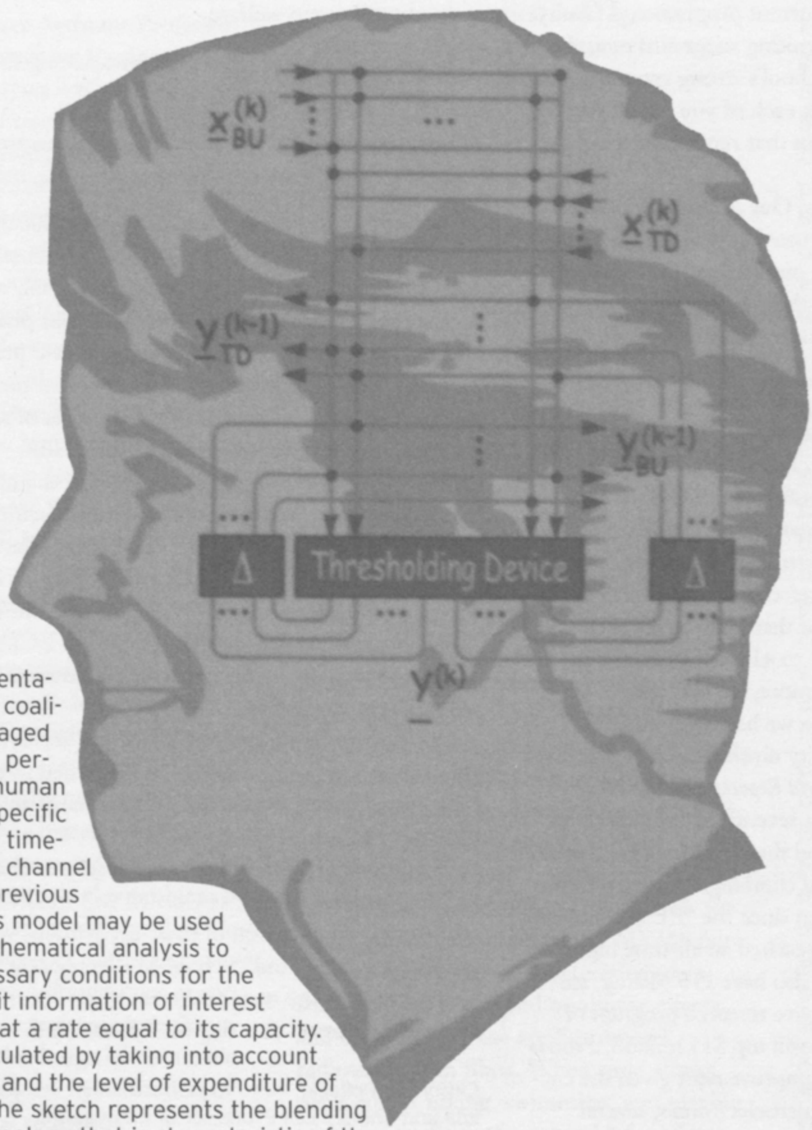
ARP #1425

CONNECTIONS

A Report from the School of Electrical and Computer Engineering • Cornell University

Biotechnology Research
in the School of Electrical and Computer Engineering



Schematic representation of a model of a coalition of neurons engaged in an act of sensory perception, say of the human visual system at a specific time. The figure is a time-discrete, finite-state channel whose state is the previous channel output. This model may be used as the basis for mathematical analysis to determine the necessary conditions for the organism to transmit information of interest across this channel at a rate equal to its capacity. Said capacity is calculated by taking into account all feedback signals and the level of expenditure of energy resources. The sketch represents the blending of biology with technology that is characteristic of the research described in this issue.

From Toby Berger, "Living Information Theory," *IEEE Information Theory Newsletter*, vol. 53, no. 1. © 2003 IEEE. Courtesy of Toby Berger, Venu Veeravalli , and IEEE. Sketch (with permission) by Robert F. MacFarlane.

This twelfth edition of *Connections* features the challenging research of our biotechnology research group, relates the history of biotechnology in the EE/ECE School, and considers the impact on the ECE School of new analytical and experimental techniques in the biotechnology field. The "Positive Feedback" section contains news of recent alumni activities. Other items of interest to alumni are listed below in the table of contents. This year, we also have included the "Campaign for Excellence" insert for your consideration. When you return the pledge card in the insert, please be sure you have filled out the "activities" section—we want to hear what you are up to.

Simpson (Sam) Linke, editor

Summer 2003

In This Issue

Report from the Director

I hope the last year has gone well for you. As an academic institution, the ECE School is sheltered somewhat from market cycles, but we know the state of the economy by the number of offers our graduates receive and by the increase in the number of applications to our M.Eng. program. Most of our students have been able to find jobs, but this year they typically are receiving only one offer. I've talked with chairmen of other electrical engineering departments around the country, and it is clear that our students have better prospects than those at most other schools. I wish I could give all the credit for this encouraging trend to our current program and faculty. However, today's graduates owe their recruiting success to you, the alumni, who have established the ECE School's strong reputation through your accomplishments. We thank each of you for all you have done for us, and we strive to maintain that reputation through great scholarship and great teaching.

This has been a year of planning for us. Our Advisory Council met in April 2002 and, after offering the usual approval of the quality of our program, faculty, and especially our students, the council members said they wanted to hear about the " big picture" on which we're working. Where is that flag on a distant hill toward which we are heading?

It was a fair request, and it stimulated a great deal of activity this year. Typical of a proud faculty, our immediate response to the Advisory Council was somewhat defensive. Based on statistics for 2002–03, this has been a remarkably successful year. We hired five outstanding new faculty members in key areas: Alyssa Apsel in high-speed interconnects, Amit Lal in microelectromechanical systems, Sally McKee and José Martínez in computer engineering, and Farhan Rana in photonics. (Please read more about them on page 3 of this issue). These hires brought the faculty size to 41 professors, the largest it has been in almost two decades. Furthermore, we now have five women on the faculty (that's five more than we had eight years ago!), and we are making steady progress in faculty diversification. In terms of national ranking, the *U.S. News and World Report: America's Best Colleges 2003 Edition* placed our program at seventh in the nation, up from eighth last year. While many of us feel these rankings are flawed, it is still comforting to be in the top 10 and climbing. Our current senior class size of 195 is the largest it has been since the "EE bubble" of the late 1980s. Our Ph.D. population has reached an all-time high, with nearly 200 students enrolled, and we also have 110 M.Eng. students—totals that reflect the strong and active research program of our faculty. Research funding for this year will top $15 million, a modest growth over last year and a substantial improvement given the current state of the economy. In the field of microelectronics, several patents have generated significant royalties (approximately $100,000) for the school, and additional lucrative patents may soon appear. The programs in biotechnology described in this issue are examples of new scholarly directions that are emerging in the school. Taken as a whole, the ECE School appears to be quite healthy.

Why are we worried about "mission" when everything is going so well? The answer is simple: we want to remain a healthy, top-ranked school. Our faculty recently reaffirmed the core values of our ECE program at Cornell:

- to develop engineers at all levels who are able to think, write, and advance the state of knowledge
- to develop engineers who are leaders and risk takers willing to promote human welfare
- to maintain the balance between teaching fundamentals and driving new technology
- to promote and explore cutting-edge research areas with honesty, ethics, excitement, and the pleasure of learning

To fulfill our mission, there are three critical areas on which we must focus our efforts. First, we must attract and reward a world-class faculty, the foundation of a great school, whose visionary scholarship improves our society. Second, as our primary obligation to society, we must maintain an undergraduate program that teaches students to think critically. Finally, we must provide an outstanding graduate program that creates a diverse set of scholars who will advance and provide leadership to our field.

We are now identifying processes and the infrastructure necessary to support our mission—from space and facilities to the establishment of design projects in the curriculum. Perhaps the most critical issue, certainly in the long-term timeframe, is developing a vision for future hiring. We recently established the William A. Anthony Distinguished Lectures on the Future of ECE, through which prominent leaders in the fields will be invited to advise us on future technologies and issues.

We are hoping to endow this lecture series and seek support for other programs and projects—as described in the "Campaign for Excellence" insert in this issue. If you have an interest in helping us, please contact me.

In 100 years, I hope that the department chair of a prestigious and important program at Cornell will fondly remind her alumni that the founding vision of their department was derived from visionaries in the "old" School of Electrical and Computer Engineering at the turn of the century. Our obligation to the future is to pursue that flag on a distant hill.

Clifford R. Pollock
Ilda and Charles Lee Professor of Engineering
Director, School of Electrical and Computer Engineering

Newcomers to the School

Alyssa B. Apsel

B.S. '95 (Swarthmore College, with distinction), M.S. '96 (California Institute of Technology), Ph.D. '02 (Johns Hopkins University), all in electrical engineering, joined the ECE School faculty on July 1, 2002 as an assistant professor. In September 2002, she was named the Clare Boothe Luce Assistant Professor of Electrical and Computer Engineering. From 1997–2002, Alyssa was an Abel Wolman Fellow and research associate in the Sensory Communications and Microsystems Laboratory at Johns Hopkins University. Together with Professor Andreas Andreou, she developed the first silicon-on-sapphire complementary metal-oxide semiconductor (CMOS) optical receiver array, and she coauthored an account of the work and two related patent applications. Her primary teaching and research interests are in the area of opto-electronic very-large-scale integrated (VLSI) CMOS systems. As head of the Optoelectronic VLSI Laboratory in the ECE School, a large portion of her work is devoted to the design of low-power arrays of optical interconnects for short-distance and chip-to-chip communication.

Professor Apsel's research focuses on merging CMOS circuits with micro-optics to build high-performance electronic systems. Interconnect problems currently are a bottleneck in the advancement of high-speed and high-performance CMOS microelectronics. She approaches this problem by using optical interfaces to connect electronic subsystems in a fusion of optics and electronics, thereby avoiding difficulties of conventional high-speed electronic interfaces. The work includes the design of electronic interface circuitry and the hybridization of electronic and optical elements.

Alyssa is a member of IEEE, has more than 20 publications in her field of interest, and has been a reviewer for *IEEE Transactions on Circuits and Systems II: Analog and Digital Signal Processing, IEEE Sensors Journal, Journal of Applied Optics, IEE Transactions on Optoelectronics,* and the IEEE International Symposium on Circuits and Systems. The Clare Boothe Luce Assistant Professorship of Electrical and Computer Engineering, which Alyssa will hold for five years, was established through a bequest, administered by the Henry Luce Foundation, "to encourage women to enter, study, graduate, and teach in the sciences (including mathematics) and engineering." When time allows, Alyssa enjoys hiking, working on her house, scuba diving, and traveling.

Amit Lal

B.S.E.E. '90 (California Institute of Technology), Ph.D. '96 (University of California at Berkeley), electrical engineering, joined the ECE School faculty as an assistant professor on July 1, 2002. From 1998 to 2002, he was an assistant professor in the Electrical and Computer Engineering Department at the University of Wisconsin–Madison and the leader of the Sonic Microelectromechanical Systems (MEMS) group at the Wisconsin Center for Applied Microelectronics. He is a recipient of the National Science Foundation CAREER award for research on applications of ultrasonic pulses to MEMS. Amit's teaching and research interests are in developing concepts technology and models for integrated microsystems using MEMS fabrication techniques, characterizing ultrasound and its linear and nonlinear effects, and investigating the applications of radioactive thin films. When time allows, Amit enjoys hiking, swimming, and playing with his son Ravi. (See page 11 for additional details of Professor Lal's research.)

José F. Martínez

B.S. '96 (Universidad Politénica de Valencia, Spain), computer science and engineering, M.S. '99, Ph.D. '02 (University of Illinois at Urbana-Champaign), both in computer science, joined the ECE faculty on August 15, 2002 as an assistant professor. He is a two-time receiver of the Spanish government's prestigious National Academic Excellence Award, and in 1998 he was inducted into the Phi Kappa Phi Honor Society for outstanding academic performance. His research interests include but are not limited to multithreaded and multiprocessor architectures for high performance and programmability, microarchitecture, and hardware-software interaction.

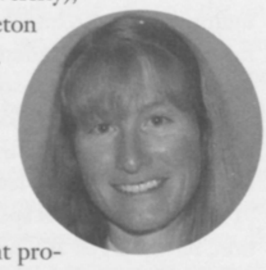
Professor Martínez's current research is concerned with speculative shared-memory architectures. Thread-level speculation (TLS), also known as speculative parallelization, has emerged as a promising architectural technology to boost the performance of difficult-to-analyze codes. Under TLS, these codes are executed speculatively in parallel. The system provides a safety net, checks for dependence violations, and squashes and restarts offending threads on the fly. José has proposed two main contributions of his work to TLS. In the first case, a scalable multiprocessor architecture is based on a hierarchical approach that uses largely unmodified speculative chip-multiprocessors (CMPs) as building blocks. In the second case, an application of TLS is used to overcome conservatively placed synchronization in parallel codes. Instead of waiting, threads execute speculatively past active barriers, taken locks, and unset flags. The proposed hardware solutions are quite simple, require no programming effort, and yield performance improvements that are very promising.

(continued on page 4)

Newcomers to the School *(continued from page 3)*

José is a member of the Association for Computing Machinery and the IEEE Computer Society. He is coauthor of "Speculative Locks: Concurrent Execution of Critical Sections in Shared-Memory Multiprocessors," in *Memory Performance Issues* (Springer-Verlag, 2003), and he is the author or coauthor of five publications that have been presented in international conferences and symposia on computer architecture, such as Architectural Support for Programming Languages and Operating Systems (ASPLOS), International Society for Computers and their Applications (ISCA), and the Annual International Symposium on Microarchitecture (MICRO). When time allows, José enjoys French cooking, Spanish guitar, or a good game of chess.

Sally A. McKee



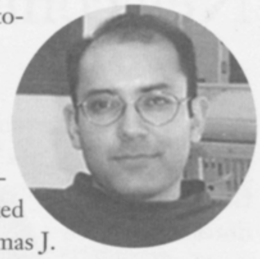
B.A. '85 (Yale University), M.S.E. '90 (Princeton University), Ph.D. '95 (University of Virginia), all in computer science, joined the ECE faculty on July 1, 2002 as an assistant professor and became a member of the Computer Science Graduate Field in September 2002. She is also an adjunct assistant professor at the University of Utah School of Computing during the 2002–03 academic year. She has taught before at the University of Virginia, the Oregon Graduate Institute of Science and Technology, Reed College, and the University of Utah and has worked for Digital Equipment Corporation, Microsoft Corporation, AT&T Bell Laboratories, and Intel Corporation. Her research interests include computer architecture, and, in particular, memory system architecture; high-performance computing; the interaction of compilers, operating systems and architectures; hardware/software codesign; performance analysis; and adaptability and accessibility.

Professor McKee's current research focuses on improving memory system performance at all levels. Microprocessor speed is increasing much faster than memory system speed, and the traditional approach to attacking the resulting memory system bottleneck has been to build deeper and more complex cache hierarchies. Studies have shown, however, that when usual caching techniques are compared with those of an optimal cache, their efficiency is generally 80 percent lower and cache sizes are up to 2,000 times larger. The upshot is that individual processors in high-performance platforms currently see idle times of 60–95 percent on important transaction processing or scientific applications. Projects under Sally's supervision in the Cornell Computer Systems Laboratory include the design and evaluation of efficient, adaptable, high-performance memory systems and the systems software to exploit them, and the development of metrics and tools for analyzing memory hierarchy performance. Sally is the principal investigator on two National Science Foundation projects and has participated in studies funded by the U.S. Department of Energy and the Intel Foundation.

As a member of IEEE, she has been active for several years in computer-related activities of the institute. She is a member of the Advisory Committee of the IEEE Technical Committee on Computer Architecture and has served as an organizing committee member of 12 international conferences on computer architecture and computing techniques. She is the author or coauthor of more than 28 publications in refereed journals and conferences and is the co-inventor of a U.S. patent. She is also a member of the Association for Computing Machinery, the IEEE Computer Society, the American Association of University Women, and the American Association for the Advancement of Science. When time allows, Sally loves to go running with her dog, play cards or other games, cook gourmet food, and visit friends and family.

