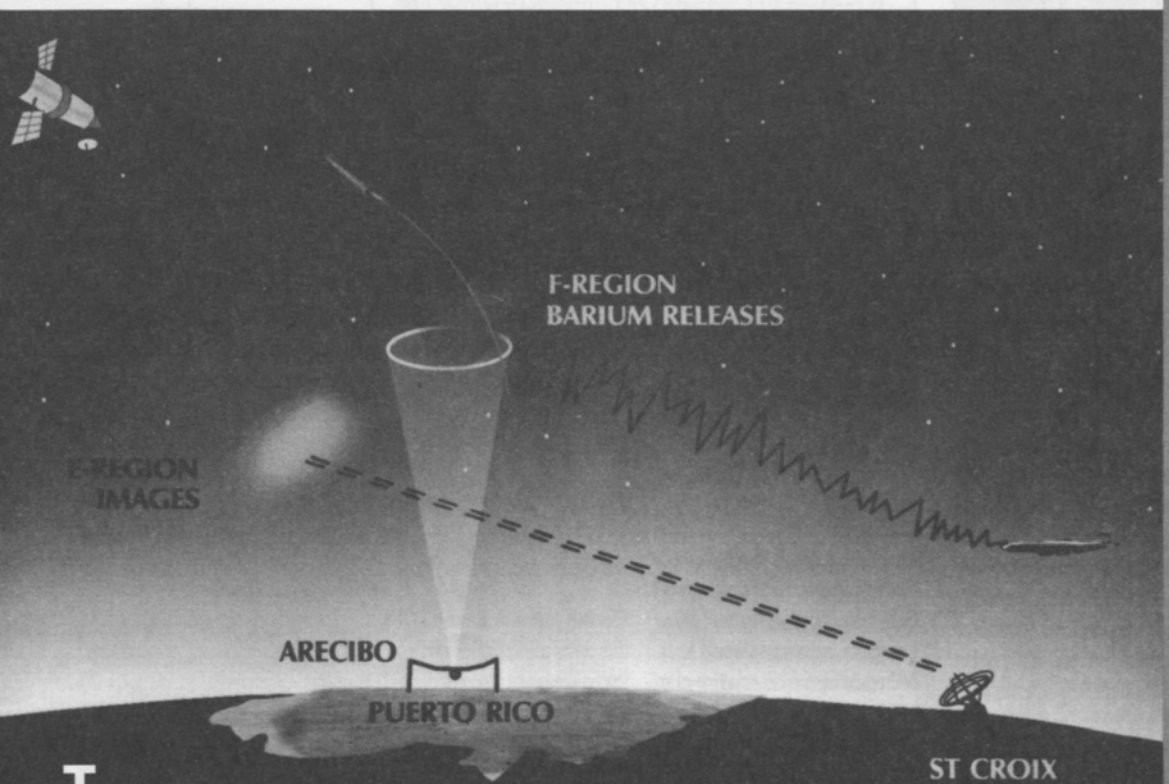
CONNECTIONS

A Report from the SCHOOL OF ELECTRICAL ENGINEERING • Cornell University

Space-Plasma Physics Research

in the School of Electrical Engineering



This sketch presents a composite view of the research tools that are available to the Space-Plasma Physics Group in the School of Electrical Engineering. Remote sensing as well as *in situ* methods may be used singly or in various combinations as required by the nature and geographical location of a given experiment. When simultaneous observations are to be made, often in cooperation with investigators from other space-physics groups in this country and abroad, a "campaign" is carefully planned over a period of months and executed within an appropriate time frame.
For example, the effects of a barium-ion cloud release in the tropical region may be observed by the Arecibo incoherent-scatter radar, a portable radar stationed at St. Croix, and by instruments in a sounding rocket launched from a suitable site.

