RESONANCE

NEWS FOR ECE ILLINOIS ALUMNI AND FRIENDS
FALL 2007

Alumnus wants you to

BURN RUBBER, NOT OIL

Also in this issue:

Aluminum foil lamps outshine incandescent lights

Big things at nano workshop

Students develop laser guided mouse

ECE Illinois

ECE alumnus Martin Eberhard and his all-electric Tesla Roadster

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The new Edison and Ford

Letter from the Department Head

Dear Friend,

The field of electrical and computer engineering touches all of us every day, often through technology that we sometimes take for granted. This issue of *Resonance* includes two stories that illustrate the efforts that our alumni and faculty are undertaking to further develop some of those technologies.

The impact of Thomas Edison's incandescent light bulb on civilization cannot be overstated, and now new technologies are being created that will replace the incandescent bulb. The LED has evolved to the point where it is beginning to compete with the incandescent bulb. Even newer technology—microcavity plasma panels—is being developed at ECE Illinois. A modern-day Edison, Professor Gary Eden and his colleagues and students are creating more efficient, flexible lighting that may have just as great an impact. Read more on page 4.

Likewise, an all-electric car could change the world, too. The most attractive all-electric car I've ever seen is preparing to roll off the production line at Tesla Motors, a company cofounded by ECE Illinois alumnus Martin Eberhard. I've had the pleasure of visiting with Martin and seeing his company, and believe he is as much a visionary as Henry Ford. When Tesla Motors is successful, as I predict it will be, many of us may drive an electric car. Read more on page 22.

And because two Edisons and two Fords aren't enough, our students continue to develop the skills necessary to be the next generation of engineering, business, and government leaders. Congratulations to all 2007 ECE Illinois graduates, including the 54 PhD recipients listed on page 15.

Best Regards,

Richard E. Blahut
Department Head
Henry Magnuski Endowed Professor of Electrical and Computer Engineering

DON'T MISS AN ISSUE!

Resonance is the best way to stay up-to-date on ECE Illinois department and alumni news. Alumni who join the University of Illinois Alumni Association (UIAA) automatically receive this magazine. If you're not already a member of the UIAA, complete the membership form on page 30 or visit the alumni section of the ECE Web site at www.ece.uiuc.edu/alumni. A portion of your membership dues goes directly to ECE to help support the department.

Cover photo by Jeff Peters

ECE NEWS BRIEFS

NEW QUALIFYING EXAM IMPLEMENTED After nearly 40 years with the same qualifying admission exam to pursue a PhD, ECE has developed and implemented a new assessment.

The new exam offers feedback for students. The old qualifying exam informed students as to whether they had passed or failed but did not give them the reasons behind the decision. Now, at the end of each oral exam, a consensus evaluation will offer candidates feedback from three faculty members.

KUDEKI NAMED ASSOCIATE DEPARTMENT HEAD In August, ECE Professor Erhan Kudeki succeeded ECE Professor Seth Hutchinson as associate department head for undergraduate affairs. Kudeki will oversee student advising, give input on the ECE undergraduate curriculum, and work with students having academic problems.

For Kudeki, who has served as chair of the ECE curriculum committee for the last several years, this was a way to continue to have a positive impact on students and the curriculum. "I am familiar with so many courses in our curriculum, having spent so much time on the curriculum committee, I felt it was sort of a natural transition here," said Kudeki. "And it is service back to the department."

Kudeki's office as associate head will be in the Advising Office in 156 Everitt Lab. ECE Professor Steve Franke holds a parallel position in that office as associate department head for graduate affairs.

NEW ECE ROBOTICS LAB OPENS The College of Engineering Robotics and Automation Laboratory, which had been located in 316 Transportation Building since 1987, moved to 267 Everitt Lab at the beginning of the Fall 2007 semester.

The new lab features eight student workbenches, each equipped with a robotic arm, computer workstation, controller, and computer vision system.

This move provides enhanced resources to support two undergraduate courses—ECE 470: Introduction to Robotics, and ECE 489: Robot Dynamics and Control. Senior design classes, Engineering Open House projects, and independent studies may also take place in the new lab. Funds for the remodeling and equipment came from the engineering surcharge.

ECE GRADUATE STUDENT ASSOCIATION FORMED ECE graduate student Robert Gregg saw a need and filled it when he decided to head the new ECE Graduate Student Association. Gregg, a University of California, Berkeley, alumnus, said it was difficult to make friends and get involved at Illinois as a graduate student because he wasn't familiar with the area or required to live in dorms like younger students.

Gregg modeled the organization after a similar one at Berkeley, where he noticed engineering graduate students were more involved.

"We're going to help with orientation, maybe have a meet and greet or an evening event," Gregg said. "We'd also like to help the department with recruiting and alumni relations."

ECE Associate Professor Steve Lumetta is the faculty advisor, and Gary Yen, an ECE graduate student, is the treasurer. For more information, visit www.uiuc.edu/ro/ECEGSA.

LEUNG RECEIVES SHETH INTERNATIONAL ALUMNI AWARD

Sophie and Brian Leung. *Photo by Beck Diefenbach, U of I Alumni Association.*

Sophie and Brian Leung (BSEE '70, MSEE '73), longtime supporters of the University, traveled to campus from their home in Hong Kong earlier this year, as Sophie received the 2006 Madhuri and Jagish Sheth International Alumni Award.

The Sheth Award recognizes outstanding international alumni who are highly distinguished in their professions; who have helped their nation or the world through outstanding contributions to government, humanity, science, art, or human welfare; and who exemplify the strength of their education at the University of Illinois.

Sophie holds a bachelor's degree in mathematics. In addition to serving as director of Bay Apparel Limited, a company she and Brian founded, Sophie is a deputy of the National People's Congress in China and a member of the Legislative Council of Hong Kong Special Administrative Region.

The Leungs established the Brian and Sophie Leung Merit Scholarship at ECE in 1993.

Aluminum foil lamps **outshine incandescent lights**

By James E. Kloeppel, U of I News Bureau

ECE researchers are developing panels of microcavity plasma lamps that may soon brighten people's lives. The thin, lightweight panels could be used for residential and commercial lighting, and for certain types of biomedical applications.

"Built of aluminum foil, sapphire, and small amounts of gas, the panels are less than one millimeter thick and can hang on a wall like picture frames," said ECE Professor J. Gary Eden, co-author of a paper describing the microcavity plasma lamps, published in the June issue of *Journal of Physics D: Applied Physics.*

Like conventional fluorescent lights, microcavity plasma lamps are glow-discharges in which atoms of a gas are excited by electrons and radiate light. Unlike fluorescent lights, however, microcavity plasma lamps produce the plasma in microscopic pockets and require no ballast, reflector, or heavy metal housing. The panels are lighter, brighter, and more efficient than incandescent lights and are expected, with further engineering, to approach or surpass the efficiency of fluorescent lighting.

The plasma panels are also six times thinner than panels composed of light-emitting diodes, said Eden, the Gilmore Family Endowed Professor in Electrical and Computer Engineering.

A plasma panel consists of two sheets of aluminum foil separated by a thin dielectric layer of clear aluminum oxide (sapphire). At the heart of each lamp is a small cavity that penetrates the upper sheet of aluminum foil and the sapphire.

"Each lamp is approximately the diameter of a human hair," said visiting research scientist Sung-Jin Park, lead author of the paper. "We can pack an array of more than 250,000 lamps into a single panel."

Completing the panel assembly is a glass window 500 microns (0.5 millimeters) thick. The window's inner surface is coated with a phosphor film 10 microns thick, bringing the overall thickness of the lamp structure to 800 microns.

Flat panels with radiating areas of more than 200 square centimeters have been fabricated, Park said. Depending upon the type of gas and phosphor used, uniform emissions of any color can be produced.

In the researchers' preliminary plasma lamp experiments, a value of the efficiency—known as luminous efficacy—of 15 lumens per watt was recorded. Values exceeding 30 lumens per watt are expected when the array design and microcavity phosphor geometry are optimized, Eden said. A typical incandescent light has an efficacy of 10 to 17 lumens per watt.

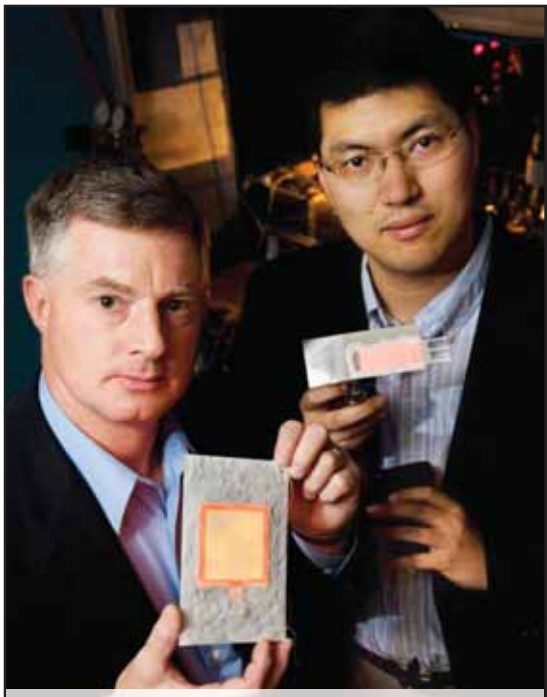
The researchers also demonstrated flexible plasma arrays sealed in polymeric packaging. These devices offer new opportunities in lighting in which lightweight arrays can be mounted onto curved surfaces—on the insides of windshields, for example.

The flexible arrays also could be used as photo-therapeutic bandages to treat certain diseases, such as psoriasis, that can be driven into remission by narrow-spectrum ultraviolet light, Eden said.

Along with Eden and Park, co-authors of the paper are graduate students Andrew Price and Jason Readle, and undergraduate student Jekwon Yoon.

In addition to directing the Laboratory for Optical Physics and Engineering, Eden is also a researcher at the University's Coordinated Science Laboratory and the Micro and Nanotechnology Laboratory.

Funding was provided by the U.S. Air Force Office of Scientific Research and the Office of Naval Research.



ECE researchers Gary Eden, Sung-Jin Park, and their colleagues are developing plasma technology with medical and lighting applications. *Photos courtesy of the U of I News Bureau.*

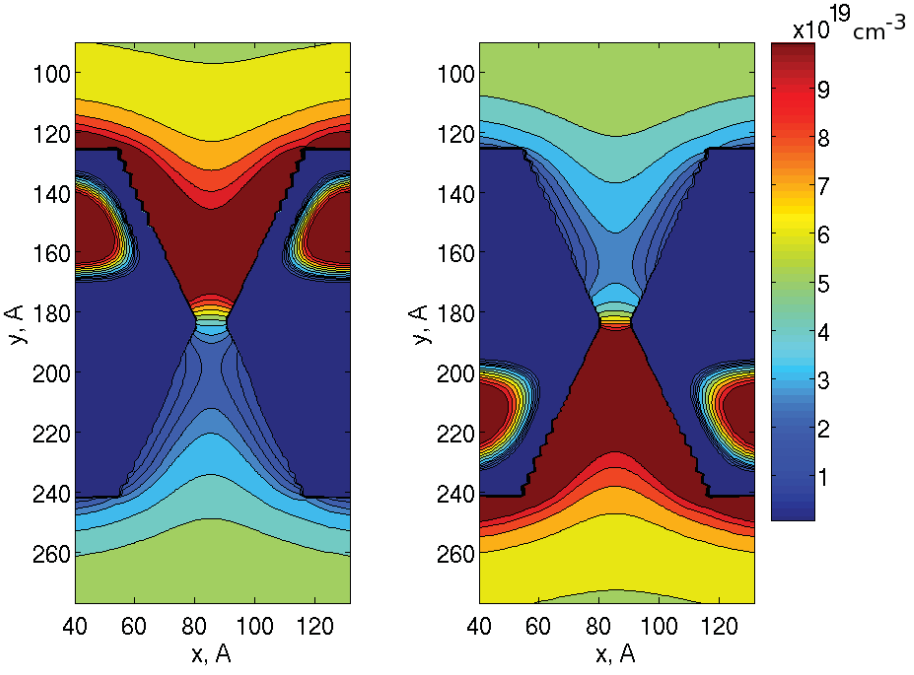
Semiconductor membrane **mimics biological behavior** of ion channels

By James E. Kloeppel, U of I News Bureau

A semiconductor membrane designed by ECE Illinois researchers could offer more flexibility and better electrical performance than biological membranes. Built from thin silicon layers doped with different impurities, the solid-state membrane also could be used in applications such as single-molecule detection, protein filtering, and DNA sequencing.

Professor Jean-Pierre Leburton

"By creating nanopores in the membrane, we can use the membrane to separate charged species or regulate the flow of charged molecules and ions, thereby mimicking the operation of biological ion channels," said ECE Professor and Lead Researcher Jean-Pierre Leburton, the Stillman Professor of Electrical and Computer Engineering.



This contour plot represents the net charge distribution in the electrolyte and semiconductor membrane. The left panel shows positive charge and the right panel shows negative charge.

Leburton, with Beckman Institute Postdoctoral Research Associate Maria Gracheva and ECE graduate student Julien Vidal, simulated the operation of the semiconductor membrane at a number of electrostatic potentials. They report their findings in a paper accepted for publication in the journal *Nano Letters* and posted on the journal's Web site.

In the researchers' model, the nanopore-membrane structure is made of two layers of silicon, each 12 nanometers thick, with opposite (n- and p-) doping. The electrostatic potential is positive on the n-side and negative on the p-side of the membrane.

The nanopore has an hourglass shape, with a neck one nanometer in diameter and openings on each side of the membrane six nanometers in diameter. The "size" of the nanopore can be changed by changing the electrostatic potential around it.

