ECE x BIO = NEW FRONTIERS
IN DATA, DIAGNOSIS, DRUGS...
AND OTHER LIFE-CHANGING MATTERS
Legendary figures and rising stars – changing of the faculty guard

Chances are, during your years at Cornell, one or more faculty had an influence on you—perhaps even a profound, life-changing impact.

The School of Electrical and Computer Engineering has long had titans in its faculty ranks. Professors Harris Ryan, Vladimir Karapetoff, Henry Booker, and William Gordon are legendary figures at Cornell and around the world. Today, senior faculty are shaping the future. Rising young stars on our junior faculty, like those featured in this issue and others, continue our heritage of breakthrough engineering and excellent teaching.

Within the next decade, fully one third of Cornell University faculty will retire. The College of Engineering will lose 65 to 70 professors. Our situation is not unique; nationwide, an entire generation of senior faculty will retire within this time frame. Competition for top new recruits grows stronger every year.

Tsuhan Chen, Director of ECE, sees this evolution as a critical challenge and opportunity. “Electrical and computer engineers are at the very epicenter of solving society’s crucial issues,” he says. “To build on Cornell’s foundation as an intellectual powerhouse, we need to compete favorably for the next generation of outstanding faculty.”

Cornell’s $100 million Faculty Renewal Fund challenges alumni and friends to make gifts that will enable us to achieve goals like Chen’s. The College of Engineering target is 15 gifts of $500,000 each ($100,000 per year for five years) to support faculty hiring and development. The university will match each gift 100 percent. The School of Electrical and Computer Engineering stands to benefit from this Faculty Renewal Fund.

Whether you are able to make a large gift or a small one, we need your support for our students, faculty, and facilities. Every gift matters. Every giver matters. Individually or collectively you are instrumental in making Cornell ECE a strong, vibrant school that produces fine engineers and essential knowledge. For information on how to make your gift, please visit www.ece.cornell.edu/support.cfm.

For up-to-the-minute information, look for Cornell ECE at:
www.twitter.com/CornellECE or www.facebook.com/CornellECE
Over the past year and a half, I’ve reported to you on initiatives to enhance our academic programs and increase our enrollment. Our initial strategies were to increase the number of undergraduates in ECE, strengthen our Master of Engineering curriculum, expand our already robust Ph.D. research base, and promote our programs more widely.

I’m happy to report on the success of our efforts: our programs are stronger, and our enrollment is growing steadily. We have consolidated teams in Bioelectrical Engineering (see page 6) that we intend to grow into national research centers. Three new freshman courses have healthy enrollment, our now-annual ECE Day generates delight and attention, and our external marketing efforts are paying off. We are also changing the way we talk about ECE, focusing on our societal impact on energy, data, and human life. And we are now on Facebook and Twitter.

So what’s next? We will continue our current initiatives and have added another: to deepen our sense of community within ECE. This effort builds upon the warm, personal welcome that our newest faculty members and incoming students have found so inviting. Strengthening our culture will further enhance our attractiveness to top faculty and student candidates, foster more idea-sharing and collaboration among our researchers, and help our students develop important social skills.

In this regard, we have already undertaken two specific activities. The first is the renovation of our Phillips Hall lounge, made possible with a generous gift from David Duffield ’62, BEE ’63, MBA ’64. (See page 4.) This space now provides us with a high quality place for meetings, a lounge designed especially to encourage conversation, and a well designed kitchen. This beautiful space has already become a hub of activity.

The second effort is to engage students through two new student-founded, student-run organizations: the Graduate Organization (GO) for Ph.D. students and the Master of Engineering Organization (MEngO) for M.Eng. students. GO sponsors a weekly coffee hour and MEngO hosts regular pizza parties; both also sponsor other events. HKN and the Cornell IEEE chapter continue to serve undergraduates’ needs.

As we move forward, I remain deeply grateful for the thoughtful insights, encouragement, and support our alumni provide. Many thanks for sharing your knowledge, recruiting our graduates, and providing the funds to help us achieve the critical goals to advance Cornell ECE.

Tsuhan Chen, Director
Recent Retirement

62 years at Cornell – 54 of them as a member of the ECE faculty. 125 graduate students under his direct supervision. 75 post docs. 111 trips to Europe. The numbers alone speak to a remarkable career of a remarkable man: Lester Eastman, now the Given Foundation Professor of Engineering Emeritus.

Eastman earned all of his degrees at Cornell. Since 1964, he has conducted pioneering research on compound semiconductor materials and devices for microwave and semiconductor laser applications. The influence he has had in his field, both through his own research and through the work of his graduate students, is profound. He has provided leadership on a large scale and has organized countless professional conferences and workshops worldwide and at Cornell to disseminate information and inspire new directions.