Farhan Rana

B.S. and M.S. '97, Ph.D. '02 (MIT), all in electrical engineering, joined the ECE faculty on January 1, 2003 as an assistant professor. As a Ph.D. candidate, he was a research assistant with the MIT Research Laboratory for Electronics, where he worked on a variety of topics related to semiconductor optoelectronics, mesoscopic physics, lasers, and quantum optics. Before starting his doctoral studies, he worked at the I.B.M. Thomas J. Watson Research Center in Yorktown Heights, New York, on silicon field-effect devices and quantum-dot memories.



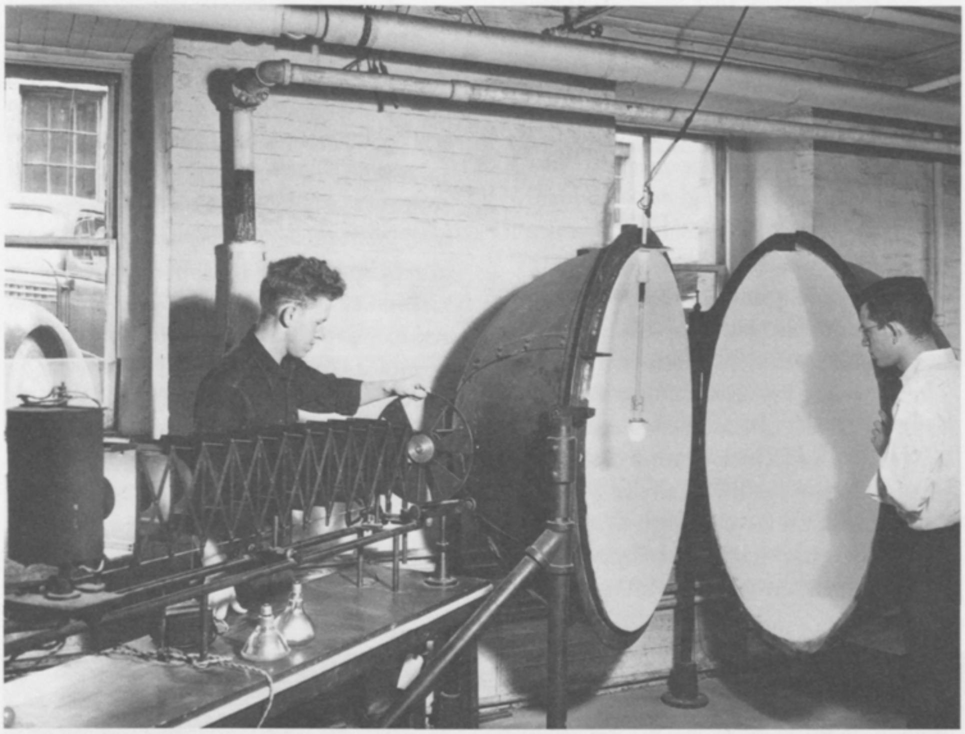
Professor Rana's current research focuses on semiconductor optoelectronics, device physics, ultra-fast optics, and quantum optics. At Cornell, he plans to lead a group that develops the next-generation devices for ultra-high bandwidth optical systems and ultra-dense optical chips. In addition to developing new technologies, he also is interested in studying novel physics associated with ultra-small and ultra-fast devices.

Farhan is a member of IEEE and the Optical Society of America (OSA) and the honor societies Tau Beta Pi, Sigma Xi, and Eta Kappa Nu. In May 2000, he was session chairman for the IEEE/OSA International Conference on Laser and Electro-Optics (CLEO) held in Long Beach, California. He served as a member of the technical and program committee for the International Society of Optical Engineering (SPIE) Conference on Noise in Photonics and Quantum Optics to be held in Santa Fe, New Mexico, in June 2003 and serves as a session chairman for the same conference. He also serves as an editor for the journal, *Fluctuation and Noise Letters*, published by World Scientific Publishing Company. He has 32 publications in refereed journals and refereed conferences. In his spare time, Farhan runs regularly and is also a big fan of soccer, tennis, and ice skating.

Biotechnology in the ECE School

"Great as the contribution of engineering is to the hardware requirements of the various biological fields, its insights and procedures are of equal importance. These contributions present perhaps the greatest opportunity for engineering and the physical sciences to join forces with the life sciences."

–Late Professor Nelson Bryant (Winter 1968 *Engineering Cornell Quarterly*)



Courtesy of Rare and Manuscripts Collection, University Library

Figure 1. Spherical photometer in the illumination laboratory in Franklin Hall used for light-flux comparison studies.

Perhaps the first attention given to biotechnology in the EE School occurred when the late Professor **Casper L. Cottrell,** Ph.D. '28, physics, joined the faculty in 1942 as an assistant professor. Prior to his appointment, he had conducted biophysics research at Cornell for several years. His work included optical studies of muscle tissue and development of counter-circuits for some of the early radioactive tracer studies. He also assisted biologists in making measurements of the electrical voltage of living cells with respect to their external environment. His research in the EE School was concerned with visibility problems and the development of a contrast-brightness threshold meter that is widely used in measuring visibility.

Throughout his academic career, in addition to regular teaching duties, Cottrell joined with the late Professor **Everett M. Strong,** B.S.E.E. '22 (Massachusetts Institute of Technology), in the application of his visibility expertise to their illumination research and development of courses in illumination.

In the early 1950s, the late Professor **William C. Ballard,** E.E. '12, became interested in the application of electrical engineering techniques to the solution of problems encountered in medical procedures. He worked with doctors in the Cornell Medical College to develop a better means of determining the coagulative properties of blood based on electrical conductivity measurements, and in 1951 he was instrumental in the establishment of the Medical Electronics Group in the Institute of Radio Engineering (now a recognized professional group of IEEE).

Following Bill Ballard's early blood-coagulation studies, the late Professor **Nelson H. Bryant,** E.E. '39, M.E.E. '49, began research in 1956 on the design and development of electronic instrumentation for the measurement of biological phenomena, thereby becoming one of the first Cornell faculty members to work in the field of biotechnology. Nelson took his second sabbatical at the University of Pennsylvania Johnson Foundation for Medical Research and continued bio-related work through 1967 before turning to other areas of interest. He directed a number of master's theses and senior projects with special emphasis on blood-chemistry instrumentation applied to automated differentiation of white-corpuscle types and the control of oxygen content in the blood. **Francis D. McLeod Jr.,** B.S. Engr. '65, electrical engineering, at the time with the Cornell College of Veterinary Medicine, was encouraged by Nelson to work on blood-flow measurements. In 1970, Fran was granted a U.S. patent on a directional Doppler-velocity blood-flow meter that has become the primary vascular diagnostic tool in the medical profession (see *Connections* 1999, page 24).

The decade of the fifties saw additional factors related to the advent of biotechnical studies in the EE School. Test equipment (see Figure 1) for an illumination laboratory was among the new facilities moved to Phillips Hall in 1955. The lab was used by Professors Strong and Cottrell in their courses EE 4611, Introduction to Illumination, and

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Biotechnology in the ECE School *(continued from page 5)*

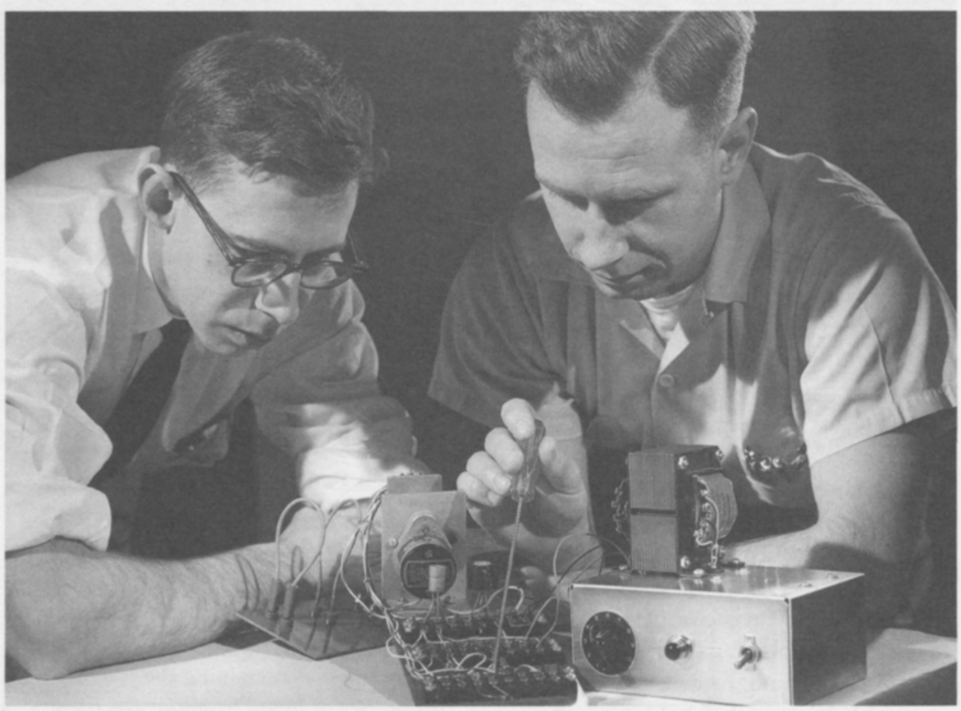
EE 4612, Illumination Engineering. These courses, together with course EE 4615, Illumination Seminar, presented problems encountered in illumination engineering and their solution, sources of light, visual perception, light control, and general illumination design. Biological concerns were considered in laboratory exercises—particularly in a glare-perception investigation that was conducted for several years and involved student volunteers as subjects. The original design for Phillips Hall included an elaborate anechoic chamber in the tower with potential for biological research related to acoustics. Unfortunately, the facility, as planned, was never completed. The biotech history of the EE School in the 1950s would be incomplete without mention of **Wilson Greatbatch,** B.E.E. '50, whose invention of the renowned implantable cardiac pacemaker in 1958 brought honor to the school and to Cornell.

In 1963, for the first time, the general introduction to graduate studies in electrical engineering in *Cornell Course Announcements* referred to "biomedical electronics" and "cognitive systems." Nelson Bryant's direction of graduate studies in blood-chemistry instrumentation illustrated the first category, and the courses in illumination and acoustics served as somewhat related examples of cognitive studies. The courses and projects in illumination continued until the mid-sixties when Professor Cottrell retired and Professor Strong was active as director of the Engineering Cooperative Program. From 1960–62, the late Professor **True McLean,** E.E. '22, offered EE 4541, Applied Acoustics, for the most part devoted to purely technical subjects. In 1963, late Professor **Clyde Ingalls,** E.E. '27 (Rensselaer Polytechnic Institute), offered EE 4593, Fundamentals of Acoustics, a lecture and laboratory course that included, in addition to purely technical components, studies of transmission, reflection, absorption, speech, hearing, and noise. Ingalls designed, built, and installed an inexpensive anechoic chamber in the Phillips Hall tower that served as his acoustics laboratory until his retirement in 1971.

In 1968, the late Professor **Henry David Block,** Ph.D. '49, mathematics (Iowa State University), Applied Mathematics and Electrical Engineering, introduced course EE 4588, Bionics and Robots, which was concerned with engineering applications of strategies and tactics of biological systems. Selected topics included machines that learn, artificial intelligence, cybernetics, information and adaptive control, and robots. Block also described his work with the late Associate Professor **Frank Rosenblatt,** Ph.D. '56, experimental psychotherapy, Neurobiology and Behavior, on the Perceptron, a primitive analog model of the human brain (see Figure 2 and *Connections* 2000, page 9). Block continued to offer this course until the mid-seventies.

Advent of Bioengineering

Biotechnology studies in the EE School were substantially enhanced at the end of the sixties decade by two members of the faculty with specific interest in the discipline. The late Professor **Myunghwan Kim,** Ph.D. '62, electrical engineering (Yale University), a specialist in control theory, who had joined the EE faculty in 1962, took a sabbatical leave in 1968–69 at the California Institute of Technology, where he began research on the application of control theory to neurological systems. Upon his return, Kim continued work in this area and also initiated research on the application of modern control theory to cancer chemotherapy. In 1970 a bioelectric systems laboratory was established at Cornell under his direction. In 1969, Professor **Robert R. Capranica,** Sc.D. '64, electrical engineering (Massachusetts Institute of Technology), came to Cornell as a joint member of the Section on Neurobiology and Behavior and the School of Electrical Engineering. His special interest combined electrical engineering with physiological and behavioral studies of animals as an approach to biocommunication. In his laboratory (see Figure 3), Capranica directed both graduate and undergraduate students in experimental projects on sound communication and electrophysiological studies of auditory processing in a variety of species of anurans (frogs and toads). Part of this work involved direct application of engineering techniques to sensory communication in an effort to explore some of the common principles underlying hearing. In 1970, Professors Capranica and Kim offered EE 4450, Bioelectronic Systems, for the first time. The course was



Courtesy of Rare and Manuscripts Collection, University Library

Figure 2. Associate Professor Frank Rosemblatt (left) and Fred Wightman examine an early component of the Perceptron.

described in *University Announcements* for that year as, "Application of electrical system techniques to biological problems, including electrical activity of nerve cells, generation and propagation of nerve impulses, neural mechanisms for vision and hearing." Both professors collaborated with EE faculty members who were working in related fields, and they continued their research in biotechnology until their retirement—Kim in 1988, and Capranica in 1993.

Another type of biotechnology study involving animals was conducted in the mid-eighties by Lecturer **Bernie Hutchins,** B.E.P. '67, who applied his signal-processing skills in the analysis of audio recordings uttered by animals, with particular attention to inaudible low-frequency vocalizations by elephants. Bernie directed several M.Eng. (Elec.) projects concerned with raising the frequency of the elephant "voices" to levels that could be heard and interpreted by individuals interested in elephant communication. Similar projects shifted the high frequency of bird songs to lower levels to aid investigators suffering from hearing loss.

Student interest in biotechnology reached a peak in the EE School in the 1975–85 decade. Courses in biology in other departments were popular, and the special curriculum-based College Program in the engineering college enrolled several students with double majors of electrical engineering and biology. In this period, several young faculty members with duties in the standard EE curriculum were active in biotechnology research. Acting Assistant Professor **Daniel J. Aneshansley,** Ph.D. '74, bioengineering, now professor and director of graduate studies in the Department of Biological and Environmental Engineering, studied insect behavior with Professor **Thomas Eisner,** Ph.D. '55, entomology (Harvard University), the Jacob Gould Schurman Professor of Chemical Ecology, Neurobiology, and Behavior. He presented some of his work (notably about the bombardier beetle, see Figure 4) in EE faculty seminars and provided his students with updates on his research. Assistant Professor **William J. Heetderks,** Ph.D. '75, bioengineering (University of Michigan), joined the EE faculty in 1976 as a specialist in sensory and motor electrophysiology with a goal of building bioelectronics in the school and creating a link between the school and biological sciences in other divisions at Cornell. In 1979, Heetderks created EE 621, Bioinstrumentation, concerned with development of microelectronic arrays that could be used for parallel recording from a population of neurons. This popular course was offered until June 1981 when Heetderks was granted a leave of absence, earned an M.D. degree at the University of Miami, and left Cornell to pursue a medical career. From 1981–83, Assistant Professor **Bruce R. Land,** Ph.D. '76 (neurobiology), Neurobiology and Electrical Engineering, now a senior research associate in Neurobiology and Behavior, taught laboratory sections of EE 422, Bioelectronic Systems, with Bob Capranica. In the same period, he also taught the computer portion of the junior electrical engineering lab, thereby allowing his students in that course to benefit from his extensive neurobiological experience. Professors Kim and Capranica continued their research until their respective retirements but did not offer biotechnology courses in the EE School after 1985.

New-Age ECE Biotechnology

From 1985–95, biotechnological activity in the EE School was at a low ebb, but two faculty members had started research that would eventually restore interest in the field, particularly since biological studies in other divisions at Cornell were experiencing major growth. EE student interest was limited for the most part to double majors in

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Courtesy of Rare and Manuscripts Collection, University Library

Figure 3. Professor Robert R. Capranica (standing) and a graduate student test an auditory processing system.