By controlling the flow of ions, the artificial nanopore offers a degree of tunability not found in biological ion channels, said Leburton, who also is a researcher at the Beckman Institute, Coordinated Research Laboratory, and Micro and Nanotechnology Laboratory.

In addition to serving as a substitute for biological ion channels, the solid-state nanopore and membrane could be used in other applications, including sequencing DNA. Leburton and ECE Professor Greg Timp are part of a multidisciplinary group that is currently investigating sequencing DNA.

The group also includes physics Professors Klaus Schulten and Aleksei Aksimentieve and biochemistry Professor Stephen Sligar.

"Using semiconductor technology to sequence the DNA molecule would save time and money," Leburton said. "By biasing the voltage across the membrane, we could pull DNA through the nanopore. Since each base pair carries a different electrical charge, we could use the membrane as a p-n junction to detect the changing electrical signal."

Funding for this project was provided by the National Science Foundation and the National Institutes of Health.

Haken's instrument **goes on tour**

By Lauren Eichmann

ECE lecturer Lippold Haken's invention, a musical instrument called the Continuum Fingerboard, was featured on famous Indian film composer and musician A.R. Rahman's Third Dimension North American Tour last summer. Rahman, who is best known for composing more than 70 film scores and soundtracks and has sold close to 200 million albums worldwide, made his Midwest debut at the sold-out Sears Centre in suburban Chicago on June 9.

ECE lecturer Lippold Haken at work building his creation, the Continuum Fingerboard. Famous Indian composer A. R. Rahman played the Continuum during his North American tour earlier this year. *Photo courtesy of Lippold Haken.*

Haken (BSCompE '82, MSEE '84, PhD '90) attended the concert and met beforehand with Rahman, who planned to give a verbal introduction of the Continuum prior to each of his shows. "He was so gracious about introducing the Continuum Fingerboard," said Haken. "It was great exposure for the University and the instrument. Since the instrument is different from a keyboard or from a wind controller or other traditional instruments, it is great to have a well-known artist take it seriously and perform with it."

Rahman said Illinois has "the magic" because the Continuum was created by a University professor, and because the Kyma sound engine, which the instrument uses, was created by Computer Science alumnus Carla Scaletti and ECE alumnus Kurt Hebel (BSEE '83, MSEE '84, PhD '89).

"I fell in love with keyboard playing as a young boy, but I was frustrated because I could not play [Indian] classical music on keyboards because of the limitations of the keys, which never let micro-intonation of notes," Rahman said at the Chicago area concert. "So recently, I discovered something that was quite a revelation for me—the Continuum Fingerboard, invented right here in Illinois by University of Illinois Professor Mr. Lippold Haken!"

The Continuum Fingerboard is made of thick metal with a soft red nylon over a neoprene surface. It is a non-traditional keyboard, as it has no keys and only visual markings to indicate finger placement. It has been described as a cross between a keyboard and the fingerboard of a fretless string instrument, like a violin.

"It is not easy to play, so it was quite a commitment on A.R.'s part to learn it," said Haken of the Continuum. "It means he believes this instrument has new expressive possibilities different from all the other instruments out there."

Although this was the first large-scale concert with the Continuum in Illinois, Rahman is not the first famous artist to have purchased one of the 90 Haken has built by hand. Jordan Rudess of the progressive metal band Dream Theatre; John Paul Jones, former bass guitarist and keyboardist for Led Zeppelin; and keyboardist Terry Lawless, who has toured with U2 for the last four years, also have purchased the instrument, Haken said.

Haken finished the preliminary design in the mid-'90s and officially released the Continuum Fingerboard in 2000. Since then, he has spent some of his extra time apart from his University teaching position trying to improve the quality of the instrument. "It has taken a lot of detail work to make it an instrument that a high-powered musician would be willing to practice for six or more hours a day," said Haken.

Haken teaches ECE 110: Introduction to Electrical and Computer Engineering, ECE 395: Advanced Digital Projects Laboratory, and ECE 402: Electronic Music Synthesis, and often incorporates the Continuum Fingerboard into his classroom activities.

To hear a recording of the Continuum Fingerboard, visit www.ece.uiuc.edu, select News, then Resonance.

Chuang, Eden invested

By Brad Petersen

Two longtime ECE faculty members were invested in April during a special ceremony in front of a full auditorium at the National Center for Supercomputing Applications building on campus. Shun Lien Chuang was named a Robert C. MacClinchie Distinguished Professor in Electrical and Computer Engineering and J. Gary Eden (MSEE '73, PhD '76) became the first Gilmore Family Endowed Professor in Electrical and Computer Engineering.

Department Head Richard Blahut, who oversaw the proceedings, said, "I have the best job in the world. It's a pleasure to be part of an event like the investiture we have today. I am deeply respectful of the impact these people have had on the world."

Joseph White, president of the University, also spoke, thanking donors Merle and Lisa Gilmore, who were present for the festivities, and the late Robert C. MacClinchie for their generosity. White also offered congratulations to Chuang and Eden, remarking that a professorship is among the very highest honors the University bestows upon its faculty.

Chuang, who has been at Illinois since 1983, has spent his career conducting research in the areas of optoelectronics, semiconductor devices physics, semiconductor lasers, modulators, quantum electronics, and electromagnetics.

"No one deserves this honor better than Shun Lien. He is a prolific researcher, has given over 100 talks, written highly cited publications, and wrote the 1995 book *Physics of Optoelectronics*," ECE Professor Weng Chew commented. "Like all good scholars, he is also a great and exemplary teacher. He is the only teacher I know whose students stand up and clap at the end of the semester!"

ECE Department Head Richard Blahut, Robert C. MacClinchie Distinguished Professor Shun Lien Chuang, Gilmore Family Endowed Professor Gary Eden, donors Merle and Lisa Gilmore, and College of Engineering Dean Ilesanmi Adesida after the ceremony to invest Chuang and Eden.

An ECE faculty member since 1979, Eden's research focuses on molecular and ultrafast spectroscopy, ultraviolet and visible lasers, high-intensity optical field-matter interactions, and microcavity plasma devices.

"Gary is an outstanding scientist, an outstanding engineer, a consummate professional, and a most remarkable man," ECE Professor Jim Coleman said during his remarks about Eden. "Gary will tell you modestly that he is just a physicist. He is indeed a fine physicist and recognized as such around the world. But don't let his modesty fool you for a minute. He is most certainly also a fine engineer—and also recognized as such around the world. This balance is reflected in his work, and his students are much the better for exposure to both of those worlds."

The Gilmore Family Professorship was endowed by Merle and Lisa Gilmore. Merle (BSEE '70) and his brother, Douglas (BSEE '75, MSEE '77), are ECE alumni. Merle joined Motorola after graduation and held numerous management positions there during the course of his career. He currently works for Ripplewood Holdings Japan, a private equity company.

The late Robert MacClinchie was a 1932 electrical engineering graduate. After a long career as an engineer, MacClinchie had a second calling and became an educator, teaching physics and mathematics at Olivet College in Olivet, Michigan.

"What gives us the confidence, or *chutzpa*, to say we want to be the preeminent public research institution? It's our professors," said College of Engineering Dean Ilesanmi Adesida to close the event.

Rao's retirement marks **a new beginning**

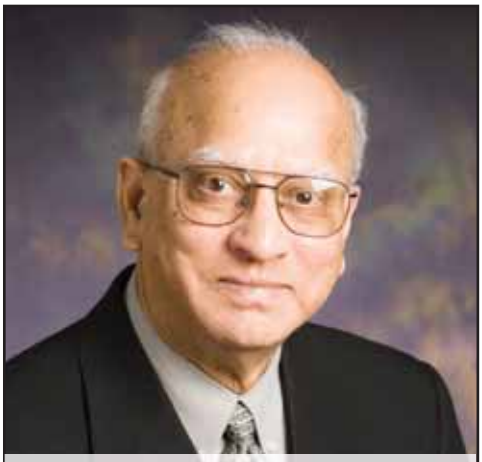
By Jamie Hutchinson

Colleagues, family, and friends of Professor Narayana Rao, the Edward C. Jordan Professor Emeritus of Electrical and Computer Engineering, gathered in Everitt Laboratory on May 11 to mark his retirement after 42 years on the ECE faculty. Rao served as ECE associate head for instructional and graduate affairs from 1987 to 2006, helping to shape the department.

Speakers at the reception included College of Engineering Dean Ilesanmi Adesida, ECE Department Head Richard Blahut, former Department Head Tim Trick, and current Associate Department Head Stephen Bishop. Blahut commented on the thousands of lives Rao touched as an administrator, teacher, and textbook author. Trick, who worked with three different associate heads as department head before filling the position with Rao, commended Rao for the stability he brought to the administration. "The associate head does the jobs nobody else wants to do, like teaching assignments and ABET," said Trick, referring to the accreditation process of the Accreditation Board for Engineering and Technology. "And if he does the job well, the department head gets all the credit."

Rao remarked on his belief in the power of education—transcending the boundaries of national origin, race, and religion—to assure the future of the world. "Nowhere else on the campus is this more evident than in the ECE Department, which is the crown jewel of the campus," he said.

Rao will continue his service to the University, mostly by helping to develop relations with his native India. Amrita University in the southern state of Tamil Nadu has named Rao its first "Distinguished Amrita Professor." During the summer of 2006, Rao taught a course in electromagnetics as the inaugural offering under the Indo–U.S. Inter-University Collaborative Initiative in higher education and research, an agreement between the Indian government, Amrita University, and 15 U.S. universities. Under the agreement, U.S. science and engineering faculty teach courses to Indian students using Amrita's e-learning setup and the Indian government's "EDUSAT" satellite network.



Narayana Rao, the Edward C. Jordan Professor Emeritus of Electrical and Computer Engineering

More than 850 students attended Rao's broadcast lectures at 22 centers across India. It was the first time students taking a satellite-based course in India could participate interactively with their teacher. A student hundreds of miles away from Amrita could send a signal to ask a question, then stand up and be seen and heard asking the question in real time on monitors at other facilities in the network.

Another highlight of the course was the "Indian Edition" of Rao's longstanding and popular textbook, *Elements of Engineering Electromagnetics*, now in its sixth edition with an international following. Planning to travel internationally, particularly to China, Rao hopes to touch students and academics around the world with his books. In this spirit, Rao is at work on a one-semester book on fundamentals of electromagnetics for electrical and computer engineering, which will bear his joint affiliation with Illinois and Amrita, as an alternative to the present two-semester book. He also has announced an "Illinois Center for Electromagnetics Education" to be established at Amrita University. "A tree will not grow unless a seed is planted and nourished," he said.

Rao earned his BSc in physics from the University of Madras in 1952 and Diploma in Electronics from the Madras Institute of Technology, Chromepet, in 1955. He came to the U.S. in 1958 for graduate study at the University of Washington, earning his MS and PhD in electrical engineering in 1960 and 1965, respectively. He was hired to the ECE faculty in 1965. His research has focused on ionospheric propagation, and he has developed courses in electromagnetic fields and wave propagation.

Pioneer of online education **retires**

By Bridget Maiellaro

Associate Vice President for Academic Affairs and ECE Professor Burks Oakley, II, one of the pioneers of online education, retired at the end of the spring semester after more than 26 years.

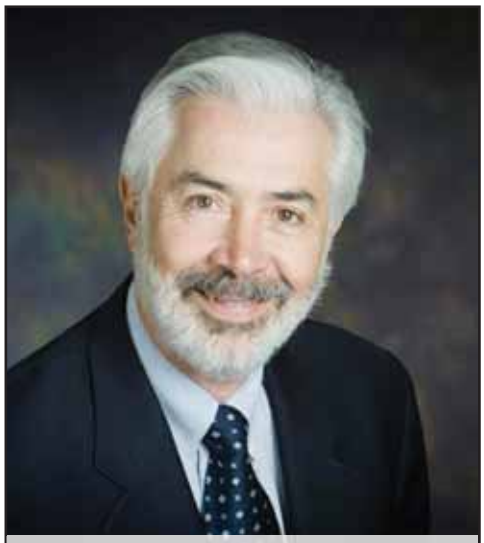
After earning his BS in chemical engineering from Northwestern University in 1971, Oakley went on to receive his MS and PhD from the University of Michigan in 1973 and 1975, respectively.

Oakley joined ECE Illinois in January 1981, teaching classes in biomedical engineering, introductory electrical engineering, and biophysics. He later served as the assistant department head and chief undergraduate advisor, working very closely with undergraduate students for three years.

Oakley said that in the late 1980s, the campus had a program to encourage faculty to use personal computers in their teaching, so he began writing tutorials on his computer to help students understand electrical circuits better.

"It turned out to be very successful software, and I just thought there was a lot of potential to use technology in teaching," he said. "Over time, I developed this interest not just in teaching, but in using technology for teaching."

Oakley then tried to encourage other faculty across campus to use technology in their teaching, leading him to obtain a multi-million-dollar grant from the Alfred P. Sloan Foundation, a philanthropic nonprofit institution, and start a campus-wide center based out of Everitt Lab in 1995. Oakley was promoted to associate vice president for academic affairs in 1997, becoming involved in issues regarding academic affairs from all the University of Illinois campuses.



> ECE Professor Burks Oakley, II, Associate Vice President for Academic Affairs

Oakley said his goal for the past 10 years has been to provide access to a University of Illinois education to those unable to attend classes on campus through the University of Illinois Online, which was established in 1997.

"That program really, I think, provided a good foundation for the University, as it now is moving into this new area of the Global Campus to do it on a much larger scale than we have ever done," Oakley said.

In addition to establishing University of Illinois Online, Oakley has taught faculty at the three campuses how to teach online, helped them secure financing to develop online programs, and developed and taught a variety of online courses for the Springfield campus. Oakley also helped obtain grants to assist community colleges throughout Illinois in developing their own online programs.