In addition to his teaching and research responsibilities, Eastman “kept contact with the real world,” contributing insight, understanding needs, and building lasting relationships. He served on the U.S. Department of Defense Advisory Group on Electron Devices and the Senior Advisory Board of the Fraunhofer Institute of Applied Physics in Germany. After helping to found an NSF-funded project now known as the Cornell Nanoscale Facility, he helped Sweden establish its $90 million nanoscale facility, and assisted Germany in founding theirs. Says Eastman, “I took it as my duty to help others get rolling.”

The list of prestigious national and international awards and honors Eastman has earned is very long. Many are from IEEE and its affiliated organizations: He is a Fellow of IEEE, winner of the society’s Graduate Teaching Award and Third Millennium Medal, the Electron Devices Society J. J. Ebers Award, and the Microwave Theory and Technique Society’s Distinguished Educator Award. Among other awards Eastman has earned are the Fellow of the American Physical Society, the Wisdom Award of Honor, Walker Medal, Annual Award of the International Symposium on Gallium Arsenide and Related Compounds, Alexander von Humboldt Senior Fellowship, and the Aldert van der Ziel Award.

Asked which of his many accomplishments are most meaningful to him, Eastman points first to his students. “Cornell is extremely good at attracting high caliber graduate students,” he says. “It is satisfying to inspire them to do something useful – to generate greater efficiency, more power – that’s what engineering is all about.” He cites countless former students who have gone on to great achievements, among them Donald MacLean Kerr, Jr., formerly director of Los Alamos National Laboratory and now Principal Deputy Director of National Intelligence, David Welch, co-founder of Infinera, Inc., and 27 professors in the U.S. and abroad. Not surprisingly, his most recent students continue to win awards. Last year, for example, Junxia Shi earned the prestigious Chinese Government Award for Outstanding Ph.D. Students Abroad and the De Kármán Fellowship for exceptional scholarship.

Lester Eastman
Device and Fabrication

As the world’s technologies continue to grow and change, the influence of Lester Eastman will be felt for generations to come.
AWARDS

Our ECE faculty members continue to earn prestigious awards. This list includes those received in 2010 and through May 2011.

Teaching Awards
Cornell Engineering Alumni Association’s (CEAA) Academic Achievement Award in the College of Engineering
Bruce Land
Cornell University, College of Engineering 2011 James and Mary Tien Excellence in Teaching Awards
Ehsan Afshari
Alyosha Molnar
Farhan Rana
Ruth and Joel Spira Outstanding Teacher Award
Alyosha Molnar, 2010
Bruce Land, 2011
2011 Tau Beta Pi Professor of the Year in the College of Engineering
José Martínez
2010 IEEE Teaching Award
Bruce Land

Graduate Student Awards
Director's Ph.D. Thesis Research Award
Omeed Momeni (Advisor Ehsan Afshari)
Director's Ph.D. Teaching Assistant Award
Alireza Vahid (Advisor Salman Avestimehr)

Research Awards
2010 MacArthur Fellow
Michal Lipson
2010 NY Academy of Sciences Blavatnik Award
Michal Lipson
DARPA Young Faculty Award (YFA)
Alyosha Molnar
US Air Force: Young Investigator Program Award
Salman Avestimehr
Young Investigator Award by Defense Threat Reduction Agency (DTRA)
Ao (Kevin) Tang

Recognition
IEEE Fellows
David Albonesi
Stephen Wicker
United States Air Force Scientific Advisory Board Selection
Stephen Wicker
Tsuhan Chen has been named the David E. Burr Professor of Engineering
Sheila Hemami has been appointed as Associate Director in the School of Electrical Engineering. Professor Hemami oversees undergraduate programs, including curricular development, and managing the teaching and laboratory budgets.
Rajit Manohar has been appointed as Associate Dean in the College of Engineering. In this position Professor Manohar oversees and supports faculty research and the graduate programs in the College.
Charles Seyler has been appointed as Associate Dean in the College of Engineering. In this position Professor Seyler oversees and supports the undergraduate programs in the College.

