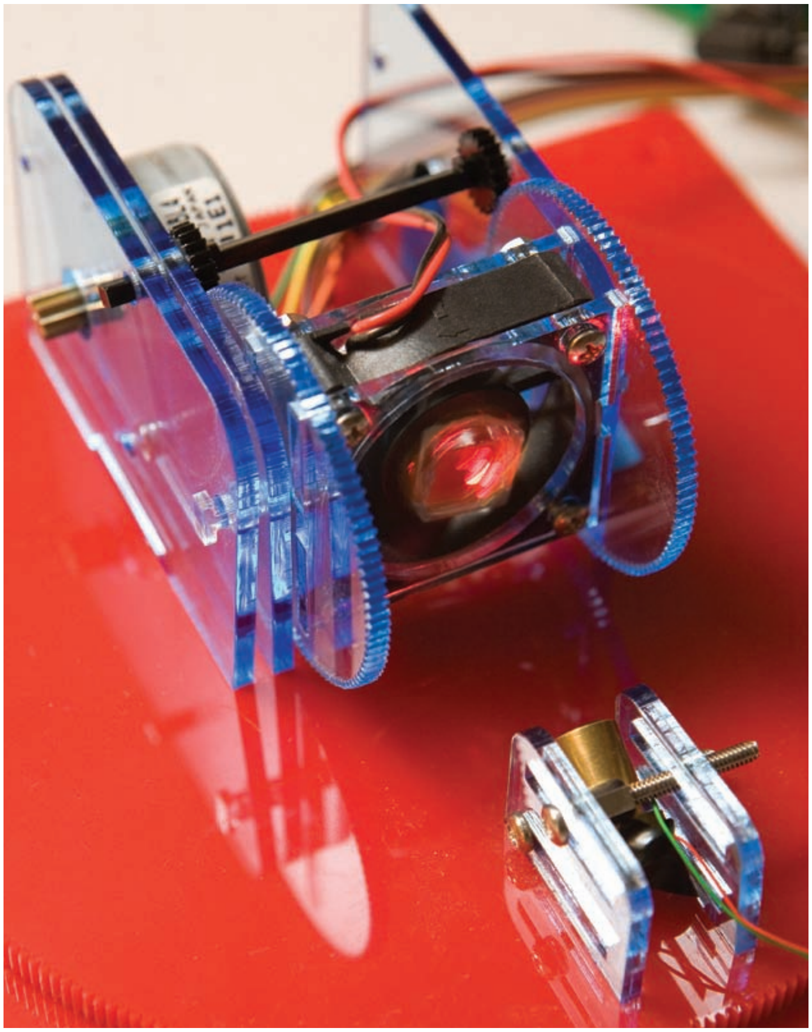
When Professor Norman Vrana (now emeritus) initiated the microprocessor design course, it was the nation's first available to undergraduates. Continuing in that forward-thinking tradition, both Professor Christopher Pottle (also emeritus) and Senior Lecturer Bruce Land (who now teaches the course) have continually morphed 476 to incorporate new technologies and address a variety of professional issues that will impact the students' work as engineers. The course now serves both undergraduate and graduate students. In class sessions, Land has added consideration of intellectual property, safety and reliability issues, and explicit discussion of engineering ethics. In the lab, students undertake a sequence of practical experiences designed to develop their skills and thought processes, culminating in a final project of their own design.

"Students come into this course with a lot of math background and a lot of circuitry and practical labs," says Land, "but they haven't had too much chance to apply everything at once. Over the first few exercises, we try to prepare them to think about

## ... and Then Some!

**The purpose of this course is to enable its students to carry out sophisticated design of the modern digital systems which now appear in products such as automobiles, appliances, and industrial tools. The basis of such systems is the microcontroller, a microcomputer optimized for single-chip system design by possessing many peripheral devices geared to real-time applications.**

***— from the Course Overview***



all aspects of a problem as they design it—to try to decompartmentalize their knowledge. Is it fast enough? Is it good enough? Is the math correct?" For many students, this is the first time they've had to deal with programming for real-time responses such as deadlines for audio wave, music, and television signals. It's also the first time most have had to specify devices and critically read manufacturers' often-cryptic, highly technical data sheets.

What are the toughest challenges for students coming into 476? "Dealing with ambiguity," says Land. "Many of our labs do not have a unique solution; there are lots of ways of getting to the result. We give them examples and guidelines, but they have to figure out a scheme they're comfortable with. For some, that's new territory."

