CONNECTIONS

A Report from the School of ELECTRICAL ENGINEERING • Cornell University

INFORMATION TECHNOLOGY RESEARCH

in the School of Electrical Engineering

Architect's sketch by R. Hoven/Zimmer, Gunsul, Frasca Partnership, courtesy of Clif Pollock.

This architect's drawing presents a view of the exterior of the planned Duffield Hall on the Engineering Quadrangle. The main structure will be parallel and adjacent to the west side of Phillips Hall with an imposing atrium inserted between the two buildings. On the south side, Phillips Hall will be connected to Upson Hall by two end atriums.
Duffield Hall will be an advanced research and teaching facility dedicated to the science and engineering of nanotechnology—the construction of devices at the molecular level—and the development of new materials for these devices. It will house the Cornell Nanofabrication Center, now in Knight Laboratory, together with the new Nanotechnology Center for the study of biological systems, and appropriate high-quality research space for the Center for Materials Research. The devices and materials that will ultimately emerge from Duffield Hall will have direct impact on information technology techniques that are discussed in the articles in this issue, including artificial neural networks, digital communication systems, videoconferencing systems, wireless data transmission, and self-configuring communication systems.

This ninth edition of *Connections* features the challenging research of our information technology research group, relates the history of control technology in the EE School, and considers the impact of new analytical techniques in the information technology field on the EE School. The "Positive Feedback" section contains news of recent alumni activities. Other items of interest to alumni are listed below in the table of contents. Please fill out the information coupon on page 27 of this newsletter, clip, and mail it to us. We want to hear what you are up to.

Simpson (Sam) Linke, editor

SPRING 2000

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Report from the Director

Our faculty recruiting program has tapered off somewhat this year. In the past six years we have hired fourteen new faculty members, and we continue to recruit in the areas of digital systems and in the theory of communications systems and networks. Our one new member in 1999 is **Michael G. Spencer,** B.S.Engr. '74, M.E.E. '75, Ph.D. '80, all in electrical engineering at Cornell, who joined the faculty on July 1, 1999, as a full professor. Michael will teach and do research in the field of epitaxial and bulk growth of compound semiconductors and the fabrication of discrete devices from these materials. Professor **Noel C. MacDonald** has transferred to the University of California at Santa Barbara but will remain on the EE School faculty as an adjunct professor. **Craig T. Higgins**, B.A.'89 (psychology and education) SUNY Albany, M.ILR.'96 (Industrial and Labor Relations) Cornell University, joined the EE School as director of administration in June 1999. (See page 3 for biographical sketches of our newcomers.)

The 1999 EE Advisory Committee Report suggested that the name of the EE School be changed to attract students who may be unaware that we are active in the computer field. After several weeks of debate on the pros and cons of changing the name, the faculty voted overwhelmingly in favor, and Dean **John Hopcroft** notified us that the College of Engineering approved the move on February 18, 2000. As of July 1, 2000, the official name of the EE School will be the School of Electrical and Computer Engineering. The following abstract from a statement by Associate Director **Paul M. Kintner** on the teaching mission of the ECE School summarizes the rationale behind the change: "We live in an age when electrical and computer engineering is primarily characterized by change and innovation. Rapid evolution in materials, devices, communications, information systems, and the impact of these advances on our social and environmental fabric, demand that students be grounded in basic knowledge that they adapt throughout their lives. The School of Electrical and Computer Engineering will deliver these concepts through a broad program of courses that consider the latest technological developments, the processes by which they arise, and the foundations upon which they rest."

In addition to their regular duties, several members of the EE faculty have been appointed to responsible part-time positions at the university and college levels, as follows: Professor **Donald T. Farley** is the assistant director of atmospheric sciences, Professor **Terrence L. Fine** is the new director of the Center for Applied Mathematics, Professor **Michael C. Kelley** is associate dean for professional development in the College of Engineering, and Associate Professor **Ronald R. Kline** is director of graduate studies for the Department of Science and Technology Studies. Professor of Astronomy and Electrical Engineering **Paul F. Goldsmith** has been named the James A. Weeks Professor of Physical Sciences.

College of Engineering Excellence in Teaching Awards were received by Professor **Charles E. Seyler**, Associate Professor Ronald R. Kline, and Assistant Professors **Edwin C. Kan**, **Bradley A. Minch**, and **Venugopal V. Veeravalli.** Professor Terry Fine received the 1999 Ruth and Joel Spira Excellence in Teaching Award in the EE School. Assistant Professor **Sheila S. Hemami** was a finalist in the 1999 C. Holmes MacDonald Eta Kappa Nu Outstanding Teaching Award Selection and has been selected as the year 2000 recipient. Assistant Professor Bradley A. Minch received a College of Engineering Excellence in Advising Award. Of the eight awards for excellence in teaching and advising, five were won by young faculty members.

Charles Harrington, Cornell University Photography

James S. Thorp

Professor **Clifford R. Pollock**, academic program leader of the Duffield Hall Project Management Team, reports that the Cornell Board of Trustees increased the budget for the new building to $58.5 million to accommodate recent increases in nanobiotechnology and nanotechnology research at Cornell. By including three atriums that will be isolated from the clean rooms and most of the laboratories, the architect attempted to design a structure that, in his words, "will create a high quality of social space inside and out." Strict attention will be given to safety and environmental concerns, and the engineering quad will be upgraded as part of the overall project. The building is now in the design and development phase, and an environmental impact statement has been prepared for presentation to the city of Ithaca Planning and Development Board. Bidding on the 150,000-square-foot facility is expected to begin in January 2001 and occupation is tentatively scheduled for 2003.

A summary of current research projects and associated funding is on page 13 of this newsletter.

James S. Thorp
Charles N. Mellowes Professor of Engineering and Director
School of Electrical Engineering

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Newcomers to the School

New Faculty Member

Frank DiMeo, Cornell University Photography

Michael G. Spencer, B.S. '74, M.Eng. '75, Ph.D. '80, all in electrical engineering from Cornell University, joined the EE School as a full professor on July 1, 1999. Following three years at AT&T Laboratories in Pasadena, California, he returned to the campus to complete his doctoral studies and then joined the faculty at Howard University in Washington, D.C., in 1981. Before coming to Cornell he was a professor of electrical engineering at Howard. During his graduate studies at Cornell, Michael held the Bell Labs One-Year-on Campus and the IBM Minority Pre-Doctoral Fellowships. At Howard he received the National Science Foundation (NSF) Presidential Young Investigator Award in 1985, the Allen Berman Research Publication Award in 1986 from the Naval Research Laboratory in Washington, D.C., and was selected by the NSF to be director of the first Minority Center of Excellence in 1987. In 1988 he received the White House Initiative Faculty Award for Excellence, and in 1992 he was awarded a NASA Certificate of Recognition.

Since 1979, Michael's research has been concerned with epitaxial and bulk growth of compound semiconductors such as gallium arsenide (GaAs), silicon carbide (SiC), and aluminum nitride (AlN), the fabrication of discrete devices from these materials, microwave devices, solar cells, and characterization of electronic materials. His particular interest has been in the correlation of device performance with material growth and processing parameters. He is on the permanent committees for the Electronic Materials Conference and the Compound Semiconductor Conference and helped to initiate and form the International Conference on Silicon Carbide and Related Materials. He has authored more than fifty publications in these areas and has two patents pending. Michael's leisure activities include playing tennis and listening to jazz music.

New Director of Administration

Provided

Craig T. Higgins, B.A. '89, State University of New York (SUNY) at Albany (psychology and education), M.ILR. '96, Cornell University (Industrial and Labor Relations), joined the School of Electrical Engineering in June 1999 as director of administration. He is certified as a professional in human resources and has had nine years of experience at Cornell and elsewhere as an academic administrative business manager with skills in facilities and human resources activities, financial management, benefits planning and administration, compensation, employee relations, and computer applications. Before accepting his present position he was director of human resources at Integral Resources, Inc., in Cambridge, Massachusetts, from 1997 to 1999. Craig changed from the field of education to human resources in 1991, began part-time graduate study at ILR, served two years as business manager in the Cornell College of Architecture, Art, and Planning (AA&P), and was assistant director of administrative operations at AA&P from 1993 to 1996. Craig is a professional musician. He studied classical guitar at SUNY Albany and has performed in the Albany Guitar Trio and the College of St. Rose Guitar Quartet and Ensemble and has also played with rock bands and jazz ensembles at several rock festivals. In addition to his music, Craig and his wife, Jacquie, B.S. '88, Ph.D. '96, Cornell University (plant sciences), enjoy hiking and canoeing, and he likes to tinker around the house with his four-year-old son, Alex.

ENROLLMENT AND GRADUATION STATISTICS

Undergraduate Program

year	*sophomores*	*juniors*	*seniors*	*degrees*
97–98	132	169	111	116
98–99	119	136	162	136
99–00	136	146	124	•

M.Eng. (Electrical) Degrees

August	*January*	*May*	*Total*
29	7	40	76
20	8	46	74
18	7	•	•

• Not available at press time.

M.S./Ph.D. Program

year	*applicants*	*admissions*	*total enrollment*	*degrees*
97–98	429	32	118	20 Ph.D., 6 M.S.
98–99	423	31	138	18 Ph.D., 10 M.S.
99–00	562	•	•	•

Note: Undergraduate students now affiliate with the EE School when the first term of sophomore mathematics 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 decreased significantly, and M.S./Ph.D enrollment has increased moderately.

Control Technology in the EE School

"**Servomechanism** n. [*servo-*, L. *servus*, a slave, servant] an automatic control system in which the output is constantly or intermittently compared with the input through feedback so that the error or difference between two quantities can be used to bring about the desired amount of control."

— *Webster's New World Dictionary of the American Language*, 2d College Edition, 1982.

Automatic control, as described in the above definition, came into general use early in the twentieth century in applications such as motor-speed adjustments in industry, voltage and frequency regulation in electric utility services, and thermostatic management of home heating systems and certain household appliances. Unlike the robotic controls of present-day production lines, many of those early applications required human intervention to guarantee reasonable success of a specific control task. Completely automatic control was realized during World War II when formal control theory incorporated the feedback concept mentioned in the definition. Urgent military needs during the war led control engineers to design systems, for example, in which conventional motor controls combined with radar signals allowed searchlights, antiaircraft guns, and fighter planes to "lock in" on enemy targets. Subsequent application of digital computers and advanced electronic circuitry to modern control systems has made automation an essential component of our everyday lives.

Engineering Publications

Figure 1. The first servomechanisms laboratory at Cornell.

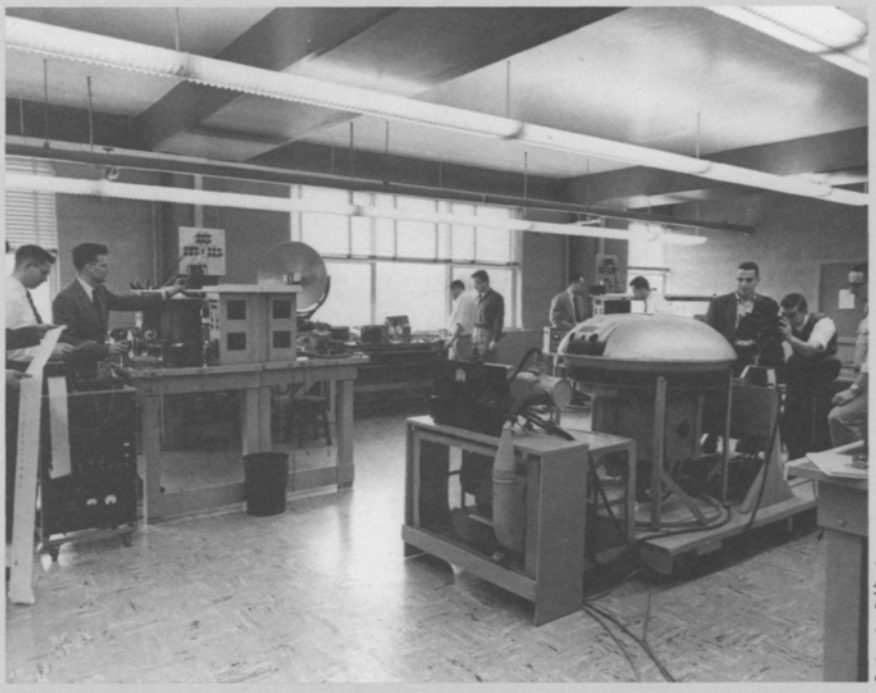
The term *control* first appeared in course announcements by the EE School in 1940, when Professor **Robert F. Chamberlain** offered EE 462, Industrial Applications and Control, under the Electric Power and Design Option. Presented initially as an adjunct to conventional ac and dc motor theory and laboratory, the course was gradually expanded during the war years to include speed control of dc motors and the design of manual and automatic control equipment for ac and dc machinery. In 1945, under the Navy V-12 Program at Cornell, Associate Professor **Wilbur E. Meserve**, M.S.E.E. '29, Ph.D. '33 (physics) offered two new courses, EE-4G-11, Motor Controls, and EE-4G-23, Application of Motors. The courses included such topics as design and functioning of controllers and protective devices for ac and dc motors, manual and automatic acceleration, voltage controls for dc motors, motor duty cycles, adjustable-speed ac drives, and "synchro" systems. Wilbur also offered a significant new course, EE-NG-52, Aircraft and Marine Electric Power and Control Systems, that gave attention to meeting the special requirements imposed by rapid and extreme changes in temperature, pressure, and humidity. A parallel course, EE-4N-11, Electronic Control Equipment, was offered in this same period by Associate Professor **B. K. Northrop**. This course presented methods of electronic interpretation of stimuli that appear in the form of heat, light, sound, or mechanical movement and examined typical electronic circuits that enabled such effects to cause controlled devices to perform desired functions.

The response of faculty and students to these various control courses indicated a need to establish a new area of study in the EE School. In September 1946, Wilbur Meserve initiated EE 4711, Servomechanisms and Automatic Control Systems, described in *Cornell Announcements* of that year as "a presentation of the basic principles of servomechanisms and the application of those principles in typical devices. Attention is given to the factors influencing error, damping, and speed of response. The subject of the transfer function or frequency

analysis of servomechanisms is introduced. The systematic procedure followed in the design of practical servomechanisms is demonstrated." In the spring term Wilbur offered EE 4712, Advanced Servomechanisms, which approached servomechanism theory from an advanced analytical point of view that included the use of transfer functions. Investigations of quantitative and qualitative performance tests of typical systems were also made in an early laboratory in Franklin Hall assembled by Professor Meserve (see Figure 1).

In 1949, Wilbur and B. K. joined other faculty members with similar interests in a division in the EE School called Electric Power Utilization that included machine theory, motor control, electronic control equipment, and courses EE 4711 and EE 4712. The latter course treated servomechanism theory from the point of view of Laplace-transform analysis and included the synthesis of systems, stability criteria to predetermine performance, and laboratory tests for comparison of observed and predicted performance of servo systems. In the 1950–51 academic year a separate new area was established in the EE School, Courses in Servomechanisms, that included EE 4711 and EE 4712, generally elective for undergraduates but required for students in the Industrial Electronics and Control Option. In his 1950 report to the university, Dean of Engineering **S. C. Hollister** commented, "It may be interesting to note that it is unusual even among leading schools to have servomechanisms available to undergraduate students."