Pictured Above
Top left, Cornell Engineering Alumni Association’s Awards Banquet, hosted by the College of Engineering on April 14, 2011. People listed from left to right - Dean Lance Collins, José Martínez, Kenneth Ferguson ’11 (Tau Beta Pi President), Bill Bruno ’69 (former CEAA Board President).
Top right, from left to right - Dean Lance Collins, Bruce Land, Bill Bruno ’69 (former CEAA Board President). Both photos by Robert Barker, University Photography
David Duffield

RIGHT PLACE, RIGHT TIME... ONE MORE TIME

C o-founder of fast-growing Workday (2005), phenomenally successful PeopleSoft (1987), ISI (1972), and a few other integrated systems ventures, Dave Duffield (’62, BSEE ’63, MBA ’64) has accomplished more than most of us can imagine. “Timing is really important, but so is considerable luck,” says Duffield when asked how he’s created such huge enterprises from scratch. “You have to be in the right place at the right time with – in my case – the right technology.”

Thoughtful and articulate, he nonetheless reveals the fire at his core. “You also have to have a great deal of enthusiasm for an idea and believe it will change the world in some way. You have to communicate its benefits and clearly demonstrate how it will make a change for the better. You have to have passion – the willingness to risk your entire life savings in pursuit of an idea – mortgage your home, empty your bank accounts.” He’s done exactly that several times, although not with Workday, where he’s the majority investor.

Right place, right time for giving

The notions of “right place, right time” apply to Duffield’s charitable donations, too. He gives money as passionately as he develops his enterprises. His most recent gift to Cornell has enabled the School of Electrical and Computer Engineering to create the right space to foster collaboration and a deeper sense of community – key strategies in achieving current ECE goals. (See Director’s Message, page 1.)

To say that the Phillips Hall Lounge has been renovated does not do the project justice. The old space has been transformed into a handsome integrated space incorporating a comfortable and inviting lounge, a meeting room outfitted with the latest technology, and a fully equipped and efficient kitchen. This is a place where faculty and student candidates get one of their first impressions of ECE, where researchers gather to discuss their interests, where presentations stimulate thought, where successes are celebrated, and where conversations flow steadily – a place, in short, where the ECE community gels.

The gifts Duffield has made to Cornell University over the past two decades all reflect his passion for his alma mater, for technology, and for the kind of collaboration that is at the heart of cutting-edge research and organizations today. In 1996, he honored his parents with a $20 million gift to help Cornell advance its technology leadership with a new state-of-the-art building and labs – Duffield Hall. He has since given in excess of $20 million in challenge grants toward both the building and an endowment to maintain Duffield Hall as a progressive and appealing facility.

For Duffield, the themes of collaboration and community resonate strongly. “We espouse the very same principles at Workday. Our employees often work across teams to solve challenges. And in our online ‘Workday Community,’ customers and Workday experts openly share tips, reports, relevant news, and innovative ways they use our products.”

Giving back

Although Duffield does not call himself a philanthropist, in 1997 he was recognized as a Foremost Benefactor of Cornell. What’s more, he and his wife Cheryl Reed Duffield have been listed on Businessweek’s “50 Most Generous Philanthropists” since 2002.

“I give back to causes that have impacted my life,” he says, “so I can impact others in the same way.” The Duffields have three giving priorities. First, they put extensive resources into Maddie’s Fund, a companion animal welfare fund named for a beloved miniature schnauzer who brightened their lives. Second, Duffield
gives back to Cornell University because his experience here meant so much to him. Third, he and his wife help to fund their local schools and public services.

Regarding his gifts to Cornell, Duffield says, “Cornell is truly a special place. The engineering school obviously enlightened my life, but beyond that, the whole Cornell experience was really defining for me. It was where I became independent from my parents, fell in love, joined a fraternity, played in a rock band, played on the baseball team, and cheered for two successive national hockey league championships. I also had passionate professors who helped inspire me – I especially remember Dick Conway and Bill Maxwell.”

Today, he hires Cornellians for Workday – interns, graduates, and alumni. Among them, quite certainly, are men and women whose lives have been enhanced by Duffield’s gifts to the university, which continue to have an impact in the right place, at the right time.

The New Phillips Hall Lounge

Top and Bottom, both images are of the new lounge. Lounge photos by Jason Koski, University Photography. Student Photos, ECE GO (Graduate Organization) team hosts weekly coffee hours in the Lounge. Graduate students, faculty and staff attend. Photos by Patricia Goneya, ECE.
Once upon a time – yesterday, for instance – electrical engineers made devices and biologists explored living systems. Today, a whole new deeply integrated field is emerging: bioelectrical engineering. At Cornell School of Electrical and Computer Engineering, a synergistic group of engineers and collaborators from medical and other life sciences is leading the field in high impact research. “In this new field, we are working on issues with great potential to change lives for the better and generating rapid growth in knowledge and technology,” says Edwin Kan.