Courtesy of Thomas Eisner and Dan Aneshansley

Figure 4. A bombardier beetle in action. The beetle takes its own picture. With the camera's shutter left open with minimal light so the beetle can be seen, the sound of the discharge triggers a photo flash.

Biotechnology in the ECE School *(continued from page 7)*

electrical engineering and biology, with courses in the latter discipline being taken in other divisions. In 1985, Associate Professor **Anthony P. Reeves,** Ph.D. '73, electronics (University of Kent at Canterbury, United Kingdom), began offering EE 547, Computer Vision, devoted to computer acquisition and analysis of image data with emphasis on techniques for robot vision. His initial computer-vision research was concerned with techniques that produced video images of living cells. Professor **Terrence L. Fine,** Ph.D. '63, applied physics (Harvard University), conducted early studies of neural networks with intent to construct mathematical models for behavior related to neurobiology and cognitive psychology.

The ECE faculty is now very enthusiastic about the current status of biotechnology research and instruction in the school. Professor **Toby Berger,** Ph.D. '66, applied mathematics (Harvard University), is applying information theory to cognitive systems. In addition to his course on computer imaging, Tony Reeves is offering a new course, ECE 548, Digital Image Processing. His research group continues to work closely with the Weill Medical College of Cornell on imaging for lung-cancer detection. Assistant Professor **Amit Lal,** Ph.D. '96, electrical engineering (University of California, Berkeley), joined the ECE faculty recently and has begun research on microelectromechanical systems (MEMS) applied to biotechnological problems. Lecturer and Assistant Director **John C. Belina**, M.Eng. '75, electrical engineering, with a long-term interest in biomedical problems, is offering a new course, ECE 402, Biomedical System Design. The course introduces techniques of measuring and conditioning low-level (biological) signals. Details of these new efforts in biotechnology in the ECE School are presented elsewhere in this issue.

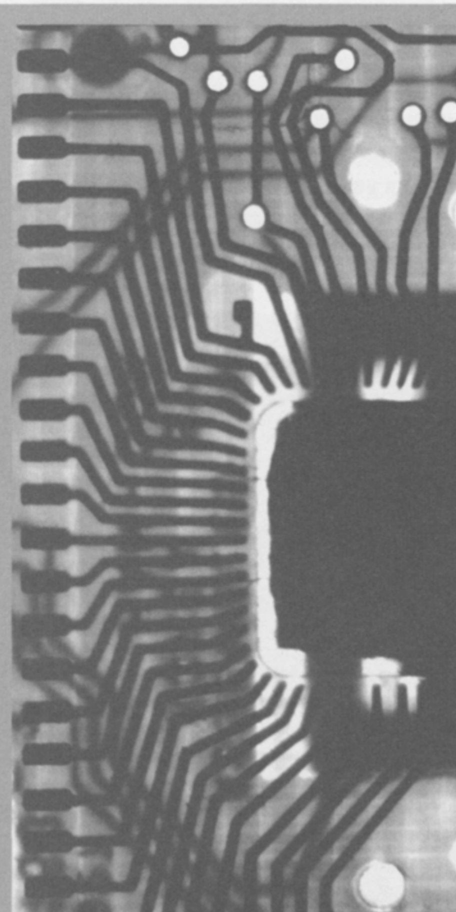
Sam Linke
Professor Emeritus
Electrical Engineering

ECE School Research Funding

Total research funds expended in 1999-00	$20,556, 217
Total research funds for 2000-01	$15,943,302
Percent decrease	22.4 %
Total research funds expended in 2001-02	$14,635,065
Percent decrease	8.2%

The 2001-02 research expenditure has decreased because the school has changed the reporting structure for calculation of expended research funds. There has also been a slight decrease in departmental expenditures since two faculty members with large research programs have left Cornell for other universities.

During the past academic year, the school has received gifts and equipment valued at more than $1.7 million in support of faculty research, teaching, and special projects. Some of these sponsors include BAE Systems, BF Goodrich, Emcore, Fuji Electric, General Electric, GTE/Verizon, Lutron Corporation, IBM, Intel, Microsoft Corporation, Northrup Grumman, Nova Crystals, NxtWave, Rockwell Scientific, RF Micro Devices, Taiwan Power, Triquent, Zepton Networks, and many others. These generous grants from corporations and foundations, coupled with equally commendable gifts from many individuals, aid the recipients in their teaching and research and make it possible for the ECE School to establish and maintain a leading edge in the discipline.



Biological Information Theory Research

Directed by Toby Berger

The **Biotechnology Research Group** in the School of Electrical and Computer Engineering consists of Professors **Toby Berger, Amit Lal,** and **Anthony P. Reeves** and their graduate students. Lecturer **John C. Belina,** who has had a long-standing interest in biosciences, has enhanced the work of the group at the undergraduate level by offering a new biotechnology course, Biomedical Measurement and Instrumentation, described on page 14 in this issue. Biotechnology research in the ECE School has been augmented in recent months by receipt of major funding from several agencies. Other faculty members with interest in biotechnology include Professor **Terrence Fine,** who has applied information theory techniques to the study of neurons; Associate Professor **Sheila Hemami,** whose research in human visual-system perception has biotechnological overtones; Associate Professor **Edwin Kan,** whose research on nanometer-scale devices has potential for computer-aided diagnostics in medical applications; and Assistant Professor **Michal Lipson,** whose research in nanophotonics may have biotechnological applications. Principal research areas of the biotechnology group are described in the following three articles.

A recent newspaper report carried the welcome news that Christopher Reeve, who has been paralyzed from the neck down for many years, has been able to breathe on his own for several minutes without the aid of a ventilator. In somewhat the same fashion as the implantable cardiac pacemaker, an implanted electronic device sends impulses to Mr. Reeve's diaphragm at suitable intervals and triggers the breathing reaction. This behavior is the result of an *engineering* solution to a medical problem. Unlike the natural breathing process, this activity is not controlled by the brain. The same newspaper account also reports that Mr. Reeve is now able to move the little finger of one hand of his own volition, clearly a brain-controlled action that may be classified as an *information-theory* solution to a medical problem. After many years of complete immobility, Mr. Reeve's finger is now able to respond to a signal from his brain that causes the movement. The study of the multitudinous factors that produced this remarkable development lies in the area of biological information theory applied to living systems. Knowledge gleaned from such studies may one day help "Superman" to walk again and have an equally remarkable impact on medical practice.

The ability of the nerve cells of a living system (neurons) to transmit impulses of information from one point of contact to another allows the nervous system to be considered as a communications system and therefore should be subject to the same analytical techniques that are employed in the study of conventional information-transfer systems. Early attempts to justify this hypothesis were not generally accepted by information theorists, but the current ability to make accurate and simultaneous recordings of pulse trains between neighboring nerve cells, to measure electrochemical behavior at contact points, and to make significant progress in the measurement of other factors in the behavior of the nervous system, make it possible to consider the possibility of theoretical and practical connections between information theory and biology.

In recent years, Professor Berger has been considering the application of information theory to biology, principally in the area of sensory perception, and has presented several guidelines for information theorists who may wish to enter the field. In particular, he finds that the traditional coding theorems and techniques of information theory may not be useful for analysis because living organisms have developed their own optimal methods to transfer information effectively. In his 2002 Shannon Lecture, which was followed by the article, "Living Information Theory," in the *IEEE Information Theory Society Newsletter* (March 2003), Toby observes, "The object is not to get to the point where you can think like a biologist. The object is to get to the point where you can think like the biology. The biology has had hundred of millions of years to evolve via natural selection to a point where much of what it does is done in a nearly optimum fashion. Hence, thinking about how the biology **should** do things is often effectively identical to thinking about how the biology **does** do things—and is perhaps even a more fruitful endeavor."

In a similar vein, the optimal behavior of a living organism suggests the presence of a variety of channels for the transfer of information—based on the requirements of the senses of the body in which the organism resides, plus environmental and other external factors. Consequently, there is no given channel that may be used for analysis, a condition that is unhappy for information theorists who generally prefer to study how impulses are best transmitted over a particular channel. Toby suggests that, as a matter of natural selection, all biological channels are well matched to the sources that supply the information to be transferred.

(continued on page 10)

Biological Information Theory Research *(continued from page 9)*

Perhaps the most important of Toby's guidelines is the hypothesis that the neural information rate in coalitions of neurons is maximized subject to energy constraints.

"A fundamental characteristic of an efficient organism is that it always should be optimally trading energy for information, or vice versa, as circumstances dictate," Toby explains in the *IEEE Information Theory Newsletter* article. "The only way to assure that pertinent information will be garnered at low latency at the maximum rate per unit of power expended is not only to match the channel to the source but also to match the source to the channel." Thus, the most desirable condition is one in which the ratio of information gain to energy expenditure is maximized.

Professor Berger is a widely known leader in research on information theory and communications. His specific interests have included multiterminal coding theory, information theory of random fields, communications networks, video compression, human-signature compression and verification, and coherent signal processing. He is particularly interested in situations in which information generated at several different locations must be transmitted over a network of communication links with limited capacity. Other problems concern applying multiterminal rate-distortion theory and multiterminal decision theory to situations in which many remote, correlated sources are connected to a common processor via separate communication links. This work is significant for multisite signal-processing applications such as interferometry, seismology, and emitter location.

Toby received the B.E. degree in electrical engineering from Yale University in 1962, and the M.S. and Ph.D. degrees in applied mathematics from Harvard University in 1964 and 1966, respectively. From 1962–68, he was a senior scientist with Raytheon as a specialist in communication theory, information theory, and coherent signal processing. He joined the Cornell faculty as an assistant professor of electrical engineering in 1968, was promoted to associate professor in 1972, and became a full professor in 1978. He was named the J. Preston Levis Professor of Engineering in 1989, and became the Irwin and Joan Jacobs Professor of Engineering in 1998. In the past decade, he has been a visiting professor of electrical engineering at Princeton University, Northeastern University, and the University of Virginia. Toby was a Guggenheim Fellow in 1976, a Japan Society for the Promotion of Science Fellow in 1980, and the Ministry of Education of the People's Republic of China Fellow in 1981. Under a Fulbright Foundation travel grant in 1986, he was a distinguished Visiting Researcher at École National Supérieur des Telecommunications in Paris, France. In 1982, he received the American Society of Engineering Education Frederick E. Terman Award for outstanding contributions by a young electrical engineering educator. In 2002, Toby received the Shannon Award, the highest honor of the IEEE Information Theory Society, which included the Annual Shannon Lecture presented in Lausanne, Switzerland, on "Living Information Theory."

Toby is a fellow of the IEEE and has served as editor-in-chief of the IEEE Transactions on Information Theory and president of the IEEE Information Theory Group. He is the author of *Rate Distortion Theory: A Mathematical Basis for Data Compression* (Prentice-Hall, 1971) and coauthor of Digital Compression for Multimedia (Morgan Kaufman, 1998). He has authored or coauthored about 75 articles that have appeared in refereed journals, and about 150 that have been published in conference proceedings. Over the years, Toby has consulted with Raytheon, IBM, Schlumberger, Teknekron Communications Systems, and AT&T Laboratories.

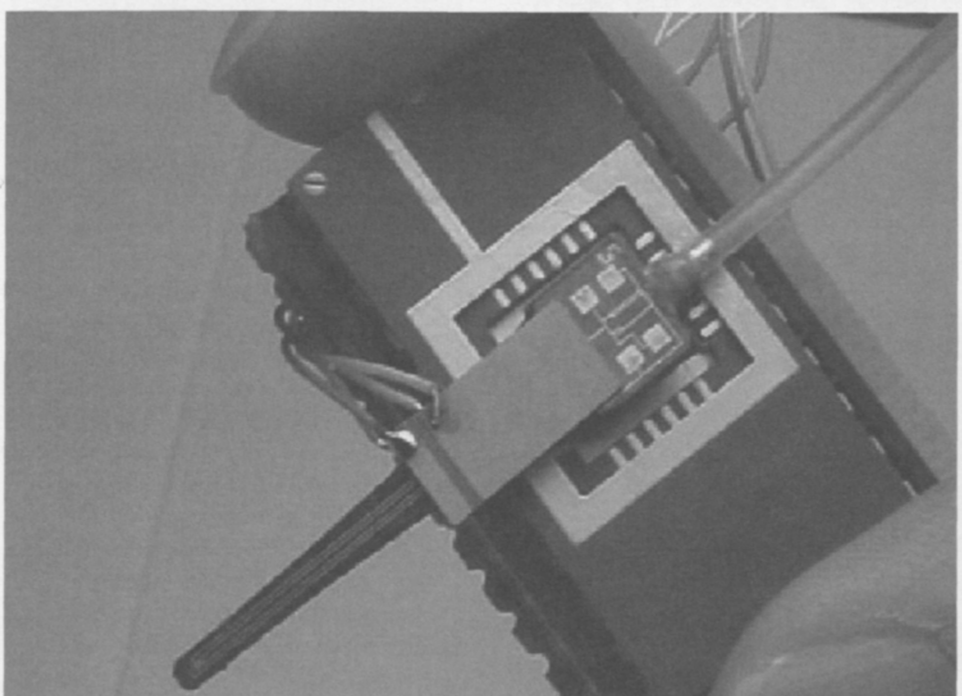
Under Toby's guidelines it becomes possible to construct a model that will approximate the behavior of a coalition of neurons engaged in an act of sensory perception—say of the human visual system—at a specific time. The illustration on the cover of this issue, a schematic representation of such a coalition, is a time-discrete, finite-state channel whose state is the previous channel output. This model may be used as the basis for mathematical analysis to determine the necessary conditions for the organism to transmit information of interest across this channel at a rate equal to its capacity. Said capacity is calculated by taking into account all feedback signals and the level of expenditure of energy resources.

MEMS in Biotechnology Research

Directed by Amit Lal

Alumni who may have had recent cataract surgery are familiar with their surgeon's description of the procedure that involves destruction of the defective lens with an ultrasonic tool, removal of the debris by vacuum, followed by insertion of the new lens. The surgeon's discussion probably did not include the fact that the lens would be pulverized with ultrasonic power supplied by a tiny blade composed of titanium alloys, vibrating at amplitudes up to 100 mm, at frequencies between 20–60 kHz, with a tip velocity of approximately 20 m/s. Cataract surgery with this tool has been eminently successful, but surgeons have noted the presence of small amounts of metal in the lens debris, excessive heating and cutting of associated tissue, and the possibility of catastrophic failure of the blade at certain frequencies of operation. Recent studies involving the micromachining of silicon wafers have produced ultrasonic tools that may eliminate these difficulties and also include electronic sensors that would help guide the surgeon during an operation (see Figure 5).

A new tool for cataract surgery is only one of many examples of miniature devices that are being developed through applied research with microelectromechanical systems (MEMS), the well-established technology employed for the production of moving electromechanical microstructures. One category of devices includes microactuators, microsensors, micromechanical structures, and systems with sensors and electromechanical actuators integrated on a silicon chip with microelectronic systems. These sensors and actuators are now combined with microcomputers and used, for example, to control the deployment of airbags in automobiles. In the future, new microsystems will be used to emulate human-like sensors for atomic-level robotics, to explore the veins in the body, and to touch and move atoms and molecules. Other potential microdevices may use the vibratory energy in ultrasonic waves to drive surgical tools, provide micro instruments for information storage, and operate light switches for optical communication. Such ultrasonic devices also could be used to image, move, and position small objects such as blood cells, and to sense our environment for obnoxious chemicals and actuate the appropriate response. MEMS research requires the full range of available silicon-fabrication expertise and equipment used in photolithography, reactive-ion etching, and thin-film deposition of metals and semiconductors.



Courtesy of Amit Lal

Figure 5. Ophthalmic microsurgical tool with integrated pressure sensor. The tool can be used to cut tissue ultrasonically while the sensor maintains closed-loop control of eye pressure during surgery.

