Visual Computing:
Seeing the Future in New Ways

Meet Tsuhan Chen, new director of ECE
Far Above: Small or Large, Every Gift Matters

These days, the economy is top of mind for nearly everyone. Certainly it has an impact on Cornell University revenues, including those specifically designated for the School of Electrical and Computer Engineering. A great deal of thoughtful analysis and rigor have gone into determining how best to live within our reduced means, yet still honor our mission and values. We have made substantive cuts in many areas; offered retirement incentives; paused both construction and hiring, and tapped some reserves.

Even as we trim our budget, however, we are determined to honor our longstanding promise of need-blind admissions. Especially now, we must increase support for students whose families face greater financial hardship. If you benefited from financial assistance during your years at Cornell, you will surely remember how important it was.

Alumni gifts designated specifically for ECE influence what we are able to accomplish. They help support the fundamentals of the education we provide: top-notch students, faculty, and facilities. In this economic downturn, every gift and every dollar have added significance. They help to bridge the financial gaps. In particular, they help to provide critical financial assistance that allows us to compete for the most talented students and enable them to start their careers without crippling debt.

If you have made financial contributions to ECE in the past, please accept our thanks once again, and hear our plea to continue giving. If you have not yet made a gift to ECE, please consider making your first this year. Whatever the amount you feel able to give, please know that it matters and will be gratefully received.
I arrived in Ithaca in January—the coldest month of the year—and immediately experienced the legendary Cornell warmth. I felt not only welcomed, but embraced as a fellow Cornellian. Daily, I am re-impressed by how much our faculty, students, staff, and alumni care about one another and about the school. What a great privilege it is to become part of such a community.

In the first six months of my tenure as the new Director of the School of Electrical and Computer Engineering, I have been immersed in listening carefully. Based on what I have heard and learned, we have set the interrelated issues of enrollment and program enhancement as our immediate priorities.

Undergraduates — We need to attract more freshmen to ECE. To do that, we must help them discover that this field is at the heart of exciting and important work. Our initial strategies are to communicate directly with them and to develop some enticing new freshman courses.

M.Eng. — We seized the opportunity inherent in the economic downturn, extending the application deadline and offering some scholarship assistance. Result: 12 additional fine students were admitted after our usual cut-off date. We continue to strengthen the M.Eng. experience and professional preparation.

Ph.D. — Our goal is to graduate one Ph.D. per faculty member each year. It will take funding and concerted effort to reach this aggressive standard. Our first step is to restructure fellowships and teaching assistantships, making it easier for faculty to increase the number of Ph.D. candidates.

We won’t accomplish these goals in isolation. It is truly heartening to know how deeply you, our alumni, are invested in the school’s success. I look forward to sharing the adventure of our growth with you.

Tsuhan Chen, Director
Robert Thomas
Throughout his 36 years on the ECE faculty, Bob Thomas has focused on the evolution of electric energy systems. His work has ranged from highly technical issues such as transient stability and voltage stability that have caused blackouts, to human behavior and the economics of energy, to wind energy systems, to public policy.

“Over the years, I’ve seen a lot of changes,” he says. “The current ones probably are the most profound. The next frontier is smart-grid technology that will involve consumers in making more decisions about their electric energy.” What will that mean? “At the most basic level, the smart-grid will provide real-time information that will allow them to make choices about the amount, quality, and price of the electricity they’re buying. It’s a completely different paradigm. The economic and policy challenges are at least as hard as the technical ones.”

Thomas first got interested in energy at about the time he was finishing his M.S. at Wayne State University. Then, engineers were headed in droves to the aerospace industry, and he was all set to accept a job at Hughes Aircraft. But his mentor took him aside and encouraged him to pursue a Ph.D., and consider a career in research and teaching. He also talked to him about energy. “I found the energy problems fascinating because they’re large scale, difficult, and complex. It’s a big industry—$400 billion a year in the U.S. alone. So if you make a one percent change in efficiency, it can save a lot of money.” Thomas was also drawn to working in a field that had a direct benefit to humanity.

Teaching appealed greatly to him, too, and has remained thoroughly rewarding. “It’s always fascinating to see the lightbulb go off,” Thomas says. “Cornell attracts some of the brightest students and faculty in the world. To work with them, to see their enthusiasm and their desire to make a difference—it’s made all the difference.”

In July, Bob Thomas will transition to Professor Emeritus. He embraces the next phase of his life with curiosity, openness to change, and—of course—energy.