One of the reasons this vibrant group produces such a wealth of productive discoveries is the fundamental difference between the two disciplines. As Xiling Shen explains, “Biologists are trained to ask questions: what does it do, why does it do it, what are the missing factors? They’re hypothesis driven. Engineers want to design very cool things, and to do that, we solve problems. We’re technology driven. The whole way of thinking is very different.” So when these two ways of thinking are brought together, the results can be... well, electrifying.

**Research that changes life...and lives**

The outcomes of bioelectrical engineering tend to fall into two broad but sometimes overlapping categories:

- Instrumentation and methods that have unique capabilities to provide far richer information about living systems than ever before, and
- Investigation and manipulation of biological systems themselves, leading to dramatic new treatment of diseases and changes to some of the building blocks of living organisms.

In the first category, for instance, are an imaging system based on the body’s nucleus magnetic moment, high-frequency scanners that can “see” tiny cavities, battery-fueled sensors that record multiple data streams on patients for long periods of time, microfluidic devices used to study asymmetric cell division, minute probes that assess blood viscosity, high-resolution imagers for the intercellular electrical and electrochemical signals, contact lens systems that measure pressure in the eye, and microsystems integrated with living tissue that can understand and even control the flight of moths.

In the second category are the manipulation of molecular structures and functions (including recombinant drugs that fight cancer), implant systems that monitor their human environment even as they remediate problems, smart synthesis of organic and inorganic materials, and nanoscale tools to deliver life-saving drugs.

**Growth 24/7**

The state of this relatively new field of bioelectrical engineering is dynamic. “One of the great things about our interdisciplinary research is that it reveals fundamental similarities across problems, and so spurs new interdisciplinary research in unexpected directions,” says Al Molnar. “There are these mental explosions that occur, so we shift to focus on the ideas with the greatest potential. One of the great things about research in a university setting (as opposed to industry) is that we can switch gears.”

The composition of the bioelectrical engineering group morphs somewhat regularly. Like a snowball rolling downhill, it gathers mass and speed as it goes. While a core of faculty and their graduate students focus primarily on this area, others incorporate some bioelectrical engineering elements into their portfolios.
One important communication challenge is huge gaps? communicators in ways that bridge those ties. How, then, can bioelectrical engineers of course, are multiple deep-niche specialties. Within each area, likewise, most biologists have little or no training in biology; this new field, very few electrical engineers have much, if any, training in biology; “What we’re seeing is normal behavior,” reports. “We’re not sure that what we’re seeing is normal behavior, but even if it isn’t, it’s still interesting that it’s happening at all.”

Challenges of a new interdisciplinary field

The deep integration of two fields results not only in complex new knowledge and research arenas, but also in big challenges in communication and education. How can bioelectrical engineers best explain their work to colleagues? Says Molnar, “All of us who have earned doctoral degrees have considerably more experience in one field than the other. We’ve all spent some time studying biology, but our bigger knowledge base is in engineering.” Outside of this new field, very few electrical engineers have much, if any, training in biology; likewise, most biologists have little or no engineering background. Within each area, of course, are multiple deep-niche specialties. How, then, can bioelectrical engineers communicate in ways that bridge those huge gaps?

One important communication challenge is figuring out how to write the most effective grant proposals for funding agencies. “If you present to a purely electrical engineering committee or a purely biology committee, neither has enough experience in both fields to understand what we’re doing,” says Shen.

The other big challenge in a blended field of this complexity is how to prepare the next generation of students to work in it. Most high school students today have no awareness of interdisciplinary opportunities. Even once they enter engineering school, they typically know little about electrical engineering until their junior or senior year. At Cornell, new freshman courses in ECE are helping to give students exposure to the field earlier on. But at the undergraduate level, there are not enough “spare” credit hours in an engineering degree program to undertake in-depth training in a second field. For those students who want to explore such possibilities, ECE faculty are working to help them identify the faculty and courses most relevant to them in a completely different field.

At the graduate level, the primary challenge is how to acquire the necessary background in both fields within a reasonable time frame. It’s a challenge that all of the bioelectrical engineering faculty members have faced and solved in their own ways – always with considerable investment of time. Both Molnar and Shen added several years of study in biology on top of their doctoral studies in electrical engineering. Kan realized early in his work on biological systems that “you cannot expect a student to become interdisciplinary while you yourself remain in your comfortable domain. Biology is not my strength; I have to lock myself in a long learning circle.” That work gives him a starting base for a much better collaboration. Now, ECE faculty and their biologist collaborators are working together to ensure that their Ph.D. students get the breadth and depth of knowledge they need.