[Sketch courtesy of Michael C. Kelley and the U.S. Air Force Phillips Laboratory]

This fourth edition of *Connections* features the exciting atmospheric and ionospheric research of our Space-Plasma Physics Group, relates early history of these studies in the EE School, describes some of the courses offered in the new undergraduate teaching laboratory facility, and memorializes three late members of the faculty. The "Positive Feedback" section contains news of recent alumni activities. Other items of interest to alumni are listed in the Table of Contents on this cover page. Please fill out the information coupon on the last page of this newsletter, and clip and mail it to us. We want to hear what you are up to.

Simpson (Sam) Linke, editor
SPRING 1995

In this Issue

Report from the Director

As my first year as director comes to a close, I can report on the beginnings of a number of activities I hope will be completed soon. The first task is the renovation of our largest classroom, Phillips 101. After forty years of service, the room has been prepared for upgrading and has been unavailable since the beginning of the 1995 spring term. I can verify those forty years. As a freshman in fall 1954, I attended orientation lectures in old Franklin 115, in a classroom with a huge slide rule on the front wall of the room. In contrast, our spring 1955 classes were held in newly completed Phillips Hall. The ILR quonset huts were still in place on the space that was to become the engineering quad, and there were tall elms on the west side of Phillips along a drive where Professor **Burckmyer** habitually parked his jeep. The room was almost untouched throughout that forty-year period. There had been attempts to upgrade the sound system, but the exposed steel columns and beams made it hard to change the acoustics of the room.

Phillips 101 is being renovated as part of a multiyear building plan for the College of Engineering. The seats have been removed and returned to the original manufacturer for refurbishing, since new seats with the same built-in longevity are hard to come by. The asbestos in the ceiling of the foyer has been removed, a new exit will be installed in the back of the room on the east side, and access for handicapped individuals will be provided by raising the floor in the front of the room to reduce the present steep slope to one in twelve. New ceiling, floor, and wall treatment will be installed to improve the acoustics and general appearance. Audiovisual and lighting components of the latest design are specified for the room, with central control to be provided by a computer-monitored system housed in the podium. Seminars and smaller-class use of the room will be facilitated by substituting conference tables for the current first three rows of seats. Room 101 was scheduled for use again in the fall of 1995, but unfortunately, as we go to press, construction has been halted. The city has refused to issue a building permit because of a town-gown dispute between Ithaca and Cornell. (The two-term mayor of Ithaca is **Ben Nichols,** EE '46, EE School faculty member from 1949 to 1988, and associate director of the school from 1985 to 1988.)

The second activity is our recruiting initiative in information technology, a field that spans both electrical engineering and computer science, and is one of three major thrust areas in the College of Engineering. Since January 1994, the EE School has received more than 800 applications for the advertised positions and has invited eighteen candidates to the campus. Our first hire in the area is assistant professor Sheila Hemami (see page 3). We plan to hire four more faculty members over the next two years in areas such as video coding and compression, signal processing, multimedia, spoken-language systems, and wireless-communication systems. GTE and AT&T Foundations have both made generous donations to the college to start this major interdisciplinary program (see page 15).

New Building Planned

A new engineering college research and instructional laboratory center is also in the planning stages. Long-standing laboratory needs within the College of Engineering would be addressed by the construction of a building, with a net area of 35,000 square feet, to accommodate the research and safety requirements of a number of faculty members from the schools of Electrical Engineering, Materials Science and Engineering, Chemical Engineering, and Applied and Engineering Physics. The building would also house a modern and safe interdepartmental teaching laboratory for hands-on instruction of engineering undergraduates and graduate students in core subjects of electronics, optoelectronics and solid-state device fabrication, and materials processing. Expansion space for the National Nanofabrication Facility and a materials analytical and microscopy central facility for the Cornell Materials Science Center are also planned. The proposed interdisciplinary research center will provide the safe, state-of-the-art graduate training and research capabilities essential for the college to continue to pursue top-flight research programs in central engineering areas of electronics, optoelectronics, materials synthesis and processing, as well as in newly emerging fields such as microelectromechanics and other aspects of nanotechnology. The renovation of Phillips Hall and the successful realization of these long-term plans will encourage significant coupling of educational and research activities between the EE School and the other schools in the college, and will serve our best interests as we prepare for the next century.