The major application of MEMS techniques to biotechnology research depends on the ability to micromachine silicon wafers into various, extremely small, ultrasonic surgical tools with integrated electronic and mechanical components. The properties of silicon make it an ideal substance that offers many advantages as an ultrasonic transducer material. Since the density of silicon is one-half to one-third that of metals, silicon devices can be made smaller than conventional ones. The speed of sound in silicon is about twice the speed of sound in metals, thereby allowing an increase in the wavelength of the pressure waves that can be produced. Internal heat losses and frictional losses at transducer material interfaces can be reduced due to the low acoustic attenuation of silicon. The material's high thermal conductivity allows more efficient heat sinks than in metals. Silicon-based micromachined devices can be driven to much higher particle velocities than metal devices and can operate at higher frequencies for longer periods without fatigue failure. The tendency for silicon to be brittle can be overcome by deposition of thin films of tougher material on the surfaces of the device.

Professor Lal has become well known for his work at the University of Wisconsin on the use of MEMS techniques applied to silicon wafers to produce high-energy ultrasonic actuators and to improve the toughness of the material by means of surface

(continued on page 12)

MEMS in Biotechnology Research *(continued from page 11)*

treatments. Under his leadership, the Sonic MEMS group at the Wisconsin Center for Applied Microelectronics worked on the development of micromachined millimeter-scale silicon-based surgical tools with integrated sensors and circuits. When used for tissue identification, these tools will allow surgeons to sculpt tissue finely and at increased speeds. The group also investigated ultrasonic microfluidics by using acoustic streaming for microfluidic pumps and valves and began development of ultrasonic atomizers for applications such as fuel injection and drug delivery. Resonator particle velocities twice that of metal-based transducers were achieved in some preliminary silicon-based devices, and attempts to achieve even higher velocities were based on research on the development of new fabrication techniques and improved resonator designs.

Amit received the B.S.E.E. degree from the California Institute of Technology in 1990 and the Ph.D. degree in electrical engineering from the University of California at Berkeley in 1996. He joined the ECE School faculty as an assistant professor on July 1, 2002. From 1998 to 2002, he was an assistant professor in the Department of Electrical and Computer Engineering at the University of Wisconsin–Madison and the leader of the Sonic MEMS group at the Wisconsin Center for Applied Microelectronics. He is a recipient of the National Science Foundation CAREER award for research on applications of ultrasonic pulses to MEMS.

Amit's teaching and research interests are in developing concepts technology and models for integrated microsystems using MEMS fabrication techniques, characterizing ultrasound and its linear and nonlinear effects, and investigating the applications of radioactive thin films. He has published more than 57 conference papers on ultrasonic sensors and on ultrasonics and micromachining, and he holds patents on micromachined acoustic sources/receivers and on silicon-based high-intensity ultrasonic actuators. As a member of IEEE, he serves on the Technical Committee on Physical Acoustics in the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society.

Amit and his graduate students conduct their research in the Sonic MEMS Laboratory at Cornell. His recent research was concerned with procedures to ensure appropriate behavior of MEMS devices composed of micromachined thin films such as silicon-nitride membranes anchored on an anisotropically etched silicon substrate. Because uncertainties in lithography, anisotropic etching, wafer thickness, and silicon-nitride thickness can result in considerable variations in final dimensions of the device, it is essential to have an accurate means of determining the mechanical properties of thin films at the die stage without damage to the films as a result of the measurement, and to avoid ultrasonic performance that could reduce the yield in the production of usable devices. Professor Lal found that the characteristics and dimensions of the material could be determined accurately by measuring the resonance frequencies of the structure and applying finite-element analysis to the data to construct a suitable linear model.

The Sonic MEMS group also is working on using radioactive thin films to power MEMS. The electrons emitted from a radioactive thin film are used to move a cantilever, thereby creating self-powered machines. This technology is being used to develop self-powered gas sensors as well as light sources.

Computer-Aided Diagnosis from CT Images

Directed by Anthony P. Reeves

The well-established diagnostic procedure based on computed tomography (CT) imaging—often called "CAT scanning" or, simply, "cat scans"—is a powerful non-invasive technique that has revolutionized the detection of cancer in the body. Lung cancer is often manifested by solid-tissue nodules that grow within the lung parenchyma. At present, the best non-invasive predictor of malignancy is nodule growth rate, which is estimated from the change in nodule size that occurs between two time-separated cat scans, usually over a period of several months. Diagnosis and treatment of cancer would be greatly enhanced if nodules could be detected at an earlier stage (that is, when they are very small) and nodule growth rate and the nature of a malignancy could be determined much more rapidly.

Professor Reeves and his Computer Vision and Image Analysis Group have used the techniques of computer vision to automatically detect very small pulmonary nodules and to segment and accurately measure the volume of these nodules. The detection algorithms assist the radiologist in identifying nodules in whole-lung CT scans. The resulting precise measurement methods permit the time delay between two scans to be reduced significantly. Reeves's research group also is attempting to predict malignancy from the appearance (shape and texture) of the nodule image, a procedure that may allow the malignancy status of the nodule to be determined after just a single scan.

Computer vision (also known as "machine vision") is the construction of explicit meaningful descriptions of physical objects or other observable phenomena from images. Computer vision has a very wide range of applications—from medical diagnosis to seeing robots, from particle physics to geological surveying, and from missile defense to quality control. The current primary research goal of Tony's group is the development of a medical computer-assisted diagnosis (CAD) system in collaboration with the Early Lung Cancer Action Project (ELCAP) at the Weill Medical College of Cornell University. The focus of this research is to evaluate patient health and diagnose disease (especially cancer) through analysis of three-dimensional images from CT scans (see Figure 6). Current programs are directed towards detecting pulmonary nodules in whole-lung scans and diagnosing nodules from high-resolution CT scans. A direct connection to the Weill Cornell Medical Center's picture archiving and communications system at New York–Presbyterian Hospital is used to transfer image data directly into the research analysis system. Projects are in progress on several image-analysis issues: advanced three-dimensional (3D) image segmentation, 3D visualization and animation, medical database development, and methods for computer-aided medical diagnosis. A research collaboration agreement with GE Medical Systems also allows GE to use these algorithms in their recent CT lung-analysis products.

A major effort resulting from the interaction with ELCAP has been the development of an interactive web-based data management system, the ELCAP Management System (EMS), for conducting clinical trials. This system is unique in that it integrates all data—patient clinical data; digital image data, including CT scans and pathology images; screening protocol; and computer-aided diagnosis tools—in one location. The system also allows for the pooling of data from different clinical sites, a critical activity for gaining information on the natural history of the disease.

ELCAP has started two major data-pooling research studies that collect data using its web-based data system. The first study, NY-ELCAP, is being conducted in New York State and involves 10 New York medical institutions. The second, I-ELCAP, receives contributions from a number of national and international medical centers. These projects are unique in their size, the web-based collection methods of CT image data, and the incorporation of three-dimensional computer-aided diagnostic methods that the group has developed for the analysis of CT images. The system currently hosts 30 sites with more than 20,000 CT scans for more than 15,000 participants. The EMS also is being used by the French national study on lung-cancer screening.

Professor Reeves's group also has developed and continually updates a computer vision package known as VisionX, an extensive flexible software system for image processing and computer vision with a particular focus on multidimensional image analysis. It has been used in research projects and courses for a wide range of applications, including: multispectral image

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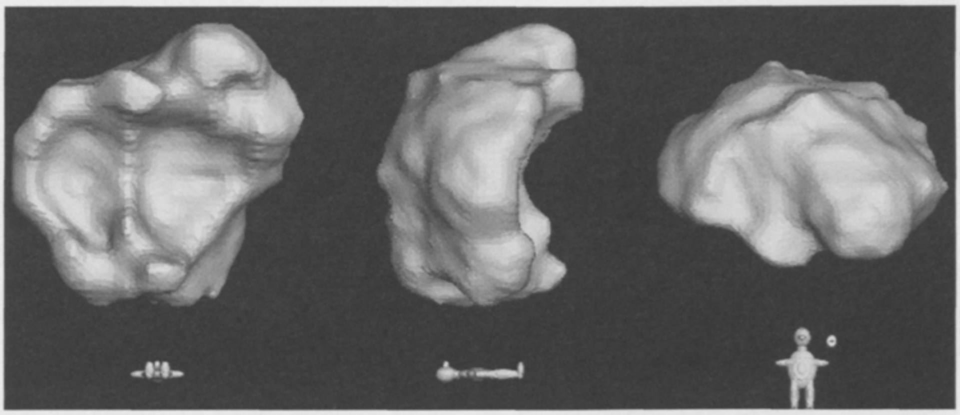


ELCAP Laboratory, Weill Cornell Medical College

Figure 6. Three-dimensional light-shaded CT image of the upper chest with a small pulmonary nodule attached. Vizualization of the nodule is viewed from axial, saggital, and coronal viewing directions.

Diagnosis from CT Images *(continued from page 13)*

analysis, 3D object recognition, multiframe image analysis, object tracking, neural networks, biological cell analysis, and 3D-CT computer-aided diagnosis. The VisionX system provides three services: a library of computer vision algorithms, programming tools for new vision algorithms, and convenient interactive access to X-Windows and MS-Windows image display. The system has been used effectively on a number of multiprocessor environments. VisionX is at a mature stage of development; many of the commands have been in use for 20 years.

Tony received the B.Sc. degree (honors, first class) in electronics and the Ph.D. degree from the University of Kent, Canterbury, United Kingdom, in 1970 and 1973, respectively. From 1976–82, he was an assistant professor in the School of Electrical Engineering at Purdue University until he joined the faculty of the Cornell School of Electrical Engineering in 1982 as an associate professor. He has held visiting faculty positions at the University of Wisconsin, McGill University (Montreal, Canada), and Pavia University (Italy). From 1987–88, he was a member of the faculty of the Department of Computer Science, University of Illinois at Urbana-Champaign. Tony is a senior member of IEEE and a member of the Association for Computer Machinery, Sigma Xi, and Eta Kappa Nu. He has authored or coauthored more than 100 publications in refereed journals and conference proceedings and has several patents.

As part of his academic duties, Tony teaches two courses related to biotechnology: Computer Vision, concerned with computer acquisition and analysis of image data, and Computer Analysis of Biomedical Images, which focuses on the quantitative analysis and computer-aided diagnosis of images from imaging modalities that are available for the evaluation of health and the detection of disease.

New Biotechnology Course:

A Culminating Design Experience

During the spring 2003 term, **John C. Belina,** B.S.E.E. '74, M.Eng. (Elec.) '75, lecturer and assistant director of the ECE School, offered for the first time course ECE 402, Biomedical Measurement and Instrumentation: a Culminating Design Experience. The course is intended for senior engineering students with microcontroller and systems engineering backgrounds who have an interest in biotechnology. The main objective is for the students to apply their skills in biotechnology while meeting the design criteria established by the Accreditation Board for Engineering and Technology and the American Association of Medical Instrumentation.

The course comprises primarily open-ended team design of a microcontroller-based biomedical measurement system, with appropriate support materials presented and developed by students and staff. The instrument designed this term is a functional prototype to measure 24-hour blood pressure in an ambulatory setting and produce relevant computer-aided analysis and reports as appropriate to the needs of front-line physicians. Next year's class will proceed from the design left behind by this first developmental group.

Emphasis is placed upon the process of using system-design principles throughout the development of the product. Techniques were presented for the measurement of low-level (biological) signals and the signal conditioning of such data. The students were required to investigate special circuits to improve the signal-to-noise measurement of low-magnitude analog signals in realistic situations. Suitable techniques also were employed to remove common-mode and correlated noise, as well as to selectively filter relevant

Demostration of a laboratory project

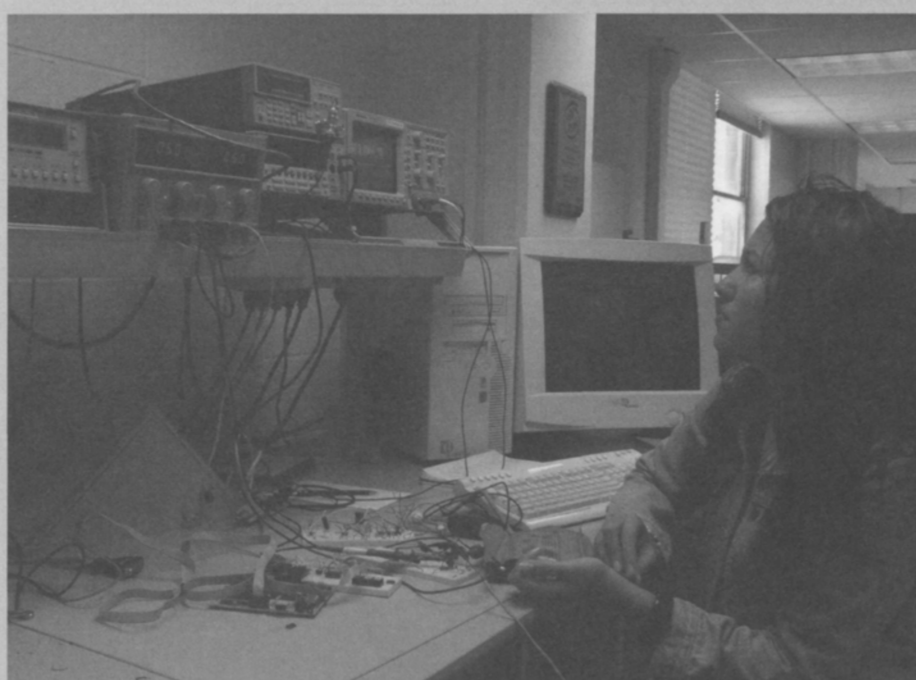
Korotkoff sound frequencies to improve the resolution of the blood-pressure measurement. Some teams chose the oscillatory method to determine the systolic, diastolic, and mean arterial pressures directly from the pressure transducer's output signal.

In keeping with the plan to present ECE 402 as a realistic system-design experience, John begins the course with a requirement for each team to draft a full-product specification, followed by the preparation of a design proposal—before they attempt any design tasks. As the teams design, fabricate, and test their instruments, weekly design reviews and progress reports are presented. (The photographs shown here illustrate the laboratory activities that are typical in the course.) In lieu of a final examination, a design report and a complete user manual are prepared, followed by a final product review and demonstration of the instrument.

The culminating design aspects of the course stress the realities of the medical care system in which early detection and close monitoring of chronic problems—such as hypertension, diabetes, and obstructive sleep apnea—are shown to have major political, economic, and societal impacts on the public health system. Health and safety issues, as well as those of manufacturability and sustainability, are realistically factored in through use of simplified Federal Drug Administration and American Association of Medical Instrumentation standards of design for such devices. Through student presentations, outside readings, in-class discussions, and design reviews, the students are exposed to concerns with economic, environmental, ethical, social, and political issues that affect complete biomedical instrumentation system design. This term, eight students signed on for one additional credit of technical writing and used this additional work to meet the college Technical Writing Requirement.

Photographs by William C. Mutch

(above and right) Student presentations of their experiments



Blood-pressure measurement experiment

In Memoriam

Professor Emeritus **Ralph Bolgiano, Jr.** died at age 80 on May 11, 2002 in Ithaca, New York, after a brief illness. Ralph received the B.S. degree in electrical engineering at Cornell in 1944. After service as an officer in the U.S. Army Signal Corps, with duties as an instructor in long-range radio and teletype communication at Fort Monmouth, New Jersey, he returned to Cornell, received the B.E.E. degree in 1947, entered graduate study as an instructor, and received the M.E.E. degree in 1949. Following five years with the General Electric Company as a development engineer, he was admitted for advanced graduate study in the EE School in 1954, served as an instructor until he received the Ph.D. degree in 1958, and joined the faculty as an associate professor in the same year. He was promoted to full professor in 1965, and retired as professor emeritus on July 1, 1990.

Ralph's 32-year career at Cornell was characterized by equal attention to undergraduate education, research, and service to the school and to the College of Engineering. In addition to direction of graduate student research, and his standard assignments in the basic electrical science, circuit theory, and junior laboratory courses, Ralph devoted a major portion of his classroom activity to developing and teaching the required junior-year courses in electromagnetic fields and waves. In all of his courses, students could expect exacting requirements, thought-provoking problems, and challenging examinations. But he was always available for questions and discussion. It was rare indeed to pass his office door and not find him in conference with a student. Not surprisingly, Ralph was the first recipient of the Ruth and Joel Spira Excellence in Teaching Award in 1983 for "inspirational teaching and interaction with students."