Pushing the very edge of new

In the dynamic environment of ECE’s bioelectrical engineering labs, surprises are not uncommon. For instance, while Molnar and Psychology Department neuroscientist Thom Cleland with whom he is collaborating were working on instrumentation for simultaneously imaging and recording from brain tissue, they began to realize that “neural tissue in the brain tends to oscillate, but it’s not oscillating in the way we expected. Separate areas are oscillating separately,” he reports. “We’re not sure that what we’re seeing is normal behavior, but even if it isn’t, it’s still interesting that it’s happening at all.”

Their work has multiple threads. One is looking at the olfactory bulb to understand how sensory neurons analyze the data they receive and distinguish among odors. From his earlier work on the retina, Molnar thinks there are some parallels with how the olfactory bulb works, but also some differences. “We know the retina recodes information it gets into something more complicated – a bit like an image compression algorithm.” In both cases, Molnar’s group is using instrumentation to collect a monumental amount of data and then facing the challenges of turning it into meaningful information.

Ehsan Afshari is taking an “old” technology in a radical new direction. He is using high frequency radio
waves in imaging biological structures – some even at the molecular level. When a signal is transmitted, it hits the side of an object; sometimes it goes in, and sometimes it is deflected back. “If you increase the frequency of the signal, the wave length shrinks, the resolution is higher, and the penetration goes down” Afshari explains. “Each molecule has different resonances, so if you want to detect whether a particular molecule is present, you transmit the signal at the specific frequency that the molecule is known to absorb. If it is not absorbed, you know the molecule is not there.”

This discovery could lead to multiple applications. For instance, skin cancer could be detected in very early stages if a doctor were able to use a scanner with terahertz signals. Another application could be scanning teeth to detect tiny cavities. There may be applications for airport security scanners, as well. What is particularly exciting is that this technology can yield much more precise information at far lower cost, compared with imaging technology used today. “The crux of our work is that we haven’t used anything expensive or fancy,” says Afshari. “A very high proportion of the electronics is based on CMOS (complementary metal oxide semiconductor), basically a very cheap process. In five to ten years, every doctor might be able to walk around with a $100 hand-held scanning device.”

In one area of research, Edwin Kan and Rick Cerione, a molecular pharmacologist at Cornell College of Veterinary Medicine, are looking at ways to program positive or negative charges on silicon that will attract antigens to the surface and subsequently release them. Antigens are specialized portions of molecules that trigger the body’s immune system to produce specific antibodies. Antibodies recognize the antigen as a foreign and potentially harmful invader and act to kill or neutralize it. The ability to control antigens holds enormous potential to boost the body’s ability to fight cancer and other diseases.

“The biggest challenge,” says Kan, is how to get the resolution down to 1 to 2 nanometers. “We can make a nanotool today without a problem, but we have a long way to go to get to a controllable and addressable structure.” While he expects that challenge to take some time, some near-term benefits can have a positive impact. “If we can use a biological molecule adsorbed on the transistor surface to recognize an antigen or pathogen instead of a physical method, we can get a much better resolution than current optical technology provides.”

Like Kan, Xiling Shen is one of a new breed of electrical engineers who are on the forefront of fighting cancer. He and Steven M. Lipkin, a medical geneticist and internist at Cornell Weill Medical College, are looking at asymmetric cell division, and particularly at colon cancer stem cells. “Not long ago, people thought all cancer cells were equal in their ability to create tumors. There was little mechanistic study to determine what a cancer stem cell is. It turns out that stem cells spread far more easily and have a higher probability of causing tumors. But cancer stem cells grow very slowly and are very hard to kill. So when oncologists use chemotherapy drugs, the result may be that they are killing the progeny cells but not the stem cells. So in effect, the treatment may actually be selecting cancer stem cells to survive.”

Shen and Lipkin are pursuing three interrelated strands of research. The first is fabricating devices that mimic the condition of the body. “Cells don’t behave the same way in a petri dish as they do in the body,” he explains. Their work will enable scientists to study cells in an environment more like their native one. A second area of research is in mathematical modeling that enables them to understand how “giant hairballs” of interconnected genetic networks within a cell contribute to cellular behaviors. The third is to enhance more traditional biological experiments with electrical engineering tools and ways of thinking. This includes synthetic biology – engineering novel genetic circuits into organisms.

Impact through commercialization

In bioelectrical engineering, as in most fields, the amount of time from ideas to commercialization varies widely. Some areas require years of research before they
yield inventions that can be turned into viable products and businesses. Other projects – often those built on an already well developed electrical engineering platform – can move quickly to commercialization. Inventions with great potential to impact human life in particular are moved to fast track whenever possible and appropriate.