Recent Alumni Survey

The areas of curriculum content and course improvement are under continuous review by various committees in the EE School. To determine the effect of course changes of recent years, associate director **Clif Pollock,** in the summer of 1994, sent a survey to members of the Class of '89 to obtain their impressions of the EE curriculum during their time at Cornell. Replies were received from thirty-one alumni who responded to questions about which courses had been especially helpful, what missing subjects should have been in the curriculum, and anything concerning their Cornell degrees that distinguished them from their colleagues. The responses reveal that our graduates are proud of their degrees and are not afraid to enter many diverse professions. Approximately one-third of the respondents are doing technical electrical engineering, one-third are in some form of management, and the remainder are distributed among graduate schools, professional schools, sales, and service in the Armed Forces. Most of the graduates wished they had taken a broader set of courses, and a majority remarked that more emphasis on communication skills should have been incorporated into the curriculum. There was universal agreement that the EE School taught its graduates how to work well under duress. Most respondents felt that they were better prepared in analytical and problem-solving skills than were their colleagues from other institutions.

From the viewpoint of the faculty it is gratifying to have this positive response to our past efforts. It is also reassuring to know that some of our recent curriculum revisions such as a greater choice of 300-level courses, more emphasis on communication skills, and a reduction in the number of EE credit hours required for graduation in order to allow students more time for additional courses such as business management, are all consistent with the majority of comments in response to the survey. We will be watching the impact of these curriculum changes to see if the students are indeed able to optimize their education.

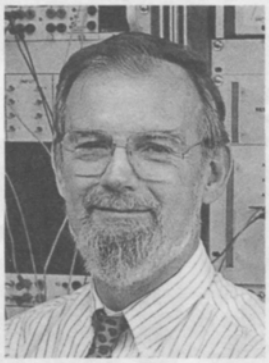
—James S. Thorp
Professor and Director
School of Electrical Engineering

Connections is published by the School of Electrical Engineering, Cornell University, 224 Phillips Hall, Ithaca, NY 14853-5401. Sam Linke, editor; Pat Leary, copy editor; Richanna Patrick, designer.

Printed on recycled paper.

Office of Publications Services
595 7.6M FLP

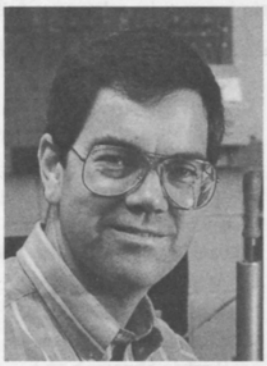
New Director and Associate Director



James S. Thorp

James S. Thorp, B.E.E. '59, M.S. '61, Ph.D. '62, all in electrical engineering from Cornell University, the Charles N. Mellowes Professor of Engineering, became director of the School of Electrical Engineering on July 1, 1994. Jim has been a member of the EE faculty for thirty-three years and served as associate director of the school from July 1, 1991, until he assumed his present position when professor **Noel C. MacDonald** resigned as director. His teaching and research interests are in the field of estimation and control of discrete linear systems with applications to the control of electric-power networks. In 1976–77 he spent a sabbatical leave as a faculty intern with the American Electric Power Service Corporation, and in 1988 he was an overseas fellow at Churchill College, Cambridge University. Jim became a fellow of the IEEE in 1989, and won the Best Professor Award of the Cornell Student Branch of the IEEE in the same year. Several years ago, Jim invented (with professor Arun Phadke of VPI) a device to measure real-time phasors in large electric-power networks. Measuring equipment based on this invention is installed on power networks to provide inputs to new adaptive out-of-step relays also developed by Jim and Arun. In 1988 they co-authored the text *Computer Relaying for Power Systems.*

• **Clifford R. Pollock,** B.S. '76, M.S. '79, Ph.D. '81, all in electrical engineering from Rice University, the Ilda and Charles Lee Professor of Engineering, became associate director of the School of Electrical Engineering on July 1, 1994. After two years with the National Bureau of Standards, Clif joined the faculty of the EE School as an assistant professor in 1983, was promoted to associate professor in 1987, and became a full professor in 1993. In 1984 he was one of the first recipients of the National Science Foundation's Presidential Young Investigator (PYI) Award in the school. His teaching and research interests are in solid-state lasers and optoelectronics. He holds five patents in these and related fields. Clif has been active in developing new material for sophomore and junior-level EE courses, and also teaches an advanced course on integrated and fiber optics. Since coming to Cornell, he has won five Excellence in Teaching awards. His textbook, *Fundamentals of Optoelectronics*, was published in November 1994.