C. Richard Johnson, Jr.
In October, Rick Johnson was honored with the first Geoffrey S. M. Hedrick Senior Professorship. He is grateful, but a bit surprised. “People who stick with one area of research and get really good at it typically are the ones who win medals and endowed chairs,” he says. Johnson has made several significant changes in his area of work, largely in response to shifting students’ interests. Recently, he decided to pursue his own fascination with art history that began when he was a graduate student at Stanford.

Johnson started out in adaptive feedback systems, then moved into blind equalization algorithms. For years, he worked back and forth between applications in control systems and those in communications, largely on the mathematical side of digital signal processing. Now he is applying technology to the thread counts and thread angles of the canvases that underlie paintings, developing sophisticated forensic art tools now being adopted by some museum conservators. “The thoroughness of the computerized information is compelling for them. With the information we’ve gotten so far, we’ve been able to place several VanGogh paintings next to each other on a roll of canvas. Some had previously been misdated and had their authenticity questioned.”

Johnson’s fundamental approach is to learn about the problems that challenge art experts and can be solved with technology. He offers a tool as an entry to learn more. “If you can walk in and say, ‘Here’s something you can use now on a problem you care about,’ they’re going to tell you about all kinds of things they’re interested in. I’m trying to make the leap seem as natural as working on airplanes or computer chips.” Johnson also inspires and cajoles colleagues from varied disciplines to come together and explore these fascinating cross-disciplinary challenges. In 2007, he conceived and chaired the First International Workshop on Image Processing for Artist Identification.

As fascinating as the work itself is, what excites Johnson most is “showing students they can go into areas where nobody thinks they belong, and succeed.” Indeed. He has, and surely some of them will.
Tina Chen is just 14 years into her career. Jim Ottobre retired 20 years ago. Both value their Cornell education. Both make regular unrestricted gifts to the Cornell School of Electrical and Computer Engineering.

Chen’s first engineering job came about as a result of her co-op at Bell Northern, which became Nortel. She joined the company when she graduated and worked for them in North Carolina, China, and Texas, largely in system testing for network switches. Along the way, she met and married Joe Chen and earned an M.B.A. In 2000, she joined Cisco Systems and the couple moved to California.

After the Chens’ first daughter came along in 2003, they wanted to be closer to family. So they moved back to North Carolina, where she continues to work for Cisco. “My work is still 90 percent hard core engineering,” she says. Her current position involves solution testing of security features for networks. Because of Cisco’s family-and-community friendly culture, Chen can work flexible hours and spend time with her husband and their daughters, now ages 3 and 5.

Jim Ottobre earned his degree in two stints—before and after his WWII military service. He started out in mechanical engineering, but after working with electronics in the U.S. Navy Airforce, he came back to earn his degree in electrical engineering.

“After graduation, I went to work as a design engineer for a small engineering company involved in defense electronics—Stavid Engineering—run by another Cornellian.” The firm grew rapidly, and in 1959 was acquired by Lockheed Aircraft and became Lockheed Electronics Company. Ottobre moved from design into program management.

But a smaller company felt like a better fit for him. So in 1966, he left Lockheed and eventually started and became CEO of Octo Limited. This was at the time when the computer industry boom began. Their specialty: distribution management systems for periodical publications and not-for-profit organizations. In 1989, Octo was sold and Ottobre retired. Now he’s enjoying life in New Jersey with his wife Toni (Antoinette Hallinan Ottobre, ’49 HE), three children (two of them Cornell graduates), and their families. This year, the Ottobres returned for their 60th reunion.

What do Ottobre and Chen remember most about Cornell? “Technically, it was very good,” says Ottobre, “and there were close relationships between teachers and students.” He and his advisor stayed in touch for many years, and he’s still in contact with some classmates.

Tina Chen says her Cornell ECE education “prepared me to stay on top of things, take risks, and try out different solutions. It was very tough, but we had some fun, too.” She, too, cherishes Cornell friendships.

The Ottobres make a point of designating their Annual Fund gifts to the areas that had a particular impact on their lives. Along with ECE, Human Ecology, the Cornell Catholic community, and Cornell Plantations are also included in their annual gift.

As for her donations to ECE, Chen says, “As a student, I received some grants. I knew somebody else gave so that I could be there, and I wanted to do the same for others.”

Now, students in ECE are benefitting from a superb Cornell experience, thanks in part to Chen and Ottobre—and others like them—who believe in giving back.
Sign language conversations take place in real time over cell phones. Tiny, early-stage lung cancers are accurately detected and characterized. Driver-less cars “see” what’s on the road and safely transport people from one place to another. Centuries-old paintings are dated and authenticated by determining their place on the artist’s role of canvas. Invisible viruses are “seen”—in 3-D.