Over the years, Oakley has received many awards for his accomplishments. While all of them are special in their own way, he said that the University's Luckman Distinguished Undergraduate Teaching Award and the Sloan Consortium Award for the "Most outstanding achievement in online teaching and learning by an individual" are most important to him.

"It felt incredible to receive the distinguished teaching award because teaching was a major part of my career at Illinois," he said. "The Sloan Consortium award represents what I have contributed to the field, and it's very meaningful for me to have that recognition of my peers around the country."

Oakley plans to remain active in the field of online education. In fact, he will be working more closely with the Sloan Consortium as a consultant and will continue to pursue his interests in technology through podcasting and teaching additional online courses and workshops.

"I very much plan to remain engaged with the field and the profession for the foreseeable future," he said. "I don't think of it as much of a retirement as it is moving into the next phase of my career."

FACULTY NEWS

ILESANMI ADESIDA, a Donald Biggar Willett Professor of Engineering and dean of the College of Engineering, was named to the board of directors for Fluor Corp. in June. Fluor is an Irving, Texas-based provider of services to the engineering, procurement, construction, operations, and maintenance industries.

SHUN LIEN CHUANG, the Robert C. MacClinchie Distinguished Professor in Electrical and Computer Engineering, will receive the 2007 William Streifer Scientific Achievement Award from the IEEE Laser and Electro-Optics Society for "contributions to the development of the fundamental theories of strained quantum-well lasers and the physics of optoelectronic devices" in October.

JAMES J. COLEMAN, the Intel Alumni Endowed Chair in Electrical and Computer Engineering, was named the 2008 IEEE David Sarnoff Award recipient for "leadership in the development of highly reliable strained-layer lasers."

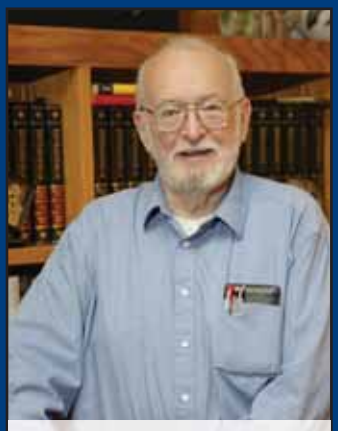
J. GARY EDEN, the Gilmore Family Endowed Professor in Electrical and Computer Engineering, has been recognized with the C.E.K. Mees Medal by the Optical Society of America (OSA) "for seminal interdisciplinary contributions to ultraviolet lasers, photochemical vapor deposition, ultrafast spectroscopy, and microplasma devices, and for strengthening international collaborations in these areas of optics and photonics."

THOMAS S. HUANG, his current graduate students Shyam Rajaram and Charlie Dagli, and former student Nanjala Petrovic received the Best Paper Award in June at the IEEE International Workshop on Semantic Learning Applications in Multimedia (SLAM) in Minneapolis, for their paper "Diverse active ranking for multimedia search."

P.R. KUMAR, the Franklin Woeltge Professor of Electrical and Computer Engineering, and his former PhD student Arvind Giridhar, received the 2007 IEEE Communications Society Fred W. Ellersick Prize in June for their paper on in-network

NOBEL LAUREATE PAUL C. LAUTERBUR, DEVELOPER OF MRI, DIES

By Diana Yates, U of I News Bureau



Paul C. Lauterbur

Paul C. Lauterbur, who was awarded a Nobel Prize in 2003 for his pioneering work in the development of magnetic resonance imaging, died on March 27 at his home in Urbana at age 77.

A member of the faculty at Illinois since 1985, Lauterbur shared the Nobel Prize for physiology or medicine with Sir Peter Mansfield of the University of Nottingham in England.

Lauterbur was among the first scientists to use nuclear magnetic resonance (NMR) spectroscopy in the study of molecules, solutions, and solids. In the early 1970s, he began applying the same technology to biological organisms. As in other NMR experiments, Lauterbur put his subjects (he first used a clam) inside a powerful magnetic field and collected the resulting radio signals that were emitted by atomic nuclei within the tissues. He discovered that using a static magnetic field and varying the intensity of a second magnetic field across his subjects yielded clearer signals, allowing better imaging of different tissues.

"Through his life and his work, Paul Lauterbur exemplified the ideals of the University of Illinois—creativity, passion, tenacity, and most importantly, commitment to mankind," said Chancellor Richard Herman. "Paul's influence is felt around the world every day, every time an MRI saves the life of a daughter or a son, a mother or a father. He will be greatly missed."

Lauterbur, who was born May 6, 1929, in Sidney, Ohio, earned a bachelor's degree in chemistry in 1951 from Case Institute of Technology, Cleveland, and a doctorate in chemistry from the University of Pittsburgh in 1962.

He joined the Illinois College of Medicine faculty in 1985. In his 22 years at the University, Lauterbur also had appointments or affiliations with ECE, the Center for Advanced Study, the Beckman Institute, and the Department of Physiology and Biophysics. At the time of his death, he was a Center for Advanced Study professor of chemistry, biophysics and computational biology, and bioengineering. He also was the Distinguished University Professor of Medical Information Sciences.

Photo courtesy of the U of I News Bureau.

computation in wireless sensor networks. The Ellersick Prize is given annually to the best original article published in a Communications Society magazine in the past year.

MICHAEL C. LOUI was appointed to an ad hoc committee overseen by the National Academies' Committee on Science, Engineering, and Public Policy in May. The committee is responsible for developing the third edition of the Academies' guide to responsible conduct of research, *On Being a Scientist*.

UMBERTO RAVAIOLI, assistant dean for academic programs in the College of Engineering, has been named as interim associate dean for academic programs. He began his new duties in August. As a college administrator, Ravaioli has been and will continue to be involved in recruiting, admissions, records, graduation, academic advising, honors programs, freshman orientation, student organizations, outreach programs, international programs, and diversity programs within the college.

ANDREW C. SINGER completed the Ironman Lake Placid in July and raised more than $5,000 for cancer research in the process. This was the second time Singer has completed a grueling Ironman event, which consists of a 2.4-mile swim, 112-mile bike ride, and 26.4-mile run.

JOSE SCHUTT-AINE was named editor-in-chief of *IEEE Transactions on Advanced Packaging.*

RICHARD W. SPROAT was named an associate of the Center for Advanced Study for the 2007–2008 academic year. The appointment grants one semester of release time for creative work on self-initiated programs of scholarly research or professional activity. Sproat, who also has an appointment in linguistics, will pursue "multi-agent simulation of the evolution of complex morphology."

BENJAMIN WAH, the Franklin Woeltge Professor of Electrical and Computer Engineering, was selected as a recipient of the 2007 IEEE Computer Society Technical Committee on Distributed Processing Outstanding Achievement Award.

CHEW BECOMES ENGINEERING DEAN IN HONG KONG

Weng Cho Chew became engineering dean at the University of Hong Kong in August. He is on leave from Illinois.

Chew said he was sad about leaving Illinois but that this position is a once in a lifetime opportunity he could not refuse. "[The University of Hong Kong] is one of the top universities in the Asia-Pacific region, and the best in Hong Kong," he said.

According to Chew, the University of Hong Kong recognizes the influence of American education and wants to incorporate that teaching style. "The American education system is the envy of the world," said Chew. "[In Hong Kong], they just want more of an American-style education."

Chew hopes to bring that North American influence to the University of Hong Kong. He said advantages of the American education system include collaboration with industry, an ability to adapt to change, the productivity of professors, and the creativity of teaching methods.

Unlike many countries, including China, that base their educational systems on field and topic specialization, the U.S. offers a more broad-based education that prepares students to adjust better to change, Chew said.

Chew, whose research focus is electromagnetics, is the Y.T. Lo Chair in Electrical and Computer Engineering. He graduated from the Massachusetts Institute of Technology with a B.S. degree in 1976, an M.S. and an Engineer's degree in 1978, and a PhD degree in 1980, all in electrical engineering. He joined ECE in 1985.

Originally from Malaysia, Chew has lived in the U.S. for nearly three decades. He has taught more than eight different ECE courses over the past 20-plus years.

Emeritus professor **still SURGE-ing**

By Jamie Hutchinson

Many ECE alumni will remember Professor Emeritus Preston Ransom (BSEE '62, MSEE '65, PhD '69) from classes like the lab-based optics course he helped develop in the 1970s, the precursor to today's ECE 460: Optical Imaging. But Ransom influenced a much larger group after he took charge of the College of Engineering continuing education program in the 1980s.

Then, the program mainly offered short courses at locations around the state to help working engineers prepare for licensure exams. By 2001, when Ransom retired, the program offered entire master's degree curricula online, setting the stage for what we now call the University of Illinois "Global Campus." Along the way, Ransom established a graduate fellowship program, Support for Under-Represented Groups in Engineering (SURGE), and a graduate recruitment program, Multicultural Engineering Recruitment for Graduate Education (MERGE), both of which he still directs part time in retirement.

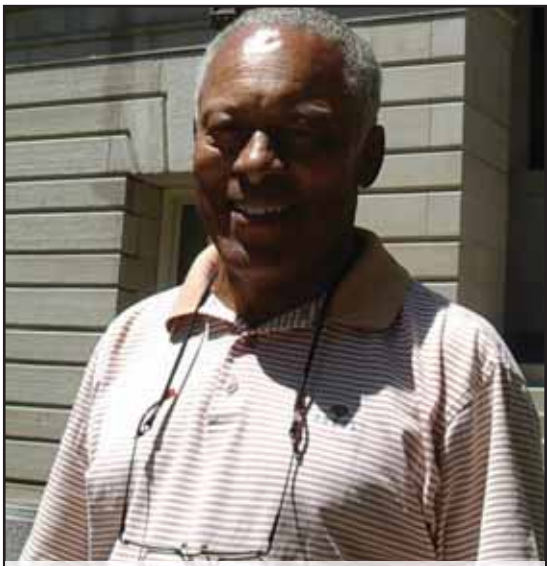
An early turn in Ransom's career was determined by the flip of a coin. It was time to declare a major, and the Illinois undergrad was ambivalent about which field of engineering to pick. "The two 'sexiest' seemed to me to be electrical and aeronautical," he recalled. "But I didn't have a preference, so I flipped a coin in front of the Illini Union and it came up electrical."

About a year shy of his degree, Ransom left school to work at Caterpillar in his native Peoria. He was drafted while working at Cat, but a post-Sputnik program in effect at the time allowed him to satisfy his military obligation by completing a few weeks of basic training at Lackland Air Force Base before returning to the research department at Cat. The idea was that the civilian job would keep sharp his technological skills—deemed critical to maintaining U.S. preeminence in science and technology—while Ransom remained on call for Uncle Sam.

Eventually Ransom decided to come back to school and finish his EE degree, which he did with the assistance of a part-time job in the Antenna Laboratory. "It was an exciting time in the old Antenna Lab because that's when they were making discoveries on frequency-independent antennas," recalled Ransom.

He struck up a longstanding, close relationship with ECE Professor John Dyson, inventor of the logarithmic spiral antenna, one of the frequency-independent devices with which the lab was absorbed at the time. Ransom worked with Dyson for his master's thesis about log spirals, and with lab director and ECE Professor Georges Deschamps for his PhD dissertation about diffraction transformation of electromagnetic fields between parallel planes. The doctoral work was part of a project aimed at using holography to visualize the currents on an antenna.

That work marked a shift in Ransom's research from electromagnetics to optics. Hired to the ECE faculty in 1969, Ransom established a close relationship with ECE Professor Chet Gardner. In the early 1970s, the colleagues started the Electro-Optic Systems Laboratory, the precursor to today's Remote Sensing and Space Sciences Lab. While Gardner's research increasingly addressed LIDAR and atmospheric investigations, Ransom took on projects like computer generated holography, a type of holographic cryptography, and even holographic eyeglasses. In 1987, Gardner became interim dean and soon convinced Ransom to join him in engineering administration.



ECE Professor Emeritus Preston Ransom

Ransom still oversees more than 75 fellows currently supported by SURGE and hosts 50 to 75 recruits for graduate study each fall through the MERGE program. He is an avid golfer and likes to listen to live jazz in local clubs with his wife Mildred, a retired school principal.

Big things at **nano workshop**

By Jamie Hutchinson

Since 2003, Illinois researchers engaged in diverse areas of nanotechnology have gathered for two days in early May along with visitors from academia, industry, and government. The annual Nanotechnology Workshop, hosted by the Center for Nanoscale Science and Technology (CNST), provides a showcase for CNST as well as a forum for researchers who approach nanotech from the perspectives of engineering, life sciences, physical sciences, medicine, and public policy.

As usual, this year's Workshop, held May 3–4 at the National Center for Supercomputing Applications, drew on plenty of participation from ECE faculty and students. Professor Kevin Kim presented his novel techniques for processing nanospheres, nanocapsules, nanowires, and nanofibers with applications for drug delivery, targeted imaging, fusion plasma refueling, plasma displays, and more. New ECE faculty member Eric Pop summarized experiments that shed light on the electro-thermal interactions in carbon nanotubes and phase-change memory. High power density poses a serious constraint on the development of these nanodevices, but Pop's research suggests there is much room for continued optimization.

Among several ECE graduate students presenting at the workshop poster session was Kirk Price, who won the best poster award. Price's poster presented results of his dissertation work on dual-wavelength, high power, semiconductor lasers. "The thing that I guess caught their interest," said Price, "is we showed you can put two of them together on the same chip, and you can use this in order to make terahertz radiation. You mix the wavelengths of light together to make a wavelength difference in the range of terahertz."