The now firmly established and popular servomechanism area changed gradually over the next few years. Wilbur was promoted to full professor in 1952 and in the same year was joined in the laboratory by Assistant Professor **Joe Rosson**, M.E.E.'51. Course content was expanded to include analysis of open-ended and closed-loop control systems and a classical differential-equation approach to industrial control problems. A new graduate course, EE 4713, Seminar in Servomechanisms, considered topics such as nonlinear effects on servomechanism analysis and performance, sampled-data systems, statistical analysis, and, as a look into the future, the application of analog computers to servo analysis and performance. When the EE School moved into Phillips Hall in 1955, the name of the control area had been changed to Feedback Control Systems, and EE 4810, Introduction to Electronic Computers, had been added to the curriculum. Joe Rosson had moved to other duties in the school, and Assistant Professor **Albert Jackson** was assisting Wilbur in a well-equipped laboratory (see Figure 2).



Engineering Publications

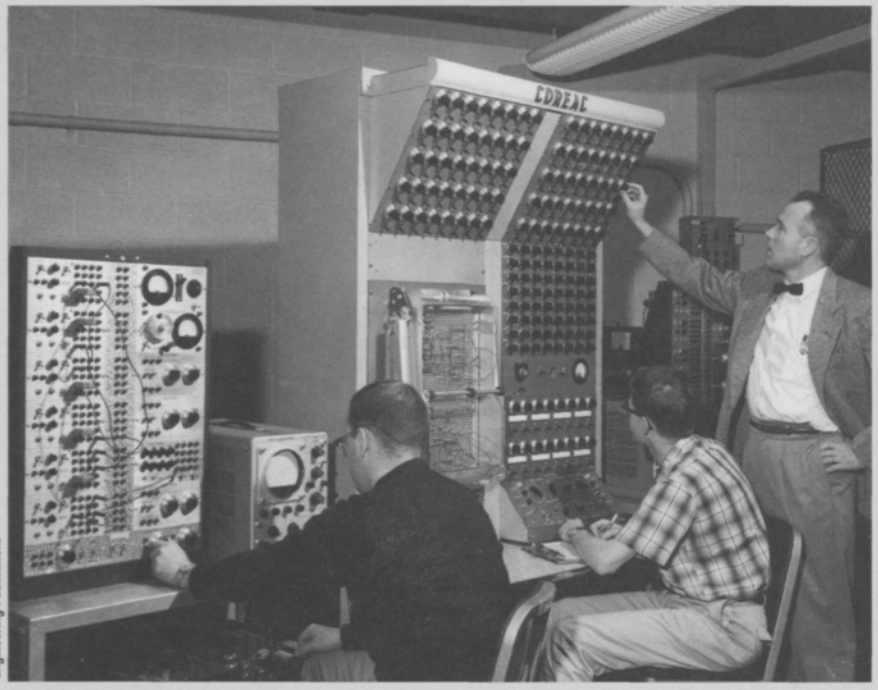
Figure 2. An expanded servomechanisms laboratory in Phillips Hall provided experimental studies fundamental to automation.

TRANSITIONS IN CONTROL TECHNOLOGY

As the EE School settled into Phillips Hall, the control area experienced little change for several years except for the gradually increasing influence of computers and switching theory in the curriculum. By 1960, these factors had become sufficiently important to warrant a change in the name of the control area to Control Systems and Computers. EE 4411, Electronic Control Equipment, EE 4415, Advanced Electronic Controls, and EE 4421, Electronic Power Converters had become standard components of the control area. EE 4810 was now concerned with analog computation, and switching systems, an important related subject, had been introduced by Assistant Professor **H. C. Torng**, M.S. '58, Ph.D. '60, in EE 4820, Switching Theory and Digital Computers. This new course was described in the 1960 *Cornell Announcements*: "An introduction to theory and design of switching circuits with a detailed consideration of switching algebra and its application to the design of digital computers, combinational systems, sequential systems, and Boolean matrix theory." H. C. soon

added EE 4821 to form the sequence Switching Systems I and II. In the control laboratory, Al Jackson designed and supervised the construction of a small electronic analog computer, COREAC, to illustrate the influence of computers in the control area (see Figure 3).

The following statement in the 1964–65 edition of *Cornell Announcements* was in a description of engineering facilities: "In recognition of the growing impact of computer technology on nearly every



Engineering Publications

Figure 3. Assistant Professor Al Jackson demonstrating his electronic analog computer.

area of engineering analysis, the Cornell Computing Center has installed a Control Data 1604 System in addition to a Burroughs 220 digital computer for use by students and faculty. Courses in principles of computers and several engineering courses make active use of these powerful computational tools in class assignments and research investigations." The growing demand for more computing power on campus soon required the Computer Center to add two additional machines, an IBM 1401 and an IBM 1410. Compared with present-day facilities, those computers were primitive, but at that time they were valuable assets to the work of the control and computer areas in the EE School.

During the 1960s major changes in the EE School in both faculty and curricula had a profound impact on the control and computer area. New faculty members with interests in control, computer systems, and network and system theory who had joined the school by 1965 included Professors **Herbert J. Carlin**, **Charles W. Merriam III**, Associate Professor **Nick DeClaris**, and Assistant Professors **Myunghwan Kim**, **Keith R. Kleckner**, B.S. '58, Ph.D. '61, **Christopher Pottle**, and **James S. Thorp**, B.E.E. '59, M.S.'61, Ph.D. '62. H. C. Torng, promoted to associate professor in 1963, continued to develop the switching-theory courses, and Associate Professor **Norman Vrana**, M.E.E. '51, began a long-term association with computer systems in the EE School, first with courses in analog computers and then in courses in digital computers. Chris Pottle served as the EE representative in establishing the Department of Computer Science in the College of Engineering, thereby ensuring active cooperation between the new department and the EE School. Professor Meserve continued to direct graduate students in the control systems area while serving as the graduate field representative in the school for three years until his retirement in 1969 as professor emeritus.

Nine courses were listed in the 1965 course catalog under the area still designated as Control Systems and Computers. Alumni who took these courses during this period will recognize the new course numbers such as EE 4481–82 (old 4711–12), Feedback Control Systems I and II, both taught by Kim, and others that extended to EE 4680, Advanced Experimental Control Systems. New courses in the control sequence included EE 4584, Optimization Techniques in Control Systems, and EE 4586, Random Processes in Control Systems, developed and taught by Chuck Merriam, Jim Thorp, and Keith Kleckner. In this period the EE School curriculum was divided into "Electrophysics" and "Systems," with laboratory instruction in both stems. In the 1965 *Cornell Announcements*, the Systems stem was defined as "a course sequence that deals with the laws that govern the interaction of devices where individual behavior is specified, as well as the response of these systems to various inputs. The systems may contain linear or nonlinear elements, and may be active, passive, or random." In keeping with this definition, the systems stem consisted of "Computing Systems and Control" and "Theory of Systems and Networks."

The laboratory for the control courses EE 4481–82 consisted of familiarization with system components and correlation of transient and frequency responses, synthesis of linear and optical control systems, and analysis of nonlinear and sampled-data systems using analog and digital computers. As the EE School entered the 1970s, the establishment of these two divisions and accompanying laboratory moved the principal study of control systems away from earlier approaches and toward network and system theory concepts. This trend is illustrated by Jim Thorp's development of EE 4505, Estimation and Control in Discrete Linear Systems, and EE 4506, Optimal Control and Estimation for

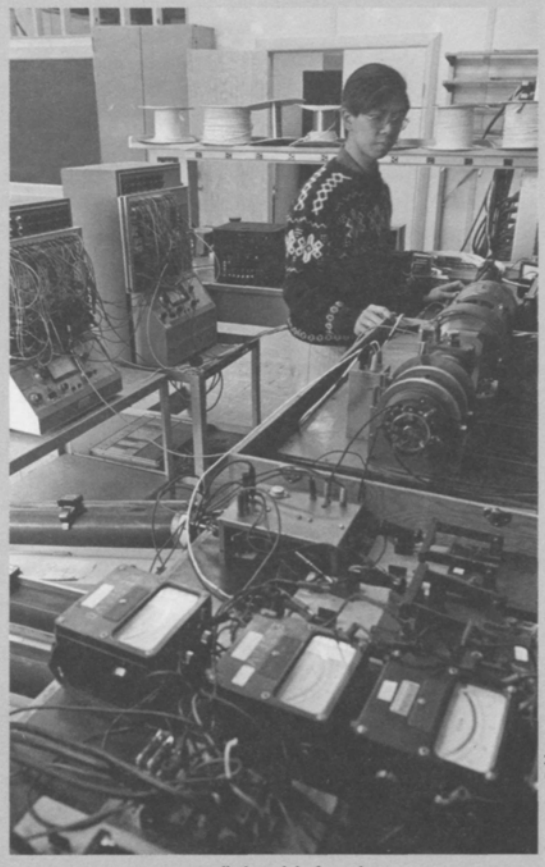
Continuous Systems. Analytical techniques studied in these courses are applicable to control problems in electric power systems, tracking systems, and guidance systems for reentry vehicles in space research. An important part of research in these areas focuses on successive approximation techniques that depend on computers, particularly for problems that require optimization in real time.

When Professor Kim transferred his interest in control systems to the application of control theory to biological systems, Assistant Professor **Robert J. Thomas**, who had joined the EE School in 1973, assumed responsibility for both lecture and laboratory components of the two feedback control courses. As dependence on digital computers for many applications in the systems area grew, the use of the Cornell mainframe computer was augmented in the early 1970s by the acquisition of a PDP/11 minicomputer in Phillips Hall. This top-of-the-line computer (at the time) was particularly useful in an early project in control theory applied to electric power systems. Bob Thomas directed the graduate research of **Peter K. K. Oey**, B.S. '71, M.E.E. '72, Ph.D. '76 , in a simulation study of a large turbogenerator connected to a power-system network (see Figure 4). When the system model was subjected to a severe short circuit, the generator became unstable. Corrective action taken by circuits controlled by the minicomputer returned the system to stable condition. The study required development of algorithms to provide on-line decisions for optimal coordinated application of various control mechanisms to the system when it was in the emergency state.

In the late 1970s, Professors Jim Thorp, Bob Thomas, and Sam Linke began to apply their expertise to control and protection problems associated with electric power systems. The Kettering Power Systems Laboratory established in Phillips Hall at that time included a relatively powerful VAX 11/750 digital computer that supported research in the laboratory and also served other areas in the school that needed computer assistance. The VAX was particularly useful in the feedback control courses for assignments of computer-aided controller design and digitally simulated evaluations. It was superseded eventually by the current Phillips Hall computer network that now serves the extensive computer activity in the school. Research in the Kettering Laboratory led Jim Thorp, Bob Thomas, and Chris Pottle to form the Electric-Power-Systems Group in the school. They were joined later by Professor **Hsiao-Dong Chiang,** who came to the school in 1987. Details of their work on problems associated with control, operation, and protection of power systems are given in the spring 1996 issue of *Connections*.

TOWARD INFORMATION TECHNOLOGY

Despite changes in the control field since its inception in the EE School, the two original feedback control courses still remain in the curriculum, admittedly in somewhat altered form. EE 471, Feedback Control Systems, is a popular course that acquaints the students with tools for analysis and design of single-input and single-output feedback control systems. The associated laboratory is keyed to modern tools for computer-aided design. EE 472, Digital Control Systems, is concerned with analysis and design of feedback control systems using digital devices to implement compensation. Z-transforms and linear algebra are the major mathematical tools. Bob Thomas and M. Kim shared teaching duties in EE 471 until Kim's retirement in 1988. Bob made excellent use of feedback control theory and practice while he was director of the Cornell Electric Car Project. EE 472 has been taught by Professor **C. Richard Johnson Jr.**, a specialist in adaptive systems theory and in control theory, who joined the EE School in 1981, and by Hsiao-Dong Chiang. During the 1990s, instruction of EE 471 has been shared by two members of the Sibley School of Mechanical and Aerospace Engineering, Professor **Mark L. Psiaki** and Assistant Professor **Raffaello D'Andrea.** In August 1999, a team of graduate and undergraduate students directed by Raffaello and Assistant Professor of Electrical Engineering **Norman Tien** won the small-league competition in the Robot World Cup Initiative (Robocup) in Stockholm, Sweden (see page 8.) The careful application of control theory and practice was a major factor in the design of the soccer-playing robots. Clearly, feedback control will continue to play an important role in information technology in the EE School.



Engineering Publications

Figure 4. A computer-controlled model of an electric power generator connected to a transmission network allowed study of power system stability.

Sam Linke
Professor Emeritus
Electrical Engineering

THE INFORMATION TECHNOLOGY RESEARCH GROUP

The Information Technology Research Group in the School of Electrical Engineering consists of three professors, **Toby Berger**, **Terrence L. Fine**, and **Stephen B. Wicker**, some of their graduate students, and several members of the Department of Computer Science. Information technology research in the EE School has been substantially augmented in recent months by the receipt of major funding from several agencies as a result of successful research proposals prepared by the group. Other members of the EE faculty who contribute to the research of the group include Professor **Richard C. Johnson, Jr.,** who is concerned with adaptive and signal processes for wireless networks, Associate Professor **Lang Tong**, who specializes in signal processing for wireless networks, and Assistant Professor **Sheila Hemami,** who performs research in visual communications. The principal research areas of the Information Technology Research Group are described in the three articles on pages 8–12.