From 1975 through 1980, Ralph was the graduate field representative for the EE School. In those days, the school's graduate office coordinated the activities of the M.S./Ph.D. and professional degree (M.Eng. Elec.) programs. Consequently, Ralph was automatically a member of the Graduate Professional Programs Committee in the College of Engineering and served as chairman of that body for a year. He was director of the Engineering Cooperative Program from 1982–84 and also served as the EE member of the Engineering Policy Committee for several years. These duties, combined with his many years of active service as a class adviser, allowed Ralph to touch the lives of several thousand students during his career.

Ralph's research specialty was in tropospheric radiophysics concerned with the transmission of electromagnetic waves through the atmosphere, the remote sensing of atmospheric structure and turbulence, and the effect of these structures on the propagation of electromagnetic waves. These investigations find application of microwave radar in studies of wind and weather phenomena in the troposphere and in related aerodynamic studies of anisotropic turbulence. For years, Ralph carried out his investigations in association with the Cornell Center for Radiophysics and Space Research. From 1961–71, he was Cornell's scientific representative on the board of trustees of the University Corporation for Atmospheric Research during its formative years. From 1960 to 1970, he was also a member of the International Union of Radio Science and the International Union of Geodesy and Geophysics Interunion Commission on Radiometeorology, serving as president of that group from 1967–70. In the summer 1991 issue of the *Engineering Cornell Quarterly* (vol. 25, no. 2), Ralph reflected on his work and that of his national and international colleagues in tropospheric radiophysics and summarized the role that radar now plays in the field of meteorology. "It is now possible," he wrote, "to detect and measure air motions—both their speed and their direction—even in the absence of precipitation or other airborne tracers. Instances of intense wind shear or turbulence, which may impose great danger to aircraft and their passengers, can be observed and suitable warnings can be issued. The structure of the windfield in severe storms (frontal systems, hurricanes, and tornadoes) can be mapped and analyzed remotely in great detail, a capability of paramount significance to atmospheric scientists who are attempting to gain a better understanding of these often catastrophic natural phenomena."

Ralph's research interests provided opportunities for study at both national and international levels. In 1964–65, he was a Guggenheim fellow and a Fulbright travel fellow as a visiting research scientist at l'Institut de Méchanique Statistique de la Turbulence, Université d'Aix en Provence, Marseilles, France. In 1971–72, he was a research engineer at the Radio and Space Research Station, National Research Council, Ditton Park, Berkshire, England. In 1979–80, he was a senior research associate at the Cooperative Institute for Research in the Environmental Sciences at the University of Colorado. He also consulted with several organizations including ADCOM, Inc., Rome Air Development Center, National Bureau of Standards, and Boeing Scientific Laboratories. Ralph was a member of the engineering honor society, Tau Beta Pi, and of the scientific research society, Sigma Xi, a senior member of the Institute of Electrical and Electronics Engineers (IEEE), and a fellow of American Association for the Advancement of Science. He was also a member of the IEEE Antennas and Propagation Society, the American Geophysical Union, and the American Meteorological Society. He was a frequent contributor to the literature in his fields of interest.

Ralph was an active sailor for a long time and had recently taken up board sailing on Cayuga Lake as an interesting alternative. He was an enthusiastic bicyclist who was a familiar figure on campus for many years. Ralph did not enter the competitive cycling events in the region but participated in the annual Race Around the Lake, which he entered, as he said, only to "enjoy the scenery." He was a youthful presence in the school, full of boundless energy, quite expected of a man who generally wore a bow tie (usually red) and was rarely seen without a sport jacket. As a faculty member, he was always willing and able to assume major responsibilities for the EE School and the College of Engineering; as a teacher, he was a vigorous lecturer, fully prepared and superbly organized, whose easily recognized resonant voice never required the use of electronic amplification.

Ralph Bolgiano will be long remembered as a dedicated scholar, a conscientious teacher and adviser, a respected colleague, and a devoted friend.

Professor Johann **Peter Krusius** died of cancer at age 58 on January 30, 2003 in Ithaca, New York. Peter graduated with honors in 1964 from the School of Reserve Officers, Finnish Defense Forces and entered the Helsinki University of Technology in Finland. He received the Diploma Engineer degree in electrical engineering in 1969, the Licentiate of Technology degree in 1972, and the Ph.D. in 1975 (in electron physics). Following receipt of his doctorate, he conducted research on semiconductor physics for two years at the University of Dortmund (West Germany) Institute of Physics, and from 1977 to 1979 as a Docent of Technology at the Helsinki University of Technology Electron Physics Laboratory. Peter came to Cornell as a Fulbright Fellow in the School of Electrical Engineering and the National Submicron Facility in 1979, remained as a research associate, was appointed an associate professor in 1980, and was promoted to full professor in 1987.

Upon his appointment to professorial rank, Peter began a remarkable career of productive research and publication, excellent instruction, and outstanding technical leadership in his fields of semiconductor electronics and microelectronics. In 1986, he was appointed associate director of the Joint Services Electronics Program (JSEP) at Cornell, a multiuniversity basic-research program supported by the U.S. Army, Navy, and Air Force. Also in that year, Peter served as associate director of a related activity, the Industrial Affiliates Program of the National Submicron Facility. During the early years of JSEP, principal attention had been given to high-speed microwave devices, but recent emphasis had shifted to optoelectronics. Following a sabbatical year at IBM's T. J. Watson Research Center in 1988–89, Peter became director of JSEP and, together with three EE faculty members, started a new three-year research program on the fundamentals of speed limits of optoelectronic devices.

By that time his research interests had begun to focus on ultra-high-density nanoelectronics, femtosecond carrier processes in semiconductor heterostructures, and integration and packaging of high-speed computers from individual circuits on a chip to full systems. In September 1990, Peter cooperated with Professor **Che-Yu Li** of the Department of Materials Science and Engineering to establish the Industry–Cornell University Alliance for Electronic Packaging. On a sabbatical leave during the spring 1995 term, Peter was a visiting professor at the Royal Institute of Technology (KTH) in Stockholm, Sweden, where he offered a special course and conducted collaborative research with circuit and system designers on system integration and system packaging for digital computing and telecommunication applications. In 1997, he became director of the Cornell University Electronic Packaging Program, following Professor Li's tenure in that office, and established the Cornell Advanced Facility for Electronic Packaging.

Peter described electronic packaging research as being concerned with attempts to bridge the gap between the largest component and the smallest component in an electronic system. Since a typical circuit with an electronic chip is a highly complex array with hundreds, perhaps thousands, of interconnections from the outside world to the tiny elements within the chip, an effective electronic package requires design of novel connection procedures, development of new materials, and avoidance of electrical interactions between closely positioned elements. Peter predicted that future conduct of electron packaging research in the new state-of-the-art clean-room facilities planned for Duffield Hall would allow his research group to reach system-level device counts comparable to the number of neurons in the human brain.

From 1998–99, Peter served as director of the Semiconductor Research Corporation (SRC) Interdisciplinary Program on Microscience and Technology at Cornell, and he also continued as director of the electronic packaging facility in a three-year program to construct a unique tool that could fabricate more than 5,000 connections to integrated circuit chips. In this period, Peter joined with Professor **Joseph M. Ballantyne** to establish Cornell, as part of a consortium of seven universities, to participate in an ambitious national semiconductor research effort known as the Focus Center Research Program, with an ultimate goal to develop a new generation of more powerful computer chips by devising new methods to interconnect microchip components.

Attention to electronic packaging concepts over the years led Peter and his colleagues to invent an important new flat-screen television and video technology. He established a research group that designed and developed techniques for joining color flat-panel television and video screens to make large active-matrix liquid-crystal displays made of three panels tiled together into a single, seamless piece of glass. In 1996, he helped found Rainbow Display Inc. (RDI), a Cornell startup company created to build the displays. In 1999, RDI signed a joint development agreement with Philips Flat Display Systems, a unit of Royal Philips Electronics of the Netherlands, one of the world's largest consumer electronics companies. Last year, the display technology won the Society for Information Display magazine's Display of the Year Gold Award, their highest honor.

The major portion of Peter's 22-year academic career at Cornell was devoted to teaching juniors, seniors, and graduate students in semiconductor electronics, microfabrication, and physical design of computer packaging. He supervised the thesis research of some 20 graduate students in these areas

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and guided many master of engineering students through design projects related to his active research program. Initially he taught courses EE 435–36, Semiconductor Electronics I and II, and later developed a new version of the junior-level course, EE 315, Electronic Circuit Design, that was offered for the first time in the 1995 fall term. That course was notable for its imaginative projects that required the students to design, build, and test control circuitry in a three-week period. Peter made major contributions to the curriculum with the popular course EE/ECE 536, Microfabrication, taken by hundreds of students through the years, and EE/ECE 537, Physical Design of High-Speed Computers. Recently he developed a 300-level version of the latter course (ECE 336) that is being offered for the first time this year; he was disappointed that his health prevented him from participating in the new course.

Peter brought to the classroom the same dedication, attention to detail, and thorough preparation that he applied to his research activities. He was greatly admired by his students who appreciated his highly organized course web page, clearly delivered lectures, and sometimes unique approach to examinations. He was generous with his office hours and his consultation time with students and always made certain that all questions were answered, even if he remained overtime. He was a particularly conscientious class adviser, and he always attended meetings of the ECE Faculty Committee to ensure his proper attention to academic actions that might relate to his advisees. Peter served on the ECE Curriculum and Standards Committee and was a member of a committee to study the Master of Engineering Program in the College.

Peter was a prolific contributor to the literature in his field. He authored or coauthored more than 200 publications in technical journals and conference presentations, wrote more than 10 invention disclosures or patent applications, won a number of outstanding paper awards, and served as editor-in-chief of the *IEEE Transactions on Components, Packaging, and Manufacturing Technology—Advanced Packaging.* He was the author of a chapter entitled "Fundamental Limits for Electronic Packaging" in the textbook *Fundamentals of Electronic Packaging* by Donald P. Seraphin, Ronald Laskey, and Che-Yu Li (McGraw-Hill, 1987). Peter was a senior member of the IEEE and a member of the American Physical Society, the Materials Research Society, the Electrochemical Society, and the American Association of Science. Despite his busy schedule of teaching, research and business affairs, Peter was an avid skier and windsurfer and enjoyed Bach, science fiction, home repairs, and automobile maintenance.

Peter Krusius's cheerful presence, keen research initiative, and technical expertise will be greatly missed. He will be long remembered as a devoted teacher and adviser, a dedicated scholar, a respected colleague, and a good friend.

Professor Emeritus **Stanley William Zimmerman** died at age 95 on May 13, 2002 in Ithaca, New York, after a brief illness. After obtaining the B.S. degree in electrical engineering and the M.S. degree in engineering, both from the University of Michigan in 1930, he joined the General Electric Company Test Program in Pittsfield, Massachusetts, as an electrical engineer with research and development interests in electric-power-system protective devices, transmission and distribution engineering, high-voltage phenomena, and lightning and surge studies. Stanley came to Cornell in 1945 as an associate professor of electrical engineering and director of the High Voltage Research Laboratory, attained full professorial rank in 1948, and retired as emeritus professor in 1973.

During his 15 years with General Electric Company, Professor Zimmerman made many contributions to the field of high-voltage engineering and related dielectric materials. His work in lightning-arrester research and development—which involved studies of thyrite, a nonlinear material used in early arresters—was basic for modern arrester design. Stanley's investigations of high-voltage systems in terms of potential distribution, ionization, corrosion, and impact of environmental conditions necessitated development of unique experimental techniques. For several years, he was associated with field and laboratory studies of high-power circuit protection and circuit interruption, with particular attention to the design and testing of 287 kV circuit breakers and transformers for the Boulder Dam (now Hoover Dam) installation on the Colorado River. Much of his work also was concerned with the development of lightning measuring instrumentation and the statistics of natural lightning. During World War II, he was engaged in the development of radio noise filters for aircraft and participated in flight tests and field tests of military radio noise–suppression applications.

When Stanley arrived at Cornell in September 1945, he took charge of the high-voltage research laboratory that had been established in 1943. The facility was housed in a large corrugated-steel structure south of the campus on Mitchell Street Extension. The building contained a bank of three 250 kV 60 Hz transformers, a Marx generator that could develop a three-million-volt lightning surge, associated control facilities, a 10-ton crane, and a railroad siding that allowed import of heavy equipment—altogether forming a site that was capable of industrial-standards testing of large electric-power apparatus. Stanley developed two senior courses, High-Voltage Phenomena and Power Apparatus and Systems, and encouraged use of the laboratory for projects in both disciplines at graduate and senior levels. He also began part-time operation of the laboratory as a testing facility for industry. Due to his familiarity with the electric-power field and through his industrial contacts, he was able to obtain substantial gifts of equipment to augment the laboratory apparatus already in place. Two 1000 kVA generators and one 3000 kVA machine were among the early major acquisitions. Under his direction, one of the 1000 kVA units was upgraded, tested, and placed in service in the first Cornell Synchrotron facility. The other two machines were prepared for short-circuit studies in the laboratory.

In order to bring the laboratory to the attention of electric utilities as a potential industrial testing service, Stanley established a series of lectures by distinguished visitors, and inaugurated tours of the facility coupled with dramatic demonstrations of the high-voltage equipment. He called one of his favorite displays a "Jacob's ladder," a high-voltage arc that would climb up between two copper rods in a vertical "V" formation mounted separately on a block of insulator material. At the top of the V, the discharge would form into a three-foot-long arc that would dissipate, only to form again at the bottom of the V and renew its climb. With the aid of the three-million-volt surge generator and two large copper spheres mounted on insulated posts, Stanley would create a 10-foot-long artificial lightning discharge with associated crackling sound effects. One particular stunt brought him some media attention. He would ask for a volunteer to climb into a "Faraday's Cage," a four-foot cube made of copper mesh. After insuring that the occupant was completely enclosed and that the cage was solidly grounded, he would discharge a lightning bolt to the cage from the three-million-volt surge generator.

On February 12, 1948, the high-voltage laboratory was completely destroyed by a spectacular fire that caused an estimated loss of one million dollars. With the aid of insurance and gifts of equipment, Stanley designed and supervised the restoration of the laboratory to its former condition plus improvements that included an upgrade of the 60 Hz high-voltage capability from the original 750 kV to one million volts and the installation of a 20-ton crane.

For several years Stanley continued to offer his former courses, directed graduate and senior projects, and resumed industrial equipment testing. By the late 1950s, however, large industrial concerns had established their own internal high-voltage testing facilities, student interests moved to other fields, and the laboratory entered a period of limited use. In 1957, the Association of Edison Illuminating Companies (AEIC) authorized a three-year extra-high-voltage underground cable testing program to begin at Cornell in 1960, with the laboratory as a staging area for the test.

In 1959, Stanley recognized that the laboratory would not return to its former use following completion of the cable test. After assisting AEIC engineers in planning the use of the laboratory for the test program, he transferred responsibility for the facility to Professor **Joseph L. Rosson,** director of the AEIC testing program, took a sabbatical leave, and upon his return to the campus taught the service courses (electrical engineering for non-electrical engineers), offered courses in high-voltage phenomena and technical writing, and served as an undergraduate adviser. During the summer months, and for many years after retirement, he consulted as a high-voltage specialist with several industrial concerns, Argonne National Laboratory, and Lawrence Radiation Laboratory.

Throughout his 28-year academic career at Cornell, Stanley, a naturally jovial and energetic man, was an enthusiastic teacher and willingly shared his expertise with his students and colleagues. He was noted for his ability to acquire substantial donations of surplus electric-power equipment, most of which he stored in the Mitchell Street laboratory building. He believed that the material would be useful some day, and, indeed, on occasion a faculty member in need of an otherwise expensive device could find it in Stanley's lab. He was a strong proponent of the practical and professional approach to the education of electrical engineers. His courses in high-voltage phenomena always included field trips to generating plants, substations, and large manufacturing plants, and his lectures in all courses were enlivened with examples drawn from his extensive industrial experience.