Price, who finished his PhD in May and is now a device engineer with West Coast startup nLight, appreciates the opportunity the Nanotechnology Workshop affords students as well as professionals. "You have the opportunity to interact with students outside your research group and outside your particular area of interest. You can go around and see what other people are working on. Also, it is a neat opportunity to see what kind of work is going on in industry because a number of people from industry are invited to speak."

A special theme of this year's workshop was societal implications of nanotech. Dietram Scheufele, a professor of journalism and mass communication at the University of Wisconsin, spoke about his research on media treatment and public perceptions of nanotechnology and other innovations. Along with CNST Associate Director Irfan Ahmad and Illinois mechanical engineering professor Mark Shannon, Scheufele appeared on a call-in program on the University's radio station, WILL AM 580, to discuss nanotechnology with a general audience.

Scheufele said that nanotechnology may be on a course to steer clear of negative public perceptions that have dogged innovations like stem cell research and genetically modified organisms. However, he is troubled by the low level of public awareness about nanotech in comparison to initiatives like the Human Genome Project. "Five percent of the genome project was set aside for ethical discussions," he said. "But the average American asks whether it is reasonable to understand [nanotechnology] and decides no."

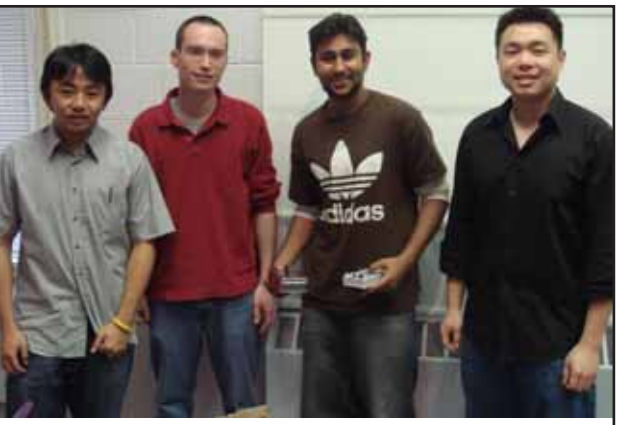
Shannon echoed that sentiment: "The taxpayer has invested billions in nanotech. We [experts] have to do a better job at justifying the investment." As director of the Center of Advanced Materials for the Purification of Water with Systems, he sees huge payoffs in exploiting the nanoscale to clean up water not only for drinking, but also for use in production of fuels of the future, such as ethanol and hydrogen.

Kirk Price holds one of the lasers he developed for his PhD. Price's poster summarizing his work won the best poster award at the 2007 Nanotechnology Workshop.

Students develop a **laser guided mouse**

By Tom Moone

Many ECE students find ECE 445: Senior Design to be the culminating experience of their time in ECE. In this course, students bring together what they have learned in a number of disparate courses to solve an electrical engineering problem of their own devising. Many students come up with projects that are innovative and exciting.



The Laser Guided Mouse project for ECE 445: Senior Design won the Instructor's Award as the best overall project of the semester. The students involved in this project were (from left) Howard Luo, Teaching Assistant Ethan Miller, Samir Desai, and James Lin. *Photo courtesy of Samir Desai.*

One such project is the Laser Guided Mouse developed by ECE seniors Samir Desai (BSEE '07), James Lin (BSEE '07), and Howard Luo (BSEE '07). These students took a typical laser pointer and repurposed it to enable instructors to access computer files, PowerPoint presentations, and Internet pages without having to return to a computer console.

The project stemmed from the students brainstorming over possible topics. Lin said that he recalled having a professor one semester who used a number of PowerPoint slide presentations during the course. Although the professor had a remote control for advancing the PowerPoint slides, "every time he wanted to open another PowerPoint file, he had to go back to the computer and use his mouse and open it that way." Desai said, "We wanted to improve upon the way that you control presentations, especially when connected to a projector."

In many ways, their project was deceptively simple. "We used a lot of technology that's already available," said Lin. "We didn't have to come up with anything new." It was how they integrated existing technologies that was particularly innovative in their project. The group created a laser pointer that had two buttons for left and right clicking with a Web camera to enable the user to access the functionality of a computer mouse from any location in a room.

Although they used existing technology, there were still a number of obstacles they needed to overcome. One such obstacle was getting the computer to "see" where the laser point was located. In testing, the laser point got lost in the illumination of the screen. The computer could not distinguish the laser point from other bright images on the screen. "What we ended up doing," said Lin, "was putting a red filter in front of the Web cam, so the Web cam only saw the color red." With the red filter, the laser point was suddenly the brightest dot on the screen, and the computer could find it easily.

Like many who take Senior Design, the students did not let these obstacles detract from the course experience. "Hands down, it was the best experience I had in the ECE Department," said Desai. Lin agreed: "The self-paced aspect and choosing your own project was something I found exciting." Both mentioned that they wished there could be more courses like this one in the ECE curriculum.

The Laser Guided Mouse transmitter and receiver. *Photo courtesy of Samir Desai.*

The Laser Guided Mouse project won the Spring 2007 Instructor's Award, which is given to the best overall project of the semester in the opinion of the instructor. "The Laser Guided Mouse provides an innovative solution to a mobile mouse for a presentation environment," said ECE Professor Gary Swenson, who directs the Senior Design course. "The students were innovative, with support from their TA Ethan Miller, in calibrating the device for any given projection."

Details about the Laser Guided Mouse, as well as information about other projects from this and previous semesters, can be found at http://courses.ece.uiuc.edu/ece445/.

ECE congratulates its **PhD recipients**

STUDENT	ADVISOR	DISSERTATION
OCTOBER 2006		
Ahmed, Arshad	Koetter, R.	Algorithms and Architectures for Soft-Decoding Reed-Solomon Codes
Chang, Shu-Wei	Chuang, S.	Slow Light Based on Quantum Effects in Quantum Wells and Quantum Dots
Choy, Young Bin	Kim, K.	Investigation on Uniform Biomaterial-Based Microspheres with Precisely Controlled Size and Size Distribution for Development of Advanced Drug Delivery Systems
Giridhar, Arvind G.	Kumar, P.	In-Network Computation in Wireless Sensor Networks
Hong, Seung Jae	Kim, K.	Development of GaN-Based Power Electronic Devices Using Plasma-Assisted Molecular Beam Epitaxy
Hong, Wei	Ma, Y.	Hybrid Models for Representation of Imagery Data
Hu, Chunyu	Vaidya, N.	Managing Critical Resources in Wireless Ad Hoc Networks—A Mac-Centric Approach
Huff, Gregory H.	Bernhard, J.	A Radiation Reconfigurable Magnetic Line Source Antenna: Modeling, Integration with RF MEMS, and Applications
Lanford, William B.	Adesida, I.	Process Development for Aluminum Gallium Nitride-Based Enhancement- and Depletion-Mode HEMTs
Liu, Tie	Moulin, P.	Some Information Theoretic Aspects of Reliable Communication with Transmitter Side Information
Lou, Zheng	Jin, J.	Time-Domain Finite-Element Simulation of Large Antennas and Antenna Arrays
McClain, Matthew R.	Levinson, S.	Semantic Based Learning of Syntax in an Autonomous Robot
Nakka, Nithin M.	Iyer, R.	Reliability and Security Engine: A Processor-Level Framework for Application-Aware Detection and Recovery
Sanghavi, Sujay R.	Hajek, B.	Decentralized Network Algorithms
Sethuraman, Vignesh	Hajek, B.	On Communication Over Correlated Fading Channels with Practical Power Constraints
Sorchini, Zakdy	Krein, P	A Framework for the Analysis and Design of Vector Controllers for Induction Machines
Tavildar, Saurabha	Viswanath, P.	Source and Channel Coding for Wireless Networks
Yang, Allen Yang	Ma, Y.	Estimation of Subspace Arrangements: Its Algebra and Statistics
Yuksel, Serdar	Basar, M. T.	Transmission of Information in Control Systems
Zhao, Weifeng	Adesida, I.	Monolithic Integration of Thermally Stable Enhancement-Mode and Depletion-Mode INP HEMTs Utilizing IR-GATE and AG-OHMIC Contact Technologies
Zhao, Zhijun	Blahut, R.	Two-Dimensional Information Transmission
DECEMBER 2006		
Comberiate, Joseph M.	Kamalabadi, F.	Tomographic Imaging and Characterization of Ionospheric Equatorial Plasma Irregularities with the Global Ultraviolet Imager
Correia, Davi	Jin, J.	A Higher-Order Perfectly Matched Layer for Open-Region, Waveguide, and Periodic Electromagnetic Problems
Kiyavash, Negar	Blahut, R.	Information Theoretic Limits for Secure Multimedia and Magnetic Recording
Lee, Bowon	Hasegawa-Johnson, M.	Robust Speech Recognition in a Car Using a Microphone Array
Ralston, Tyler S.	Boppart, S.	Interferometric Synthetic Aperture Microscopy
Sen Gupta, Ananya	Singer, A.	A Structural Approach to Multi-User Detection
Wang, Hongcheng	Ahuja, N.	Recognition, Mining, Synthesis, and Estimation (RMSE) for Large-Scale Visual Data Using Multilinear Models
Wang, Ying	Moulin, P.	Detection- and Information-Theoretic Analysis of Steganography and Fingerprinting
Wu, Bing-Ruey	Cheng, K.	Molecular Beam Epitaxy of Gallium Arsenide Antimonide-Based Ultra-High-Speed Double Heterojunction Bipolar Transistors and Light Emitting Transistors
Zhang, Guoliang	Krein, P.	Torque-Angle Based Analysis and Control of Induction
MAY 2007		
Albrecht, Peter M.	Lyding, J.	Scanning Tunneling Microscopy and Spectroscopy of Carbon Nanotubes Interfaced with Silicon Surfaces
Amrhein, Marco	Krein, P.	Induction Machine Performance Improvements—Design Oriented Approaches
Atkinson, Ian C.	Kamalabadi, F.	Techniques for Approximating Optimal Linear Estimators of Multidimensional Data
Bagci, Hakan	Michielssen, E.	Time-Domain Integral-Equation Based Analysis of Complex Structures Loaded with Cables
Byoun, Jaesoo	Chapman, P.	Analysis and IC Implementation of Digitally Controlled Multi-Port DC-DC Converters
Chu, Kuan-Lun	Masel, R.	Porous Silicon Membrane Based Formic Acid Fuel Cells for Micro Power Generation
Da Cunha, Arthur L.	Do, M.	Geometrical Representation, Processing, and Coding of Visual Information
Elarde, Victor C.	Coleman, J.	Nanoscale Selective Area Epitaxy for Optoelectronic Devices
Gao, Chunyu	Ahuja, N.	Advanced Imaging Through FOV and Aperture Manipulation
Geng, Xin	Krein, P.	Design and Analysis of Pulse-Width Modulation Techniques for Spectrum Shaping
Hu, Sai	Hess, K.	Simulations of Biological Ion Channels by Using the Shockley-Read-Hall Formalism
Jiang, Peilin	Michielssen, E.	Time Domain Integral Equation-Based Methods for Analyzing Electromagnetic Scattering from Objects Residing in Lossy Media
Lehman, Ann C.	Choquette, K.	Evanescently Coupled Vertical Cavity Laser Arrays
Leisher, Paul O.	Choquette, K.	Proton-Implanted Photonic Crystal and Holey Vertical Cavity Surface-Emitting Lasers
Meng, Jun	Michielssen, E.	Two Novel Fast Algorithms for Analysis of Low-Frequency Transient Electromagnetic Phenomena
Morrison, Robert L. Jr.	Do, M.	Multi-Channel Methods for Restoration in Computed Images
Rajaram, Shyam Sundar	Huang, T.	On Modeling Order and Structure with Applications to Computer Vision and Time Series Data
Ruppalt, Laura B.	Lyding, J.	Integration of Single-Walled Carbon Nanotubes with Gallium Arsenide(110) and Indium Aresenide(110)
Shakkottai, Srinivas	Srikant, R.	Exploiting Resource Diversity in Networks of Peers
Shen, Hongxia	Basar, M. T.	Linear and Nonlinear Pricing for Network Games with Complete and Incomplete Information
Wu, Hong	Cangellaris, A.	Methodologies and Algorithms for Finite Element Analysis of Electromagnetic Devices and Systems
Yang, Zhicheng	Ravaioli, U.	Study of Biological Ion Channels by Using PNP/ECP Model
Zysk, Adam M.	Boppart, S.	Surgical Breast Cancer Localization Via Coherent Measurement of Endogenous Optical Properties

Securing the future at Illinois

By Jonathan Hill, Director of Development

brilliant futures

THE CAMPAIGN FOR THE UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

On June 1, the University of Illinois launched an exciting and ambitious campaign to secure the future of all three campuses. Titled "Brilliant Futures," the campaign has set the lofty goal of raising $2.25 billion for students, faculty, research, and the campus environment. Of that University-wide goal, $1.5 billion is for the Urbana campus and $325 million is for the College of Engineering. Within the college, the money raised will be used specifically to help grow endowments; add scholarships, professorships, and chairs; and help fund a new building for ECE.

As of early August, the campus had met 55 percent of its goal thanks in part to a $100 million gift commitment—the largest gift in campus history—from history, business, and computer science alumnus Thomas M. Siebel.

So, why the name Brilliant Futures? According to the campaign Web site, brilliant describes the teachers and researchers whose contributions have been the foundation for this campus. It also describes the many opportunities students in ECE and across campus find here. Brilliant Futures becomes a reality when supporters who share the campus' vision come together to create something that's larger and more powerful than all of us.

I couldn't have said it better myself. And the University cannot assure a brilliant future without the continued support of our valued alumni and friends. For more information about the campaign or to make a donation, visit www.ece.uiuc.edu and click on the Brilliant Futures logo.