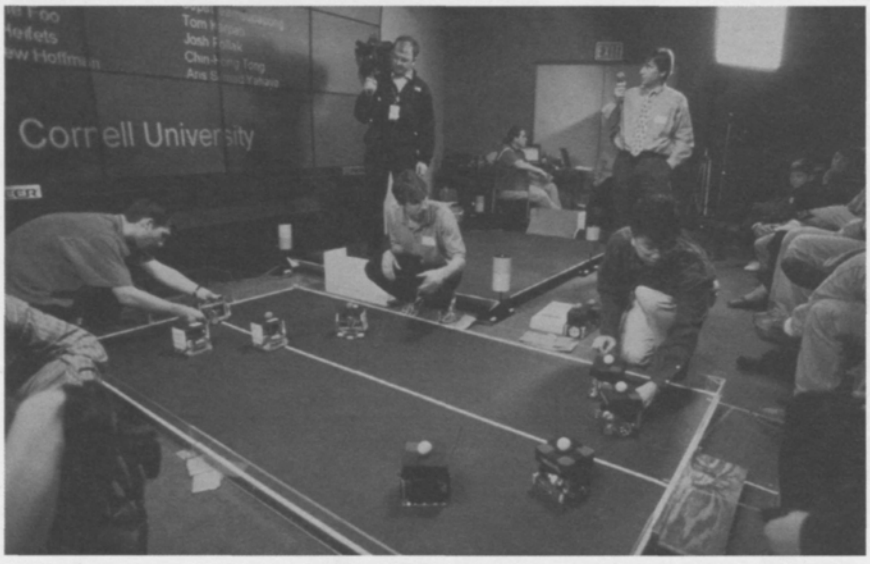
VIDEOCONFERENCING SYSTEMS RESEARCH

Directed by Toby Berger

Adriana Rovers, Cornell University Photography

After the telephone became a well-established means of communication at a distance, certain visionaries thought that transmission of a picture along with voice would be desirable. Unfortunately, early technology did not allow the realization of this idea, but alumni who were "Depression kids" may recall the curiosity aroused by the circa 1926 boyhood adventure story *Tom Swift and His Photo Telephone*. In 1971, AT&T devised a two-way videophone, but the product did not catch on with the public, possibly because of lip synchronization problems and unacceptable audio delay at both ends of the line. Today, one-way transmission of video and audio signals is commonplace, and advances in two-way video/audio communication technology have allowed the development of some videoconferencing networks and a possible early return of the videophone. The problems common to both communication systems, however, still require intensive research effort before general market acceptance will be achieved.

The advent of videoconferencing has been eagerly awaited. Business interests, government agencies, education centers, lawyers, and many others will value the benefits of reduction in expensive travel, rapid interchange of information and data, and the advantages of face-to-face discussion that will accrue from the availability of such a facility. Information technology seems to have advanced to the stage that widespread videoconferencing can become a reality, provided adequate solutions are found to certain inherent system problems. At present, adequate communication is achieved by makeshift techniques such as multiple transmissions of video and audio signals over separate channels or by means of expensive special-purpose hardware-assist boards, each comparable in cost to a personal computer, that ease the signal-processing burden on the central processing unit (CPU).



Smithsonian Institution

Figure 5. Soccer robots in action.

The prevalence of the Internet, compact disks, compact disk-read-only-memory (CD-ROM), high-definition television (HDTV), digital audio tape (DAT), and video disks indicates that communications systems at all levels have entered into the digital mode. The digital mode is much more efficient than the analog communication modes of the past. Both video and audio signals may be transmitted very easily with less distortion, information and data may be stored in more compact form, audio reproduction is generally considered to be of very high fidelity, and privacy of communication can be more easily maintained. All of these qualities are ideal for application to videoconferencing.

A fundamental quality of digital communication is that the video and audio signals must be transformed into several samples per second with each sample containing a designated number of "bits" of information. For example, standard telephony is represented by 8,000 samples per second and 12 bits per sample, for a total bit rate of 96 kilobits per second (kbps). But the bit rate allocated to a cellular voice channel in North America is only 8 kbps.

Hence the necessary bit rate, which translates into bandwidth, exceeds the channel bandwidth by a factor of 12. Similar calculations can be made for other communications media. Video signals are particularly complex, not only because of the much higher transmission frequency but for the specification of 30 frames per second, hundreds of lines per frame, hundreds of color pixels per line, and 24 bits per pixel, for a total of the order of 200 megabits per second. This bandwidth may be well above that of standard transmission. The solution to this problem is data compression, which Toby Berger has defined as "the representation of a source in digital form with as few bits as possible while maintaining an acceptable loss in fidelity."

Professor **Toby Berger** is a widely known leader in research on information theory and communications. His areas of specific interest have included multiterminal coding theory, the 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 of significance 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 to 1968 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. Toby is a Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and has served as editor in chief of the *IEEE Transactions on Information Theory* and as 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 Bell Laboratories.

The necessity for data compression of sampled video and audio sources introduces major problems in the design and development of interconnected videoconferencing systems that can deliver affordable seamless communication between multiple terminals without end-to-end audio delay and with proper video/audio synchronization. Development of ever-faster semiconductor chips will not satisfy these requirements. Solutions that will result in successful videoconferencing systems will depend on research and development of coding algorithms and corresponding software and on improved transmission capabilities. Under Toby's direction, the DISCOVER Lab, a research facility in the EE School for video/audio compression development, is engaged in research on appropriate algorithms and software for this application.

Last year's competition in the Robot World Cup Initiative, won by Cornell's soccer-playing robots (see Figure 5), suggested the need for communication capability between the robots. This requirement has posed a videoconferencing challenge to the members of the DISCOVER Lab. At present, a supervisory camera obtains game-status information and sends it to a special computer that analyzes the action and transmits radio commands to the robots. The players' mastery of the game would be greatly enhanced if they could communicate with one another to relay visual data and suitable electronic commands. A robot "videoconference" would serve as a superb test site for research on wireless video communication between mobile terminals. Obviously, video/audio lip synchronization would not be a problem, but removal of end-to-end delays would have major priority.

ARTIFICIAL NEURAL NETWORK RESEARCH

Directed by Terrence L. Fine

Frank DiMeo, Cornell University Photography

In 1960, a visitor to a small laboratory in Kimball-Thurston Hall would have been able to view an unusual demonstration. A standard home movie screen illuminated by a slide projector was placed several feet away from a second vertical screen fitted with many photocells. The rear of the photocell structure contained a large number of wires connected in random fashion to the cells and to electronic circuitry, with connections brought out to a small television monitor. When the word CORNELL was projected on the movie screen, the monitor also displayed CORNELL. When the letters C R N L were projected on the screen, the monitor again read CORNELL. This device, called a "Perceptron," was a primitive analog model of the human brain conceived mathematically by the late associate professor of neurobiology and behavior **Frank Rosenblatt** and constructed by his co-workers. It may have been the first physical example of an artificial neural network.

Rosenblatt's perceptron behavior was similar to that of a brain in a biological system. Many "neurons" were interconnected in random patterns and switched on and off between sensory points (S-units), associative units (A-units), and responsive units (R-units), as illustrated in Figure 6. An S-unit that had been exposed to a physical stimulus would transmit impulses to the A-units that would either excite or inhibit the associative area. Net impulses that resulted from these impulse interactions would be transmitted to the R-units. The network of connections between S and A units was arranged to be random so that any S-unit could be connected to any A-unit with equal probability and also would have connections to different A-units scattered at random throughout the entire A set. With associated electronic controls, this relatively simple interconnected network could be "trained" to exhibit the kind of intel-

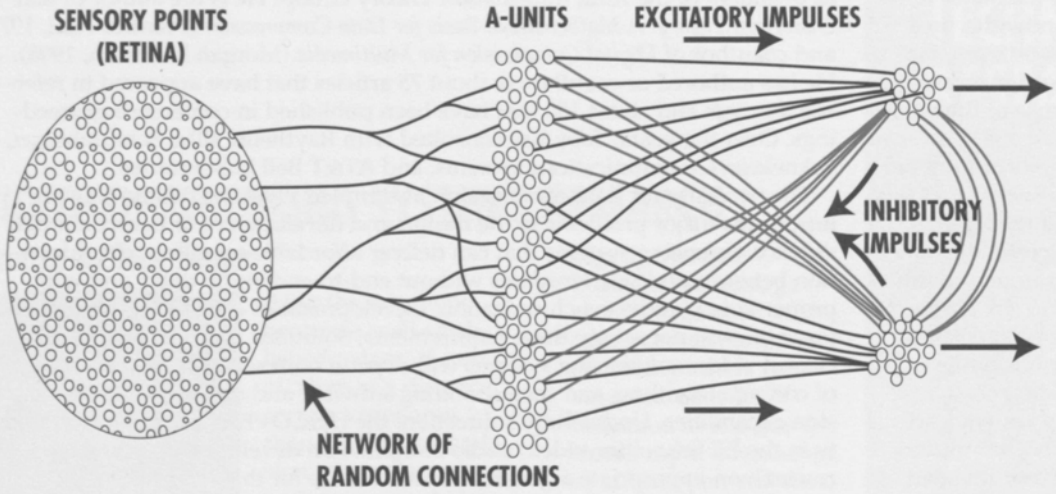


Figure 6. Organization of a simple perceptron. (Adapted from Cornell Aeronautical Laboratory Special Report *The Perceptron* by Frank Rosenblatt, 1958)

ligent system behavior described in the first paragraph.

Although Professor Rosenblatt is generally credited with the establishment of the current notion of an artificial neural network, the perceptron concept could not be applied successfully at the time. Practical analog circuitry would have been much too massive to build and too difficult to train, and the state of the digital computer art was still too immature to allow development of training algorithms. In the 1980s, however, new developments in network theory and the availability of cheap, powerful workstations and computers allowed a reemergence of the study and application of artificial neural networks.

Those early studies of neural networks attempted to understand and construct mathematical models for behavior related to neurobiology and cognitive psychology. Current developments continue to shed light on these disciplines, but the principal focus of present research and teaching is on the role of neural networks in procedures for treating large classes of statistical and engineering problems. Feed-forward artificial neural networks, also called multilayer perceptrons, and their computer-intensive design (training) algorithms have, for the first time, provided the engineering and statistics communities with effective techniques for the construction of truly nonlinear systems that can accept large numbers of inputs. Marked success has been achieved in applications to engineering and statistics problems of classification, regression, and forecasting, by fitting neural networks to applications through a computer-intensive learning-from-examples methodology that depends on relatively little prior knowledge. Incorporation of expert beliefs or heuristic programs that require that the network designer understands the essentials of the application are not needed to obtain a proper fit. Of course, some understanding of the nature of the application is necessary and is reflected in the choice of input variables and network architecture. Usually, little more is assumed known than that the data (training set) constitute independent pairs of network inputs and desired outputs. The goal of Professor Fine's research is to expose the mathematical properties of these systems so as to delineate their capabilities and to present the methodology by which they are deployed to confront applications.

Professor **Terrence L. Fine** is widely known in the information theory field for his long-term research on the foundations of probability, particularly the alternative concepts of comparative and complexity-based probabilities and upper- and lower- or interval-valued probability. Since 1989 he has been examining statistical inference and algorithmic issues that arise in the design and analysis of feed-forward neural networks and in the development of neural network methodology applied to information technology applications.

Terry received the B.E.E. degree from the City College of New York in 1958 and the S.M. and Ph.D. degrees in 1959 and 1963 respectively, both from Harvard University. He was a lecturer and research fellow in the Division of Engineering and Applied Physics at Harvard University until 1964, when he was awarded a Miller Institute Junior Research Fellowship at the University of California at Berkeley. He joined the School of Electrical Engineering at Cornell in September 1966 as an assistant professor. Terry was promoted to associate professor in July 1970, became a full professor in July 1979, and is a member of the graduate fields of Applied Mathematics, Electrical Engineering, History and Philosophy of Science and Technology, and Statistical Science. He was a visiting professor of electrical engineering at Stanford University in 1972–73 and in 1978–80. Terry received the Fiona Ip Li and Donald Li

Teaching Prize for 1996 and the Ruth and Joel Spira Excellence in Teaching Award for 1999. He is a fellow of the Institute of Electrical and Electronics Engineers, has been an associate editor of *IEEE Transactions on Information Theory*, and is a past president of the Board of Governors of the IEEE Information Theory Society. He has been a member of the governing board of the IEEE Neural Networks Council and is a founding member and director of the Neural Information Processing System Foundation. In July 1999, Terry was named director of Cornell's Center for Applied Mathematics. He is the author of *Theories of Probability: An Examination of Foundations* (Academic Press, 1973) and of *Feedforward Neural Network Methodology* (Springer-Verlag, 1999). He holds a patent for statistical delta modulation.

Terry's current research centers on physical layer issues in sensor-assisted wireless mobile communications and on the performance capabilities, training algorithms, and applications of feed-forward neural networks to problems of wireless mobile communications and to signal processing. These ideas are now being considered for use in systems of management to improve the efficiency of mobile wireless communication and to facilitate the development of a future mobile wireless internet. Another potential application of neural networks related to national defense is the use of special sensors, combined with communication sensors, to detect and warn of biological warfare attacks, a project that is in its preliminary stages.

Frank DiMeo, Cornell University Photography

SELF-CONFIGURING COMMUNICATION RESEARCH

Directed by Stephen B. Wicker

During recent weeks, readers of the op-ed page of the local newspaper, the *Ithaca Journal*, found many letters to the editor that were highly critical of the proposed erection of several tall wireless-communication towers in Tompkins County. Apparently, the letter writers did not believe that the promise of greatly improved cellular telephone service would offset the aesthetic damage to the region. The current controversy has been resolved satisfactorily, but future similar disputes across the country may be avoided altogether as a result of the self-configuring communications research that is scheduled to begin in the EE School this summer.

The basic purpose of this new approach to mobile wireless communication is to establish a network of "sensors" that would assure high-quality service between users regardless of location or movement. Although reasonably good service is already available by means of communication towers, the inevitable "dead spots" necessitate the construction of additional towers. The proposed self-configuring network would consist of a large number of small low-power sensors randomly distributed throughout the local region of interest, perhaps mounted on telephone poles and building corners, and arranged to communicate with adjacent sensor networks. Each sensor would have the usual radio reception and transmission capabilities, and built-in detectors would allow it to perform the self-configuration functions to fulfill its mission. For example, a sensor serving a mobile user would be able to detect motion and direction until the user is about to move out of its range. The call would then be transferred to one or more appropriate adjacent sensors so that communication would be maintained (see Figure 7).

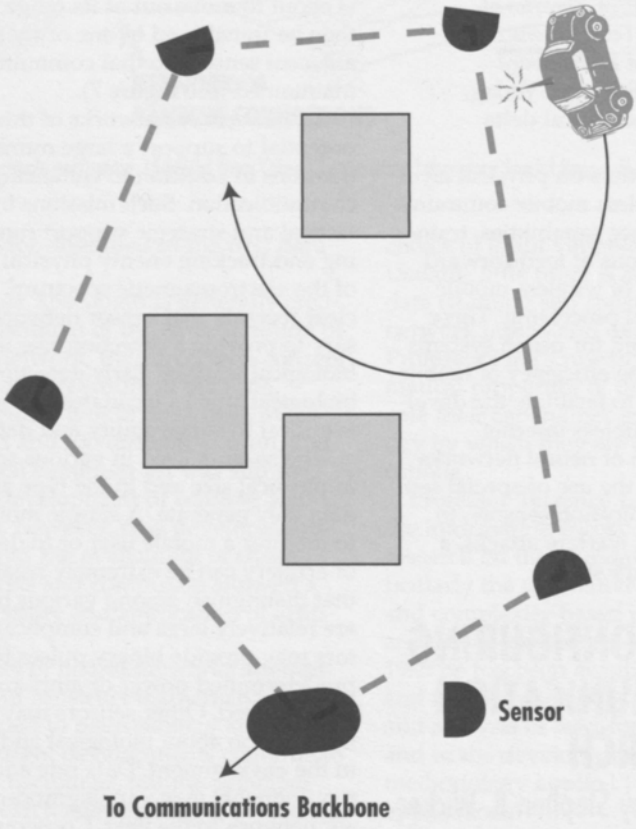
Ad hoc sensor networks of this sort have the potential to support a large number of important missions in addition to enhancing mobile wireless communication. Such missions include the obvious tactical and strategic support functions of identifying and tracking enemy physical resources and use of the electromagnetic spectrum. It has become clear recently that sensor networks will be necessary to provide a detection role in chemical and biological warfare. Early detection of chemical and biological attacks facilitates the early response that is critical to survivability and deterrence.