He was a member of the New York State Society of Professional Engineers and frequently helped students in other branches of engineering prepare for the electrical portion of their professional license examinations. He participated in both national and local activities of the American Institute of Electrical Engineers (AIEE), authored articles and reports in his specialties, and was named a fellow of the AIEE in 1963 "for contributions in the field of high-voltage engineering." In 1973, he was named a life fellow of its successor organization, the Institute of Electrical and Electronic Engineers (IEEE). He also was a member of the Conférence Internationale des Grands Réseaux Electriques à Haute Tension, the electrical engineering honor society Eta Kappa Nu, and the American Society for Engineering Education.

Stanley Zimmerman will be long remembered as an active and innovative investigator in his chosen field, a dedicated teacher and adviser, a respected colleague, and a good friend.

Recent Faculty Accomplishments

Awards noted in blue were announced at the College of Engineering Fall 2002 Awards Ceremony.

• Professor **Joseph M. Ballantyne** (opto-electronic devices and materials) has been on leave during the 2002–03 academic year. In collaboration with Professor **J. Richard Shealy,** he has been conducting research with his graduate students on high-efficiency ultraviolet light emitters on silicon.

• Lecturer **John C. Belina** (bioelectronics), assistant director of the ECE School, worked with Professors **Charles Seyler** and **Mike Kelley** to redefine and revise course ECE 210 and to create the lecture material in support of the course. Many of the students enjoyed the new approach and found the design experience to be rewarding. Visitors from companies in the engineering cooperative program reported definite improvement in the practical technical knowledge and abilities of students they have interviewed this cycle. John, with student assistant **Eric Lippart,** created the on-line *ECE Handbook* for fall 2002 that provided important quality advising and graduation-requirement information to our students, their advisers, and the undergraduate affairs office. He also found that working with the IEEE student branch in support of this year's IEEE Distinguished Centennial Lecture Series was a very rewarding experience.

• Professor **Toby Berger** (information theory and communications) the Irwin and Joan Jacobs Professor of Engineering, presented the 2002 Shannon Lecture on July 4 at Lausanne, Switzerland. Toby attended a review meeting of the Multidisciplinary University Research Initiative (MURI) at Harvard University where his Ph.D. student, **Igor Davetak,** presented their joint paper on quantum rate-distortion theory. The paper was extremely well received by the reviewers. Toby feels that the paper played a large part in the continuation of the MURI program through its fourth and fifth years.

• Associate Professor **Adam Bojanczyk** (computer engineering, parallel architecture, and algorithms for signal and image processing) proved stability of hyperbolic methods for indefinite least squares (paper has been submitted to the Society for Industrial and Applied Mathematics, SIAM); developed relaxation methods for orthogonal Kronecker procrustes problem (paper has been accepted by SIAM); analyzed sensitivity of the weights computation in the space-time adaptive signal-processing systems (paper has been submitted to IEEE SP).

• Assistant Professor **Martin Burtscher** (computer systems, microprocessor architecture, compiler optimizations) reports that he taught ECE 475 for the first time and improved ECE 575 and made it more web-based, as suggested by last year's observations. He is still researching prediction, but he has diversified into predicting things other than load values. He has collaborated on publications with Assistant Professor **Evan Speight** and with Assistant Professor Amer Diwan at the University of Colorado at Boulder, and he has secured his first research funding at Cornell with a grant from Intel Corporation.

• Professor **Hsiao-Dong Chiang** (analysis and control of nonlinear systems with applications to electric-power networks) has been on leave of absence from 2001–03 with Global Optimal Technology, Inc. in Ithaca, New York. He has been working on optimization technology, in particular with finding global rather than local solutions to nonlinear optimization problems. Global solutions have practical applications in almost every branch of engineering—for example, VLSI design. Chiang has developed an innovative approach, called multi-tier Dynamic Decomposition Point (DDP)–based search paradigm, for finding a comprehensive set of local optimal solutions from which the global optimal solution is found. Two patents applications have been filed.

• Associate Professor **David F. Delchamps** (control and system theory) reports that his research program has been somewhat in limbo for the last couple of years due at least in part to his teaching and advising duties and major university committee assignments. He is particularly pleased with his contributions to the Hazing Task Force and the Fraternity and Sorority Residential Initiative Committee.

• Professor **Lester F. Eastman** (compound semiconductor materials, devices, and circuits), the John LaPorte Given Professor of Engineering, reports that he cooperated with Professor **J. Richard Shealy** to achieve world-record microwave power densities (11.7 W/mm) at 10 GHz using AlGaN/GaN high electron-mobility transistors. These results are 15 percent higher than have been achieved elsewhere with the same material and an order of magnitude higher than those obtained with the usual GaAs-based transistors. Cited by the contract monitor as the best contract results he has ever experienced, this research has led to tens of millions of dollars in Defense Advanced Research Projects Agency industrial contracts to develop materials and microwave transistors with these nitrides. Lester was selected as the 2002 recipient of the IEEE Electron Devices Society's J. J. Ebers Award, which recognizes outstanding technical contributions to electron devices.

• Professor **Donald T. Farley** (radiowave and upper atmospheric physics), the J. Preston Levis Professor of Engineering, received two James and Marsha McCormick Excellence in Advising Awards in 2000 and 2001. Don reports that he really enjoyed interacting with his freshmen advisees last year and this fall and writes, "It's nice to know that I still have some rapport with them at my advanced age!"

• Professor **Terrence L. Fine** (information theory, inference, and decision making in the presence of uncertainty), director of the Center for Applied Mathematics, reports his belief that his research with his student, **Chin-Jen Ku,** has resulted in a new approach to the important problem of blind source separation or independent component analysis (ICA). This active research area was part of the subject of a recent invited talk in the Department of Computer Science. He further believes that they are the first to understand why all current approaches often fail to find such a separation or analysis. Progress is continuing on the construction of data sequences that might be best modeled by the imprecise probability concept of envelopes of measures. Fine received the 2002 Douglas Whitney '61 Excellence in Teaching Award.

• Associate Professor **Zygmunt J. Haas** (wireless communication and networks, mobile systems) reports that in the past year his group has continued to develop the ad hoc networking technology, concentrating on the aspects of security, routing, quality of service, medium access control, and reliability. In particular, significant progress has been made in their research on securing communications in ad hoc networks, with quite positive feedback from the scientific community as well as considerable interest from the commercial sector. They also have been able to develop the theory behind use of multi-path routing for reliability and scalability in wireless networks, in general, and ad hoc networks, in particular. A joint MURI proposal in this area with the University of Maryland (with Zygmunt as the principal investigator at Cornell) has been funded. Work has begun on setting up a large-scale experimentation facility to demonstrate protocols developed by the group, including those that have been submitted to the Internet Engineering Task Force (IETF) for standards consideration. Applicable patents also have been filed.

• Professor **David A. Hammer** (plasma physics, controlled fusion, intense ion beams), the J. Carleton Ward, Jr. Professor of Nuclear Energy Engineering, reports the award of a three-year cooperative agreement with the U.S. Department of Energy and its National Nuclear Security Agency to establish the Center for the Study of Pulsed-Power-Driven High-Energy Density Plasmas. The award, joint with Professor **Bruce**

R. Kusse, Applied and Engineering Physics, will allow the center to conduct high-energy density research that will encompass the fundamental physics as well as applications of the dense plasmas produced from fine metal wires that are exploded when current pulses of up to 1,000,000 amperes are passed through the wires. Cornell is the lead university in the consortium of organizations that are collaborating on this research. The others are Imperial College (London); University of Nevada, Reno; University of Rochester (Rochester, New York); Weizmann Institute of Science (Rehovot, Israel); and the P.N. Lebedev Physical Institute (Moscow).

• Assistant Professor **Mark Heinrich** (computer architecture) has set his goals for next year to secure additional funding from the National Science Foundation and to ramp up research efforts in active input/output systems and system-area networks. His active memory research is going quite well. Several papers and two journal articles were submitted last year. With his Ph.D. student, **Daehyun Kim,** he plans to continue to conduct innovative research in the area of multinode active memory clusters. He also plans to demonstrate a field programmable gate array (FPGA) prototype of an active memory controller, a project driven by one of his master's students.

• Associate Professor **Sheila S. Hemami** (application-specific compression techniques for packet networks, networking aspects of visual communication, and multirate coding and transmission), during her sabbatical leave in the academic year 2001–02, held a visiting fellow position at Princeton University and was the Texas Instruments Visiting Associate Professor at Rice University. She worked on understanding the human visual system responses to suprathreshold distortions in images and video, and on robust source coding and transmission techniques.

• Professor **C. Richard Johnson, Jr.** (adaptive control and signal processing) reports that he signed a contract with Prentice Hall for publication of a senior-level textbook on telecommunications receiver engineering (Cornell course ECE 467) and notes that his 100th publication appeared in March 2002. He also co-invented a new channel-shortening equalizer for multicarrier communication systems that has commercializable potential in digital subscriber loop technology. Two of his Ph.D. students graduated in June 2002 and are headed to research and development positions in the U.S. telecommunications industry. Johnson received the 2002 J. P. and Mary Barger Excellence in Teaching Award.

• Associate Professor **Edwin C. Kan** (modeling and fabrication of nanometer-scale devices) reports that his group has obtained many positive results on the integration of metal nanocrystals on complementary metal-oxide semiconductor (CMOS) devices. The phenomenon has become well established in both theory and experiment

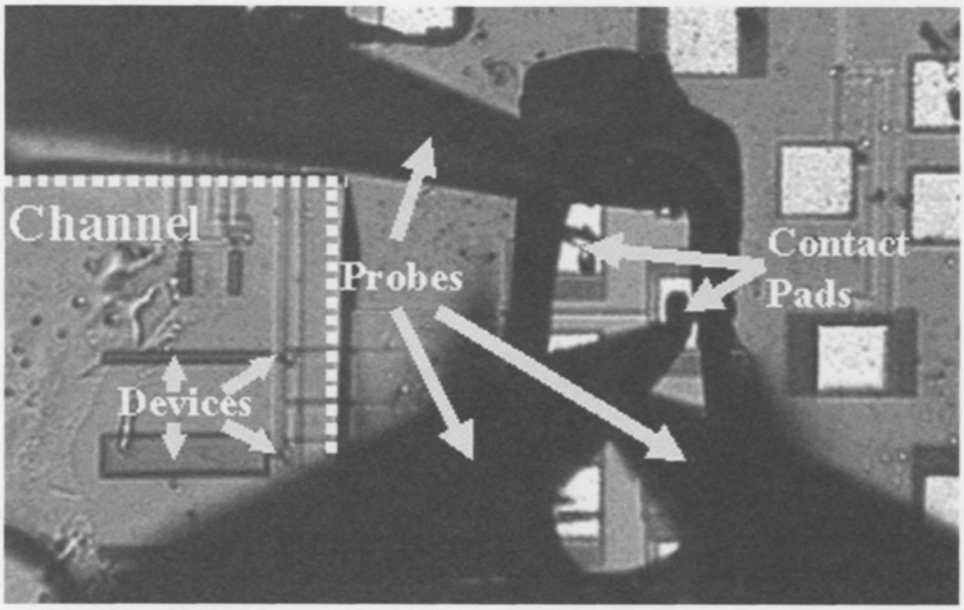


Figure 7. Test chip of a chemoreceptive neuron metal-oxide-semiconductor(MOS) that can provide interaction between a complementary MOS and molecules in fluids. Both sensing and actuation of the molecules can be established from the same structure.

and includes improved multi-bit nonvolatile storage and enhanced carrier injection across interface barriers. An experimental demonstration of the use of nonvolatile charge for attractive and repulsive actuation in MEMS devices also has been achieved by his group for the first time. Kan filed three patents with Cornell during the year and filed an additional patent with IBM during his summer faculty partner program. Edwin says that his research involves determining how to create a biomedical interface with a semiconductor technology (see Figure 7). As part of his teaching load, he has taken over the MEMS course (ECE 432) and has established a new measurement lab in the area.

• Professor **Michael C. Kelley** (upper atmospheric and ionospheric physics), the James A. Friend Family Distinguished Professor of Engineering, chaired a committee of the National Academy of Sciences last year with the responsibility to create a 10-year vision for the field of Atmosphere-Ionosphere-Magnetosphere Science. In part because of this work, Kelley was named a National Associate of the Academy for life, the first nominee for this new title. He was on sabbatical leave under a Fulbright award during the fall 2002 term at the Department of Physics of the University of Crete in Greece. A Cornell undergraduate, **Mike Nicolls,** set up an airglow camera on Milos, and joint observations were made with a radar unit on Crete.

• Professor **Paul M. Kintner** (atmospheric plasma physics) taught ECE 415, Global Positioning Systems (GPS): Theory and Design and a small projects course ECE 497, Advanced GPS, in fall 2001. He was on sabbatical leave in spring 2002 but continued to run the Advanced GPS group and collaborated on development of a Cubesat satellite that will carry a GPS receiver. He served as an Accreditation Board for Engineering and Technology (ABET) resource for the college for the entire academic year and also conducted his first ABET evaluation at the University of Illinois ECE School during the fall term. This task involved a site visit, extensive preparation, a final report, and an evaluation by ABET that resulted in praise for a "very thorough visit and an outstanding final report."

• Professor **Ronald M. Kline** (history of technology and electrical engineering) continued research on a book about the history of information theory and its applications to engineering, the physical sciences, and the social sciences.

• Associate Professor **Kevin T. Kornegay** (computer-aided design for VLSI circuits) reports that his group's silicon carbide MEMS work has captured the attention of many in the U.S. Department of Defense as well as in commercial research communities, particularly in the B.F. Goodrich Corporation. Other achievements include invitations to several high-profile conference technical program committees, election to sit on a distinguished defense panel, a nomination to participate in the fifth German-American Frontiers of Engineering Symposium, and invitations to present three distinguished lecture seminars last year at Rensselaer Polytechnic Institute, Polytechnic University (Brooklyn, New York), and Purdue University. He also participated on a distinguished panel of experts from academia and industry to address the topic of the "Digital Divide." The discussion was moderated by select

(continued on page 22)

Recent FaculyAccomplishments *(continued from page 21)*

members of the media, aired on a New York television station, and broadcast over the Internet. Kornegay was featured in several magazine articles that noted his receipt of the 2002 Black Engineer of the Year Award in Higher Education. In January, 2003, Kevin was selected by the Chicago Museum of Science and Industry to be featured in an exhibit showcasing contributions made by black Americans in the field of information technology.

• Assistant Professor **Michal Lipson** (nanophotonics, optical nanostructures, optical telecommunications) reports that since arriving at Cornell in August 2001 she has built an infrastructure for creating a strong program in nanophotonics. Funding has been secured from several agencies/centers including the Defense Advanced Research Projects Agency, the NSF-funded Center for Nanoscale Systems at Cornell, and the Alliance for Biotechnology. An important breakthrough was made in eliminating fundamental losses in photonic band gaps. This work was presented at the Conference on Lasers and Electro Optics (CLEO) in May. A patent application has been made for use of this technique. Her group's biggest accomplishment this year was the demonstration of an "optical solder" coupling light between a micro-scale fiber and a nanoscale waveguide. A paper on this topic is forthcoming in *Optics Letters*.

• Assistant Professor **Rajit Manohar** (asynchronous VLSI design, computer architecture, parallel computing) reports that his asynchronous VLSI and architecture group has been studying the design of energy-efficient asynchronous VLSI systems. Over the past year, major components of an efficient microprocessor have been designed. These components include the memory system, arithmetic blocks, register file, and instruction fetch. As a specific application of low-power design, the group recently designed a new microprocessor that has been optimized for sensor network applications. Common network protocol operations are efficiently executed due to hardware support. Preliminary estimates indicate that the processor requires about 15 picojoules to execute an instruction, which is less than 1/50th the energy required by commercial low-power designs or microcontrollers.

• Assistant Professor **Bradley A. Minch** (analog and digital VLSI circuit design) reports that his group has developed a new low-voltage bipolar/complementary metal-oxide semiconductor (CMOS) differential pair, called an inverted differential pair, based on the folded floating-gate differential pair that they discovered/invented last year. Their past development of translinear synthesis methodology has been placed on a more solid footing and has begun to be fielded in a number of different application areas. Minch has developed a new project course, ECE 493—to accompany ECE 453—in which students have an opportunity to have their final design project from ECE 453 fabricated. He continues to develop design-oriented digital process instrument analysis techniques and source/drain symmetric MOS transistor models for CMOS integrated circuit design education. He was the 2002 recipient of the Michael Tien '72 Excellence in Teaching Award.