Clifford R. Pollock

New Faculty Member

Sheila S. Hemami

Sheila S. Hemami, B.S. '90, University of Michigan; M.S. '92 and Ph.D. '95, Stanford University, joined the EE School faculty as an assistant professor in 1995. Her major research and teaching interests include application-specific compression techniques for packet networks, networking aspects of visual communications, and multirate coding and transmission. Her current teaching assignment is EE 549, Image and Video Coding, an upper-level and graduate course concerned with international standards in image and video compression, including coding schemes such as the Joint Photographic Experts Group (JPEG) and the Moving Pictures Experts Group (MPEG). Her leisure activities include traveling, outdoor sports, music, and cooking.

ENROLLMENT AND GRADUATION STATISTICS

UNDERGRADUATE PROGRAM

Year	Sophs	Juniors	Seniors	Degrees
92–93	—	114	117	127
93–94	—	103	111	120
94–95	125	112	110	*

M.ENG.(ELECTRICAL) DEGREES

August	January	May	Total
40	5	37	82
32	11	48	91
57	19	*	*

M.S./PH.D. PROGRAM

Year	Applicants	Admissions	Total Enrollment	Degrees
92–93	617	10	134	18 Ph.D.s, 10 M.S.s
93–94	508	17	126	23 Ph.D.s, 11 M.S.s
94–95	556	13	117	20 Ph.D.s, 7 M.S.s

Note: Students now affiliate with the EE School when the first term of sophomore math and physics is completed. These figures indicate that over the past three years, the undergraduate program has remained stable, the M.Eng.(Elec.) program has increased significantly, but the M.S-Ph.D. enrollment has declined sharply.

*Not available at press time.

EE Research in the "Outdoor Laboratory"

Earth's outer space is a natural outdoor laboratory for ground-based scientific exploration of ionospheric phenomena. Many readers of the articles in this issue on the work of the Space-Plasma Physics Group will recall that Cornell EE School faculty members were among the first investigators to use radio and radar to study these celestial events. Initial activities in the late 1940s concentrated on solar astronomy. As the discipline developed over the years, Cornell reached its current status as one of the major centers in the world for radiophysics and space research.

View of the solar astronomy radio telescope at the Tompkins County Airport, circa 1950. Mike Colbert is at right.

When **Charles R. Burrows** became director in 1945, one of his first priorities was to improve the research status of the school. His strong interests in radiophysics and wave propagation led him to establish the solar-astronomy program to study radio noise associated with sunspot activity. A radio telescope with a large polar-mounted parabolic antenna, as shown in the photo above right, was installed near the Tompkins County airport. The associated mechanical structure featured a massive turntable that allowed the telescope to follow the Sun's traverse across the sky automatically. **S. Michel (Mike) Colbert,** who later became a staff member of the Cornell Center for Radiophysics and Space Research, directed the operation of a control and data-collection center housed in an adjacent building. **Wilson Greatbatch** '50, **Lyman Howe** '49, and **Larry White** '50, undergraduates at the time, worked on the design of the low-noise amplifiers required for the project.