The sensors used in various scenarios will differ in physical size and in the type and quantity of the data they generate. A simple motion detector used to monitor a mobile user or to detect the movement of artillery can be extremely small, whereas sensors that distinguish among various biological agents are relatively large and complicated. Simple detectors may provide binary pulses to denote that a predetermined power or amplitude threshold has been crossed. Other sensors may provide detailed information about biological and chemical agents in the environment. Data rate and reliability requirements may vary significantly from one sensor network to the next. Consequently, the requirements for the data processing that controls the operation of the sensor networks will vary significantly from one network mission to another.

Professor **Stephen B. Wicker** is well known in the wireless telecommunication field for his research in wireless information networks, digital communications systems, and error-control coding. He has focused on the development and application of advanced technologies for data links and multiple-access protocols in wireless networks, including the application of artificial intelligence and expert systems to the development of automatically configuring communications networks, turbo error control, and iterative channel-estimation algorithms.

Steve received the B.S. degree from the University of Virginia in 1982, the M.S. degree from Purdue University in 1983, and the Ph.D. degree from the University of California at Los Angeles in 1987, all in electrical engineering. After working as

a space and communications staff engineer in the Information Science Department of the Hughes Aircraft Company in El Segundo, California, from 1983 to 1987, he became a member of the faculty of the School of Electrical and Computer Engineering at the Georgia Institute of Technology. In 1992 he was named a visiting fellow of the British Columbia Advanced Systems Institute. He joined the Cornell faculty as an associate professor of electrical engineering in July 1996 and was promoted to full professor on July 1, 1999.



(Courtesy of Stephen Wicker)

Figure 7. A simple self-configuring communication network.

Over the years, Steve has been a consultant on error-control techniques and coding theory to about a dozen corporations. He is a senior member of the IEEE, a member of the IEEE Communications, Information Theory, and Vehicular Technology Societies, and was elected to the Board of Governors of the IEEE Information Theory Society in 1996. Steve is the author of *Error Control Systems for Digital Communication and Storage* (Prentice-Hall, 1995) and is the coauthor, with Professor **Chris Heegard**, of *Turbo Coding* (Kluwer Academic Press, 1999). The latter work is the first book published on turbo coding, an advanced technique that decodes received information several times, compares the results to arrive at a consensus, and recalculates whatever cannot be resolved. He is also the coauthor of a volume on Reed-Solomon codes and of another book on error control, cryptology, and speech compression. He has contributed a chapter titled "Deep-Space Applications" to the *Handbook of Coding Theory* (Elsevier, 1998) and has contributed to other volumes on coding theory and coded protocols. He is the editor for coding theory and techniques for the *IEEE Transactions on Communications*, coeditor of *Reed-Solomon Codes and Their Applications* (IEEE Press, 1994), and has authored or coauthored about 32 articles that have appeared in refereed journals and about 70 that have been published in conference proceedings, mostly on coding theory and error-control protocols. Steve and a colleague hold a patent on an analog neural-net Viterbi decoder, and, together with other colleagues, has several patents pending on related decoders.

Steve's group includes **Terry Fine**, **Lang Tong**, and **Venu Veeravalli** of the EE School and **Carla Gomez** of the Department of Computer Science. They will do research under a new grant from the Defense Advanced Research Projects Agency (DARPA) Sensor Information Technology Program to develop generic wireless data transmission and sensor signal-processing technology for decentralized ad hoc sensor networks. The goal is to develop a network matrix into which arbitrary types of sensors can be inserted in a variety of missions to provide for a random distribution of sensors. The sensor network will be self-configuring; local clusters of sensors will communicate with decentralized processing nodes distributed along a communications "backbone." Data-processing functions will be allocated to each of the decentralized processing nodes. The individual nodes will be able to task sensors for additional data critical to an analysis function, and the network will be reconfigurable to allow for the reassignment of priorities to arbitrary sensors.

The performance of the self-configuring network in a given environment will be determined through the assignment of utilities by the user. The utilities will reflect the performance requirements perceived by the user and will be the basis on which the network makes configuration decisions. The impact of a given set of utilities will be determined through simulation studies that assume several different scenarios. The final product of the program will be software that provides adaptive data-link and network-layer protocols for generic, self-configuring wireless sensor networks. The program will also produce statistical data-processing software that provides background modeling and decentralized detection for a wide variety of scenarios. The software will be supported by a simulation package that allows the user to determine the impact of utility settings. The program will use recent advances in communication theory and statistics to create sensor network technologies that are widely applicable, fast, inexpensive, and offer powerful solutions for individual applications.

PROJECT NOTES

PSERC Program Expands

By the end of this year the Power System Engineering Research Center (PSERC), a consortium of universities led by Cornell, will receive funding of from $5.5 to $6 million per year over a five-year period. The Electric Power Research Institute, together with the U.S. Department of Defense Complex Network Initiative, provides funding at $2 million per year. At year's end, the current grant from the National Science Foundation Industry–University Cooperative Research Center will grow from $1.5 to $3.0 million per year. The U.S. Department of Energy Consortium for Electric Reliability (composed of four national laboratories) funds PSERC at $0.5 million per year. Other members of the consortium now include Arizona State, Berkeley, Carnegie-Mellon, Colorado School of Mines, Georgia Tech, Illinois, Iowa State, Texas A&M, Washington State, and Wisconsin.

Professor of Electrical Engineering **Robert J. Thomas**, director of PSERC and principal investigator of the program, emphasizes the major importance of the research of the consortium on the economy and the well-being of the nation. He cites the 1999 interim report of the U.S. Department of Energy's power outage study team and its conclusion that the restructuring of the electric power industry has created operating practices and conditions that could jeopardize the reliability of our power delivery system.

GPS Group Plans Space Research

Professor of Electrical Engineering **Paul M. Kintner** has been awarded $288,000 by the Defense University Research Instrumentation Program of the U.S. Department of Defense. The award will be used primarily to purchase a signal simulator and some ancillary ionosphere instrumentation to allow continued research on ionospheric effects on the Global Positioning System (GPS).

In just four years, GPS has gone from a curiosity to the focus of Paul's research group. In some cases the emphasis is on how GPS works, but the group concentrates primarily on the use of GPS to improve other research. One line of activity is concerned with the development of GPS receivers. The group currently has three different receiver designs in various stages of progress. Although the receivers are primarily designed for space flight, testing them on rockets is so expensive that a signal simulator is needed for development, testing, and evaluation. Under a project called SIERRA, the group's first receiver model will be launched into the northern lights next January from Poker Flats, Alaska.

Information Technology Research Funds Increase

In the past two years the information technology group in the EE School has received nearly $7 million in research funding from several agencies. In 1998, Professors **Wicker**, **Fine**, and **Halpern** (Computer Science) were granted $900,000 by the National Science Foundation (NSF) for the study of sensor-assisted random-access protocols. In 1999, Professors **Berger** and **Veeravalli** received $600,000 from NSF for their research on adaptive code-division multiple-access systems. This year, the Multidisciplinary University Research Initiative of the U.S. Navy has granted Professors Wicker, **Tong**, **Haas**, **Hemami**, **Manohar,** and **Proakis** (Northeastern University) $4.5 million for their research on cross-layer adaptive communication systems. Another $800,000 will be granted by the Defense Advanced Research Projects Administration, starting in July 2000, for the study of adaptive sensor networks by Professors Wicker, Fine, Tong, Veeravalli, **Selman**, and **Gomez** (the latter two from Computer Science).

Electronic Packaging Research Continues

The Semiconductor Research Corporation (SRC), an industrial research consortium, has awarded Professor of Electrical Engineering **J. Peter Krusius** a $330,000 contract to continue his investigations into electronic packaging interconnect sciences. Over the past 15 years, SRC has awarded a total of $6.4 million to the Electronic Packaging Program at Cornell. The program is also funded by the National Science Foundation and the Industry–Cornell University Alliance for Electronic Packaging.

Professor Krusius explains that electronic packaging research is 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, avoidance of electrical interactions between closely positioned elements, and placement of special miniature capacitors as close as possible to the circuit connections.

Lung Cancer Research Uses CT Scans

The Early Lung Cancer Action Project, directed by Dr. **Claudia Henschke** of the Weill Medical College of Cornell University, has been collaborating with the computer vision research group in the EE School for over three years. New approaches are being explored in the use of computers to help radiologists diagnose lung cancer from spiral computed tomography (CT) images. Associate Professor of Electrical Engineering **Anthony P. Reeves**, who directs the computer vision research group, reports that initial research has resulted in methods that accurately measure and characterize previously detected lung nodules from follow-up high-resolution CT scans. Currently, the best noninvasive predictor of malignancy is nodule growth rate, which is estimated from the change in nodule size that occurs between two time-separated CT scans. Unique three-dimensional computer algorithms have been developed to segment and accurately measure the volume of a nodule. The resulting precise measurement methods permit the time delay between the two scans to be reduced to just a few weeks. The research group is also attempting to predict malignancy from the appearance (shape and texture) of the nodule image, a procedure that will allow the malignancy status of the nodule to be determined after just a single scan. Preliminary results using three-dimensional image-shape features are very promising.

These pre–World War II alumni give us the benefit of their accumulated wisdom and experience.

We invite suggestions of additional notable alumnae for future issues of *Connections*.

John P. Wood received the M.E. degree in 1924, the E.E. degree in 1925, and the M.E.E. degree in 1934, all from Cornell University. In 1926 he joined the Westinghouse Electric Corporation in East Pittsburgh, Pennsylvania. He returned to Cornell in September 1929 as a graduate student and instructor in electrical engineering. After completing his graduate study he remained as an instructor in the School of Electrical Engineering until 1941. After a short period with *Electrical Equipment Magazine* in New York City and in a civilian position with the U.S. Navy, John joined the National Aniline Division of Allied Chemical Corporation in Buffalo, New York, in September 1943. He worked there in various positions over the next 26 years, primarily in the engineering department and power operating staff. He retired in October 1969 but continued for several years with Allied Chemical in a consulting position. In retirement he designed and built a travel camping trailer and traveled extensively throughout the United States. John is a life senior member of the Institute of Electrical and Electronic Engineers and the IEEE Power Engineering Society.

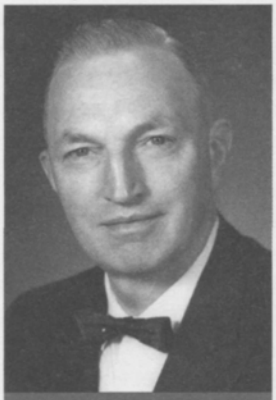
John P. Wood

John comments:

By the time I completed my first degree in mechanical engineering I had become greatly interested in electrical engineering. College costs in the 1920s were low enough to allow my father to approve my request to continue at Cornell long enough to obtain my EE degree. Although my subsequent engineering career was in association with a chemical industry, my Cornell education and experience as an instructor allowed me to provide satisfactory solutions to the electrical engineering challenges that I encountered throughout my years in the engineering department and power operating staff. Those experiences form the basis for my very positive opinion that an engineering curriculum must have a different emphasis than that for any degree that just says: science (or arts!). In other words, the student must learn by making mistakes on real working equipment and, let's hope, sooner or later have the equivalent of a circuit breaker opening with a loud bang, not too close to the face, we trust. (There was no OSHA to worry about in the 1930s—too bad for present-day students—that flashing circuit breaker made a lasting impression.) Certainly, the curriculums in the 1990s had, and those of 2000 to 2010 will have, different highlights from the ones that were typical of the 1920s and 1930s, but the educational principles are the same.

Because of modern changes in the EE profession there seems to be considerable attention given these days to the labeling of electrical engineers. In my opinion, for an individual to be entitled to use the label "engineer," he (or she) must have enough knowledge and experience to deal with actual physical equipment (including transistors).

Edwin L. Harder received the E.E. degree from Cornell University in 1926. He then received the M.S. degree in electrical engineering in 1930 and the Ph.D. degree in mathematics and engineering in 1946, both from the University of Pittsburgh. In 1926 he began a distinguished 44-year career with the Westinghouse Electric Corporation during which he directed development of the "Anacom," the first full-scale power-network transient analyzer, made many contributions to the protection of electric power systems, and encouraged the development and general use of analog and digital computers. He was also active in the International Federation of Information Processing and from 1964 to 1966 served as president of the American Federation of Information Processing Societies (AFIPS). Ed retired from Westinghouse in 1965, continued as a consultant until 1970, then devoted himself to research and writing. He is a life fellow of the Institute of Electrical and Electronic Engineers and a member of the National Academy of Engineers. Ed is the recipient of the IEEE Lamme Medal, the AFIPS Distinguished Service Award, and many other industrial and national awards and honors. He has published over 150 technical papers and a book, *Fundamentals of Energy Production* (Wiley, 1982), and has been awarded 66 U.S. patents for electrical apparatus, for which he received the 1990 George Westinghouse Lifetime Innovation Award.



Edwin L. Harder

Ed comments:

My inspiration to become an electrical engineer stemmed from my father, an EE graduate from Pennsylvania State University who was superintendent of distribution stations for the Buffalo, New York, electric power company. A high school summer job with that company added further motivation. My father wanted me to go to Penn State, but I received a four-year land-grant scholarship from Cornell, which had one of the top EE programs in the country. As preparation for industry, engineering students received hands-on training in foundry, forging, woodworking, machine shop, and mechanical drawing. There were three years of physics and chemistry instruction and an unusually heavy dose of mathematics, including differential equations and Heaviside's operational calculus. EE courses began with dc circuits and proceeded to ac circuits with extensive laboratory work in both electrical and mechanical engineering studies. I was particularly inspired by the teachings of Professor **Vladimir Karapetoff**.

My mathematical training at Cornell was of great importance both in my graduate study and throughout my career with Westinghouse. I was fortunate to have an inventive ability that was augmented by my skill with mathematics. Many of my inventions were highly technical or mathematical in nature. The problem would be expressed mathematically, and I would try to find apparatus that would do what the resulting equations said had to be done. Some of my finest and most valuable inventions were a result of this procedure. Although not everyone is blessed with inventive ability, I believe that an engineering education should emphasize the importance of coupling mathematical analysis with practical solutions by providing ample opportunities for every student to experience a similar design process.

I think my activities with our various professional societies did more for the overall advances in electrical engineering and computers than my specific contributions. One of the greatest ways for promoting our profession is the technical interchange provided by our societies. Here each advance is brought to the attention of our peers, discussed, criticized, expanded, and soon inspires the next development. Here we meet new friends, though possible competitors in industry, and share in the progress of our profession.