• Professor **Thomas W. Parks** (signal theory and digital-signal processing) established contacts at Lockheed Martin Corporation and at the Center for Electronic Imaging Systems and received initial research funding from both.

• Professor **Clifford R. Pollock** (lasers and optoelectronics), the Ilda and Charles Lee Professor of Engineering and director of the School of Electrical and Computer Engineering, reports that most of his time during the past year has been concerned with Duffield Hall and running the school. Construction planning for Duffield Hall has involved investigating problems such as the presence of magnetic materials and electric currents near the characterization space, upgrading the third floor to meet H-5 fire code, and interviewing potential facility managers. His first year as director involved reorganizing the undergraduate office to help it handle the number of students in ECE and to improve the interface to the college student services staff, hiring five new faculty members, developing a space plan that will handle the growth the ECE School is experiencing, and managing more than $1 million in renovations.

• Associate Professor **Anthony P. Reeves** (parallel computer systems, computer-vision algorithms) states that the main achievements of his computer vision group result from the ongoing collaboration with **C. Henschke** and **D. Yankelevitz** at the Weill Cornell Medical College. The group's leadership position in research for lung cancer screening has allowed progress in a number of areas. In cooperation with the New York–Early Lung Cancer Action Program, a multicenter trial involving 13 different medical institutions has been started; all participants use the Cornell protocol and are sending computed tomography (CT) images to a unique central-secure web-accessible database facility that the group has developed. An international consortium has been started to pool data for lung cancer research, and 10 new medical institutions have joined this year and are sending data to the central Cornell repository. The group is participating in the National Institutes of Health Lung Image Database Consortium and in the EU/US Spiral CT Collaborative Group to promote research in screening for lung cancer areas and to provide a national database for test algorithms for computer-aided diagnosis (CAD) of lung cancer. A research collaboration agreement for lung cancer management CAD has been signed with the General Electric Company.

• Assistant Professor **Anna Scaglione** (statistical signal processing, communication theory) feels that her receipt of a 2002 National Science Foundation Faculty Early Career Development Award is her peak achievement of last year. She believes the award has increased her visibility in her field. The five-year $350,000 grant will support her research for the period.

• Assistant Professor **Sergio D. Servetto** (networks, information theory, signal-processing applications) completed his first single-authored journal paper, currently under review by *IEEE Transactions on Information Theory.* He had a visiting appointment at the Institute for Pure and Applied Mathematics, a mathematical sciences research institute at the University of California at Los Angeles that is funded by the National Science Foundation (NSF). He collaborated with Professors **Heinrich, Minch,** and **Scaglione** on submission of a joint research proposal to the NSF and developed two individual proposals.

• Professor **Charles E. Seyler, Jr.** (space plasma physics, theoretical and computational plasma physics), associate director for academic affairs in the School of Electrical and Computer Engineering, proposed a revised course ECE 210, Introduction to Circuits for Electrical and Computer Engineers, in which lectures and laboratories are closely connected. Together with Professor **Mike Kelley** and Lecturer **John Belina,** he also developed ECE 210 laboratory experiments leading to a design project experience. Together with his research group, he made significant progress toward understanding the origin of small-scale magnetic (Alfvenic) activity that is likely responsible for transverse energization of ionospheric ions in the auroral regions. This work is a high-priority scientific objective for the NASA Geospace Sciences Program, which is funding the research. Seyler was the 2002 recipient of the Kenneth A. Goldman '71 Excellence in Teaching Award.

• Professor **J. Richard Shealy** (development of compound semiconductors), in cooperation with Professor **Lester F. Eastman,** achieved world-record microwave power densities (11.7 W/mm) at 10 GHz using AlGaN/GaN high electron-mobility transistors. These results are 15 percent higher than have been achieved elsewhere with the same material and an order of magnitude higher than those obtained with the usual GaAs-based transistors. Cited by the contract monitor as the best contract results he has ever experienced, this research has led to tens of millions of dollars in Defense Advanced Research Projects Agency industrial contracts to develop materials and microwave transistors with these nitrides.

• Assistant Professor **W. Evan Speight** (distributed computing, parallel processing, computer architecture, operating system research), in conjunction with Professor **Mark Heinrich,** initiated and served as co-organizer and program chair of the First Annual Workshop on System Area Networks (SAN-1) held at the 2002 International Symposium on High-Performance Computer Architecture (HPCA) in Boston, Massachusetts. Since the workshop was exceptionally well attended, they were asked to organize SAN-2 at the 2003 HPCA Symposium. During the course of this past academic year, Speight completely revised the ENGRD 231–232 sequence to focus the course on the design aspects of digital logic and worked on the material to better integrate it with the ECE 231–314–475 computer engineering core courses. He also directed the consolidation of ECE 231–232 into a new version of course ENGRD 230. In collaboration with Professors **Mark Heinrich** and **Martin Burtcher,** he has published papers on different topics in high-performance computing. He was the 2002 recipient of the Ralph S. Watts '72 Excellence in Teaching Award.

• Professor **Michael G. Spencer** (growth of compound semiconductors and fabrication of discrete devices from these materials), director of graduate studies in the School of Electrical and Computer Engineering, reports that an unfortunate delay in access to laboratory space caused a significant disruption of the research effort of his group. His current goal is to bring all the equipment in his laboratory to operational status and to engage it in productive research. Specific topics to be advanced are the production and characterization of heteropolytype junctions in silicon carbide (SiC) and the realization of initial results in bulk growth of gallium nitride (GaN).

• Professor **Chung-Liang Tang** (lasers, optoelectric devices, nonlinear and coherent optical processes), the Spencer T. Olin Professor of Engineering, reports that his research group carried out the first comprehensive experimental study of optical orientation and femtosecond relaxation of spin polarized holes in semiconductors. Undoped bulk GaAs at room temperature was the first to be studied. This study opened up the whole field of studying the dynamics of spin polarized holes in semiconductors, in general, for the first time.

• Professor **Robert J. Thomas** (control techniques for large-scale networks, analysis of microelectromechanical systems) reports that during the past year he developed a successful new graduate course on Power Systems Engineering and Economics with Professor **Tim Mount** of the Department of Applied Economics and Management. Thomas continues as director of the National Science Foundation Power Systems Engineering Center (PSERC), which has grown to a consortium of 11 universities with Cornell as the lead institution. Current industrial support of PSERC is $1.55 million from 40 companies, and four U.S. national laboratories provide an additional $1 million. Groundbreaking research on new power-system market mechanisms has been presented to the Federal Energy Regulatory Commission and the National Electric Reliability Council. Thomas was on sabbatical leave with Sandia National Laboratories in Livermore, California during the fall 2002 term. His assignment was to provide advice on critical infrastructure simulation needs and issues.

• Professor **James S. Thorp** (estimation and control of discrete linear systems applied to electric-power networks), the Charles N. Mellowes Professor of Engineering and former director of the School of Electrical and Computer Engineering, reports that his research group has developed a formulation of the spinning reserve market for electric power. The model is based on a set of critical contingencies (and corresponding probabilities) that define the need for the reserves. The co-optimization involves selecting a generation pattern that minimizes the total expected cost of supplying energy and paying for the required reserves. A side benefit is that locational shadow prices for both energy and reserves are obtained. Thus, for the first time, a rational for different reserve prices in different locations has been obtained. The results of the optimization are used to clear the market after the participants offer selection of the energy and reserves from each generating unit along with the location energy and reserve prices.

• Professor **Sandip Tiwari** (electronic and optical-semiconductor devices and compound semiconductors), the Lester B. Knight Director of the Cornell Nanofabrication Center (CNF)'s Knight Laboratory, submits the following statement on the potential of CNF activities: "After three to four years of development of new techniques and technology for the nanoscale in the Cornell NanoScale Facility, the different directions of the effort have reached a point where there is a large increase in industrial interest in bringing the experimental research work of the group into development and production. These include techniques of three-dimensional integration of silicon electronics, a back-gated transistor technology that allows adaptive power control of circuits together with configurability, and a new silicon memory structure that is scalable to tens of nanometers in dimensions."

• Associate **Professor Lang Tong** (digital-signal-processing algorithms, estimation theory, wireless communication systems) spent his sabbatical year at the University of Delft in the Netherlands, a leave that resulted in the development of a new area of research that combines control theory with communications. He has received a five-year grant from Army Research Laboratory as part of its Communications and Networking Consortium, as well as gift funds from Legend Silicon Corporation. He also has made progress in other industrial collaborations.

• Professor **Stephen B. Wicker** (wireless information networks, digital communication systems, error-control coding, cryptography), associate director for research in the School of Electrical and Computer Engineering, finished his fourth book, published a number of papers, and developed some of his ideas regarding self-configuring networks. Wicker has been defining his role as associate director for research and, perhaps most importantly, he graduated five Ph.D. students, bringing his total to 22.

Addendum

The following names have been added to the EE/ECE Faculty Honor Roll.

Tor Hagfors
1982-1993

Professor **Tor Hagfors,** appointed in 1982 as director of the National Astronomy and Ionosphere Center and professor of electrical engineering and astronomy at Cornell University, became professor emeritus on July 1, 1993. He is now director emeritus of the Max-Planck Institut für Aeronomie in Lindau, Germany.

J. Peter Krusius
1980-2003

Professor **J. Peter Krusius,** appointed in 1980 as associate professor of electrical engineering, died on January 30, 2003 after a brief illness. See page 17 in this issue for a memorial statement.

Student Project Notes

The following projects are conducted principally by undergraduate students and several graduate students. The projects are interdisciplinary in nature, with student representation from all branches of the College of Engineering. The students perform all design, development, construction, and testing, seeking guidance from faculty advisers only as necessary.

BRAIN Project

The Cornell University Autonomous Underwater Vehicle (CUAUV) was started by sophomores in September 1999 under the supervision of ECE Associate Professor **Kevin Kornegay,** who continues as faculty adviser. The original and still informal name of the project team is Big Red Artificial Intelligence Navigation (BRAIN). The motivation of the team is to enter the annual International AUV College Competition, which features remotely controlled underwater vehicles that search for and record the presence of a specific number of objects. The CUAUV project gives students the opportunity to apply the knowledge learned in classroom studies in a systems engineering project that demands serious organization, innovation, and teamwork to be successful. The Cornell team won second place in their first competition in 2000, suffered a lost vehicle in 2001, and came in a close second to Massachusetts Institute of Technology in the 2002 competition in San Diego, California. Based on its experience in past competitions, the team is hoping for first place in 2003.

RoboCup Project

The Cornell RoboCup project was started in 1999 under the supervision of Associate Professor **Raffaello D'Andrea** of the School of Mechanical and Aerospace Engineering, who continues as faculty adviser. The objective of the RoboCup team is to participate in the annual international RoboCup competition. Entrees must construct a fully autonomous, fast-moving robot team to compete against similar teams of robots in a robotic soccer match. The soccer matches are played by teams composed of five robots. Competitors must design robots that will operate as a team as well as build vision systems to enable the robots to detect the ball and distinguish between their own players and their opponents. The robots also must be able to decide on the best moves to put the ball into the other team's goal. The RoboCup project is an excellent testbed for developing new tools and techniques for controlling autonomous systems in uncertain and dynamic environments. From an educational perspective, it is also a great means for exposing students to the systems engineering approach for designing, building, managing, and maintaining complex systems. Cornell teams won first places in 1999 and 2000, a third place in 2001, and another first in 2002. The current team has high hopes for a first in the 2003 competition.

ASTRO Project

The Cornell Aerospace Systems Technology and Rocket Operations Team (ASTRO) is a multidisciplinary student research team that includes students and faculty from Mechanical and Aerospace Engineering, Electrical and Computer Engineering, Computer Science, and Operations Research and Industrial Engineering. The mission of ASTRO is to build a re-usable, autonomously controlled, rocket-powered landing vehicle (ALV) that can descend from a height greater than 1,000 feet and land softly with no damage to its components. Each year, a new ALV is redesigned and fabricated, building upon prior work and incorporating new systems and technology. The ASTRO team is focused on providing the undergraduate community with opportunities to learn about and apply themselves to all the fields involved with building the ALV. The project invests heavily on lab improvements, allowing members to work with state-of-the-art equipment. Through this investment in computers, software, and other lab equipment, all members of the team have access to these resources and see all aspects of designing and fabricating the lander.

Senior Laboratory Design Project

Course ECE 476, Digital System Design Using Microcontrollers, is a popular course taught by **Bruce Land,** Ph.D. '76 (neurobiology and behavior, and electrical engineering), senior research associate. Students working in pairs design, debug, and construct several small systems that illustrate and employ techniques of digital system design acquired in previous courses.

Enrollment and Graduation Statistics

Undergraduate Program

Year	Sophomores	Juniors	Seniors	Degrees
00-01	157	169	130	116
01-02	132	195	151	153
02-03	115	172	188	179

M. ENG. (Electrical) Program

Year	August	January	May	Degrees
00-01	36	7	37	80
01-02	29	11	57	97
02-03	28	11	*	*

* not available at press time

Courtesy of Bruce Land

Students in course ECE 476

M.S./Ph.D. Program

Year	Applicants	Admissions	Total Enrollment	Degrees
00-01	600	32	155	18 Ph.D., 14 M.S.
01-02	834	24	187	20 Ph.D., 6 M.S.
02-03	810	26	194	17 Ph.D., 13 M.S.

Note: Undergraduate students now affiliate with the ECE School when the first term of sophomore math and physics is completed.

These figures indicate that over the past three years the undergraduate program has increased moderately, the M.Eng. (Elec.) program has increased moderately, on average, and M.S./Ph.D. enrollment has remained unchanged, on average.

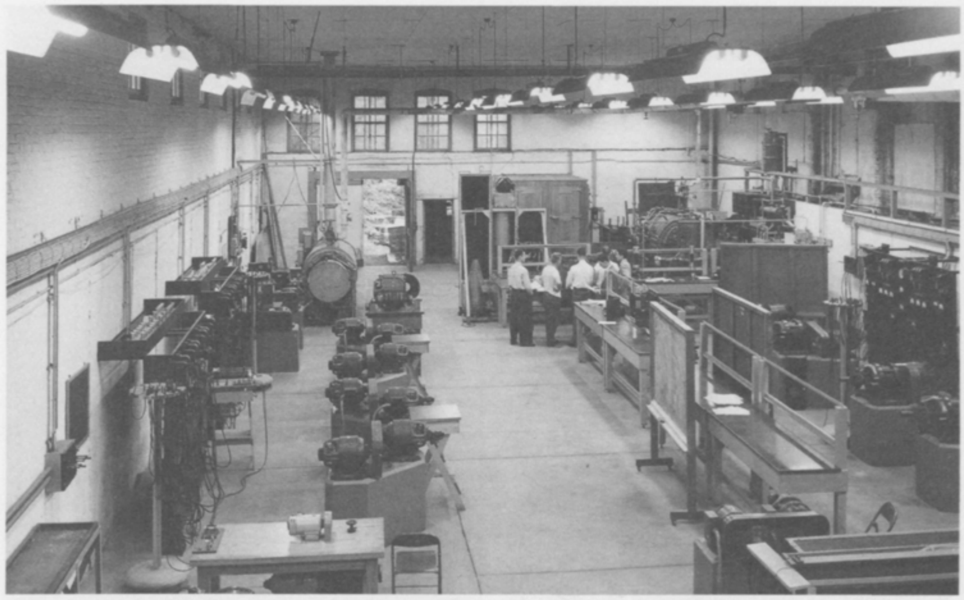
More Tales from the Past

Your tales from the past are always welcome. Send us your favorite stories about professors, labs, classes, projects, stunts, or whatever you think made the EE/ECE School a special place. We'll print 'em as space allows.