What do these next-generation developments have in common? Three things: 1) All use visual computing. 2) All are being developed at Cornell. 3) All intersect with other disciplines—some quite far from engineering.

Visual computing is an area of research that involves analyzing, processing, and synthesizing visual data. This rapidly expanding field is generating a host of promising solutions and opportunities. Says Tsuhan Chen, “Over the years, we’ve used a number of terms to describe some related engineering activities—image processing, visual communications, pattern recognition, computer vision, computer graphics and visualization, medical imaging, machine learning, and others,” says Chen. “I think they all come under the same umbrella. When we connect, we all gain.” Faculty at Cornell and other institutions around the world are connecting and rapidly advancing visual computing.

Chen’s own research focuses on visual computing techniques for multimedia applications. In his work, “multimedia” refers to more than a simple combination of text, audio, images, graphics and video. “The interaction among these media and their interaction with humans are what really make our multimedia research exciting,” he says.
Visual Conversations via Cell Phones

One of ECE Professor Sheila Hemami’s primary research objectives is to enable high quality, reliable visual communication—still, video, and interactive images—for all users, regardless of their technology platforms. For the past four years, she has focused on making it possible for the deaf to communicate by cell phone.

Hemami and colleagues at the University of Washington are integrating several streams of research to answer three fundamental questions. What is most important for users of American Sign Language (ASL) to see? What visual information does the brain need in order to recognize natural images of objects and scenes? How can essential ASL information be transmitted with utmost efficiency?

What must signers see? “Signing involves both gestures and facial expression,” says Hemami. “Since expression can change the meaning of a gesture, it’s important to transmit facial images clearly.” In the structure of ASL, the speaker makes a gesture, holds it, then makes the next. Hemami is factoring some results from linguistic research into her work. “We can eliminate movements that do not contain any linguistic information, but it’s not as simple as just deleting some frames. We’re using intelligibility metrics to guide us.”

How does the brain process images? “We’re trying to understand what it is about an image of a tomato, for instance, that allows the brain to recognize it as a tomato.” She and her colleagues have developed algorithms that eliminate some complexity from images without losing visual quality. With the strides she’s made in this, Hemami has laid the groundwork for further advances in the understanding of cognition.

How can transmission be made most efficient? The answers to the first two questions are integral to the third. By determining which visual information is most critical for users and how the brain processes images, Hemami and her colleagues can reduce the amount of data transmitted and eliminate the power-consuming compression/decompression process. They are also implementing other systems that vary power use depending on whether a user is signing or watching.
Detecting and Measuring Tiny Tumors

“Lung cancer results in more deaths in the United States than any other cancer,” ECE Professor Tony Reeves writes in the 2008 edition of Connecting with Cornell. “It accounts for more deaths than breast, cervix, colon, and prostate cancer combined. Because lung cancer has no symptoms in its early stages, more than 85 percent of…[those] diagnosed with lung cancer today are diagnosed … after symptoms occur and when there is very little chance of cure.”

How, then, to tackle the challenges of early detection? In a collaboration between Cornell University’s Vision and Image Analysis (VIA) group and the Early Lung Cancer Action Program (ELCAP) at Weill Cornell Medical College, Reeves is working on technologies that identify tiny, very treatable tumors.

The primary tool for detecting lung tumors is the CT scan. In CT images, abnormal lung growths show up as pulmonary nodules—dense patches of tissue that are frequently situated near other dense structures. Since each scan may contain more than 200 images, the radiologist’s task of searching through all these to identify tiny abnormalities is demanding, tedious, and time-consuming. The next challenge is to determine whether these abnormalities are actually cancerous. “Not all nodules are cancer and the smaller the nodule, the greater the probability that it is benign,” says Reeves.

The VIA group developed algorithms for both tasks. One processes all of the images and identifies pulmonary nodules. If these are of intermediate or large size, physicians may use needle biopsies or PET scans to determine whether they are malignant. For smaller nodules, the best predictor of malignancy is a high growth rate, detected via repeat scans. So the team developed volumetric sizing algorithms that measure the total volume of the nodule—a method far more accurate than two-dimensional measurements—and allow them to assess growth.

Reeves is finding other uses for these technological advances. Not surprisingly, there are direct applications in veterinary medicine. Farther afield, Reeves and Susan Ashdown in the College of Human Ecology are applying 3-D image analysis methods to fit garments to bodies.