Richard Shealy is director of a grant titled “Innovative Technologies for Medical Instrumentation,” a collection of projects funded by Blue Highway, LLC. Blue Highway is an innovation incubator owned by Welch Allyn, a leading manufacturer of frontline medical diagnostic and healthcare products.

One of the projects is a magnetosensor, a collaboration between Sunil Bhave in ECE and R. Bruce van Dover in Materials Science. Such a sensor makes it possible to image the chest cavity using the magnetic fields produced by the heart and lungs. It offers several advantages over current electrocardiogram technology, including the ability to do fetal monitoring. Magnetosensors exist now, but they are extremely expensive because they use cryogenics. Bhave and Dover are working on developing one that operates at room temperature and can be produced at much lower cost.

Amit Lal is pursuing another challenge with the potential to deliver life-improving results. The problem: bioelectrical interfaces such as neural probes may work for days or weeks, but the interfaces tend to degrade over time. Along with Robert Gilmour at the College of Veterinary Medicine and Chris Schaffer in Biomedical Imaging, Lal is working to devise a highly instrumented neural probe that measures both mechanical and electrical signals to help identify failure mechanisms of the interfaces. In the process of discovering failure modes, the team hopes to discover ways to make neural interfaces reliable over 40 years of operation, so that lifelong implants maybe possible.

Other beneficial inventions may come from a project run by Alyssa Apsel and Rajit Manohar at Cornell ECE, along with Marie Karen Gagnon at University of California at Davis. They are working on developing a miniaturized sensor that might take the shape of a Band-Aid or a pill to be swallowed. Various types could be made to monitor blood glucose levels or heart rhythms. “The push here is to make this platform very low power so the devices will last a year,” says Shealy.

Yet another project with the potential to impact human life is Amit Lal’s silicon ultrasonic probes that can sample very small amounts of blood and measure the viscosity of these tiny samples. The patient can measure blood viscosity in addition to glucose levels, providing another useful variable to the doctor. By using the probes to monitor the patient viscosity, doctors should be better able to manage blood thinning drugs in patients with clotting problems. This project has moved along quickly, and one of Lal’s former doctoral students, Abhishek Ramkumar, is working to establish a new venture to commercialize the technology.

Challenges that inspire

“What I’ve discovered about myself and all engineers,” says Al Molnar, “once we’ve found a hard problem, it’s inspirational.” In bioelectrical engineering, all the problems seem to be hard – hence the high levels of energy and palpable excitement that characterize the group. The work itself is brain-bending, sometimes yielding the “wow” of a completely new insight or major breakthrough. The field’s great potential to dramatically impact human health and other aspects of life are equally inspirational. Certainly this is a field – and Cornell ECE is a place – that fairly shout, “WATCH!”
Women face a lot of pressure. In graduate school, on top of the general societal issues of what others believe we should look like and how we should act, we face additional issues related to being in a male-dominated environment. Unless people have strong connections with friends, their feelings about these get bottled up. That’s the reason we have this support framework – to help women communicate more with each other and prepare them to become professionals.

~ Nini Munoz, Ph.D. candidate

The support framework she references is a group called the Women of ECE. Associate Professor Michal Lipson was instrumental in its founding in 2003. “We wanted to create a culture of belonging and a venue for women to share experiences they have in common with female colleagues,” she says. The group focuses primarily on female graduate students in ECE, but seniors who plan to pursue graduate school are also encouraged to participate. Undergraduates often find common ground and resources through the Cornell chapter of the Society of Women Engineers.

Monthly luncheons
From the outset Lipson, along with professors Alyssa Apsel and Sheila Hemami, have provided strong support for the Women of ECE. These women faculty take turns hosting monthly luncheons. Sometimes, outside speakers are invited; at others, the meal provides an informal venue for open discussion. “It’s good to get perspective and to have female faculty there to give us insight,” says Munoz. “They have faced similar issues.”

Discussion focuses on a range of issues that are either unique to women or that incorporate uniquely female aspects. Balancing work and family; getting letters of recommendation, invitations to speak, summer internships, and jobs; negotiating a salary; dealing with gender biases and even subtle sexual harassment – all of these and more are on the table. Having open discussion helps women to feel less isolated and ultimately more confident as they gain perspective and skills.

IBM-sponsored grants
A gift from IBM provides funding for three types of small grants: ECE Women’s Conference Travel Grants, ECE Women’s Professional Development Grants, and ECE Women’s Technical Exposure Grants. Female graduate students may apply for these and must meet specific criteria.

The Conference Travel Grants provide a stipend for students who are not presenting a paper to attend professional
meetings. “It’s important for young women to hear the lectures, gain exposure within the community, and interact with people who may later have an influence on their careers,” says Lipson.