### Independent Projects

The course culminates in independent team projects that begin with a $75 parts budget (provided through a generous alumni donation) and a dream. The ensuing six weeks generally involve long hours, frustration, creativity, dead ends, unanticipated research, teamwork, flexibility, time pressure, failures, laughter, problem solving, and changes in design or intended outcomes. Coolness is often a motivating factor, and both the pressure to succeed and natural exuberance fuel the process.

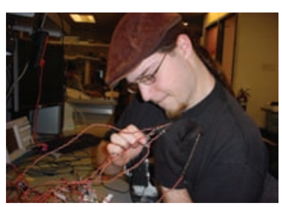
### Robust 476 Website

The course website provides students with assignments, schedules, policies, extensive reports on past final projects, and a wealth of information, resources, and advice. See what is available to students online at http://instruct1.cit.cornell.edu/courses/ee476/.

**PeanutBot, The Audio-Homing Robot**

**Team: Seth Spiel, Angela Israni, Hemanshu Chawda**

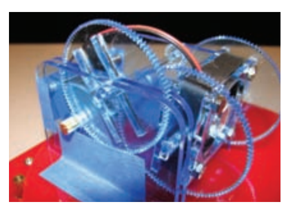
Working with Cornell's Adaptive Communications and Signal Processing Group, this team implemented a signal processing system that made PeanutBot, a small, triangular robot, move toward a sound when it "heard" it.



**Air Jam, Wearable Air Guitar**

**Team: Adam Beece, Yuan "Ryan" Ning**

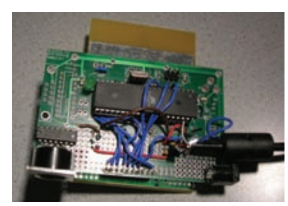
With a little practice, anyone can rock this synthetic acoustic guitar! The basic components are software, an accelerometer, and a glove with a flex sensor (variable resistor) sewn into each finger.



**Wall of Pong**

**Team: Adrian Wong, Bhavin Rokad**

This team developed a digitally controlled laser projection platform that can draw a pong ball onto any flat surface. Players use hand paddles with embedded sensors to play the fast-moving interactive game.



**Movement to Music: A Wearable Wireless Sensor System**

**Team: Andrew Godbehere, Nathan Ward**

With a fundamental belief that dance and music deserve a close relationship, Andrew and Nathan created a new musical instrument—a sensor network that allows a wearer to create sound based on his or her own motion.

**Norman Vrana** (left) initiated the microprocessor course. **Christopher Pottle** (right) continued to advance it, in a similarly forward-thinking approach.

Students develop projects that align with their own interests. Pop culture influences many. But make no mistake: projects like a laser-based pong game, a wearable air guitar, an audio-homing robot, and a wearable sensor network that generates music based on the user's dance motion may sound like play, but they demand thorough understanding and application of theory, relentless problem-solving, and smart engineering.

Almost every project provides some surprises. For Adrian Wong and his Wall of Pong team, the biggest was the discovery that the photo sensor they had designed and built just didn't work as they had expected it to. "The light reflection just seemed to be wandering around!" Wong says. So in week four, the team morphed their original project design (a laser tracking system built around fast eye movement) into the Wall of Pong—a fast-moving, interactive, laser-based pong game that could be projected and played on any flat surface. For Nathan Ward and Andrew Godbehere, there were plenty of challenges in designing their wireless dance-into-music sensor, but their biggest surprise turned out to be the number and range of applications for their invention. "It started out being completely music based, but toward the end, we actually used it like a Nintendo Wii—we could control a game. We also found we could run a PowerPoint presentation with gestures," says Godbehere.

For Hemanshu Chawda, there were no big surprises but plenty of challenges. "When I was learning equations and theory in classes, I had the naïve assumption that you would just apply them and things would be fantastic," he says. "But in real life, every piece of equipment has tolerances, and those introduce imperfections into our calculations." His team struggled with the microphones they were using to guide their robot. Some picked up interference; others were too insensitive. For Adam Beece and Ryan Ning, the challenges involved both programming and soldering. Beece soldered the circuit board—a completely new experience for him. Ning figured out how to synthesize the guitar sound using solely the microcontroller. "You can do it fairly easily on a PC with lots of memory," he says, "but with the microprocessor, we had to be really efficient."