Driverless Car Safety: Predicting What Happens Next

Dan Huttenlocher, recently named Dean of the Faculty of Computing and Information Science (CIS), is particularly interested in the intersection of engineering and psychology.

Huttenlocher and Mechanical and Aerospace Engineering Professor Mark Campbell, who advised the DARPA Urban Challenge team, continue to explore a number of issues that grew out of that autonomous vehicle project. Huttenlocher sees important civilian as well as military applications. “With our aging population, especially seniors without access to public transportation, driverless cars could give them a safe way to get around and maintain their independence.”
It’s a great idea, but there are challenges. One of the biggest is to create “vision” systems that can predict actions in a dynamic environment. “The ability to anticipate is very important to safety and systems that can get you home safely,” says Huttenlocher. “For instance, a fire plug and a toddler are approximately the same size and shape, but only one is likely to run into the road.” A car can be equipped with multiple sensors—RADAR (Radio Detection and Ranging) and LIDAR (Light Detection and Ranging) systems, and cameras—that provide a great volume of data. “We try to analyze all of that using a combination of modeling and algorithms, and then validate our work using human driving data.” The problem of predictive visual systems still requires more work.

Meanwhile, Huttenlocher is also exploring another research thread that combines visual computing and psychology: mapping the world’s photos. “What’s so powerful about today’s search engines is that they measure social data. They don’t just analyze text; they analyze what people are saying about the text. But there are no organizing principles for big photo collections. So we decided to look at spatial concurrence of photos as a way of looking at the social aspect of photo-taking.” By using computer vision to analyze image content, Huttenlocher and his team can produce maps showing the landmarks that people have “voted” most popular simply by photographing them. Huttenlocher sees a host of potential commercial applications including online travel guides and visual search engines.

And So Much More

Rick Johnson (see Faculty Highlights, page 2 and the Cornell Engineering cover story, Spring 2008) applies his expertise in signal processing to help museum curators and art historians in The Netherlands and elsewhere date and authenticate paintings. His current work analyzing thread patterns is making it possible to determine the sequence of canvases cut from a roll, and hence place paintings in historical order.

Ramin Zabih, Professor of Computer Science and Radiology, is investigating how several state-of-the-art advances in energy minimization algorithms can be applied to pixel-labeling in computer images. One of the major challenges is to maintain accuracy while benefiting from efficiency gains. Among the applications: modeling textures, segmenting interactive photos, and automatically placing seams in digital photomontages.

Professor Peter Doerschuk applies computational nonlinear stochastic systems to biological and medical systems. Among his projects are development of algorithms and parallel software that use electron microscopy images and x-ray scattering data to help researchers “see” the three-dimensional shape of viruses—an important step toward understanding how they attach to hosts, and ultimately preventing them from doing so.

Within ECE, across campus, and around the world, an eclectic array of visual computing research is changing ideas and lives. What’s next?
**Fuchs:** You and I are both EEs who took positions at Cornell without ever having spent time on campus before our interviews. And yet we are very much at home in this great institution, working on some truly exciting challenges.

**Chen:** You’re right. As happy and comfortable as I had been at Carnegie Mellon and other universities, Cornell is unlike any other place I’ve been. There’s a strong sense of community here—it’s unusually welcoming, and I felt at home right away.

**Fuchs:** Partly based on my own experience, I’m convinced there’s a real advantage to coming into an institution with a completely fresh perspective. In ECE’s case, it had been 40 years since we’d had an outsider come in as head of the school. So when Clif Pollock finished his term, it felt like the right time to do an external search.

**Chen:** Being the new guy does give me the right to ask all kinds of questions—for just a little while—and I’ve taken full advantage of that. Many people who have been here awhile seem open to rethinking what we do and how we do it. I often find that they either see new possibilities themselves or they are ready to explore ideas that others pose.

The other abilities we were looking for don’t show up on resumes. We were looking for certain personality traits—largely leadership traits—that would be a good match for ECE and Cornell. We knew whoever we hired would be coming into a department of very smart, very accomplished individuals. A lot of them have strong voices and opinions—exactly what you need to be a top-notch school. But working with such a group requires a lot of energy and tact, as well as genuine kindness and respect for a very diverse cross-section of people.

We have an excellent School of ECE—well within the top ten in the U.S., by virtually all measures. But, no institution can rest on its laurels, or more aggressive schools will run right past it. So we needed someone with both the vision and ability to take ECE to new heights.

That’s what we all agreed we saw in you.