With the arrival of Dr. **Henry G. Booker** in 1948, the emphasis on radio astronomy underwent a decided change to reflect Henry's specialty in radar and his interest in wave phenomena in space. Early studies of radio-wave scattering through the ionosphere were conducted by interferometers installed at the airport to observe emissions from the radio source in the stellar constellation Cassiopeia. Three "gun-barrel" traveling-wave antennas and a "mattress-type" antenna, all oriented on the North Star, were used for this purpose. An early ionospheric research laboratory, established on the original site of radio station WHCU near the Fuertes Observatory, contained an ionosonde, a pulsed radar with an operating range of from 1 MHz to 20 MHz. Several graduate students, including **Walter A. Flood, Jr.,** '50 and **Rolf B. Dyce** '51, measured reflected signals from the ionosphere using a simple horizontal-wire antenna. A number of graduate students from other institutions as well as from Cornell, including **William E. Gordon, Lorne H. Doherty, Charles L. Seeger III** '46, and **Kenneth L. Bowles** '51, performed their thesis research with this instrument or with the solar telescope. Other graduate students who were early workers in various aspects of space physics, and who eventually became members of the EE School faculty, include **Nelson H. Bryant** '39, **Ralph Bolgiano, Jr.,** '44, **Ben Nichols** '46, **Joe Rosson** M.E.E. '51, and **Donald T. Farley, Jr.,** '55.

After Bill Gordon obtained his Ph.D. degree in 1953 and joined the EE faculty, he began the study of scatter phenomena in the upper atmosphere that led to his development of the radar telescope at Arecibo, Puerto Rico. In 1958, at a memorable EE faculty-student colloquium, Bill described the concept of a 1,000-foot-diameter hemispherical antenna with associated radar transmitter. Funding for the telescope was obtained soon thereafter from the U.S. Department of Defense Advanced Research Project Agency (ARPA), with management of the project conducted by the U.S. Air Force. By means of aerial-photography techniques, professor of civil engineering **Donald J. Belcher** provided valuable guidance in the selection of a suitable site, professors of civil engineering **George Winter** and **William McGuire,** M.C.E. '47, guided the structural design of the telescope, and overall design and construction were under the direction of Professor Bill Gordon, ably assisted by Dr. **Thomas E. Talpey** '47, chief project engineer **Merle LaLonde** '59, and project associate **George Peter.** The completed telescope was formally dedicated on November 1, 1963, designated as the Arecibo Ionospheric Observatory, and operated by Cornell. The original motivation was to use radar to probe deeper into the earth's ionosphere than ever before. Very early the observatory was recognized as a powerful tool for radio astronomy as well, and both aspects prospered throughout the 1960s. Cornell electrical engineer Dr. Ken Bowles designed a similar radar telescope at Jicamarca, Peru (see page 7), that was placed in operation in 1961 and has been administered by Cornell ever since.

George Peter recalls that after his return to Ithaca from Puerto Rico in the early '60s, he became director of laboratory operations of the new EE School ionospheric research laboratory on Fisher Settlement Road in South Danby. The solar telescope was transferred from the airport, installed on the roof of the laboratory building, and began service as a remote adjunct to Arecibo after demonstrating that signals bounced off the moon by the Arecibo radar could be detected by the 430 MHz receiver in Ithaca. The solar telescope also

> **"Ground was broken recently for a $2 million on-site Visitor Center to host the 40,000 annual guests, and to provide them with an effective glimpse into astronomy and atmospheric science."**

obtained data from observations of solar flares and sent them to Arecibo and the National Bureau of Standards in Boulder, Colorado. George says an account of the South Danby operation should include mention of a special eighty-five-foot segment of a spherical dish that was installed on a 20° slope near the lab and arranged to survey the same area of sky covered by Arecibo. In addition to serving as a remote accessory to Arecibo, this antenna was modified by **Franklin H. Briggs IV,** Ph.D. '74, Merle LaLonde, and professor Neil M. Brice to serve as a test bed for a projected upgrade of the 1,000-foot antenna at Arecibo. An approximate spherical surface had been achieved by placement of steel panels with the aid of a theodolite. After an inflatable rubber dome was erected to weatherproof the dish, one-inch-thick foam panels were glued to the steel surface and mechanically ground down close to true spherical dimensions by means of a mechanical guidance system controlled from an appropriate focal point. After a coating of very thin mylar-backed aluminum foil was glued to the foam, the final spherical surface was accurate to a few millimeters. Testing of the improved receiver antenna revealed increased frequency capability up to several gigahertz, and the sensitivity of radio-astronomy experiments was improved. The surface was damaged when the dome collapsed twice during storms, and the antenna was eventually retired from service.