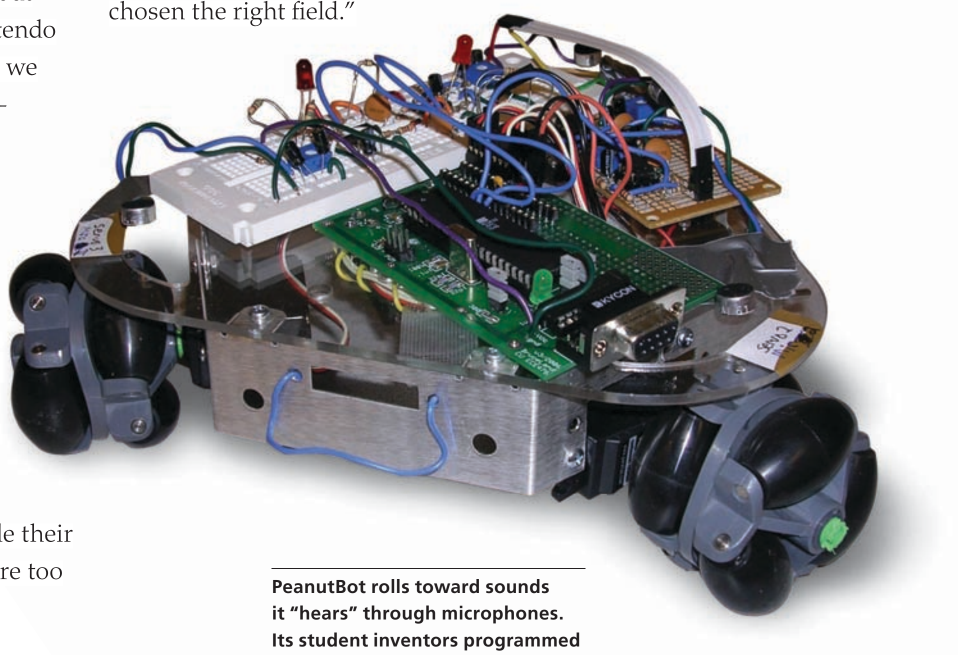
In the end, the students feel pride in their success. They have taken on real design projects that, like most real-world assignments, have time and resource constraints.

They have relearned and applied theory and math, mined new information, and learned how to troubleshoot and problem-solve using a variety of resources. They leave better equipped for graduate programs or jobs in the real world. Some even get recognition via the Internet, and each year, several student designs are published in national magazines. But, perhaps, best of all is what Adam Beece discovered about himself: "When I worked 40 hours a week in the lab—on top of all my other coursework—and didn't feel tired at the end, well, that was a real confirmation that I had chosen the right field."

## Bruce Land's Advice to Students

This is a design course. We expect you to show considerable creativity, flexibility, and motivation. We're trying to prepare you for the real world. So, in particular, you'll need to:

- Hit the web. Go to the library. Find your own answers to questions.
- Dig out your old textbooks and stack them on the corner of your desk. You'll need to use material you've had in other courses.
- Read and understand every aspect of manufacturers' data sheets for devices you may use.
- Find solutions on your own from incomplete specifications. The lab assignments become more open-ended as the semester progresses. Clever, efficient solutions will be rewarded.




**PeanutBot rolls toward sounds it "hears" through microphones. Its student inventors programmed its microprocessor to determine the number of degrees the robot must turn before moving toward the signal.**

# The Jacobs Fellowships: Attracting Top Graduate Students to Cornell

**"Just as Ezra Cornell's original endowment of Cornell University changed the form of American universities, Irwin and Joan Jacobs' endowment for graduate fellowships will have a profound impact on our future in ECE," says ECE Director Clif Pollock. "These fellowships will help us to attract the finest talent from around the world and then allow the recipients to explore research options thoughtfully during their first year, without the pressure to find financial support."**

Rajit Manohar, ECE Director of Graduate Studies adds, "Graduate fellowships are one of our key recruiting tools for top Ph.D. students. In the past, we could make only a limited number of Cornell fellowships available. Being able to award nine or ten Jacobs Fellowships gives us a tremendous advantage. Only a few other top echelon schools are in a position to make similar offers."

The Jacobs Fellowships for ECE graduate students and Jacobs Scholarships for undergraduate engineering students are funded through Irwin and Joan Jacobs' $30 million endowment gift to Cornell University's Far Above capital campaign.