**Chen:** Thank you. I’m deeply honored. I’m keenly aware of the big responsibility you’ve placed in my hands. It would be overwhelming if I had to accomplish it by myself. Fortunately, I don’t. I’ve stepped into a remarkable group of people who are determined to move the school forward.
After serving as the Joseph Silbert Dean of the College of Engineering, Kent Fuchs became Cornell University’s 15th provost. Before joining Cornell in 2002, he had been head of the School of Electrical and Computer Engineering and a Distinguished Professor at Purdue University since 1996. Previously, he was at the University of Illinois in the Department of Electrical and Computer Engineering. An electrical engineer, Fuchs’ research interests are in developing robust and fault tolerant systems.

Enhancing a school that’s already this good can happen only if we share a vision and shoulder the work together. My job, as I see it, is to add some fresh ideas for consideration, and to keep the ECE community energized and focused as we move forward together.

Fuchs: You’ve gotten off to a superb start. I know you have developed some immediate priorities and are taking action, even while you’re still getting to know the place.

Chen: Our immediate priorities are to increase enrollments and to continue enhancing our degree programs. We’ve taken some steps on both of these, and they’re already beginning to pay off. I’m also excited about our efforts to further enhance opportunities for our faculty to collaborate with industry. We initiated a series of meetings and workshops. The first one, which was initiated by Professor Ehsan Afshari, was with Agilent, and our alumnus Roger Stancliff led a delegation who came and heard faculty presentations.

At the heart of what I think we must do across all of our efforts is reinvigorate our communication about the field of electrical and computer engineering—and our school. We need to tell our story better… and louder! There has never been a more exciting time to be in ECE. What we do has profound influence on some of the world’s most important issues: energy, nanotechnology, biotechnology, information, communications, and the environment. ECE is at the very center of these fields and many others. We’re helping to find solutions to some of the world’s biggest, most pressing problems. People think that engineering is somehow separate from human needs. Nothing could be further from the truth! So we have to get the word out—to our students and to the world—that ECE is hot! And that at Cornell, we’re at the epicenter of hotness! What we need to do is recruit people to help spread the word.

Fuchs: I couldn’t agree more. With the large number of ECE alumni, you have a great built-in power base for your campaign. You’ve already been on the road. What kind of relationship are you hoping to establish with alumni? How do you plan to help them, and how do you want them to help ECE?

Chen: You’ve hit on a great resource for our campaign, and I am asking for their help in spreading the word about ECE.

Although I’d heard about Cornell alumni before I got here, I’ve been blown away by their talent, warmth, and enthusiasm. In March, I made my first trip as ECE Director to the Alumni Association Conference in California. It was one of the most heartwarming and exciting events I’ve ever experienced anywhere. These people love Cornell—love it!—and their passion is truly contagious! Cornell alumni are truly remarkable, as individuals and as a group.

It’s my hope that we can greatly expand our cadre of actively engaged ECE alumni. At various times in their lives, they may need our help with their careers. Or they may benefit from access to the new technologies our faculty generate. They can help us in lots of ways: by keeping real-world perspectives in front of us, hiring our students, funding our initiatives, and serving as ambassadors and champions for Cornell ECE. And since they’re Cornellians, I expect they have some ideas I haven’t thought of. I’m ready to listen.
ECE faculty are regularly recognized for excellence in teaching and research. These are the most recent award recipients.

**Teaching Awards**

*Cornell University, College of Engineering*

2008 James and Mary Tien Excellence in Teaching Awards
- Sunil Bhave
- Bruce Land
- Richard Shealy

*Cornell University, School of Electrical and Computer Engineering*

Ruth and Joel Spira Outstanding Teaching Award
- Wesley Swartz 2008
- Rajit Manohar 2009

**Advising Award**

*Cornell University Kendall S. Carpenter Memorial Advising Award*
- David F. Delchamps

**Research Awards**

2009 IEEE Signal Processing Society Distinguished Lecturer
- Lang Tong

Air Force Office of Scientific Research (AFOSR) 2008 Young Investigator Program (YIP) Award
- G. Edward Suh (pictured teaching at left), for study of a heterogeneous multicore platform through diversity and redundancy for enhancing the security of future systems

125th International Ionospheric Effects Symposium First Prize Paper
- Paul Kintner, for “Simulating Ionosphere-Induced Scintillation for Testing GPS Receiver Phase Tracking Loops”

Cornell University Provost Award for Distinguished Scholarship
- Michal Lipson, for her research in the field of silicon photonics, which develops technology for manipulating light signals on a microelectronics chip for future low power consumption