Ackmann endows scholarship

In describing his motivation for an endowment to fund scholarships for ECE students, Lowell Ackmann (BSEE '44) said, "Students always come first." He has a deep appreciation for how his Illinois education has had a positive impact on his career success.

At the time he received his degree from the University of Illinois, Ackmann had already been drafted into the Navy. He was part of a group of 400 Navy servicemen who came to Illinois to complete their engineering degrees. Though he had been in the Department of General Engineering as a civilian, Ackmann switched his focus. "I took electrical engineering because it was the part of engineering that I was having trouble understanding," he said.

That kind of tenacity and willingness to take on challenges served Ackmann well during his career. After he left the Navy, he worked for Allis Chalmers manufacturing company and later ran a construction company. In 1954, he joined Sargent & Lundy, a leading company in power engineering. At the time of his retirement in 1987, Ackmann was the senior partner of Sargent & Lundy.

Of his career and desire to provide for other Illinois students, Ackmann said, "The University was fundamental to my success, and I wanted to give something back." His wife Dorothy, also an Illinois alumnus, joins him in providing this endowment.

ECE alumnus and donor Lowell Ackmann with ECE Director of Development Jonathan Hill at last year's Chicago Cubs alumni event.

ECE Department Head Richard Blahut said, "ECE students at Illinois are among the best in the nation, and they will be the future national and world leaders in engineering and other endeavors. It is important that we recognize and encourage the very hard work that our students do. The scholarship endowment given by Lowell Ackmann and his wife, Dorothy, will enable ECE Illinois to continue to provide this type of recognition to future generations of students."

The Ackmann Family Endowment in ECE will award annual Ackmann Family Scholarships in ECE.

Alumni thoughts on **George Anner**

Professor George Anner

Thank you to those alumni who took time to type out their memories of Professor George Anner. A few of your recollections are below. More comments are posted at www.ece.uiuc.edu/news/resonance. If you'd like to share a comment, go to www.ece.uiu.edu/anner.

"George Anner was an outstanding lecturer. Coupled with the lab, I learned tricks and techniques that have served me well in academia and industry. One of my favorite 'Annerisms' was the way he would characterize thickness. If something was very thin, he would say that 'it's even thinner than a slice of Arby's roast beef!' George was also an inspiration out of class. He was an avid runner and his dedication to it was impressive even from the vantage point of a 23-year-old grad student!"

–Robert Black (PhD '84)

"In 1979, the local paper ran a full-page article on Professor Anner and his hobby of building Harpsichords from a kit. He wrote two books before he got into semiconductors—one was in math on differential equations and the second was on television. What a diverse man. The other lab Anner started was EE 346 on thick and thin films. Both of these 'fab labs' gave incredible hands-on experience with typical real-world lab equipment that other schools could not match."

–Jim Flynn (BSEE '78, MSEE '79)

"I worked with George as an intern in 1967 to set up the future lab for EE 344. He was the spark that started my 32 years in the semiconductor industry. I kept in touch with George after college and considered him a good friend. He is the only teacher in my life that I considered a great teacher, motivator, and semiconductor icon."

–Ray Bregar (BSEE '69)

"Before the Fab Lab came into being, I had Professor Anner for a couple courses, and he was outstanding. [One day while] walking down Green Street, I ran into Professor Anner by chance walking towards me. He stopped me to tell me he had been relooking at the final exams and that he found he hadn't given me enough credit for one problem, and when he did, I got an A for the class instead of a B. How many times does a professor voluntarily change your grade? I'll always remember that."

–Monte Ross (BSEE '53)

"This was before the Fab Lab. I have two special memories from when I took his course, in '58 or '59. From his lectures: 1) 'If it be true, and I call your attention to the correct use of the present subjunctive mood, if it be true that ...' 2) He crosses something out on the board and then he realizes that it's right, so he writes 'stet' on the board beside it, and says 'Stet, from the Latin steto, stetare, stetavi, stetatus: Let it stand!'"

–Don Lacy (BSEE '59, MSEE '61)

"I took the EE 344 class in 1971 from Professor Anner and it changed my life. George taught the class at 8 a.m. because 'that way I am done with all my work for the day by 9 a.m.' and 'only students who are really motivated will sign up for a class at 8 a.m.' I was a TA lab instructor for George during my first year of grad school in 1973–74. It was a real treat."

–Jerry Marcyk
(BSEE '73, MSEE '76, PhD '78)

Funds sought to create Anner Fund

Professor George Anner and the ECE Fab Lab he developed had a profound effect on generations of ECE students. Anner was not only an excellent teacher, but a multifaceted person who was entertaining and well-respected. Despite his sometimes tough exterior, those who got to know Anner found him to be a gentleman.

Anner passed away in 2004. To honor his memory, ECE is seeking donations to create the George Anner Fund to provide funding for ECE 444 facilities, equipment, and TAs. With enough support, the department hopes to one day convert the fund to the George Anner Endowed Professorship. If you would like to help honor Anner's memory, contributions may be submitted online at www.ece.uiuc.edu or mailed to:

Jonathan Hill
Director of Development
53 Everitt Laboratory
1406 W. Green St.
Urbana, IL 61801

DONOR PROFILE

For **Gilmore**, connection with ECE a **gift**

By Brad Petersen

Before becoming an industrial partner with Ripplewood Holdings Japan Inc., a private equity company, Merle Gilmore (BSEE '70) had a 30-year career with Motorola. He started with the company as an applied research engineer after graduating from Illinois. By the time he left, Gilmore had held numerous senior management positions, including president of the Land Mobile Products Sector; president for Europe, Middle East, and Africa; and president of the Communications Enterprise.

Alumnus Merle Gilmore displays a replica of the medallion given to Professor Gary Eden upon his investiture as the Gilmore Family Professor.

All of those leadership positions and five patents later, Gilmore credits ECE with not only helping him get his first job, but with giving him a solid foundation as his career progressed. "The background that I got from Illinois was critical to building the basis I would use throughout my career at Motorola to understand the technical challenges that led to the business decisions," Gilmore said.

The ECE Department and its students have in turn benefited from Gilmore's success. Merle and his wife, Lisa, established the Gilmore Family Faculty Fellowship in 1998 and have been contributing to it ever since. Professor Rayadurgam Srikant is the 2005–2008 fellowship holder.

In 2007, the Gilmores expanded their support of ECE by creating the Gilmore Family Professorship in Electrical and Computer Engineering. Professor Gary Eden became the first faculty member to hold the new professorship in April (see story on page 7).

"I never thought about any other school, never applied anywhere else, just always knew that Illinois was the place for me," Gilmore said in his remarks at the investiture ceremony. "Like most engineering students, my four years were hard, but I knew there was no better way to prepare me for my career and my adult life than to be here. The history and tradition, but most of all the excellence in the academic courses, students, and professors, are influences that help define what I am today."

Gilmore said that when he and Lisa thought more about giving back to the University, they focused on how they could help students benefit as he did from his experience here. That's why they chose to help maintain and enhance the foundation on which the excellence of ECE is built: the faculty.

Gilmore remembers fondly his communications classes, a quantum electronics class he took with Professor Nick Holonyak, and the Fab Lab, in particular. "The integrated circuit lab and Professor [George] Anner made an impression. It was a very hands-on experience," Gilmore recalled. "Back in 1968, semiconductors were just starting to become a force in electrical engineering. The opportunity to be able to understand the theory, fabrication, and real-life implementation of solid-state circuits was amazing."

Gilmore, who said he never really appreciated how privileged he was to attend Illinois until recruiters came calling during his senior year, feels that giving back to the department is a win-win for alumni. "I think it's important clearly to the department, but it's also important for the alumni. Step one is to stay connected. Continue to be involved with the deans and the department heads and the professors to keep that level of contact there. Figure out how to stay involved. I find it in no way a burden, but a gift to be able to remain active as many ways as I can with both the department and the college."

Donor List

February 2007 through June 2007

ECE is extremely grateful to the alumni, friends, and partners who have made contributions to the department. This list includes financial donations, but we are just as grateful for the ongoing support you lend in other ways. ECE could not maintain its position as a great educational and research institution without you.

The following list includes charitable gifts designated for ECE and received between February 1, 2007, and June 30, 2007. Gifts to other campus units may be recognized in other campus publications.

We strive to make this list as accurate as possible. If your name is listed incorrectly or omitted, please accept our apologies. To report an error or omission, or for information about making a gift, please contact Jonathan Hill, director of development, at (217) 265-6567 or jonahill@uiuc.edu.

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Rockwell Collins
Rockwell Collins Charitable Corp.
S&C Foundation
SC Johnson Fund, Inc.
Science Applications International Corp.
Seagate Technology
The Sun Microsystems Foundation, Inc.
TAC, LLC
TECO-Westinghouse Motor Co.
Tellabs Operations Inc.
Texas Instruments Foundation
United Technologies Corporation
Verizon Foundation
Videojet Technologies, Inc.
Wm. Wrigley Jr. Company Foundation

Major Gifts

Ackmann, Lowell E.
Anner, George (trust)
Chang, Herbert and Stella
Grainger, David W.
Henderson, Joan K.
Jeschke, Donald R.
Renwick, Brian L.
Steeper, Donald E. (estate)
Yau, Leopoldo D.

Gifts of $1,000 to $5,000

Beanblossom, Todd M. and Gale
Borth, David Edward
Chou, April
Chow, Doris W.
Horsley, Sherel D.
Kiesling, Robert W.
Mitchell, Joan L.
Moretti, Jo-Ann
Nearing, Fredric G.
Plofsky, Jordan
Smolik, Kenneth F.
Sample, Steven B.
Semmer, Joseph W. and Carole L.
Tolli, Dominic M. and Natalie J.

Gifts of $250 to $999

Altenbaumer, Larry F.
Beall, Charles W.
Bennett, Norman J.
Bennett, William S. and Cheryl S.
Beste, Randal T.
Briggs, James B.
Chickermane, Vivekanand
Cochran, Paul L.
Connors, Daniel P.
DeGregorio, Gary L.
Dickmann, James W.
Egbert-Jordan, Caroline W.
Grohoski, Gregory F.
Holm, John R.
Kang, Sung-Mo and Myoung A.
Koczo, Jr., Stefan
Kreer, John B.
Kuhlman, Mary A.
Lachman, Phillip M.
Landreth, Russell
Lewicki, Laurence D.
Nordquist, Walter R.
Norling, James A.
O'Neill, John G.
Oberstar, John B.
Owdom, Ronald S.
Papamarcos, Mark S.
Priegnitz, Robert A.
Schmitt, Ross A.
Senese, Thomas J.
Simaan, Rita
Stahl, Alan L.
Tomasic, Michael G.
Turic, Denise M.
VanBlaricum, Michael L. and Pamela Calvetti
Wishner, Richard P.

Gifts up to $249

Amaya, Luis E.
Anderson, Arne D.
Arndt, Jonathan M.
Arseneau, Timothy J.
Avey, Spencer E.
Barmann, Mark G.
Bartsch, John R.
Beck, Robert W.
Benkler, Jeffrey G.
Bertetti, David D.
Bigger, Walter H.
Bishop, Stephen G. and Helene E.
Blastic, William R.
Block, Patricia M.
Blumenthal, Michael E.
Brandt, Wayne D.
Boesdorfer, Gary W.
BonDurant, Edward H. and Marcia B.
Breeding, Juliann B.
Buhrmester, Leslie W.
Burge, Donald R.
Bushman, Joseph E.
Carlson, Richard L.
Campbell, Jr., Henry G.
Cangellaris, Andreas C. and Helen S.
Carr, James A.
Cason, David G.
Caspary, P. Jay
Centanni, James D.
Chan, Chi K.
Chapman, Bruce E.
Chu, Andrew
Chu, Henry M.
Cleveland, George M.
Colbert, James L.
Costa, Michael J.
Crain, James H.
Cropper, Leigh C.
Dalissandro, Frank A.
Delveaux, William J.
Desai, Samir A. and Bhavini S.
Desmond, John P.
Diong, Billy M. and Temmy
Dougherty, Mack X.
Dowding, Fielder G.
Dunbar, Mark E.
Dunning, Wendell R.

SHOW YOUR ECE PRIDE!

The ECE store now has several new items featuring the ECE logo, including a stylish hoodie, short sleeve polos in both blue and orange, and dressy button-down shirts for both men and women. There are also coffee mugs and T-shirts.

Items can be purchased online. Go to www.ece.uiuc.edu, choose ECE Illinois, then ECE Merchandise.