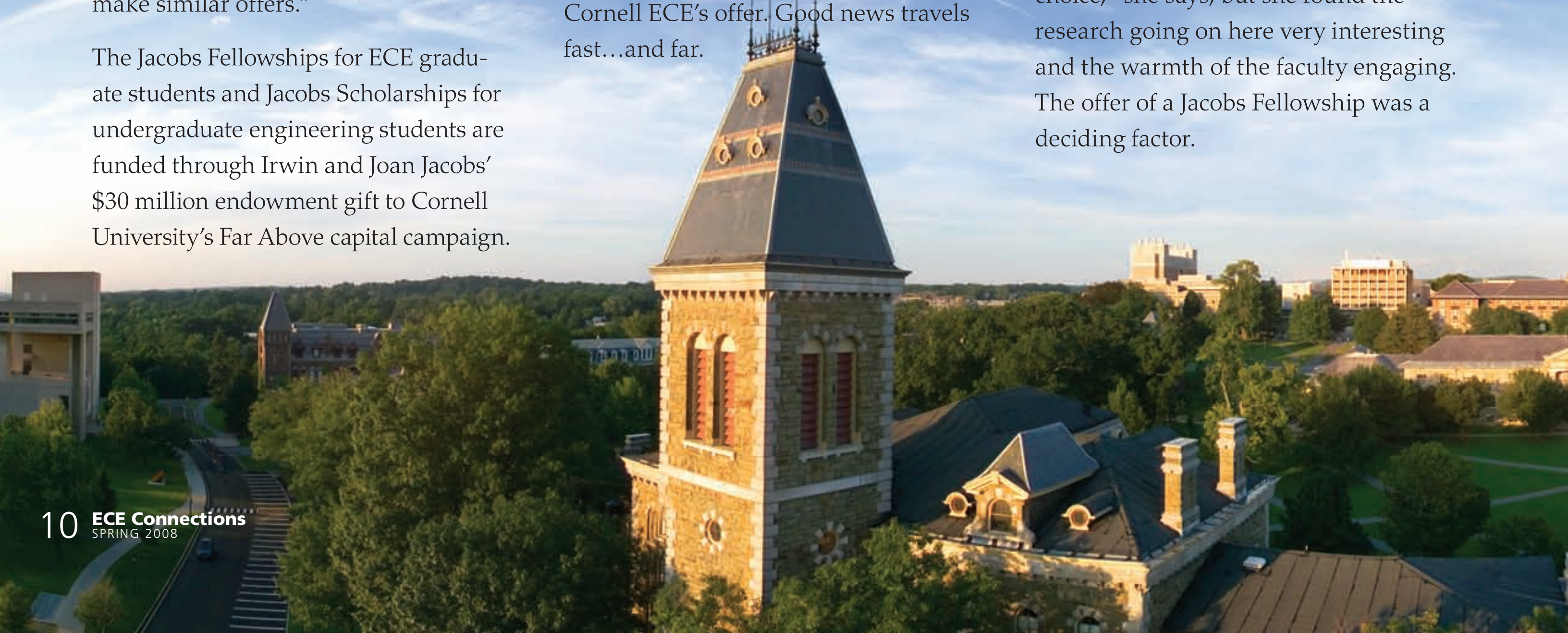
Dr. and Mrs. Jacobs, who met at Cornell and earned their bachelor's degrees here, have also endowed an ECE professorship, currently held by Lang Tong (see Page 12) and made other major gifts to the School of Human Ecology and Cornell University.

This is the first year of Jacobs Fellowship awards. The nine recipients have come from Nepal, Great Britain, Tunisia, China, Iran, and across the U.S.A. All had offers from other top ECE schools. Some arrived with a clear research direction in mind, while others valued having time to explore a range of ideas. All have now settled in with a faculty advisor and found a research direction.

Now, the second round of Jacobs Fellowships is being awarded. Manohar notes that he has already seen an impact on the quality of students who apply and accept Cornell ECE's offer. Good news travels fast…and far.

**Susmita Bhandari**
A native of Nepal, Susmita Bhandari earned her B.S. in Engineering from Trinity College (Hartford, Connecticut) in 2007. "I wasn't sure whether I wanted to do engineering, so I went to Trinity because it has good liberal arts and good engineering." By the time she graduated, she had become fascinated with microelectromechanical systems (MEMS), bio-MEMS and microfluidics. After arriving at Cornell, Bhandari quickly found her way to Professor Sunil Bhave's lab and is now working on inertial sensors.