The Professional Development Grants provide funding for women to attend a professional development conferences and workshops for women in sciences or engineering. Such programs provide a wealth of information and contacts for women as they prepare to enter either industry or academia careers.

The Technical Exposure Grants offer support for advanced female Ph.D. candidates to visit a relevant lab or research group. Such visits provide them with professional networking opportunities, the chance to share their research more widely with experts in their field, and an opportunity to heighten their professional visibility in preparation for entering the job market.

Taken together, the grants, the luncheons, and particularly the closer relationships formed through Women of ECE are helping talented women become confident and valued members of their profession.

Pictured here

Top left: Two students working in the semiconductor lab. Photo by Patricia Gonyea, ECE. Top right: Three women faculty are (left to right): Michal Lipson, Alyssa Apsel and Sheila Hemami. Photo by Lindsay France, University Photography. Right: Trudy Chu working on a project for the ECE 2100 class. Photo by Patricia Gonyea, ECE. Bottom: Monthly gathering of ECE women faculty and graduate students. Names of individuals are as follows: back row, left to right - Caroline Anderson, Eliana Mossa-Gonzalez, Ishita Mukhopadhyay, front row, left to right - Meng Wang, Alyssa Apsel, Sheila Hemami, Kriti Charan, Michal Lipson. Photo by Lindsay France, University Photography.
Tsuhan Chen talks with Michal Lipson, Associate Professor and Winner of MacArthur "Genius" Award

**Chen:** You are breaking new ground in nanophotonics – combining fundamental photonics and silicon fabrication engineering in ways that are revolutionizing our ability to harness the power of light. Talk with me about the most critical technological changes your work has brought about.

**Lipson:** Ten years ago I started using silicon instead of traditional materials in photonics. Until then, silicon was used only in electronic components. We’ve shown we can use it to make optical devices with performance comparable to other traditional optical devices such as optical modulators that initially made it possible for optoelectronics telecommunications systems to increase the distance and capacity of high quality data transmission over copper systems. With silicon technology, we can deliver tremendous increases in bandwidth and use less power compared with existing optoelectronics systems.

Nanophotonics technology allows us to produce high bandwidth, high speed, and ultra-small optoelectronic components. With this kind of dramatic increase in output, this technology has the potential to revolutionize telecommunications, computation, and sensing.

**Chen:** What led you into this combination of technologies in the first place, and what goes into your ongoing decision process as you choose where to focus your efforts?

**Lipson:** Choosing a topic is the most important thing that a junior faculty member needs to do; this is more important than anything else. In my case, I picked a topic that had some fundamental issues. I picked something very challenging which also had applications that would serve industry. In my field, there’s a strong balance between fundamental science and applications.

When I started, I was pretty naïve. That’s very typical of junior faculty, but it’s also a very good thing. There’s so much one is not very aware of yet at that stage in one’s career, so a lot of the persistence comes from naïveté. I cannot tell you that I did not have second thoughts about the topic choice after my first year in this field. It did take some courage to continue to believe in it. But ten years later, here we are, and it’s very, very exciting.

**Chen:** You’re no stranger to awards – you’ve won quite a number – but the MacArthur Fellowship, popularly called the “Genius Award” is certainly a capstone honor. We’re all truly thrilled that you won this and honored that you’re in our midst.

The MacArthur Foundation says it selects those “who have shown extraordinary originality and dedication in their creative pursuits and a marked capacity for self-direction.”

The other half of my group does fundamental science. They’re exploring different areas that won’t necessarily have any applications in the next five to ten years. For example, one technology we’ve developed is optical cloaking – hiding objects by bending light around them. It turns out there are fantastic applications for that. When we started, the applications were not there, but we’ve identified new ones that offer tremendous potential in defense, communications, and other industries. As we work in new areas, we often see potential for new applications as we are developing the technology itself.

**Chen:** As you look ahead over the next ten years, what do you think will be the next big frontiers in photonics and electronics? What will be next questions you want to answer?

**Lipson:** The way I divided my group reflects my thinking on this. Half of my group is still directed at silicon photonics. The project has been so successful that it’s now ready for industry. So that group will probably transition soon.

The other half of my group does fundamental science. They’re exploring different areas that won’t necessarily have any applications in the next five to ten years. For example, one technology we’ve developed is optical cloaking – hiding objects by bending light around them. It turns out there are fantastic applications for that. When we started, the applications were not there, but we’ve identified new ones that offer tremendous potential in defense, communications, and other industries. As we work in new areas, we often see potential for new applications as we are developing the technology itself.