Ehmann, Gregory E.
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Emery, Edith R.
Erlebacher, Seth A. and Melissa A.
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Fama, Donald F.
Fehner, E. Charles
Fenoglio, Pete
Gallinat, Douglas J.
Gardner, Chester S. and Nancy C.
Gerber, Howard L.
Geschwind, David P.
Gibbs, Robert K.
Gouveia, Christopher M. and Leslie Lauren
Grabacki, Silvia M.
Graff, Timothy E. and Therese C.
Green, Philip B.
Guilette, Michael S.
Hadfield, Jean B.
Hale, Michael C.
Hall, Douglas C.
Hansen, Timothy R.
Hanson, Allen W. and Christine M.
Harmon Webb, Jennifer L.
Haruch, John
Hassebrock, Melvin D.
Hassler, Kerry W.
Hausfeld, Erica
Hill, Kent B.
Hill, Michael L.
Hipple, Martin J.
Ho, William W.
Hodel, A.S.
Hodges, IV, Eugene W.
Hoeflinger, August J.
Horst, Robert W. and Julie A.
Hunt, Stanley R. and Betsy R.
Hwang, Jong T.
Jepsen, Alan M.
Jha, Niraj K.
Johnson, Judith A.
Johnson, Peter L.
Jones, Jr., Edwin C. and Ruth M.
Kanney, Robert F.
Kennedy, John J.
Kim, Jaehu
Kochan, David A.
Konrad, Steven S.
Kruger, Douglas W. and Deborah J.
Kunkel, Mark C.
Langdon, Fe C.
Langlois, William M.
Laursen, Robert L.
Layman, Roger S.
Lee, Jeffrey J.
Lockhart, G. William
Maher, Robert C.
Marble, Donald C.
McCarthy, Thomas G. and Elizabeth L.
McGreer, Thomas H.
Morgan, Jr., Thomas M.
Moring, Stuart A.
Mowery, Robert W. and Elizabeth H.
Munson, Bill A.
Musick, Sr., Charles R.
Nagel, Jeffrey M.
Neuhalfen, Michael A.
Ng, Spencer W. PhD
Nichols, JeanAnn
Nowakowski, Donald J. and Susan R.
Nuspl, Stephen J.
O'Brien, James D.
Ortiz, Alexandra
Pagones, Michael J.
Parikh, Mitesh M.
Parks, Rodney T.
Patha, Robert R.
Pawlowski, Andrew J.
Peckham, Vernon D.
Pellizzari, Michael P.
Peterson, Andrew F.
Peyer, H. Alan
Phelps, Weldon L.
Pluth, John
Polesky, Richard W.
Potter, Lee C.
Pottle, Christopher
Porter, Jeffrey S.
Quirin, James D.
Radke, William A.
Ray, Howard K.
Rejc, Jerome T. and Cheryl
Repke, Joseph P.
Resman, John B
Ritzert, John A.
Ruby, Robert A.
Ruffner, Gregory N.
Samaras, Nick
Sanders, William H. and Emily E.
Schafer, Wayne F.
Scheer, Roger L.
Schellinger, Michael W.
Schrock, Anthony W.
Schultz, Joseph G.
Schwartz, Alan M.
Segal, Andrew C. and Laurie Dahm
Seuring, Jeremy N.
Shah, Ketu K. and Priti
Shedko, Marilyn J.
Sheehan, Michael R.
Short, Jeanette A.
Simmons, Michael F.
Singleton, Russell M. and Louise C.
Sipinski, Gene
Sowder, John M.
Stapleton, Jim
Stephens, James E.
Stocker, Jeffrey E.
Stocks, John C.
Stoneburg, Edward F. and Beverly J.
Strom, Harold
Stroming, James W.
Sumrall, George E.
Sutton, Edmund C.
Swanson, Richard C.
Swatik, Donald S.
Swim, Alan D.
Taggart, Donald K.
Tan, Kwang G.
Tang, Donald T.
Taylor, Javin M.
Terry, S. Wayne
Tietz, Elmer M.
Trick, Michael D.
Tolish, Theodore
Torkildsen, Robert A.
Turkowski, Kenneth E.
Valenti, Sam
Van Pelt, Richard T.
Wagner, Mark S.
Wanka, John R.
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Wheeler, Jonathan S.
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Wilhelm, Andrew L.
Wirth, Robert D.
Witte, Elden H.
Woerner, Leo G.
Wytmar, III, Richard J.
Xu, Junjie
Yin, Felix X.
Young, Jr., Newell F. and Paulette
Yu, Gilbert S. and Mabel L.
Zarnow, David F.
Zinkus, Thomas J.
Zona, Mark J.
Zuzzio, Zach

INTERESTED IN MAKING A DONATION TO ECE ILLINOIS?

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To schedule an informal appointment, please contact:

Jonathan Hill,
Director of Development
53 Everitt Laboratory,
1406 W. Green St.
Urbana, IL 61801
(217) 265-6567
jonahill@uiuc.edu

Contributions can also be made via secure Internet transaction at www.ece.uiuc.edu.

President's letter

Letter from the ECE Alumni Association Board of Directors President

Dear Fellow ECE Alumni,

I am honored by the opportunity to serve as your board of directors president.

I was introduced to the possibility of a career in technology in the early 1980s by exuberant news stories about a booming Silicon Valley. From what I read and hear today, the outlook for technology careers is not perceived to be as rosy. The reality is just the opposite. While the number of U.S. students entering STEM-related (science, technology, engineering, and math) occupations is declining, the pervasiveness of technology in our lives is rapidly increasing. As a result, the gap between the number of technology workers the U.S. needs and the number that schools like Illinois are graduating continues to widen.

As ECE Illinois alumni, we can help reverse this alarming trend. We can:

- Encourage children to study math and science and to explore careers in engineering.
- Participate in programs that introduce students to the world of engineering and technology in local schools, through employers, and through professional organizations.
- Mentor current ECE students and new graduates by becoming active alumni.
- Answer students' questions by posting responses on our Alumni Web Board.
- Network with students and alumni by registering for Always Illinois, the University's online community.
- Support our alma mater by volunteering, recruiting, and donating.

As ECE alumni, we are 20,000 strong, and we live and work around the world. If each of us communicates a positive message in our own backyard about our experiences, education, and careers, another generation of students can be encouraged by the promise of a bright technology future and ensure an abundant supply of talented engineers.

Sincerely,

Denise Turic (BSEE '88)
ECE Alumni Association
Board of Directors President

Always Illinois—your online network

Log on to Always Illinois for a fun, free, easy way to interact with Illinois alumni and students. This private online service provides a great way to connect with old friends, build a network of new ones, share memories, or look for job opportunities. For more information, go to www.ece.uiuc.edu and enter the Alumni section.

Alumnus wants you to **burn rubber, not oil**

By Brad Petersen

Behind two nondescript office building doors that could hide any call center, insurance company, or consulting firm sits one of the most talked about startup companies ever. These doors are the gateway to Tesla Motors, a four-year-old company that's all about energy—both figuratively and literally. This past summer, the San Carlos, California, company's offices were buzzing as employees prepared to begin production of the Tesla Roadster, an electric sports car that may signal a revolution in the automotive industry that some would say has been a long time coming.

Tesla's cofounder and CEO is Martin Eberhard, an ECE alumnus (BSCompE '83, MSEE '84) and a man who possesses a rare combination of brilliant ideas, passion, leadership, and salesmanship. Much has been written about Eberhard's affinity for cars, but it's actually his entrepreneurialism and strong belief in environmental responsibility that have driven him to create an all-electric car that's as efficient as it is beautiful.

AN UNNECESSARY DILEMMA "I was thinking about my next car, and I thought that I would buy another sports car," Eberhard said. "In a time of wars in the Middle East and…global warming becoming more obvious, for me to spend a bunch of money and buy a car that gets lousy gas mileage and puts a lot of CO_2 in the air just seemed irresponsible. On the other hand, the kinds of cars you can buy that get reasonable gas mileage are no fun. They're not pretty."

Eberhard, who is originally from Berkeley, California, but spent his senior year of high school in Illinois, decided to build a car unlike the other electric vehicles that had been built over the years.

"I thought it was crucial for our first car to absolutely change the way people think about electric cars. They don't have to be a letdown. They don't have to be a compromise. You don't have to give up what you love about cars to drive a car that doesn't burn gasoline," Eberhard explained. "It was critical for us to really hit a home run on the looks and performance of the car."

ONE MOVING PART And Tesla has done just that. A sleek, low-riding, two-seat sports car, the Tesla Roadster is every bit as eye-catching as a Porsche or Corvette. The similarities, however, end with the car's attractive exterior.

"Mechanically, it's simple. Technology-wise, it's quite sophisticated," Eberhard said. "Our motor has exactly one moving part, whereas your engine in your car probably has 200 moving parts. There's just the rotor that turns. Behind it is a pretty amazing piece of electronics, though."

That simplicity means car maintenance is pretty easy. Say goodbye to oil changes, smog checks, timing belts, oxygen sensors, and spark plugs. The Roadster's 70-pound motor has just two bearings, which need to be relubricated every 100,000 miles. Of course, like any vehicle, you'll still need new tires and brakes periodically.

Eberhard said the car is powered by about 400 volts and, at its peak, outputs more than 650 amps. When the Roadster motor is pulling at full power, it can generate 185 kilowatts, or as much power as 10 houses functioning at their peak. The Roadster's patented battery system runs on 6,831 lithium ion batteries—the same ones you'll find in a laptop computer. They're easy to recharge by simply plugging the car in at the end of the day.

IT PAYS TO BE NAIVE Eberhard, who founded startups Network Computing Devices and NuvoMedia before Tesla Motors, knew what he was getting into—sort of.

"Everybody says that starting a car company is really hard. And they're right! It is really hard. I think that a necessary ingredient to be an entrepreneur is a certain amount of naivete," Eberhard proclaimed. "If you really know how hard a problem is, you won't do it! That's been true for every company I've ever started, and this is my third one."

The first problem was finding investors. Eberhard says that the issues of global warming and dependence on foreign oil weren't as prominent four years ago when he and Marc Tarpenning, now Tesla's vice president of engineering, began the company. Nonetheless, he was able to find supporters who also saw the connection between oversized, gas guzzling vehicles and these now-unavoidable issues.

"What's hard about what I'm doing is the sheer number of balls I'm juggling at once, and they aren't balls. They're knives and chainsaws and burning [stuff], and the trick is not dropping any of that. That's what makes it hard."

But raising money was just the first challenge. Taken alone, the task of designing a new car is a daunting one. Then consider that, for each newly engineered component, the company needed to find the best, most efficient way to manufacture it. Eberhard set up a factory in Taiwan to build the motor and another in Thailand to produce the batteries. Lotus, a pretty well-known carmaker in its own right, will assemble the final product for Tesla in England. Then throw in navigating a world of auto rules and regulations, necessary licenses, safety testing, and setting up a network of stores stocked with spare parts around the world and you begin to see just how overwhelming creating Tesla Motors and the Roadster has been.

"What's hard about what I'm doing is the sheer number of balls I'm juggling at once, and they aren't balls. They're knives and chainsaws and burning [stuff], and the trick is not dropping any of that. That's what makes it hard."

Photos courtesy of Tesla Motors

A FAMILY CAR, TOO All that having been said, Eberhard and Tesla Motors have already launched their next project: a family sedan.

"We have a long way to go yet. The idea is to sell more of them. We'd like to sell 10,000 to 20,000 cars a year, which is still tiny in the world of the auto industry, but it's 10 times what we're doing now. If I can do 10 times every couple of years, well, pretty soon I take over the whole universe." (Continued on page 30.)

EBERHARD RECALLS HIS TIME AT ILLINOIS

Martin Eberhard, who said he received his most expensive speeding ticket while at Illinois driving an old Mustang to Philo, served as a teaching assistant in the Advanced Digital Systems Lab (ADSL).

When he wasn't breaking the law, Eberhard spent time working on his master's thesis project: a robot that was essentially a giant piece of aluminum with a wheel on each corner that was independently steered.

"Movement was coordinated by a network of 8,051 microprocessors. This thing was designed so you could translate while you're driving or spin in a straight line while you were moving," Eberhard recalled. "The amount of freedom of movement that was possible was absolutely unbelievable. It was this big giant ungainly thing, and when you turned it on, it was a ballerina."

Eberhard, whose focus was in control systems, was influenced by Professor Ricardo Uribe, who oversaw ADSL at the time and was one of his advisors. He called Professor Ed Davidson's classes a delight (Davidson was his other advisor).

Eberhard said he chose Illinois over Berkeley because there were fewer distractions and he was better able to focus on his studies.

Banerjee **brings his expertise** to Hewlett-Packard

By Tom Moone

"I have been in academia for 20-plus years. It's time to take some risks and see if I can apply my skills in a totally different domain." So said ECE alumnus and former Illinois faculty member Prith Banerjee (MSEE '83, PhD '85) in explaining why he left his position as dean of the College of Engineering at the University of Illinois at Chicago to join Hewlett-Packard as senior vice president of research and director of HP Labs on August 1.

Banerjee came to Illinois after receiving his undergraduate degree from the Indian Institute of Technology, Kharagpur. After receiving his master's and PhD degrees from ECE, he joined the ECE faculty and taught at Illinois from 1985 to 1996. "The last two years at U of I," said Banerjee, "I got my first taste of administration as the founding director of the Computational Science and Engineering Program [www.cse.uiuc.edu], which was a graduate program involving 10 departments in the College of Engineering to promote the field of computational science." This administrative experience soon led him away from Urbana-Champaign.

In 1996, Banerjee joined the Department of Electrical and Computer Engineering at Northwestern University, and in 1998, he became the department chair there. While at Northwestern, he focused much of his efforts on improving the stature of the department. "With the help of our faculty, we were able to move our department up in rankings to the mid-teens," said Banerjee. "That was a really, really exciting challenge."

In 2004, Banerjee became the dean of the College of Engineering at the University of Illinois at Chicago (UIC). There, he worked to improve the rankings of the entire college.

Now, as part of HP, Banerjee will oversee numerous facilities around the world. HP Labs, which was established in 1966, has its headquarters in Palo Alto, California, and has other facilities in Bangalore, India; Beijing, China; Bristol, England; Haifa, Israel; St. Petersburg, Russia; and Tokyo, Japan.

HP Labs performs its research in a way similar to university research. Rather than simply focusing research on the next product line, HP Labs takes a long-term view, looking perhaps 10 years into the future for research developments and opportunities. In this way, Banerjee's academic administrative experience will fit in nicely. "Through my experience as a department head at Northwestern and as a dean at UIC, I've been able to lead academic research organizations in a wide variety of fields," said Banerjee. "So, that part will translate very easily into HP Labs, which is essentially an industrial research lab that's not tied to any products."