Bhandari had offers—with funding—from Princeton, Yale, Brown and Stanford, as well as Cornell. "It was a tough choice," she says, but she found the research going on here very interesting and the warmth of the faculty engaging. The offer of a Jacobs Fellowship was a deciding factor.



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> *Rajit Manohar,*
> *ECE Director of Graduate Studies*

For Bhandari, the Jacobs connection has also had a personal impact. During her first semester, she was invited to a luncheon with Irwin and Joan Jacobs. "Learning about all the achievements of Dr. Jacobs and being a part of that legacy inspired me to feel like I should try to do good work and good things for others eventually. With any fellowship, you have to take the opportunity seriously; but Dr. Jacobs is such a good role model, it makes me want to try even harder."

**Benjamin Kelly**

Before coming to Cornell in 2006, Benjamin Kelly earned his bachelor's and master's degrees in Computer Science from the University of Nottingham in his native England. During his master's work on data compression, he became interested in Information Theory and decided to pursue further graduate studies. He was initially attracted to Cornell because of Toby Berger's work. As he began to explore further, he got a phone call from Aaron Wagner, who was about to join the ECE faculty. "We got along well, and one of the things I found in my master's work was how important it is to have a good advisor." He and Wagner immediately clicked and are enthusiastic about their work together.

For Kelly, the Jacobs Fellowship was awarded in his second year, at Wagner's recommendation. "It's made a significant difference to me this year, as it's allowed me to focus on my research." Like Bhandari, he feels a connection to Irwin Jacobs beyond the fellowship, in part because he is pursuing research in the same field. "I'm taking a class on digital communications at the moment, and the professor recommended we read Dr. Jacobs' book, "Principles of Communication Engineering". It's a great read and a great connection to Dr. Jacobs."

**Albert Wang**

At Harvard, Albert Wang majored in chemistry and physics, but some of his research in atmospheric research involved instrumentation…which involved electrical engineering…which seemed "like magic." He says, "I found that more interesting than the atmospheric research I was involved in," so after a two-year hiatus teaching English in Japan, he explored EE graduate programs.

The Jacobs Fellowship definitely influenced his decision to come to Cornell. "The biggest reason was that I didn't know what I wanted to study," Wang says. "Having flexibility in my first year meant I could wander around before choosing. I'm really glad I took that approach because now I'm studying something I'd never planned on."

"When I got to Cornell, I scrolled down the faculty list and talked to everybody that was doing something that interested me. I found Professor Molnar's work fascinating. We had lots of brainstorming sessions and then took an idea and ran with it. It's both research and a springboard to more learning. More magic."

Photo Credit: Robert Barker / University Photography

# Clif Pollock Talks with Lang Tong about Cornell ECE, Teaching, Communication, and the Future of Electrical Engineering

**Q: You've worked or studied at a number of fine universities. How would you characterize Cornell's School of Electrical and Computer Engineering? Are there things that distinguish us from other top schools?**

A: I think the academic environment here is extremely attractive. It's very stimulating intellectually, and faculty research is driven by curiosity, not by what's fashionable. Cornell is unique in not coupling faculty research with external funding, so we can focus on more fundamental research.

We have an extremely talented faculty, people who are at the top of their fields. The team here is very strong, and the quality of the department continues to rise. It's also an excellent environment for young faculty. They're nurtured here, and they have a real opportunity to shine.

The other thing that really distinguishes Cornell from other places is the degree to which our faculty care about students and teaching. They take the time to work with students; they're not rushing out the door to their start-up companies. That makes this a very unique place.

**Q: What do you enjoy about teaching?**

A: We have fantastic students, on par with the best in the world. They are the reasons I get up excited every morning and stay up late writing proposals.

Teaching forces me to think clearly, to appeal to students' logic and intuition. I like the challenge of finding the perfect explanation, a new angle to a difficult question. When I see students start to understand things, this is as close to a homerun as a non-sports person can feel! It gives me a real sense of balance in my life. I feel terrible if I don't teach well!

Teaching is very different from doing research. Most of the time in research, you're struggling, going in circles, not getting anywhere. You hope that out of all the paths you explore, you'll finally discover something that somebody else doesn't, so there are rare occasions of high. But in teaching, you have those every day.