I think Dean **John Hopcroft** is doing an excellent job! His programs are very innovative.

Larry Dwon received the E.E. degree from Cornell University in 1935, the M.B.A. degree from New York University in 1954, and certificates for special studies from five universities over the years. Following three years of industrial engineering experience he joined the American Electric Power Service Corporation (AEPSC) in 1938. In 1957 he became the manager of engineering manpower at AEPSC and remained in that position until his retirement in 1978. He has since consulted in energy conservation, lighting, manpower use, and related areas. He was a registered professional engineer from 1941 until his registration retirement in 1992. Larry is a Fellow of the Institute of Electrical and Electronic Engineers, an Eta Kappa Nu Eminent Member, recipient of the IEEE Centennial Medal and the Fred L. Plummer Award, and has received many other honors, awards, and citations. He has been active in voluntary activities for over 55 years with eight national professional societies and served as national president of Eta Kappa Nu in 1958. He has published more than 200 technical papers and professional articles and has presented more than 200 technical and professional talks.

Larry Dwon

Larry comments:

I was inspired to study electrical engineering by childhood experiences and by my studies at Stuyvesant High School. My desire to pursue a lifetime career in the electrical engineering profession was reinforced by the undergraduate program at Cornell, its required and elective courses, the required comprehensive reports in all the laboratories, and the dedicated efforts of Professors **E. M. Strong**, **Vladimir Karapetoff**, **B. K. Northrop**, **L. A. Burckmyer**, and others. My EE education at Cornell prepared me to formulate problems, think logically, seek facts, and analyze and arrive at conclusions to help me synthesize proper solutions. I was also provided with the technical fundamentals that allowed me to master an advanced electronics course at Harvard and to study and later teach energy conservation concepts. Sufficient emphasis was lacking, however, on the great need to develop skills in writing and speaking and their combination into effective presentations to different audiences. Nor were we made aware of or informed on how to deal with unethical and unprofessional situations that occur in industry and how they affect an engineer's career regardless of the performance quality. I had to learn these things through experience and self-study.

An undergraduate program by itself cannot adequately prepare one for a lifetime career. At best, an undergraduate program should teach a person how to think and learn and should provide the foundation to sustain a self-motivated continuing education program. I recommend the establishment of a more formal and complete effort to inform students about lifelong career problems and methods to deal with them. Practicing engineers from industry should be involved in such a program. These critical issues in engineering education have been discussed for several decades in many articles by practicing engineers and educators.

I believe that if graduates of an EE program cannot formulate and solve electrical engineering problems, they should *not* be called electrical engineers. If graduates cannot pass a professional engineer's examination that is developed by practicing electrical engineers, they should be called what they truly are so the public, other graduates, and potential students will not be deceived.

Dwight C. (Bill) Baum received the E.E. degree from Cornell University in 1936 and went directly to Harvard University Business School, where he received the M.B.A. degree in marketing in 1938. Following graduate study he joined the Mine Safety Appliance Company in Pittsburgh, Pennsylvania, as an assistant to the vice president of that firm, or as Bill puts it, "chief assistant to the assistant chief." In 1940 he took a leave of absence to help the post-Dunkirk-desperate British by serving in Washington, D.C., until 1946 as the armament supply officer in America for the Royal Air Force. In that position he procured all of the aircraft machine guns and bombs used by the British against Nazi Germany and was decorated with the Order of the British Empire. After World War II Bill began a long career in business finance in Los Angeles, California, starting as a partner with Eastern Dillon & Company, advancing through managerial positions with that firm and its successors, and serving as a senior vice president with Painewebber, Inc., from 1980 to the present. Bill is a member of the National Association of Securities Dealers, the Society of Financial Analysts, and the Pacific Stock Exchange, Inc., and is listed in *Who's Who in America*. He is a life member of the Institute of Electrical and Electronic Engineers and continues to have a lively interest in electrical engineering developments.

Dwight C. (Bill) Baum

Bill comments:

As a boy I always loved to experiment with electricity, build crystal detector radio sets, and tinker with amateur radio. I also developed a personal fascination with business finance. Consequently, I matriculated at Cornell with the full expectation of gaining a good undergraduate electrical engineering education and then attending graduate business school with the goal of pursuing a business career armed with the technical knowledge and discipline gained in EE. In retrospect, the combination worked for me. I cannot imagine a better base than EE on which to build a career. In my years in the investment banking business, the organized thinking and rationalization of an engineering background proved to be invaluable. My career has ranged from security analysis to corporate finance involving both high-tech and low-tech companies. I have served on numerous corporate boards and industry activities, and I am happy to say that I have loved every minute of it.

I think we need to return to overlay courses that present the fundamentals of the broad spectrum that EE still encompasses. This does not mean we need to take foundry or machine shop again, but every EE should have hands-on exposure to both macro and micro electrical and electronic components. After all, we must still deal with motors and power mains regardless of how computer oriented we become. Graduates will be able to build new technologies onto this broader base.

Since the EE field seems to be firmly split, we really do need to divide it formally. Perhaps "cyber engineering" could cover the areas of computers, nanofabrication, and information technology, and a traditional EE program could produce technically literate and creative real-world engineers.

Recent Faculty Accomplishments

Most of the awards listed below were announced at the College of Engineering Fall 1999 Awards Ceremony and Faculty Reception on September 21, 1999.

• Professor **Joseph M. Ballantyne** (optoelectronic devices and materials),with student Chen Ji, formulated a new theory of unidirectional and bidirectional operation of diode-ring lasers which explains the noise properties of those devices. This understanding is important to the design of low-noise diode-ring lasers. Ballantyne was instrumental in recruiting Professor **Sandip Tiwari** to assume the Lester B. Knight directorship of the Cornell Nanofabrication Facility and a position on our faculty.

• Lecturer **John C. Belina** (bioelectronics) is developing a new version of EE 490 that incorporates many of the systems engineering and entrepreneurial interests into an EE design course. He will be adding ethics and other Engineering Criteria 2000 accreditation material to the course. He assisted Professor **Hsiao-Dong Chiang** in the introduction of some biomedical applications into the revised nonlinear dynamics course, EE 594. In research he is collaborating with Associate Professor **Robert F. Gilmour's** cardiac electrophysiology group in the Physiology Department. Joint proposals are planned when John completes his Ph.D. study.

• Professor **Toby Berger** (information theory and communications), the Irwin and Joan Jacobs Professor of Engineering, reports on the work of a team of more than twenty undergraduate M.Eng. and M.S./Ph.D. students working under his direction in the DISCOVER Lab. They have produced Windows NT versions of our CU30 videoconferencing and video streaming utilities that transmit 30 frames per second of full-color, high-motion, good-quality digital video. This activity has been an enlightening pedagogical exercise for the group and also has potential commercial applications that are being explored with the Cornell Nanofabrication Facility.

• Associate Professor **Adam Bojanczyk** (computer engineering, parallel architecture, and algorithms for signal and image processing) has generalized precision-propagation functionality of the multi-instance library approach to allow performance optimization and C-code generation for a variety of space-time adaptive processing applications.

• Professor **Hsiao-Dong Chiang** (analysis and control of nonlinear systems with applications to electric power networks) has developed an innovative methodology for global optimization of power system operation. He has also collaborated with Taiwan, Republic of China, on a patent award #083962, "Dynamic Method for Preventing Voltage Collapse in Power Systems." Hsiao-Dong took a sabbatical leave during the fall 1999 semester to develop two new courses, one in nonlinear computation and the other in document processing. Both courses are intended for senior undergraduates and graduate students.

• Associate Professor **David F. Delchamps** (control and system theory) reports that his group's research program in intelligent and dynamical systems has led in some interesting new directions over the last three years. Such systems mix continuous and discrete variables and often feature massively parallel architectures along event-driven dynamics and collective phenomena. The group has come to recognize the central importance of evolutionary computational approaches to the modeling, analysis, and control of such systems. Current research that applies dynamical systems techniques to problems in cognitive science and learning theory has continued to play a role in these investigations.

• Professor **Lester F. Eastman** (compound semiconductor materials, devices, and circuits), the John LaPorte Given Professor of Engineering, and his group have designed, fabricated, and characterized gallium-arsenide-based field-effect transistors, thereby advancing the state of the art in frequency response, efficiency, and microwave power.

• Professor **Donald T. Farley** (radiowave and upper-atmospheric physics), reports that the thesis research of one of his Ph.D. students has shown clearly that the existing explanations for naturally occurring plasma instabilities in the Earth's atmosphere at altitudes near 100 kilometers at middle latitudes (i.e., over Arecibo) are mostly incorrect. Associated theoretical work in collaboration with Professor **Charles E. Seyler Jr.** seems to provide a far better understanding of the physics of these instabilities, which has been a long-standing puzzle to ionospheric scientists. Don was named the J. Preston Levis Professor of Engineering in the 1999 spring semester.

• Professor **Terrence L. Fine** (information theory, inference, and decision making in the presence of uncertainty) completed the research monograph *Feedforward Neural Network Methodology* for Springer-Verlag's series on Statistics for Physical Science, Engineering, and Information Science. The volume was published in June 1999. Terry is preparing a textbook on probability theory and its applications at the level of EE 310, Probability and Random Signals, under contract with Prentice-Hall. His research activities have focused on the use of neural networks to process the information received from a sensor array deployed with a wireless mobile cellular communications system. The objective is to improve the throughput of ALOHA, a random-access protocol, by estimating the number of blocked calls and improve handoffs across cell boundaries by predicting boundary crossings based on inferences about caller mobility. Terry was the recipient of the 1999 Ruth and Joel Spira School of Electrical Engineering Excellence in Teaching Award.

• Associate Professor **Zygmunt J. Haas** (wireless communication and networks, mobile systems) has developed and analyzed the mobility-management framework for mobile wireless ad hoc systems, thereby demonstrating the significant improvement of the prepared scheme (which is based on the Quorum Theory) as compared with conventional mobility-management schemes. He also developed and analyzed a novel user-location algorithm, based on prediction of the user's movements, that shows the reduction in mobility management costs as compared with distance-update schemes. During the 1999 fall term, Zygmunt spent a leave of absence at Brooklyn Polytechnic Institute, where he taught and did research in his field of expertise.

• Professor **David A. Hammer** (plasma physics, controlled fusion, intense ion beams), the J. Carlton Ward Jr. Professor of Nuclear Energy Engineering, served his second term as director of graduate studies in the EE School. With support from Sandia National Laboratories and the U.S. Department of Defense, Dave and his group continued their research on intense ion beams and exploding-wire X and Z pinches. Their publications include four refereed journal articles and nine conference presentations.

• Assistant Professor **Mark Heinrich** (computer architecture) has studied the performance and scalability of distributed shared memory (DSM) cache coherence protocols using the flexible architecture for shared memory multiprocessor to keep the hardware and applications fixed while varying only the coherence protocol being used. This research identified bottlenecks in current protocols and showed that no existing protocol is best across a wide range of applications and problem sizes. Even more surprising, the best protocol can change as the machine size scales, even within the same application. Insights from this work can help lead to more robust hybrid coherence protocols and also argue for flexibility in the choice of coherence protocol in large-scale, cache-coherent DSM machines.

• Assistant Professor **Sheila S. Hemami** (application-specific compression techniques for packet networks, networking aspects of visual communication, and multirate coding and transmission) was a finalist in the 1999 Eta Kappa Nu C. Holmes MacDonald Outstanding Teaching Award selection, and we have just learned that she won the 2000 C. Holmes MacDonald Outstanding Teaching Award. Sheila also received a travel grant from the President's Council of Cornell Women in support of her proposal "Presenting Video Compression Research at 1999 IEEE International Conference on Image Processing (ICIP)" in Kobe, Japan.

• Professor **C. Richard Johnson Jr.** (adaptive control and signal processing) was on sabbatical leave in California during the 1998–99 academic year where he taught adaptive equalization at both Stanford University and the University of California at Berkeley. Under support from the National Science Foundation, he had a visiting appointment at Applied Signal Technology in Sunnyvale, where he focused on blind adaptive equalizers for single and multiuser wireless communication systems. His other consulting activities while in California dealt with adaptive equalization in high-definition television receivers and in digital subscriber-loop transceivers.

• Assistant Professor **Edwin C. Kan** (modeling and fabrication of nanometer-scale devices) has collaborated on the Microelectronics Advanced Research Corporation Interconnect Focus Center's effort to find novel solutions for very-large-scale-integrated (VLSI) interconnect problems. Edwin was a 1999 recipient of the James and Mary Tien College of Engineering Excellence in Teaching Award, together with **Bradley A. Minch**, for their efforts in revising the VLSI curriculum.

• Professor **Michael C. Kelley** (upper atmospheric and ionospheric physics) was named a 1998 **Stephen H. Weiss** '57 Presidential Fellow. Mike and his group made observations in the Leonids meteor shower that explain perplexing observations made over 130 years ago. Starfire Optical Range lasers and telescopes were used to study hour-long luminous trails behind some meteors. The data have explained the meteor structure in terms of a catalytic process involving sodium and ozone.

• Professor **Paul M. Kintner** (atmospheric plasma physics) was the principal investigator for one sounding rocket launch, co-principal investigator for a second launch, and has had a new rocket launch proposal accepted by the National Aeronautics and Space Administration. During the year he gave a colloquium talk to the Thayer School of Engineering at Dartmouth College in Hanover, New Hampshire, as well as invited talks at several institutions on space engineering and the Global Positioning System. In addition to his duties as associate director of the School of Electrical Engineering, he taught one semester of EE 416, Global Positioning Systems.

• Associate Professor **Ronald M. Kline** (history of technology and electrical engineering) has completed revisions on his book manuscript *Consumers in the Country: Technology and the Contested Modernization of Rural America* (Johns Hopkins Press). The volume was pubished in the spring of 2000. Ron is the director of graduate study for the Department of Science and Technology Studies and was the 1999 recipient of the **Douglas E. Whitney** '61 College of Engineering Excellence in Teaching Award

EE School Research Funding

Total research funds expended in 1996–97	$13,857,387
Total research funds expended in 1997–98	$13,370,224
Percent decrease	3.5 %
Total research funds for 1998–99 (as of June 30, 1999)	$17,387,886
Percent increase	30 %

In addition, approximately $1,590,000 has been received by the school in the past academic year in support of faculty research and special projects from Alcoa, Applied Signal Technology, Eastman Kodak, GTE, Intel Corp., Lockheed-Martin, Lutron Foundation, Motorola, 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 EE School to establish and maintain a leading edge in the discipline.

• Assistant Professor **Kevin T. Kornegay** (computer-aided design for VLSI circuits) and his group have developed the first submicron silicon-carbide metal-oxide semiconductor (MOS) devices intended for high-temperature electronics service. The group also is the first to document short-channel effects in submicron silicon-carbide MOS devices. Kevin is the recipient of a Faculty Early Career Development Award from the National Science Foundation. He was invited to attend the annual three-day Frontiers of Engineering meeting sponsored by the Academy of Engineering. Participation in this event is by invitation following a competitive nomination and selection process.