In addition to his experience as an administrator and researcher, Banerjee will also bring experience as an entrepreneur. In 2001, he founded Accelchip, a company that developed products and services for electronic design automation. This company was later bought by Xilinx Corporation. In 2004, he founded Binachip, which produces software to enable embedded systems developers to design and implement high-performance applications on hardware. This experience in technology transfer will assist Banerjee as HP Labs works to transfer its technological innovations to its commercial divisions.

ECE alumnus Prith Banerjee has joined Hewlett-Packard as senior vice president of research and director of HP Labs.

Banerjee's wife, Swati, will join in his move from Chicago to Palo Alto. Their son, Swaraj, will begin his own university career at the University of California, Berkeley, this fall.

Alumnus **Scarpelli reflects on career** in patent law

By Jamie Hutchinson

As an undergrad in ECE, alumnus Nate Scarpelli (BSEE '58) absorbed the teachings of ECE faculty in the classroom. He never dreamed that years later he would be defending their research in the courtroom.

Scarpelli's uncle, a chemical engineer who started law school while Scarpelli was attending Illinois, told him about his plan to enter the field of patent law. "I didn't know what that was," recalled Scarpelli. "I said, 'What the heck is patent law?'"

By his last semester, Scarpelli was interested enough to take a general engineering law course as a nontechnical elective. "It was a lot easier than the engineering courses," he recalled.

Scarpelli began his career as a contract engineer for Cook Research Labs, a military contractor based in Morton Grove, Illinois. He worked out of Macon, Georgia, installing weather-related instrumentation on Air Force bases and down-range missile tracking stations. "We were sending up the Vanguard missiles with the monkeys, and they were going down off the coast of Africa. The government was tracking those missiles, so they needed cloud-height measuring equipment and wind measuring equipment and such."

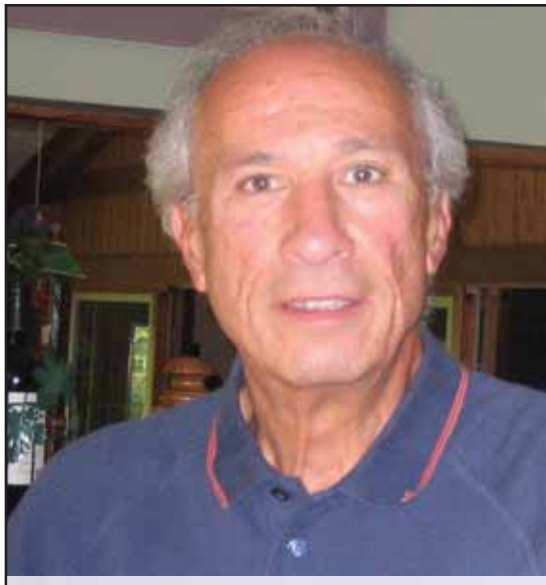
Scarpelli left Cook for a short stint in the military, then returned as an employee at company headquarters. "It was all government contracts, all top-secret work. I really liked it, but after six months or a year, I just started thinking again about patent law and feeling that maybe I should do something else."

He decided to take night classes at DePaul law school while continuing to work full-time at Cook. During his last year of law school, he secured a job preparing patent applications for Automatic Electric, a Chicago-based telephone equipment manufacturer.

For Scarpelli, preparing patent applications was anything but dull. "It's exciting because you're using your engineering skills; you're at the state-of-the-art; you're talking to engineers; you have to understand what they're talking about; and you have to be able to ask pertinent questions." What's more, Scarpelli had enjoyed writing since his days working on his high school newspaper.

After a year and a half with Automatic Electric, Scarpelli decided to try his hand at litigation. In 1965, he joined Merriam, Marshall, et al., where he remained until his retirement in 2002. With this Chicago firm (presently called Marshall, Gerstein & Borun, LLP), Scarpelli went on to file patents for ECE inventions like the plasma display panel and PLATO, and to litigate cases involving ECE's famous log-periodic antennas (LPDs). Scarpelli and colleagues at Merriam Marshall defended the University's claim on the LPD all the way to the Supreme Court, where they lost the case on a procedural matter (see ECE *Alumni News*, Summer 2004).

"As a patent guy, you don't handle just electrical cases—you get into different things," said Scarpelli. In one memorable case, Scarpelli successfully defended a pharmaceuticals manufacturer against an antitrust suit, allowing the company to continue licensing its product for treating iron deficiency in humans and piglets. In another, the distributor of a Velcro dart game hired Scarpelli's firm to defend him against a patent infringement suit by the famous inventor Jerome Lemelson. Scarpelli recalled that decision with satisfaction: "I think it's one of the few cases Lemelson ever lost."



Nate Scarpelli at home in Glen Ellyn, Illinois. *Photo courtesy of Nate Scarpelli.*

Scarpelli and his wife Sue have lived in Glen Ellyn, Illinois, for over 40 years. All four of their children are Illinois alumni.

ALUMNI CLASS NOTES

1960s

Paul R. Gulbis (BSEE '66, MSEE '68) joined WestWind Technologies, Inc., a leading aircraft integration services provider, as vice president of engineering.

Robert A. Malstrom (BSEE '69) became a partner in the Chicago office of Sidley Austin LLP, one of the world's largest law firms.

William A. Wulf (MSEE '63) was elected to the American Philosophical Society on April 27.

1970s

Vijay Balakrishnan (MSEE '76) was appointed chief operating officer of VSoft Corporation, a global information and technology provider of process improvement solutions for financial institutions.

Russell D. Dupuis (BSEE '70, MSEE '71, PhD '73) received the prestigious 2007 IEEE Edison Medal at the 2007 IEEE Meeting Series II conference in June.

Philip B. Green (MSEE '73) retired as director of engineering for the Advanced Products Center of Raytheon after working for more than 34 years with Raytheon/Texas Instruments.

Michael E. Klockenga (BSEE '73) joined Progressive Electric, a division of Protection & Communications, Inc., that specializes in residential and commercial line voltage installations, as its president in 2006.

William O'Brien, Jr. (BSEE '66, MSEE '68, PhD '70) received the 2007 William J. Fry Memorial Lecture Award, which recognizes an individual who has significantly contributed to the scientific progress of medical diagnostic ultrasound.

Mark Pflederer (BSEE '79) became vice president for the Heaving Construction & Mining Products Division at Caterpillar Inc., the world's leading manufacturer of construction and mining equipment, diesel and natural gas engines, and industrial gas turbines.

1980s

Camron Amin (MSEE '88) began a two-year term as associate dean of the college of arts, sciences, and letters at the University of Michigan-Dearborn on August 15.

Roy A. Axford, Jr. (BSEE '77, MSEE '80) received the 2006 Department of the Navy Top Scientists and Engineers of the Year Award. Axford, who received a PhD in electrical engineering from the University of California, San Diego, in 1995, was recognized for leading a team of engineers that, through interoperability testing, uncovered a flaw in a new Department of Defense communications satellite payload prior to launch.

Prith Banerjee (MSEE '83, PhD '85) became senior vice president of research and director of Hewlett-Packard Labs on August 1.

Edward Butte (BSEE '82) was named vice president and general manager of Magnetek, Inc., Communications Power Systems Division, a company specializing in the development, manufacture, and marketing of digital power and motion control systems.

Timothy C. Chou (MSEE '78, PhD '81) joined the board of directors at Blackbaud, Inc., a leading global software and services provider targeted specifically for nonprofit organizations, in June.

Roger E. Merel (BSCompE '84) was appointed vice president of product strategy at Scintera, Inc., a fabless semiconductor company specializing in products that empower multi-gigabit communication and networking systems, in April.

1990s

Ioannis Kanellakopoulos (MSEE '89, PhD '92) was appointed chief technology officer at Actelis Networks, the leading global supplier of Carrier Ethernet over Copper solutions.

Todd Slama (BSEE '97) and Allison Holder were married August 12, 2006, in Freeport, Ill. Todd is an electrical engineer at Honeywell in Freeport.

David J. Smentek (BSEE '94) and Jill M. Fink were married October 21, 2006, in Bloomingdale, Ill. David is an electrical engineer at Motorola in Arlington Heights, Ill.

2000s

Graham R. Alvey (BSEE '04, MSEE '06) and Nicole R. Wiggs were married June 17, 2006, in Belleville, Ill. Graham is an electrical engineer at Motorola in Chicago.

KEEP IN TOUCH!

Have good news you'd like to share with your fellow alumni? E-mail Jill Jarboe, alumni and student relations coordinator, at jjarboe@uiuc.edu, or submit your information online at www.ece.uiuc.edu. Go to the Alumni section and select "Keep in Touch Form." You may also mail your news to:

Jill Jarboe
Alumni and Student Relations Coordinator
55 Everitt Laboratory
1406 W. Green St.
Urbana, IL 61801

Jay A. Fleck (BSCompE ’00) and Suzanne Powaga were married August 18, 2006, in Oak Brook, Ill. Jay works for Jackson Software in Glencoe, Ill.

Brent R. Nauman (BSCompE ’05) and Megan N. Richardson (LAS ’06) were married December 30, 2006, in Taylorville, Ill. Brent currently works at Caterpillar Inc. in Aurora, Ill.

IN MEMORIAM

David G. Berry (BSEE ’54, MSEE ’55) died January 27, 2007. He was 77. Berry served in the U.S. Army Air Corps and Air Force. He retired after 40 years of working in the aerospace industry.

Earl S. Constant (BSEE ’33) died February 23, 2007. He was 95. After college, he ran his own engineering company, E.S. Constant Co., until his retirement at age 70.

Christopher L. Dilks (BSEE ’89) died May 3, 2007. He was 40. Dilks had served as an electrical engineer with Facilities and Services at Illinois since 1998.

John Fijolek (BSEE ’51) died in June 2007. He was a World War II and Korean War Army veteran.

Darrell L. Gieseking (BSEE ’60, MSEE ’61, PhD ’64) died February 1, 2007. He was 69. Gieseking worked at McDonnell Douglas Corp., Hughes Aircraft Co., and Raytheon Missile Co. At the time of his retirement from Raytheon in 2000, he was vice president of Ballistic Missile Defense.

Robert E. Green (BSEE ’49) died April 30, 2007. He was 84. Green served in the Army during World War II and received a Purple Heart. He went on to work at Andrew Corporation and retired after 32 years of service.

Warren T. Hunter (BSEE ’49, MSEE ’50) died February 10, 2007. He was 79. Hunter served in the U.S. Army Air Corps during World War II. He later worked for Douglas Aircraft in California for nearly 40 years.

Walter J. Komorowski (BSEE ’48) died May 17, 2007. He was 81. Komorowski served in the U.S. Navy as a navigator bombardier during World War II. He was a career employee of Illinois Bell.

William C. Mescher (BSEE ’53) died April 8, 2007. He was 79. Mescher had been a South Carolina senator since 1993. Before joining the Senate, he was president and CEO of Santee Cooper and served in the military during the Korean War.

Chung-Dau Mo (BSEE ’68) died January 26, 2007. He was 69. Mo was a scientist and engineer for Lockheed Martin Corp.

Harvey A. Nelson (BSEE ’50) died April 27, 2007. He was 83. Nelson served in the Navy during World War II.

Alexander D. Perwich (BSEE ’51) died February 15, 2007. He was 82. Perwich served in the U.S. Army.

William T. Reace, Jr. (BSEE ’42) died November 23, 2006. He was 86. Reace was a U.S. Navy veteran and electrical engineer for General Electric.

Ralph M. Roney (BSEE ’40) died May 22, 2007. He was 89. Roney served in the U.S. Navy during World War II. He later worked for the Village of Rantoul Electric Department as consultant engineer and retired from Chanute Air Force Base as an electrical engineer after 38 years.

Harold C. Schlicht (MSEE ’66) died January 23, 2007. He was 75. Schlicht served in the U.S. Air Force for 20 years, five of which he spent on the faculty at the U.S. Air Force Academy. He also worked for the Lockheed Martin Corp. as an engineer.

Joseph Spengler (BSEE ’39) died March 16, 2007. He was 88. Spengler served as a lieutenant commander in the U.S. Navy during World War II as a pilot on the USS Chicago and USS Yorktown. He later worked at Illinois Power Co. as an electrical engineer for 36 years.

Charles W. Studt (BSEE ’49) died February 13, 2007. He was 83. Studt was a veteran of World War II and became a farmer after graduation. He was also a board member of the Ashkum Township Fire Department for 40 years.

Myron L. Stuebe (BSEE ’65) died January 20, 2007. He was 68. Stuebe served in the U.S. Navy for four years. He later became an electrical and controls engineer for Proctor and Gamble, where he received the PRISM Award for his technical mastery in processing and equipment innovations in the paper engineering and manufacturing division.

Robert G. Thomson (BSEE ’71) died May 18, 2007. He was 65. Thomson retired from ON Semiconductors of Tempe, Arizona, as a senior design engineer.

Willis M. Whitfield (BSEE ’48) died January 8, 2007. He was 86. Whitfield served in the U.S. Army during World War II as master sergeant during the European Campaign. He later taught physics and math at Granite City High School for 31 years.

A NEW TRADITION BEGINS

Members of the Class of 2007 became the first alumni to officially make their mark on the walls of Everitt Lab. All 2007 graduates were asked to sign the Class of 2007 banner, which is now hanging on the main floor in Everitt, a tradition the department hopes to continue for many years to come.

Bioacoustics Research Lab: A history of innovation

By Tom Moone

The Bioacoustics Research Lab (BRL) at Illinois has been at the forefront of research in the area of ultrasound for more than 60 years. In addition, it was an early leader in bioengineering research at the University. Throughout its history, this lab has led to advances in science that are providing medical benefits to countless individuals every day.