**Chen:** As you look ahead over the next ten years, what do you think will be the next big frontiers in photonics and electronics? What will be next questions you want to answer?

**Lipson:** The way I divided my group reflects my thinking on this. Half of my group is still directed at silicon photonics. The project has been so successful that it’s now ready for industry. So that group will probably transition soon.

The other half of my group does fundamental science. They’re exploring different areas that won’t necessarily have any applications in the next five to ten years. For example, one technology we’ve developed is optical cloaking – hiding objects by bending light around them. It turns out there are fantastic applications for that. When we started, the applications were not there, but we’ve identified new ones that offer tremendous potential in defense, communications, and other industries. As we work in new areas, we often see potential for new applications as we are developing the technology itself.
an educational institution and as individual teachers, how can we foster each of those characteristics in our students?

In my opinion, in order to be creative, you need to have self-confidence in your knowledge; they go hand in hand. That is often a problem for female students. If they are insecure, they do not have courage to think out of the box. So part of my job as a teacher is to help infuse confidence. I see this with my graduate students. The more confidence I can give them, the more creative they are.

Chen: You are a leader not only in electrical and computer engineering, but also in establishing the Women of ECE group and helping women to pursue this field at Cornell. Why do you think the number of women in electrical and computer engineering everywhere is relatively small?

Lipson: If we knew the answer to that, we could solve the problem! Women still make up a small percentage of ECE students at the undergrad level (around 10%) and the number becomes miniscule when you go up into grad school and faculty. There are lots of theories about why so few women enter our field. When I took a sabbatical, I read quite a lot of research on what’s preventing women from entering these careers. There are a lot of barriers to overcome, many of them aspects of the culture, including subtle discrimination. These have a lot to do with self confidence of women.

We need to be aware of the things that prevent women from feeling that they belong in the field. Academia in general is not a very inclusive environment for women; engineering is worse, and ECE even tougher. To be honest, whenever I see a woman in my class, my heart goes to her, knowing that she probably feels very alone.

When I talk to female junior faculty members, which I do a lot around the country, one of the main points I make is to understand their own sense of self discrimination. It’s not personal, and they’re not alone; other junior women faculty members are experiencing the same thing they are. I believe it will go away with recognition. When I dig in my memory, I remember how alone I felt when I started out. Today I feel completely comfortable among my peers.

Chen: What do you think that diversity in the environment can bring to ECE?

Lipson: There’s lots of evidence that the more diverse a group is, the more successful it will be, in all different fields. Particularly in technical fields, being inclusive will help any organization succeed.

Chen: You were on a telecast town hall panel with Al Gore on math, science and the future of our nation. What are your thoughts about how to excite students’ interest and improve the quality of education in these areas from an early age?

Lipson: It was a fascinating panel. I was one of a handful of people all around the world who talked about their experience in educating young scientists. It was very exciting for me to have hundreds of students there offering their opinions. There were lots of girls in the audience, and they were very involved. I found that very encouraging.

Most of the problem is that we are getting away from math and science in middle school. So the real challenge is how to excite students about science at that level. That was a lot of the focus of what was said in the individual town halls.

One of the ways I think we can make science come alive is to incorporate lab components whenever possible, even if it’s just a demonstration during class. Labs make a tremendous impact on students. They’re critical in the process of helping young people develop abstract thinking ability.

Science, math, and engineering are all such exciting fields today. There are so many different careers that can have a huge impact on society. So I think getting more students to feel that excitement and to see the opportunities is critical. I think it can happen. We have to make it happen.
Remembering Paul Kintner

The ECE community mourns the passing of Paul Kintner, Professor of Electrical and Computer Engineering and head of the Global Positioning Systems Laboratory at Cornell University. He died at his home in Ithaca on Tuesday, November 16, 2010, after a courageous battle with pancreatic cancer. Kintner was an internationally recognized authority on the interaction of radio signals, both natural and man-made, with space environments, particularly the ionosphere and magnetosphere. His studies included the effect of the space environment on GPS signals.

Please find a complete obituary online at: ece.cornell.edu/kintner/index.cfm

Photos: Below, entire GPS research group (2009), which Kintner founded and led for more than 10 years. Upper right, Kintner at Yosemite Park, photo taken by Connie Kintner. Lower right, Paul Kintner with graduate student Erik Lundberg (current ECE Ph.D. candidate) alongside the SICFER-2 sounding rocket payload that was launched from Andenes, Norway to study the aurora. Kintner was Principal Investigator for this NASA science mission. Pictures below and lower right were both taken by Steven Powell.