• Professor **J. Peter Krusius** (solid-state electronics, semi-

conductor devices and systems, and electronic packaging) is the director of the Cornell component of a semiconductor technology Focus Center Research (FCR) Program funded by Microelectronics Advanced Research Corporation and New York State. The FCR team includes Stanford University, Massachusetts Institute of Technology, SUNY-Albany, Rochester Polytechnic Institute, and Georgia Institute of Technology. On July 1, 1999, Peter was appointed director of the Semiconductor Research Corporation Program on Microscience and Technology.

• Professor **Richard L. Liboff** (physics of microsemiconductor devices and solid-state plasmas) conducted research in the formulation of the thermal conductivity in noble metals stemming from the quantum Boltzmann equation. The study revealed a curve for this parameter that strongly resembles experimental data.

• Associate Professor **Yu-Hwa Lo** (optoelectronic materials and devices and integrated optoelectronic circuits) and his group demonstrated the first integrated optical microelectromechanical systems biosensor for glucose detection that approaches the Federal Drug Administration requirements in sensitivity.

• Professor **Noel C. MacDonald** (microelectromechanical and nanoelectromechanical systems) was named the Acheson/Laibe Professor of Business Management and Leadership Studies in the College of Engineering in spring 1999. Noel was also elected to the National Academy of Engineering in February 2000. He continued his leave of absence during the 1999–2000 academic year in Washington, D.C., with the Defense Advanced Research Projects Agency as director of the Electronic Technology Office. During the year, Noel made frequent visits to the campus to consult with his graduate students.

• Assistant Professor **Rajit Manohar** (asynchronous VLSI design, computer architecture, parallel computing) and his group have developed a formal framework for the design of asynchronous VLSI systems that avoids traditional methods of behavior analysis based on all possible interleavings of execution. The new procedure focuses instead on the data values exchanged in the system. This methodology was used to demonstrate the correctness of all important transformations used in the design of a high-performance asynchronous microprocessor. We are pleasd to announce that Rajit has just been awarded the Tau Beta Pi and Cornell Society of Engineers 1999–2000 Excellence in Teaching Award.

• Professor **Paul R. McIsaac** (microwave theory and techniques) reports that his most important research contribution for 1998–99 was concerned with the further study of the scattering matrix associated with a reflection-symmetric iris in a uniform waveguide. In particular, the consequences of the symmetries of the iris and of the port waveguides for the elements of the scattering matrix were explained.

• Assistant Professor **Bradley A. Minch** (analog and digital VLSI circuit design) has devised a structured methodology for synthesizing dynamic translinear circuits using floating-gate MOS transistors. A wide variety of linear and nonlinear adaptive information processing systems can be built with such circuits. Bradley was a 1999 recipient of the James and Mary Tien College of Engineering Excellence in Teaching Award, together with **Edwin C. Kan**, for their efforts in revising the VLSI curriculum. He also received a 1999 **James M.** and **Marsha D. McCormick** College of Engineering Award for Excellence in Advising First-Year Engineering Students.

• Professor **John A. Nation** (electromagnetic fields and waves) and his students have successfully operated a high-power 75 MW, X-band traveling-wave tube at 55 percent of power conversion efficiency. This is the highest efficiency achieved at this frequency in any microwave device at this power level.

• Professor **Thomas W. Parks** (signal theory and digital-signal processing) has developed a new course, Introduction to Color Imaging Science, with Hsien Lee from Eastman Kodak Company in Rochester, New York.

• Associate Professor **Alfred Phillips Jr.** (quantum mechanical devices, optical switches, and process modeling) reports that he is making significant progress on the creation of something new in quantum mechanics that he hopes to complete this summer. He is also working on a new field-effect transistor theory that is in the review process at present.

• Professor **Clifford R. Pollock** (lasers and optoelectronics), the Ilda and Charles Lee Professor of Engineering, continued his assignment as academic program leader of the Duffield Hall Project Management Team. He has been working with the university and the College of Engineering faculty on the building design and site selection.

• Associate Professor **Anthony P. Reeves** (parallel computer systems, computer-vision algorithms) and his group have developed and calibrated size measurement methods to identify lung cancer from computed tomography (CT) chest images. This method has the potential for significantly reducing the time required for noninvasive image-analysis techniques to determine that a pulmonary module is malignant. This work is a collaborative effort with the ongoing Early Lung Cancer Action Project at the Weill Medical College of Cornell University. Tony's group has also implemented a 16-camera multi-view stereo vision system that is capable of high-accuracy depth measurement. This multi-view approach overcomes fundamental limitations of conventional binocular stereo vision systems.

• Professor **Charles E. Seyler Jr.** (space-plasma physics, theoretical and computational plasma physics) was a 1999 recipient of the **Michael Tien** '72 College of Engineering Excellence in Teaching Award.

• Professor **James R. Shealy** (development of compound semiconductors) will be on sabbatical leave for the calendar year 2000. During this period Dick will oversee the start-up of two new research projects and continue to supervise his graduate students. He also plans to interact with colleagues at Harvard University and develop research opportunities in the area of transistors with researchers at Raytheon Corporation.

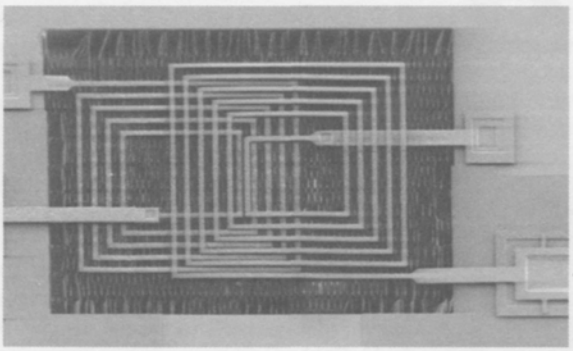
• Professor **Chung-Liang Tang** (lasers, optoelectric devices, nonlinear and coherent optical processes), the Spencer T. Olin Professor of Engineering, used the broadly tunable femtosecond optical parametric oscillator to carry out the first comprehensive study of the ultrafast dynamics of holes in gallium-arsenide in the near- and mid-infrared

band. The results are important for the development of ultrafast semiconductor electronic and optical devices.

• Professor **Robert J. Thomas** (control techniques for large-scale networks, analysis of microelectromechanical systems) is examining new experimental results concerning restructured electric-power-system auction design. He is the chairman of the Curriculum and Standards Committee of the EE School and is working on the redesign of the electrical engineering curriculum.

• Professor **James S. Thorp** (estimation and control of discrete linear systems applied to electric-power networks), the Charles N. Mellowes Professor of Engineering and director of the School of Electrical Engineering, reports that his group has obtained preliminary results on studies of a new global approach to analysis of electromechanical oscillation problems in electric power generator rotors. These disturbances result from faults and other random events in the operation of interconnected electric power networks. Simulation techniques have also been developed to study new protection strategies toward safeguarding the global stability of power systems.

• Assistant Professor **Norman C. Tien** (microelectromechanical systems [MEMS] for radio-frequency circuits and optoelectronics) reports on his development of a new MEMS fabrication process that integrates polysilicon-surface micromachining with bulk-silicon micromachining. He has also developed a polysilicon microactuator, a low-voltage large-travel electrothermal vibromotor that has been used to drive micromirrors intended for optical-switching applications. A micromachined device is shown in Figure 8.



(Courtesy of Norman Tien)

Figure 8. A microscopic 2kV transformer.

• Professor **Sandip Tiwari** (electronic and optical-semiconductor devices and compound semiconductors), the Lester B. Knight Director of the Cornell Nanofabrication Center Knight Laboratory, reports on measurements that have allowed researchers to distinguish between the role of bulk quantization and coupling effects and that of localized interface states. These measurements of frequency, bias, bias-ramp, and time-dependence of operation can be used to describe the role of interface states in nanocrystal memories that use silicon quantum dots coupled to a field-effect transistor channel.

• Associate Professor **Lang Tong** (digital-signal-processing algorithms, estimation theory, wireless communication systems) and his group have developed new signal-processing techniques for signal detection and estimation in wireless networks. This work has resulted in a new National Science Foundation grant for a project called "Adaptive Signal Processing in Wireless Asynchronous Transmission Mode (ATM)."

• Assistant Professor **Venugopal V. Veeravalli** (wireless communication, detection and estimation theory, and information theory) reports that his research on Code Division Multiple Access (CDMA) has exposed a major flaw extant in most analyses of asynchronous CDMA systems. He has taken a new approach to graduate study in the EE School by tailoring graduate courses to meet the needs of both M.Eng. and Ph.D. students. The approach was tried in spring 1999 in EE 568, Mobile Communication Systems. Venu is a recipient of the 1999 **Michael Tien** '72 College of Engineering Excellence in Teaching Award.

• Professor **Stephen B. Wicker** (wireless information networks, digital communication systems, error-control coding, and cryptography) and his students have created a laboratory that focuses on application of artificial intelligence to wireless communication networks. In the past year they have shown that various optimization techniques, including generic algorithms, simulated annealing, and random walk, can be used as the basis for dynamic networks that learn and evolve while providing services to mobile users.

A Distinguished Graduate School Alumna

Allyson D. Yarbrough received the B.S. degree in electrical and computer engineering from New Mexico State University in 1979 and the M.S. and Ph.D. degrees in electrical engineering at Cornell University in 1985 and 1988 respectively. As a graduate student her work focused on the reduction to practice of a novel three-dimensional monolithic microwave integrated circuit interconnect for use in high-frequency circuits known as trench waveguides. This research project provided her with valuable semiconductor processing experience through contact with the National Research and Resource Facility for Submicron Structures now known as the Cornell Nanofabrication Center.

Following her undergraduate study, Allyson gained research and industrial experience at the radio astronomy observatory at Arecibo, Puerto Rico, and at the Hewlett-Packard Company (now Agilent Corporation) in Santa Rosa, California. During summers while at Cornell she held internships at the former IBM Federal Systems Division in Owego, New York, and with Hewlett-Packard. Upon completion of her doctoral studies, she joined the electrical engineering faculty at California State University at Los Angeles, where she taught courses in electromagnetics, analog electronics, and electrical measurements. In 1989, she joined the Aerospace Corporation, which operates a federally funded research and development center near Los Angeles and provides systems engineering expertise to the space technology interests of the U.S. Air Force. As a member of the technical staff and later in her position as manager of the Microwave/Millimeterwave Electronics Section, she conducted applied research in the development of microwave components in support of satellite communications payloads. She has also been active in pursuing development of micro-electromechanical systems devices for microwave applications. During the course of her work she has published in the areas of satellite communications and microwave development, and she holds two patents with others pending.

In February 1999, Allyson was promoted to director of the Electromagnetic Techniques Department in the Communication System Subdivision. The department provides technical support to military, civil, and commercial satellite projects through an active program of applied research and development and technology assessment. In this position she leads approximately 40 staff members with expertise in communication electronics, wireless communications, antennas, and wave propagation.

Since leaving Cornell, Allyson has participated in several student-support programs including an annual Science Fair held at the Aerospace Corporation for middle and high school students; MathCounts, a math enrichment program; and math refresher activities for adults. She has been honored with awards, including the Aerospace Corporation's Woman of the Year Award, the Robert H. Herndon Black Image Award, and several technical awards.

Allyson attributes much of her success with engineering teams at the Aerospace Corporation to her experiences at Cornell. She particularly values the guidance of her thesis advisers, Professors **G. Conrad Dalman** and **Charles A. Lee**, for their dedication to students, mentoring, collaboration, and commitment to the conduct of high-quality science.

We congratulate Allyson on a distinguished career and wish her continued success in technical endeavors as well as in her commendable public service activities.

John Nation Retires

John A. Nation, a member of the EE School faculty for 35 years, will become professor emeritus on July 1, 2000.

John received the B.Sc. degree in physics in 1957 and the Ph.D. degree in physics in 1960 from Imperial College, University of London, England. Following completion of his doctoral study he spent a year and a half at the Comitato Nazionale per L'Energia Nucleare Laboratory in Frascati, Rome, where he worked on a theta-pinch fusion device. In 1962 he joined the staff of the Central Electricity Generating Board Research Laboratories in Leatherhead, England, and remained there until 1965, when he came to Cornell as a visiting assistant professor in electrical engineering. The following year he joined the EE School as an assistant professor, became an associate professor in 1972, and was promoted to full professor in 1978. From 1975 to 1984 he served as assistant director and then associate director of the Cornell Laboratory of Plasma Studies, and from 1984 to 1989 he was director of the School of Electrical Engineering. He will retire as professor emeritus in 2000.

John's career at Cornell has been devoted to teaching, research, and service to the EE School, the College of Engineering, and the university. Over many years he developed and taught courses in electromagnetic fields and waves at the junior and senior year levels, and he was the first instructor to introduce the use of computers in those courses. John also developed and taught graduate courses in electrodynamics and directed the research of many graduate students in various aspects of high-current accelerator physics.

John has been highly regarded by his students as a vigorous lecturer and an excellent instructor and was named twice as the runner up in the annual college-wide selection of the Tau Beta Pi Excellence-in-Teaching Award. A telling example of his teaching style is illustrated in the following excerpt from his lecture on energy storage and forces: "A jelly-filled doughnut contains the same amount of energy as a 12-volt car battery or as a stick of dynamite: one megajoule (one million watt-seconds). The difference in their behavior is in the duration of the energy release." Such extremely rapid releases of energy occurred nearly every day in his laboratory, the old high-voltage lab on Mitchell Street, during investigations of high-power microwave radiation, intense relativistic electron beams, traveling-wave-tube amplifiers, and other aspects of pulsed-power technology.

From 1984 to 1989 John served as director of the EE School, coincident with a period of growth in student enrollment in electrical engineering that created serious problems in space and instruction at both undergraduate and graduate levels. During John's term of office several steps were taken to alleviate these concerns. Thirteen new faculty members were appointed to the school, computer-aided instruction was introduced in several courses, and a committee was established to initiate studies for a major addition to Phillips Hall. As an interim move, members of the radiophysics and space-plasma groups occupied newly added space in Upson Hall. In 1987 John formed an advisory council of 17 members, representing alumni, industry, and other academic institutions, that would meet annually to review the academic programs of the school and to discuss proposed plans for faculty hiring. The council is still in existence, and its deliberations over the years have resulted in recommendations that have been of significant value to the school.

Engineering Publications

The EE School Centennial Year celebration in 1985 was dedicated to the theme "Future Directions in Electrical Engineering." Six cross-country symposia featured 36 outstanding speakers from the United States and abroad, who addressed a range of electrical engineering topics. The many appreciative alumni who attended the meetings applauded John's skillful management of the celebration and concurred with his summation: "As we celebrate these past achievements, we can look forward with confidence to producing equally significant additions to our challenging discipline."