Bioacoustics as a research area has its beginning at Illinois with the arrival of William Fry on campus in 1946. During World War II, Fry was at the Naval Research Laboratory working on sonar systems. When he arrived at Illinois, he was ready to carry on similar research topics dealing with ultrasound. Fry's brother, Frank, also came to Illinois to work on ultrasound research.

When he arrived on campus, the Electrical Engineering Building (which later became known as the Electrical Engineering Research Lab (EERL) a few years later once the building now known as Everitt Lab was built) was cramped for space. The building spanned the Boneyard Creek in an area now occupied by the Bardeen Quad, and during this time of space crisis, Fry found himself with office space located below the Boneyard in a steam tunnel connecting the north and south sections of the building. Fortunately, this colorful beginning was only temporary, and more permanent and suitable quarters were soon found.

Though Fry began his research projects upon his arrival, it was in 1948 that he organized what was then known formally as the Bioacoustics Laboratory. What essentially began in a steam tunnel would eventually find its quarters in a major research facility. From EERL, the lab moved to the Electrical Engineering Annex in 1965, a building that once housed the University's power plant. Then, in the early 1990s, BRL moved to its current state-of-the art facility within the Beckman Institute for Advanced Science and Technology.

Fry began his research by studying the biological effects of ultrasound on animal tissue. Through this research, it was learned that ultrasound had an effect on all types of tissues, that the effects could be permanent or temporary, and that repeated exposure to ultrasound that was below the threshold level of permanent damage would not adversely affect the tissue.

Because the lab was so unique in its research, many of the instruments needed had to be invented and produced by the lab. During an interview in 2003, ECE Professor Emeritus Floyd Dunn (BSEE '49, MSEE '51, PhD '56) recalled, "We designed and fabricated ultrasonic instruments in the lab. We had to make everything ourselves." All the equipment to create, detect, and analyze ultrasound was built from scratch. Although, as Dunn notes, "many of the materials used now were not available in those days," this did not adversely affect the research.

One of the lab's key research areas was the use of ultrasound for disease therapies, including surgery.

Fry had been interested early on in developing ultrasound so it could be used as an alternative method for neurosurgery. By the mid-1950s, research had advanced to a point where surgical methods through ultrasound were ready to be tested. "Bill Fry tried to interest the U of I Medical School in doing something with this," recalled Dunn, "but they were not interested." In 1955, Russell Meyers, a professor of

In order to make room for his laboratory equipment, Bill Fry moved his desk out of his office into the only available space: a steam tunnel beneath the EERL. *Photo courtesy of the College of Engineering Publications Office.*

neurosurgery at the medical school of the University of Iowa in Iowa City showed interest.

Several years were needed to prepare rooms in the hospital there for housing the appropriate instrumentation. In 1958, an operation using ultrasound was performed on a patient who had Parkinson's disease. Over the next four years, said Dunn, "Our lab sent people for two weeks of every month to oversee and conduct the procedures." After Meyers left Iowa, this surgical research ended, and the lab's main focus returned to mapping brain structures and studying the biological effects of ultrasound.

For much of its history, ultrasound has also been used for imaging. ECE Professor Bill O'Brien (BSEE '66, MSEE '68, PhD '70) said, "Understanding how sound interacted with the biological material made it possible to realize that you could in fact image biological tissue. When the electronics became available…it was a no-brainer to think, 'Well, yeah, we can [create] images.'" This understanding of the nature of the interaction of ultrasound and biological tissue was a pioneering effort of BRL. Without this research, the development of ultrasound imaging would have been greatly delayed. "It's not that none of this would have gotten done," said O'Brien, "but it occurred much, much earlier."

Over time, the expanse of research in BRL moved beyond bioacoustics. The research still kept a biology focus, but researchers were not simply focusing on acoustics. ECE Professor Emeritus Leon Frizzell recalled of the lab, "Basically, everybody was bioengineering-oriented, but different fields of bioengineering."

ECE Professor Bruce Wheeler, who also serves as interim head of the Department of Bioengineering, came to Illinois to be part of BRL in 1980. He is one of the BRL members whose research interests did not focus on acoustics.

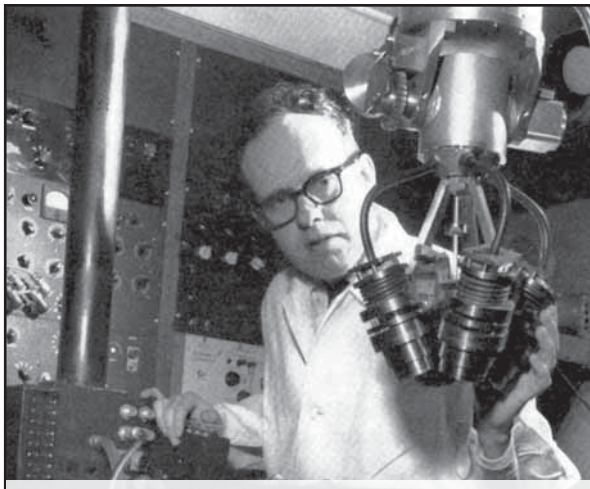
"I came in, and I have always been interested in neural signals," said Wheeler. "I got interested when I got here in learning to do microfabrication of electro-arrays. I taught myself how to do that while I was here. I tried to make some devices before the microelectronics labs were started. I ended up with a niche that is pretty simple fabrication devices, but a lot of interface work with biology."

Wheeler echoed Frizzell's assessment of BRL. "We were the bioengineering end of the EE Department," said Wheeler. In fact, Wheeler said they were close to being the Bioengineering Department for the University, since so many people who were studying bioengineering were from ECE, especially those who were in BRL. "Nobody was offering courses like we were in this area," said Wheeler.

Over time, BRL became less and less the center of bioengineering-related research in the department. And the number of researchers across campus who had interests related to bioengineering grew. In 2003, the University opened its new Department of Bioengineering. This department is not a direct spin-off from ECE or BRL, and researchers in ECE interested in bioengineering have generally stayed with ECE. Nevertheless, the early pioneering research in bioengineering-related fields that took place in BRL was a precursor to this new department.

BRL continues in its research in providing therapy to this day. O'Brien said, "The area of therapy we work on goes by the buzzword 'gene therapy.' We're doing studies to affect the permeability of membranes to get drugs across membranes to treat diseases." Through the use of ultrasound, cell membranes in a very small, very controlled area can be altered to allow the administration of drug therapies.

Work continues on imaging with ultrasound. "We're looking at mammary cancer diagnosis," said O'Brien. And for O'Brien, the word "diagnosis" is key. Currently, ultrasound is used simply for detection: it can locate an abnormality in the anatomy. "What we're looking at is doing some of the next set of tests also by ultrasound," said O'Brien. They are trying to perfect the ultrasound process to be able to say whether an abnormality is cancerous or not, and if it is, what type of cancer it is.



Four ultrasonic generators are aimed by Fry so that their beams are focused at a single point.

But clinical applications of this research are perhaps five or 10 years away. And O'Brien said the lab had always been working at that stage—several years ahead of current technology. "I think if we're doing our job right, we're working on problems that are that far out. Companies won't do it because the risk is higher. . . .We're working far enough out—that's what a university should be doing."

Those who worked and continue to work in the lab have a great deal of pride in its history and in the work that continues to be conducted there. Summing up his BRL experience, Frizzell said, "I'm very happy to have been associated with BRL. It was a great lab and a great department. I feel honored and lucky to have been part of that."

Alumnus wants you to burn rubber, not oil

Continued from page 23.

The Tesla sedan will be less expensive than the Roadster, have greater seating capacity, and be made in the USA using parts almost entirely designed by Tesla specifically for the vehicle. You can still expect a great-looking, high-performance car. Tesla is aiming to finish the car in 2010.

In the meantime, Eberhard has gone from zero to nearly 570 orders for the Roadster in four years, a statistic rivaled only by the silent automobile's ability to go from zero to 60 mph in about four seconds. Helping to spread the word has been an avalanche of attention from nearly every major media outlet in the country. Tesla Roadsters will begin delivering late this year, and Eberhard expects big things to happen from there.

"We set out to build a car that would change the way people think about electric cars, and I think we've done that," Eberhard said. "Even without having shipped one single car, already people now think that electric cars don't have to be dorkmobiles. They can be beautiful and they can be fast, and that has completely restarted the whole conversation about what kind of cars we have to be driving."

To hear Eberhard describe the motor in the Roadster and other extras, visit www.ece.uiuc.edu/news/resonance.

TESLA MOTORS AND THE ROADSTER

- Company named for Nikola Tesla, inventor of the AC induction motor
- Built by Lotus in England
- $100,000 price tag
- Production begins Fall 2007
- So far, 570 cars ordered
- All lights are LEDs, except the license plate lights and headlights
- Speed: 0 to 60 in about 4 seconds
- 70-pound AC induction motor
- Can travel up to 250 miles on a single charge
- Charges using special outlet that comes with vehicle
- For more information, visit www.teslamotors.com

CAMPUS ROUNDUP



Photos courtesy of Kalev Leetaru

NAPERVILLE CAMPUS OPENS In June, the University of Illinois at Urbana-Champaign opened a new campus in Naperville, Illinois, to offer for-credit graduate programs in engineering and computer science. Located at 1100 E. Warrenville Road, the campus will also be home to Business and Industry Services (BIS), which is supported by the UI Extension and provides training and consulting services for various organizations. Courses at the new campus will be taught both on-site and online. For more information, visit http://online.engr.uiuc.edu/naperville/.

MARTINEZ NAMED ASSOCIATE DEAN Edgar Martinez became associate dean for strategic initiatives in the College of Engineering in May. Martinez had served as assistant dean for research and entrepreneurship at Purdue University.

In his new position, Martinez will improve the college's visibility at state and federal agencies to broaden research collaborations. His extensive experience in dealing with federal agencies will allow him to identify forthcoming funding initiatives, assist faculty in developing successful proposals for major research grants, and build strong relationships with the national laboratories.

GLOBAL CAMPUS On March 13, the University of Illinois Board of Trustees voted to establish the Illinois "Global Campus," offering fully accredited master's degrees, bachelor's completion degrees, and certificates in a wide variety of disciplines. Courses will be developed and delivered in partnership with regular University faculty.

ECE faculty member Chet Gardner is the special assistant in charge of developing the Global Campus plan. "We're convinced our information technology is robust, our timing is good, and that we will succeed and add luster to the national and international reputation of the University of Illinois," said Gardner in a news release.

The Global Campus Web site is www.uigc.uillinois.edu.

MEMORIAL STADIUM RENOVATIONS After the 2006 Fighting Illini football season, work began on renovations to Memorial Stadium that will result in improved sightlines, wider concourses, new concessions and restrooms, a state-of-the-art press box, luxury boxes, and more. Historic exterior features like the brick and limestone façades, memorial colonnades, and ramp towers will remain unchanged.

Dubbed "Illinois Renaissance," the estimated $100–$150 million project will be finished in time for the 2008 football season. For more information and the latest drawings, go to www.fightingillini.com and follow the "Illinois Renaissance" link.

NEW DEPARTMENT HEADS NAMED Craig Dutton, who previously served as chair of the Department of Mechanical & Aerospace Engineering at the University of Texas, Arlington, became head of the Aerospace Engineering Department on September 1.

Jong-Shi Pang became head of the Department of Industrial and Enterprise Systems Engineering (IESE) in mid-August. Prior to joining Illinois, Pang was the Margaret A. Darrin Distinguished Professor in Applied Mathematics in the Department of Mathematical Sciences at Rensselaer Polytechnic Institute, as well as a professor in the Department of Decision Sciences and Engineering Systems.

IMPE The Campus Recreation renovation of the IMPE facility is on schedule and beginning to take shape. Besides adding a 34-foot climbing wall and an additional floor to the existing building, the facility is receiving a major overhaul in terms of additional space, functionality, and format. More than 120,000 square feet will be added, bringing the total to almost 350,000 square feet. Combine that with Campus Recreation Center East (CRCE), and the campus will have approximately 470,000 square feet of state-of-the-art recreation space. The new IMPE will offer something for everyone, including basketball, martial arts, and studying space, and is scheduled to open in the summer of 2008.

UI CONFERENCE CENTER UNDER CONSTRUCTION Construction is underway for a University-funded conference center and privately developed restaurant and hotel on First Street near the Research Park. The project will be completed in 2008 and includes a five-story hotel, 220-seat full-service restaurant, and 38,000-square-foot conference center featuring a ballroom with banquet seating for 500.

To read campus news as it happens, visit UI Now at www.uiuc.edu/uinow.

UPCOMING EVENTS

HOMECOMING WEEKEND—OCTOBER 26–27 Mark your calendars for Homecoming 2007. The Illini men's football team will take on Ball State. The College of Engineering will host a postgame party for all engineering alumni. For more information, visit www.engr.uiuc.edu/alumni/events.

BAY AREA ALUMNI RECEPTION—NOVEMBER 15 The ECE and Computer Science Departments will hold their annual Bay Area reception at Google in Mountain View.

ENGINEERING OPEN HOUSE—MARCH 7–8 The College of Engineering's premier event is fun for the whole family. This is the perfect time to make that trip back to campus you've been pondering.

CHICAGO AREA ALUMNI RECEPTION—MARCH 2008
Join ECE and the College of Engineering for this annual event. This is a great opportunity to visit and network with fellow Engineering alumni.

For more information about upcoming ECE-sponsored events, view the ECE Alumni Calendar at www.ece.uiuc.edu; select "Calendars" then "ECE Alumni Events." You can also contact Jill Jarboe, alumni and student relations coordinator, at jjarboe@uiuc.edu or (217) 333-5817.

Resonance is published twice a year by the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign. Your comments and suggestions are welcome. Please e-mail them to Brad Petersen, editor, at bradp@uiuc.edu or mail to the address below.

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