The Faculty Honor Roll in the summer 2002 issue of *Connections* brought a flood of memories to many alumni and a gratifying number of interesting comments. One in particular, from **Vladimir Kenn** '49, stated that the photos were a delightful surprise but he missed the picture of his old ac-dc machinery instructor, Professor **Henry Hansteen.** Vladimir described Henry as a tall and very dynamic professor, with a booming voice, who taught some of the recitation classes normally taught by graduate students. Vladimir recalls one occasion when one of the students had fallen asleep and Henry walked up to the student's desk, pounded on it with his fist and shouted, "Wake up, wake up, this is good stuff, you may need it later!"

Henry, known as "Hank" to his colleagues, came to the EE School as an associate professor in 1946 from City College of New York, where he had held a similar position. He was promoted to full professor in 1947 but decided to return to City College in 1950. In subsequent years, he served there as chairman of the Department of Electrical Engineering and was a visiting scientist at Brookhaven National Laboratory in Upton, Long Island, for many years. After his retirement, Hank returned to Ithaca, where he died several years ago. He was not associated with Cornell in his retirement years.

Memories of Hank and those early years following the end of World War II bring back recollections of a situation in the EE School that may have been generally unknown to many EE alumni of the time. In 1946, many students on campus were veterans on the G.I. Bill of Rights. In the College of Engineering, all non-electrical majors were required to take two semesters of electrical engineering, a substantial problem for the EE School. The problem was solved by establishment of "service courses," under Professor **Bill Erickson,** who directed the activities of a crew of graduate-student instructors that included **Nelson Bryant, Sam Linke,** and **Joe Rosson,** among others. Although lectures were held in Franklin Hall, the associated laboratory sessions took place in the Old Heating Plant, located near the present site of Bard Hall.



Courtesy of Rare and Manuscripts Collection, University Library

Figure 8. The Old Heating Plant Machinery Laboratory

The service-course instructors were pleasantly surprised one day when a recently appointed instructor, **Walter Keenan,** B.E.E. '45, brought in his newly acquired gadget, the first commercial 33-1/3 rpm LP record player. It was a monaural Columbia Broadcasting System turntable in a compact brown plastic case with a Philco amplifier and speaker. Walt placed a large vinyl disk on the turntable and the group heard an unbelievably clear 20-minute rendition of "Til Eulenspiegel's Merry Pranks" by Richard Strauss.
It was predictable that the recording industry was soon to undergo dramatic changes.

The Old Heating Plant Laboratory (see Figure 8) had been established by the U.S. Navy for the V-12 Program during the war. The ac and dc machinery motor-generator sets with associated control and instrumentation panels were ideal for service-course instruction without need for the use of the regular EE machinery in Rand Hall. The equipment was transferred to Phillips Hall in 1955 and continued its service-course function for a number of years longer.

Over the years, many amusing incidents occurred in the Old Heating Plant, but none was perhaps as memorable as the "case of the amazing dry cell." One afternoon, two groups of students were conducting simultaneous familiarization experiments on two separate dc motors to identify the shunt-field winding, the series-field winding, and the armature winding from six unmarked terminals of each machine. Each group was to perform the task with the aid of a six-volt dry cell (the tall battery seldom seen these days), a mounted 100-watt incandescent light bulb, and a 120-volt dc source under the control of the instructor. In his introductory remarks, the instructor reminded the students that the three separate windings could be determined easily by trial and error with the aid of the dry cell, but since two of the windings had very low resistance, complete identification would require use of the light bulb in series with a winding in order to avoid high currents when the dc source was applied. As a safety matter, the connections were to be checked by the instructor before the dc source was to be turned on. A single panel with separate con-

(continued on page 26)

More Tales from the Past (continued from page 25)

trols for each motor also contained two dc power sources with switches mounted side-by-side on the center of the panel. Group A had made their connections and asked the instructor to check their work. Group B was still working with the dry cell. The hapless instructor, who shall remain nameless, checked the connections, went to the control panel, and closed the switch to *Group B's* bench. Suddenly a 10-inch blue flame erupted from the dry cell to the amazement of all. The instructor quickly opened the switch and everybody agreed it was time for a break.

Sam Linke reporting: This tale about dc machinery reminds me of the time when I was a sophomore in electrical engineering at the University of Tennessee in Knoxville and took a course in dc machinery with Professor Charles A. Perkins. Although Dr. Perkins was hale and hearty, he was in his 80s and tended to be a little forgetful. He had a favorite anecdote about the days when he had been a student in electrical engineering and worked his way through school by working nights at the campus electric power plant that consisted of a lone dc generator. In those days there were no automatic controls, so, Dr. Perkins would say with a chuckle, "Every time a student in a dorm turned on a light I had to get up and shift the brushes on the generator." The problem, of course, was that Dr. Perkins told this story over and over again. One day a downtown movie theater was showing the film, *Edison, the Man*, with Spencer Tracy. At the point in the movie when Edison was having trouble running two generators in parallel and the screen was filled with flashing lights, bells ringing, and general confusion, a stentorian voice in the balcony cried out, "SHIFT THE BRUSHES!" You might be wondering what this has to do with Cornell. Well, when I was teaching dc machinery in Phillips Hall, one semester I told this story in class (only once!). After that, for some time, whenever anything went wrong with machinery experiments in the laboratory, someone was sure to yell out, "SHIFT THE BRUSHES!"

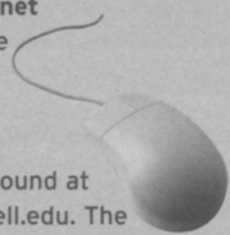
Sam Linke

Positive Feedback

A Link Between Alumni and the School of Electrical Engineering

In this issue, we are continuing the "Positive Feedback" feature of previous years. The first eleven issues of *Connections* triggered a gratifying number of responses. We hope that this issue will stimulate even more returns of the reply card (see insert) or reports on your recent activities. The e-mail for *Connections* is SL78@cornell.edu.

Note for Internet surfers: on the World Wide Web, the ECE School home page may be found at www.ece.cornell.edu. The College of Engineering URL is www.engineering.cornell.edu.



Note: Our alumni file is somewhat incomplete. If you know of school alumni who are not receiving *Connections,* please urge them to send their names and addresses to **Jeanne Subialka,** B.S. '99 (ILR), Engineering Public Affairs, 248 Carpenter Hall, Ithaca, NY 14853-5401.

Vladimir F. Kenn, B.E.E. '49, now retired and living in Palm Springs, California, writes that he was delighted to receive the copy of *Connections* with the "Faculty Honor Roll," which brought back fond memories of his days at Cornell.

Simpson (Sam) Linke, M.E.E. '49, professor emeritus of electrical engineering at Cornell and historian of the Ithaca Section of IEEE, was the featured speaker at the IEEE Region 1 Board Meeting Banquet in the Statler Hall Ballroom on Saturday, August 17, 2002. As part of the Centennial Celebration of the Ithaca Section held jointly with the Region 1 Meeting, Sam presented a brief history of the Section.

Wilson Greatbatch, B.E.E. '50, M.S.E.E. '57 (University of Buffalo), inventor of the implantable cardiac pacemaker, was the keynote speaker at the first annual Cornell BioEngineering Exposition on April 8, 2003. His talk focused on the past, present, and future of bioengineering. On his current research on the application of fiber optics to pacemakers he commented, "The innovation in this area is still not over. There is still a lot of work to be done and a large part of it is being done right here at Cornell."

Joseph P. Hesse, Jr., B.E.E. '51, retired financial manager now living in Windsor, Connecticut, writes that he was very pleased to receive the *Connections* issue with the photographs of his 1950–51 era professors, particularly, **Larry Burckmyer, Michel Malti,** and **Jack Tarboux.**

Lester F. Eastman, B.E.E. '53, M.S. '55, Ph.D. '57, the John LaPorte Given Professor of Engineering at Cornell, was selected as the 2002 recipient of the IEEE Electron Devices Society J. J. Ebers Award. This award recognizes outstanding technical contributions to electron devices. Lester's citation reads: "for sustained technical contributions and leadership in the development of high-frequency heterostructure transistors." The Ebers award was presented to Lester at the 2002 International Electron Devices meeting on December 9, 2002.

Irwin M. Jacobs, B.E.E. '56, M.S. and Sc.D. degrees in electrical engineering from MIT in 1957 and 1959, respectively, chairman and chief executive officer of QUALCOMM, was the guest lecturer in the Distinguished Lecture Centennial Series sponsored by the Cornell School of Electrical and Computer Engineering and the Ithaca Section of IEEE. Irwin spoke on the topic, "The Third Generation of Wireless Communications and Beyond." The event occurred on October 10, 2002 in Phillips 101, as part of the Centennial Celebration of the Ithaca Section of IEEE.

Robert M. Clifford, B.E.E. '62, project manager for Raytheon Systems Company in Fullerton, California, writes that the 2002 issue of *Connections* with the "Faculty Honor Roll" was a welcome surprise. Many of the professors shown had a lasting impact on his life. Seeing their pictures reminded him of how grateful he is for the opportunity to learn from them.

Karl F. Miller, B.E.E. '65, M.E.E. (Rensselaer Polytechnic Institute), management adviser and engineering consultant at Karl F. Miller & Associates in Ridley Park, Pennsylvania, was elected president of the Cornell Society of Engineers (CSE), for 2003–04 at the annual meeting of CSE on April 5, 2003. Karl has twice been chairman of CSE conferences and was secretary of the Board of Directors in 2002–03.

Robert E. Maroney, B.S. ENGR. '72, M.B.A. (Harvard), president and owner of RM Capital Holdings in New Canaan, Connecticut, president of CSE, presented introductory remarks on April 4, 2003 to open the CSE Conference on Breaking the Size Barrier, and chaired the annual meeting of CSE on April 5, 2003. Robert is a past member of the Cornell University Council and has served as a CSE conference chairman.

Sarah Thole Fischell, B.S. ENGR. '78, M.E.E. '79, consultant at Sarah T. Fischell in Fair Haven, New Jersey, was conference chair for the 2003 CSE Conference on Breaking the Size Barrier. The conference was held at Cornell on April 3–5, 2003.

William J. Schaff, B.S. ENGR. '78, Ph.D. '84, senior research associate in the ECE School responsible for the Cornell Molecular Beam Epitaxy (MBE) Facility, was the guest speaker at the ECE Faculty Seminar Series on Photonics on October 10, 2002. Bill spoke on the topic, "III-Nitride Semiconductors: Reaching for Longer and Shorter Wavelengths."

Jerry M. Woodall, Ph.D. '82 the C. Baldwin Sawyer Professor of Electrical Engineering at Yale University, was a featured speaker on April 4, 2003 at the 2003 CSE Conference on Breaking the Size Barrier. Jerry spoke on the topic, "Higher Bandwidth Devices Using Exotic Materials instead of Smaller Dimensions."

David F. Welch, Ph.D. '85 (electrical engineering), CTO and co-founder of Infinera, was a featured speaker on April 4, 2003 at the CSE Conference on Breaking the Size Barrier. David spoke on the topic, "Technology Leverage in the World of Telecommunications: How to Thrive as a Start-up."

Stephen J. Akerley, B.S. ENGR. '89 (electrical engineering), J.D. '92 (University of San Francisco School of Law), an IP litigator with the international law firm of McDermott, Will & Emery in the firm's Silicon Valley, California office, has been recognized by the *National Law Journal* in the publication's recently published "40-under-40" feature as one of America's most successful young litigators.

Staff News

Kim Cotton joined the ECE School as an administrative assistant on August 1, 2002. Before coming to Cornell, Kim was employed for eight years by Salomon Smith Barney, Inc. in Ithaca, New York, as a senior registered associate. She is a native of Candor, New York, graduated from Candor High School, attended Tompkins County Community College, and is currently studying to become an emergency medical technician through the Tioga County Emergency Medical System. At present, she is a member of the Candor Emergency Squad and will be certified to provide pre-hospital care without supervision when she completes her training in May 2003. Kim is a board member of Tioga County Relay for Life and is active in several other activities in her community. When time allows being away from her two young children, Kim enjoys gardening and reading.

Melissa Fields, office systems specialist, a member of the ECE computer maintenance group since 1997, has accepted a position in the College of Art and Sciences in the Department of Linguistics. She will be the systems administrator for Morrill Hall, where the department is located. We wish her success in her new position.

That melodious voice you hear when you call the director's office belongs to **Lisa E. Gould,** administrative assistant, who has transferred from Rhodes Hall to the main office in Phillips Hall to provide support to Director **Clif Pollock,** Director of Administration **Craig Higgins,** and Assistant to the Director **Susan M. Drake.**

Jason Seymour, joined the computer support group in the ECE School on January 1, 2003 as Windows systems administrator with primary responsibility for the Windows servers, labs, and desktops. He comes with a very strong background in computer operations. For two years prior to his arrival here, he was a research technology support specialist and a Windows systems and local-area-network administrator for Fairfax County Public Schools in Virginia; he held a similar position in the previous year with the National Institutes of Health in Bethesda, Maryland. A native of Wausau, Wisconsin, Seymour graduated from E.C. Everest Senior High School in Schofield, Wisconsin, and attended the University of Wisconsin at Green Bay. He admits that most of his spare-time activities are concerned with computers at home, but he enjoys reading and travel, when time allows.

Paula G. Solat, administrative assistant, has moved from the main office in Phillips Hall to Rhodes Hall, where she supervises support for ECE faculty and programs. She recently established publication of the *ECE Newsletter,* to be distributed to all ECE faculty, staff, and graduate students.

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Connections is published annually by the

School of Electrical and Computer Engineering
Cornell University
224 Phillips Hall
Ithaca, NY 14853-5401

Sam Linke, editor
Jamie Edgar, alumni relations manager
Jeri Wall, copy editor
Dennis F. Kulis, designer

Photography: University Photography, Farhan Rana, Anthony P. Reeves, David Reuther Photography, PhotoDisc, University Library Rare and Manuscripts Collection, University Registrar

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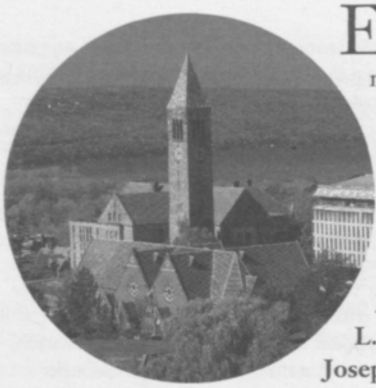
Produced by Media & Technology Services at Cornell University

Printed on recyclable paper

6/03 8.5M CP MTS10849

Eminent Professors' Fund



Eleven years ago, the EE School established the Eminent Professors' Fund to honor the memory of notable members of the school's faculty of past years, including professors **Ralph Bolgiano, Jr., Henry Booker, Nelson H. Bryant, L.A. Burckmyer, Walter W. Cotner, Casper L. Cottrell, William H. Erickson, Clyde E. Ingalls, M. Kim, J. Peter Krusius, Charles A. Lee, Michel G. Malti, Malcolm S. McIlroy, Wilbur Meserve, True McLean, B.K. Northrop, Robert Osborn, Joseph L. Rosson, Howard G. Smith, Everett Strong, Joseph G. Tarboux, Stanley W. Zimmerman,** and others whom alumni may recall.

The objectives of the fund are twofold: (1) to acquire specific grants to improve laboratory and research facilities in the ECE School, and (2) to establish endowments to provide on-going financial support for undergraduate and graduate students. The ECE School has given high-priority status to the establishment of:

- an endowment fund to supplement the operating costs of the undergraduate computing center and the undergraduate teaching laboratory
- an endowment fund to provide financial support, on a yearly basis, for graduate and undergraduate students who serve as teaching assistants in our laboratories
- one-year fellowships to support professional master's candidates for the M.Eng. (Electrical) degree
- a fund to support M.Eng. (Electrical) research projects

Alumni who would like to contribute to the Eminent Professors' Fund should contact Professor **Clifford R. Pollock** in care of the School of Electrical and Computer Engineering, Room 224, Phillips Hall.

ece ONLINE NEWS

New ECE Web Page

The ECE School web site has been extensively modified. The current version contains a guide for enrolled and prospective students, an updated alumni section, and general information about the school and faculty. Check it out at www.ece.cornell.edu.

ECE Alumni Online

Alumni may access alumni information that has been organized specifically for them by clicking on the "Alumni" link on the home page of the ECE School web site.

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