John has served on many committees in the EE School, the College of Engineering, and the university. He has been a past member of the EE Faculty Committee and the EE Graduate Committee and served many times as chairman of the EE Policy Committee. Along with these and his other duties, he was an active class adviser throughout his career in the EE School. In the college he was chairman of the Engineering College Policy Committee

and was a member of the Long-Range Facilities Planning Group. He was a member of the University Research Council and served as chairman of the University Nominating Committee. A particularly notable committee assignment was John's service as chairman of the University Professional and Economic Status of the Faculty Committee. His colleagues on that committee considered his performance to be so effective that he was elected to serve as chairman for two terms. During his tenure in that position the committee was successful in raising the consciousness of the university administration to the relatively modest Cornell faculty salary levels compared with those of similar academic institutions.

John was a senior visiting fellow with the Scientific Research Council in London and has taken sabbatical leaves at the University of London, the École Polytechnique, the Academia Sinica, and the European Organization for Nuclear Research. He is a Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and of the American Physical Society and was awarded the IEEE Centennial Medal in 1983. Through the years he has served on many program committees for conferences on advanced accelerator concepts and has been a member of program review committees at Argonne National Laboratory, at the Stanford Linear Accelerator Center, and at the Brookhaven National Laboratories Advanced Accelerator Test Facility. He was a member of the National Science Foundation Graduate Fellowship Board in 1994 and has served as a reviewer for numerous applied physics journals. John is the author or coauthor of over 115 refereed journal papers. He is listed in *Who's Who in America* and is a member of Sigma Xi.

In 1969, following the production of the first relativistic electron beams by the pulsed-power facility in the Mitchell Street Laboratory, John thought that the beams could be used as sources of powerful microwave radiation. In those days when financial support of plasma physics research was minimal, the necessary diagnostic tools to confirm this conjecture were unavailable. Fortunately, the school had just received a U.S. Department of Defense gift of control and communication gear from an obsolete Nike missile system. John visited the equipment spread out on the floor of 126 Phillips Hall and found a veritable gold mine of three-centimeter waveguides and other useful devices that could be used for diagnostic purposes. Soon thereafter, John performed the first experiment that demonstrated the generation of ultra-high-power microwave pulses using pulsed-power technology. His subsequent research over the years, as described in the 1997 issue of *Connections*, established Cornell as a major contributor to the technology of high-power microwave generation. John's research has been sponsored principally by the U.S. Department of Energy and the U.S. Air Force Office of Scientific Research under the Multidisciplinary University Research Initiative Program on High-Power Microwave Sources. He has also had collaborative programs with the Technion in Haifa, Israel, and the Institute of Applied Physics in Nizhny-Novograd, Russia.

In retirement, John plans to leave technology for the present, perhaps travel, and consider a possible change of residence. He admits to a particular fondness for Ithaca. After all, it is here that he finally succeeded in making a hole-in-one after many years on the golf links, a feat that was witnessed by Professors **Jim Thorp** and **Tom Parks**.

A NEW COMPUTER SYSTEMS TEACHING LAB ESTABLISHED

In October 1999, the School of Electrical Engineering received a generous gift of 58 desktop Pentium III systems from the Intel Corporation to support both teaching and research in computer systems. Under the direction of Assistant Professors **Mark Heinrich, Rajit Manohar**, and **Edwin Kan** and their graduate students, the units were checked out and placed in service during the week of their arrival and were fully operational on Friday, October 29, 1999. The workstations were immediately available to 106 students enrolled in EE 475, Computer Architecture, and 50 students enrolled in EE 571, Asynchronous VLSI Design. In the spring 2000 term, the machines have supported 219 students enrolled in EE/CS 314, Computer Orientation, and 45 students enrolled in EE 572, Parallel Computer Architecture.

The facility, known as the Intel Computer Systems Teaching Laboratory (ICSTL), consists of 48 workstations in use, five units in place as servers, two units acting as filtering bridges, and three spares. (A partial view of the laboratory is shown in Figure 9.) To facilitate efficient use of the laboratory, Cornell Information Technologies allocated a new subnetwork for ICSTL so that the teaching lab could be configured separately from the electrical engineering network (EEnet). Since EE clients are primarily connected to the EEnet, the separate subnet permits the ICSTL network to provide fast connectivity between the laboratory servers and the workstations.

Figure 9. A partial view of the Intel Computer Systems Teaching Laboratory.

Bobert Beaver, B.S. '90, Computer Science and Electrical Engineering (Rochester Institute of Technology) joined the EE School in October 1999 as manager of computer operations to take the position formerly held by **Paul R. Weber,** who has transferred to the Cornell Law School. Before coming to Cornell, Bob held positions in Texas with the Alcatel Company and with Nortel Networks, both in Dallas, and with Brooks Air Force Base in San Antonio. In 1996, he transferred to Nortel in Rochester, New York, where he remained for two years and also consulted for IBM and Eastman Kodak Company during that period. His past experience involved both software and hardware applications related to the installation, testing, and debugging of operating systems. In addition to his regular computer-related duties in the EE School, he will be in charge of converting the EE Network to the wireless mode of operation. Bob is a history buff with particular attention to the pre–World War I period. His personal library contains over 1,200 books on the subject.

Susan (Sunny) Bulkley joined the EE School as an administrative assistant in May 1999. Before coming to Cornell she spent 26 years with the Cargill Salt Company in Watkins Glen, New York, where she began work while she was still in high school. As an apprentice with the company she spent 11 months in actual salt production in order to learn the business "from the ground up." During her career with Cargill, Inc., Susan was a clerical support specialist in accounting and associated clerical duties and a personal computer specialist concerned with both software and hardware applications. She is a graduate of Odessa-Montour High School and has an occupational certificate in business from Corning Community College. Her hobbies include sewing and making craft items, and she has done volunteer work for the Work Force Development Group of the New York State Labor Department.

Patricia Doxtater, administrative assistant in Rhodes Hall, was transferred to her new office in Room 215 of Phillips Hall in February of this year to assume the position formerly held by Cheryl Francis, who has moved to the EE accounting office. The move will allow Patty to take on greater responsibilities in keeping with her multiple job skills.

Cheryl B. Francis joined the EE School as an administrative assistant in June 1999 to assume the position previously held by **Catherine J. Kuhl,** who retired on June 30, 1999, after many years of faithful service in the school. In January 2000, Cheryl transferred to the EE Accounting Office as accounts representative succeeding **Jutta Brann,** who has transferred to the Electronic Packaging Program. Cheryl began her career at Cornell in 1994 as a travel receptionist in the University Travel Office, joined Human Service Studies in the Department of Policy Analysis and Management as an administrative assistant, and moved to the Planning Design and Construction Group in University Facilities before coming to the EE School. She is a graduate of Moravia High School and took courses in accounting and computer programming in Tompkins Cortland Community College and Cayuga Community College. Cheryl helps to manage a 300+ acre farm and says that her current particular pride and joy is a red 1965 Mustang that she and her dad restored from "rust-bucket" status. Cheryl is an administrator of her church and enjoys singing in the church choir.

Mukles Haddad, who has been a productive office system specialist and program analyst in the EE School for 17 years, transferred to the Department of City and Regional Planning as computer operations manager. We wish him all success in his new position.

Paula G. Solat has been promoted to administrative assistant IV in the EE School. She has been assigned additional responsibilities, including administrative support for the director of the EE School and the director of administration in the areas of gift processing, donor and foundation relations, financial tracking of gifts, and many similar tasks. Paula will also coordinate the administrative support staff of the school.

Jamie Wright joined the EE School as an administrative assistant in Rhodes Hall on February 1, 2000, assuming the position formerly held by Patty Doxtater. After graduating from Candor High School, she took business courses in Oneonta College and Tompkins Cortland Community College. Jamie goes to night school at Ithaca College and expects to receive her B.S. degree in business administration in spring 2001. She enjoys reading when time allows.

In Memoriam

Mrs. **Pearle Ian Meserve**, wife of the late professor emeritus **Wilbur E. Meserve**, died on July 29, 1999, at Straub Clinic and Hospital in Honolulu, Hawaii, at the age of ninety-one. A resident of Ithaca for 45 years, Pearle had been a teacher in the Ithaca school system. She was a lifelong garden club enthusiast, who shared her considerable talent in flower designing with many groups in Ithaca and with similar groups in Honolulu when she moved to Hawaii after Wilbur retired from Cornell. In early years she participated in the activities of an EE faculty wives group in the school and later contributed to many areas of life in Ithaca, including the Ithaca Women's Club, the Ithaca Garden Club (past president), and the Cornell Campus Club. She will be long remembered for her dedicated efforts to enhance the natural beauty of the environment.

Mrs. **Dorothy Wellington McIlroy**, wife of the late professor of electrical engineering **Malcolm S. McIlroy**, died on December 14, 1999, in Ithaca, New York, at the age of ninety-one. A resident of Ithaca for 52 years, Dorothy received her bachelor's and master's degrees in mathematics and physics from the University of Rochester. When Malcolm died in 1956, Dorothy took over the operation of his analog computer, the McIroy Fluid Network Analyzer, and consulted for major cities and utility companies for several years. Dorothy had an encyclopedic knowledge of birds and natural areas in the Ithaca region and was recognized as "Ithaca's first lady of birding" in the periodical *Living Bird* produced by the Cornell Laboratory of Ornithology. Later in life Dorothy became an avid ecotourist and watched birds, whales, animals, and flowers in remote locales of every continent except Antarctica. Her many friends will long remember her as a true lover of nature.

Jerry K. Goff '74 Fund Established

We regret to report the death of **Jerry Kenneth Goff** '74, in a tragic glider accident several months ago. Jerry studied electrical engineering at Cornell and was a member of the Varsity Crew. In 1980 he founded Performance Controls, Inc., a builder of high-performance electronics systems with applications that extended from digital motor controls for robotics to developments in the field of biomedical engineering. Several of his many inventions evolved into important contributions to medical diagnostic technologies. The **Jerry K. Goff '74 Fund** has been established in his memory to provide support for the Bioengineering Program in the School of Electrical Engineering.

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 School a special place. Further examples of the Matthews Criterion, as demonstrated at Cornell, are also of interest. We'll print 'em as space allows.

The account of wireless technology in the EE School in the last issue of *Connections* evoked some interesting comments from EE alumni who were involved with radio station WHCU. So far we have not received an account of a famous prank in the early 1950s, when WVBR was taken over one fine spring evening by a bunch of masked seniors. The bold intruders proceeded to broadcast a phony "War of the Worlds" program that reputedly caused some campus hysteria and eventually brought down the wrath of the Federal Communications Commission upon the hapless station operators. Perhaps some knowledgeable alum will favor us with the story. In the meantime, **Alan Markham** B.E.E. '49, writes:

"Wireless Technology in the EE School" in the spring 1999 issue of *Connections* prompted me to delve into my archives to confirm my recollections. And there it was: my FCC Radio Telephone Operator License, bearing a certification that I had served as operator of station WHCU, dated September 18, 1944, and signed by [Professor] **True McLean**, Chief Engineer. At that time the transmitter and the towers mentioned in the article were located near the [Fuertes] observatory. There were two studio locations: the campus studios in a separate little building south of Bailey Hall, and the downtown studios (which included the control room shown in Figure 3 of the article). I can't identify the third party in the photo, but it isn't me. The only celebrity I recall seeing there was President Day.

Classmate (now professor) **Paul McIsaac** and I operated the campus studio during the regular live broadcasts of the Cornell Agricultural Hour, hosted by the same Professor **Elmer S. ("Flip") Phillips** mentioned in the article. Scheduling required that the CBS soap operas, which originated at the same time as the Agricultural Hour, be transcribed for later broadcast. Due to wartime restrictions on aluminum, the transcriptions had to be made on glass recording blanks. [*Note to young alumni: There were no tape recorders in those days! —Ed.*]

My tenure at WHCU was terminated by an urgent invitation from the Selective Service System. Since I had taken the popular (with EE students, at least) Eddy Test, I qualified for the Navy Radio Technician Program and spent my tour of duty in the Radio Material School and at sea, nurturing the Navy's latest electronic gear. When I returned to Cornell in 1946, Professor **H. G. Smith** advised me that there was an opening for a resident operator at the WHCU transmitter building, but I had developed other interests and did not accept the position.

On the same subject, **Ulrich F. (Rick) Caro** B.E.E. '47 relates:

I was fascinated to read your article on Wireless Technology in the EE School. I was a 1947 EE graduate who spent most of my spare time in Cornell at both WHCU and the Cornell Radio Guild. To supplement the very generous McMullen Scholarship, I worked part time at WHCU, mostly at the console pictured on page 6 with Professor McLean. At that time there was also a small recording studio next to Bailey Hall, where we made recordings off the CBS line for later playback. At lunch time I was there to record one of the soap operas (I think it was "Romance of Helen Trent," or something like that) and in the evenings, half of some CBS entertainment shows, with the other half being recorded downtown. In that studio I often had the company of a Cornell coed, who subsequently became my wife. (We just attended her 50th reunion at Cornell.) It was also most interesting to read about some of my former professors: **Berry Credle**, **Howard Smith**, **Bill Ballard**, and your former mayor, **Ben Nichols**. All in all it was a great experience, both the formal instruction and the work at WHCU, all except a course in vacuum tube making, which was a total disaster and which I almost flunked.

All this early experience provided me with the opportunity to get in on the ground floor of television broadcasting at NBC, where, together with the parent company RCA, I spent the better part of a fascinating career. Without the guidance of True McLean and the others, I would have never gotten involved in such wide-ranging projects as the establishment of broadcast facilities at the 1948 political conventions, and the design of the first TV studios in New York, Chicago, Washington, and Burbank. Other relevant activities included the conversion to color of many of NBC's TV studios, the first use of computers in election coverage, the consulting to German, Swedish, and Finnish government TV systems, and the setting up of the original TV studios in Nigeria.

The article on the McIlroy Pipeline Network Analyzer prompted **John E Gerling**, B.E.E.'51, to recall that Professor **McIlroy** encountered difficulties with meter loading when low-level node readings were required. Mac obtained accurate readings by using vacuum-tube voltmeters that he had adapted for the purpose. John also describes his involvement with two senior research projects:

Professor **Alexis Romanoff** of the College of Agriculture, famous author of *The Avian Egg*, suggested an EE senior project to make an egg grader based on a conjecture that the dielectric constant of the white of an egg changes with age. I made an oscillator with an egg in the feedback system as a test system. I had a box of eggs that were very old and obtained a box of fresh eggs every week that I used for comparison purposes. I was never able to achieve a reproducible difference. I don't know if it was my measurement technique or if there was any difference to measure.

Another project, funded by Philco Corporation (I was a Philco co-op student) was to design and construct a variable-frequency rotating-field audio system to test omnidirectional microphones. My project partner was **M. Bruce Lees**, B.E.E. '51. Actually, the project was designed to test microphonics in vacuum tubes. The microphone aspect was an afterthought. Professor **Walter R. Jones** was the project advisor with assistance from Professor **William C. Ballard**. [*At that time, Walt Jones was conducting a large-scale EE School research project for the armed services on the analysis of vacuum-tube characteristics.—Ed.*] The purpose of the test was to use a non-destructive technique to find microphonic elements and frequencies that would allow standard tubes to be compared with tubes that were designed to have reduced microphonics. We elected to use capacitive changes between the tube elements as the indicator of element motion. Since the changes were very small, making the test equipment to measure the changes consumed the major part of the project time. However, we did succeed in making measurements on some type 6J6 and 6AQ5 tubes.