**Q: You are known for pioneering several breakthroughs in signal processing techniques for communications. Do you think the field of communications will change in the future, or are we getting close to a new stable point? Is more big change coming?**

A: Before people could listen to voice in real time, the only thing they could do was write a letter. Real-time communication was an enormous step forward. Now we have cell phones, and we're no longer tied to the phone on the wall, but we still can't see the people we communicate with. The ultimate communication is face-to-face, but we're still not there yet.

Broadcasters used to rely on radios and TVs. Now those business pieces are transferred to Internet service providers, so we can do all those things on the Internet. Wireless and telephone providers won't let it stay that way; they'll make it possible for us to watch the news on our cell phones.

The problem in all this is that we're fundamentally limited by the availability of the wireless spectrum, and there is tremendous growth in wireless applications. We need to be creative and find new ways of using and sharing the spectrum. Historically, it's been licensed, and you are not allowed to transmit unless you own a license, even if the spectrum is not being used. This will require changes, but it also creates new challenges for communication theory, system design, and future devices.

**Q: What else excites you in Electrical Engineering?**

A: Energy is a really important area. I think what happened to communications will happen to energy, too. Not so long ago, AT&T owned the line, and we paid them for phone service. Now the ways we communicate have changed, mostly driven by technology. We no longer depend on a single service provider, and having choices further stimulates innovation.

I can see a similar scenario in the energy industry. Right now, power is generated centrally and a single provider delivers it to your home. In the future, there could be a lot more ways of generating energy, including many at a very local level, such as fuel cells. Rather than energy coming from a single place, we'll share and store it. That will require different distribution systems, controls, and security. ECE will be at the center of all these developments. It integrates sensing, control, adaptation, and devices that convert energy from different sources efficiently. I find that exciting! It may not be the right time yet, but it's inevitable that it will happen.

**Q: Would you recommend freshmen to go into EE?**

A: Absolutely. I think ECE will play a dominant role in this century, from devices that harvest and convert energy to networks that deliver and share energy resources. ECE is rooted in science and mathematics and applied to all kinds of practical situations. We are needed in many different fields. It's a fabulous discipline!

**LANG TONG**
**Irwin and Joan Jacobs Professor in Engineering**

**Lang Tong joined the Cornell faculty in 1998 and was named the Irwin and Joan Jacobs Professor in Engineering in 2006. "Irwin Jacobs played a major role in both theoretical and practical aspects of engineering. It's very humbling to me to have this connection to him and his wife."**

**Tong's research interests include statistical and signal processing, communication systems and wireless networks. His work on blind equalization—an approach to using the spectrum more efficiently—has been widely acclaimed. He is a fellow of IEEE and the winner of best-paper awards from the IEEE Signal Processing Society and the IEEE Communications Society.**

**Before joining Cornell, Tong served on the faculties of West Virginia University, University of Connecticut, and as a visiting professor at the Delft University of Technology. He earned his B.E. from Tsinghua University in Beijing and his Ph.D. from the University of Notre Dame. He conducted postdoctoral research at Stanford University's Information Systems Laboratory.**

"When I see students start to understand things, this is as close to a homerun as a non-sports person can feel!"

—Lang Tong

# Faculty AWARDS

**Our faculty continue to earn prestigious awards. This is a list of awards received in 2007 and through March of 2008.**

## Lifetime Achievement Award

**2008 Benjamin Franklin Medal in Electrical Engineering**

Awarded to James Thorp and his colleague Arun Phadke for pioneering contributions to the development and application of microprocessor controllers in electric power systems. Their work resulted in devices that protect components throughout the power grid and play a key role in diminishing the frequency and impact of blackouts. Over a span of 30 years, Thorp and Phadke revolutionized the field.

## Teaching Awards

**2008 Defense Advanced Research Projects Agency (DARPA) Young Faculty Awards**

Awards made to 39 faculty in 27 universities nationwide

Ehsan Afshari
Sunil Bhave
Farhan Rana

**2007 Ruth and Joel Spira Outstanding Teaching Award**

David Hammer

**John Swanson College Teaching Award**

Alyssa Apsel

**Kendall S. Carpenter Memorial Advising Award**

John Belina

## Research Awards

**National Science Foundation Faculty Early CAREER Awards**

G. Edward Suh
Sunil Bhave
Aaron Wagner
Alyssa Apsel

**2007 Fellow of Optical Society of America**

Michal Lipson

**Fellow of the Institute of Electrical and Electronics Engineers**

Zygmunt Haas

**2007 IEEE Cledo Brunetti Award**

Sandip Tiwari

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