Alumni who attended the late Professor **Joe Rosson's** lectures will recall that he was a remarkable blackboard artist. During EE School faculty meetings, Joe was famous for another aspect of his artistic ability, the construction of elaborate doodles. Joe would arrive at a faculty meeting in Room 219 in Phillips Hall with a pad of quadrille paper and a handful of newly sharpened color pencils. For the most part, he would never say a word during an entire session but would listen intently and afterward could be depended on to have registered everything that had occurred. As he listened, he would very carefully fill in square after square in a complex symmetrical pattern that would gradually take shape as the meeting progressed. Each pattern was of individual form, and he always managed to complete the design by the end of the meeting. A typical example of a Rosson doodle is shown in Figure 10.

Sam Linke

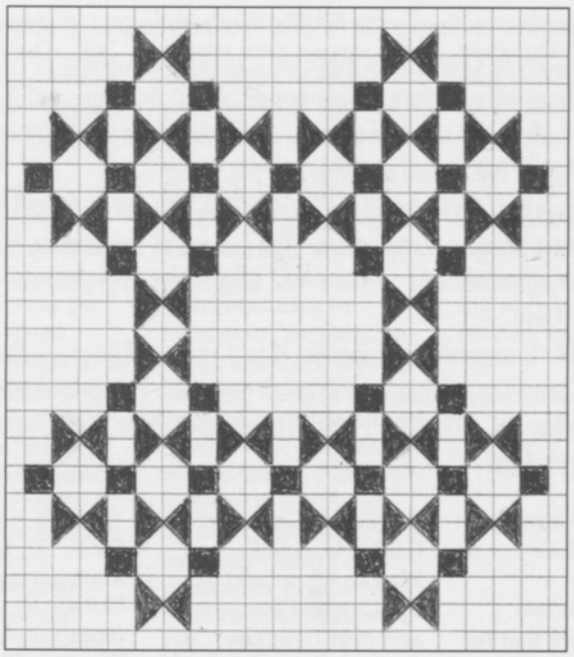


Figure 10. A Joe Rosson doodle.

Alumni Breakfast

The annual EE School Alumni Breakfast was held on Saturday, June 10, 2000, from 7:45 to 9:30 A.M. in the Phillips Hall Lounge. Alumni, companions, and friends joined members of the EE School faculty and staff for an event that is always a festive and memorable occasion.

Positive Feedback

In this issue we are continuing the Positive Feedback feature of previous years. The first eight issues of *Connections* triggered a gratifying number of responses. We hope that this issue will stimulate even more returns of the coupon at the end of this newsletter. The bullets (•) attached to some of the names in the following list refer to respondents who are mentioned elsewhere in this issue.

Note for Internet surfers: On the World Wide Web the EE School home page may be found at < www.ee.cornell.edu >. The College of Engineering URL is < www.engineering.cornell.edu >. The e-mail address for *Connections* is < SL78@cornell.edu >.

Our alumni file is somewhat incomplete. If you know of EE 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.

Douglas B. Whitney, B.E.E. '43, M.E.E. (Northeastern University), retired engineer, writes that he enjoyed reading the history of the EE School that was presented in the wireless technology article in the 1999 issue of *Connections*.

Robert H. Garmezy, B.E.E. '44, B.M.E., M.A.E. '45, retired from the Chrysler Institute and now living in Ithaca, New York, has made a generous grant in support of Professor **Paul Kintner's** Global Positioning System laboratory program.

• **Ulrich F. (Rick) Caro**, B.E.E. '47, M.S., Management, New York University, a certified financial planner in Pleasantville, New York, enjoyed the wireless technology article in the spring 1999 issue of *Connections* and submitted some recollections of his own experiences with radio station WHCU and the Cornell Radio Guild.

• **Alan S. Markham**, B.E.E. '49, M.B.A. Loyola College, retired from Allied Signal/Bendix and now living in Baltimore, Maryland, enjoyed the "nostalgia trip" provided by the 1999 *Connections* wireless technology article and wrote of his tours of duty with WHCU as well as recalling some of his notable contacts with members of the EE faculty.

• **John E. Gerling**, B.E.E. '51, writes from Medford, Oregon, that he has caught up with some earlier issues of *Connections*. The "More Tales from the Past" feature triggered recollections of a couple of senior projects that he describes for us in interesting detail.

Harold D. Craft, Jr., B.S. '61 (Electrical Engineering), Ph.D. '70 (Radio Astronomy), whose duties at Cornell have included service as director of the Arecibo radio telescope in Puerto Rico and vice president for facilities and campus services, has been appointed vice president of administration and chief financial officer of the university.

Stuart S. Pattison, B.E.E. '64, writes that he now makes his home in Wake Forest, North Carolina.

Roger W. Burnell, B.S. '66 (Electrical Engineering), president of Arnell Enterprises, Inc., in Los Altos, California, sent us a "nontechnical" report last December that may be of nostalgic interest to many alumni: "My wife Joelle and I ventured back to New York City last month to participate in the 50th Anniversary of the Cayuga's Waiters—held at the Cornell Club. Being there was a 'first' for us, in both respects. And finding that some difficult arrangements in four-part harmony could come back to a retired larynx from deep limbic system storage was a pleasant surprise—but didn't hold a candle to vibrating in the warm blend of melodic voices spanning 50 successive graduation years! It was a refreshing reminder that our Cornell experience reached well beyond the universe of our pet electrons."

Martin Tang, B.S. '70 (Electrical Engineering), S.M., MIT, Chairman, Asia; Spencer Stuart in Hong Kong, sent us a brief outline of his career. After a stint in the army (he was in ROTC at Cornell) he joined the Bank of America in San Francisco, transferred to Taipei for two years, then moved to Hong Kong in 1977. Martin has been a university trustee since 1994 and returns to Ithaca several times each year.

Robert E. Maroney, B.S. '72 (Electrical Engineering), venture capitalist, RM Capital Holdings, Inc., is a member of the Cornell Society of Engineers (CSE) Board of Directors for the 1999–2000 academic year and served as executive vice president of the 1999 conference in Ithaca.

Jaclyn A. Spear, B.S. '75 (Electrical Engineering), principal engineer and member of the technical staff at Westinghouse Savannah River Company in Aiken, South Carolina, is a member of the CSE Board of Directors for

ee ON-LINE NEWS

New EE School Web Page is Now On-Line

The EE School web page 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.ee.cornell.edu

EE School Alumni On-Line Database

Alumni may visit the site by clicking on the ALUMNI DATABASE link of the main EE page URL, as follows:

www.ee.cornell.edu

the 1999–2000 academic year and served as executive vice president for membership.

Leslie B. Tyler, B.S. '75, (Electrical Engineering) writes that he now lives in Worcester, Massachusetts.

Sarah Thole Fischell, B.S. '78, M.Eng. '79 (Electrical Engineering), consultant in Fair Haven, New Jersey, is a member of the CSE Board of Directors for the 1999–2000 academic year and served as executive vice president for programs.

Philip R. Raymond, B.S.E.E. '79, M.S.E.E. '80, senior partner, IMCO Electronics in Seoul, South Korea, attended the 1999 EE Reunion Breakfast and enjoyed meeting several of his former professors. Philip shared interesting photographs of **John Nation**, **Ben Nichols**, **Toby Berger**, and **Tom McCarthy** that he had taken in previous years.

Steve W. Ackerman, B.S. '80, (Electrical Engineering), J. D. Hofstra University, practices law in Beverly Hills, California, and is a member of the Executive Council of the Walt Disney Company in Burbank, California.

Samuel R. Trapani, B.S. '81 (Electrical Engineering), president, Springwaters, Inc., in Rochester, New York, wrote to Professor **Sam Linke** about his recollections of his Cornell days and recalled a particularly interesting project involving a group study of the university low-head hydropower plant in the gorge. He also reported that he did not end up going to law school as he had originally planned.

Brian C. Wadell, B.S. '81 M.Eng. '82 (Electrical Engineering), formerly a development engineer with Teradyne, Inc., in Boston, Massachusetts, writes that he enjoyed the 1999 issue of *Connections*, particularly the wireless technology article. After 14 years in semiconductor test instrumentation, he has joined a startup called Trakus that makes systems that digitize athletes in real time, which allows him to "skate, play golf, and race cars as part of his job."

Paul M. Enquist, M.Eng. '82, Ph.D. '86 (Electrical Engineering), senior research engineer with Research Triangle Institute (RTI) in Durham, North Carolina, has received an award for contributions to RTI's growth in size and stature in the field of high-speed, low-power semiconductor circuit design. He led the development of a patented technology that enables implementation of the world's fastest low-power semiconductor circuit.

Joseph R. Cavallaro, Ph.D. '88 (Electrical Engineering), associate professor in the Department of Electrical and Computer Engineering at Rice University in Houston, Texas, reports that his interests continue to be in computer systems and very-large-scale-integrated (VLSI) circuit design with current application to special-purpose VLSI architecture for wireless communications systems.

Gyorgy A. Porkolab, Ph.D. '94 (Electrical Engineering), staff engineer with Dominion Semiconductor in Manassas, Virginia, writes that he is a member of an integration team responsible for devices and yield in manufacture of 256-megabit synchronous dynamic random-access memories with 175 nanometer geometries in silicon substrates. The company is a brand-new $1.7 billion facility jointly owned by IBM and Toshiba.

Rodney G. Wiltshire, B.S. '97 (Electrical Engineering), who studied global positioning systems with Professor Paul Kintner while at Cornell, reports that he has started his own rock band, has released a CD, and is a full-time entertainer. He is on the radio in light rotation on 37 stations nationwide, has been signed by Deep Kill Records, and is working very hard to become big time.

Alumni: Please fill out this coupon for the "Positive Feedback" feature and return to: Sam Linke, Cornell University, School of Engineering, 204 Phillips Hall, Ithaca, NY 14853-5401; e-mail: SL78@cornell.edu

Name: _____ class year

Position title: _____

I am employed by: _____

_____ street

_____ city state zip

My current activities are: _____

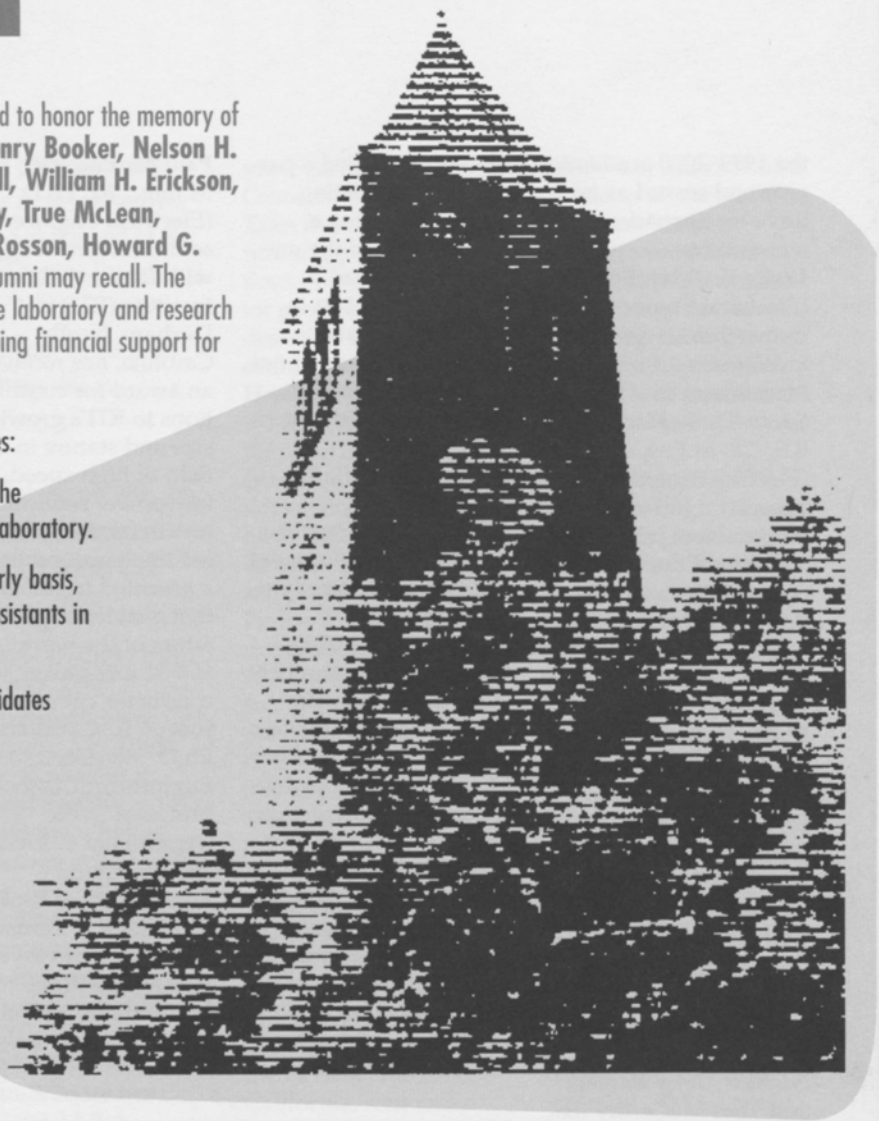
OPTIONAL

I would like to explore possibilites in the following areas:

- ❑ Contributions to the Eminent Professors' fund
- ❑ Contributions to the Joseph L. Rossen (Papa Joe) Memorial Fund
- ❑ Establishment of one-year fellowships for professional master's students
- ❑ Engineering Cooperative Program
- ❑ Job placement of Cornell EE School seniors or graduate students
- ❑ Other _____

Eminent Professors' Fund

Eight years ago the EE School established the Eminent Professors' Fund to honor the memory of notable members of the EE faculty of past years such as Professors **Henry Booker, Nelson H. Bryant, L. A. Burckmyer, Walter W. Cotner, Casper L. Cottrell, William H. Erickson, Clyde E. Ingalls, M. Kim, Michel G. Malti, Malcolm S. McIlroy, True McLean, Wilbur Meserve, B. K. Northrop, Robert Osborn, Joseph L. Rosson, Howard G. Smith, Everett Strong, Joseph G. Tarboux,** and others whom alumni may recall. The objectives of the fund are twofold: to acquire specific grants to improve laboratory and research facilities in the EE School and to establish endowments to provide ongoing financial support for undergraduate and graduate students.



The EE School has given high-priority status to the following activities:

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

Alumni who would like to contribute to the Eminent Professors' Fund should contact Professor **James S. Thorp** in care of the School of Electrical Engineering, Room 224, Phillips Hall, Ithaca, NY 14853-5401.

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