The limited sensitivity and relatively low-frequency capability of the Arecibo facility during the early years of operation indicated a need to upgrade the telescope in order to bring the site to its full potential as a radar and radio telescope. At South Danby, an increase in the spherical accuracy of the antenna surface had demonstrated improved sensitivity and increased frequency capability. Similar improvement of the Arecibo antenna surface was considered to be feasible when the structure was found to be stable after the sixty-two-mile-an-hour winds of Hurricane Inez occurred in August 1966. The original reflecting antenna consisted of a wire mesh mechanically adjusted to approximate a spherical surface to an accuracy of one inch, thereby allowing a maximum operating frequency of 630 MHz without sensitivity degradation. With funding by the National Science Foundation (NSF), a new surface was created by replacing the wire mesh with 38,778 perforated aluminum panels attached to a network of steel cables. Each panel was optically adjusted to provide an overall spherical accuracy of plus-or-minus two millimeters, thus allowing an increase in operating frequency to four gigahertz, and an increase in radar sensitivity by a factor of 300. The upgrade was completed in November 1973. The facility was named the National Astronomy and Ionosphere Center (NAIC), and continues to be operated by Cornell under contract with NSF.

A second upgrade of NAIC, now in progress, will allow an increase in frequency up to ten gigahertz, increase the sensitivity of radio-astronomy experiments by a factor between 3 and 10, and increase the sensitivity of radar-astronomy experiments by a factor between 6 and 40, depending upon the zenith angle. The original feed lines installed overhead structure will be replaced by a Gregorian feed concept (a conventional horn and two reflecting surfaces) in order to minimize ohmic losses and antenna noise contributions inherent in the current feeds, and to operate at higher frequency levels than can be achieved at present. A sixty-foot-high screen, as shown below, has been erected around the perimeter of the antenna to lower receiver noise levels and to minimize antenna noise contributions from the ground. Coincident with the upgrade, NSF funded an initiative to revitalize Cornell involvement at Arecibo after a decade of modest participation. Professor **Michael C. Kelley** was named special advisor for atmospheric science at the observatory, and at present there are five EE graduate students doing their doctoral research at Arecibo.

From the outset, the Arecibo telescope and associated instrumentation has been highly productive in areas of atmospheric and ionospheric studies, in solar-system radar investigations, and in radio-astronomy research. The observatory has also had a major role in scientific education at all levels of instruction from high school to graduate research. As a multidisciplinary national research facility, it is uniquely suited to excite and inspire science-oriented students of all ages. Ground was broken recently for a $2 million on-site Visitor Center to host the 40,000 annual guests, and to provide them with an effective glimpse into astronomy and atmospheric science.

I am grateful for discussions with George Peter, who provided me with pertinent information about the early days of ionospheric studies at Cornell, and with Mike Kelley, who brought me up-to-date on recent events at Arecibo.

—Sam Linke
professor emeritus
electrical engineering

Upgrade in progress at the Arecibo Observatory in Puerto Rico. The original line feeds shown in the photo will soon be replaced by horn feeds.

Upper Atmospheric Dynamics Research

THE SPACE-PLASMA PHYSICS GROUP

The Space-Plasma Physics Group in the School of Electrical Engineering consists of four full professors, **Donald T. Farley** '56, **Michael C. Kelley, Paul M. Kintner,** and **Charles E. Seyler**; an assistant professor, **Niels F. Otani**; a senior research associate, **Wesley E. Swartz**; a senior engineer, **Steven P. Powell** '82; and affiliated graduate students. In addition, professor **Ravi Sudan** dabbles a bit in space research. Experimental data obtained from ground-based radars, sounding rockets, and orbiting satellite probes form the basis of the group's theoretical and analytical studies of ionospheric physics and space-plasma phenomena.

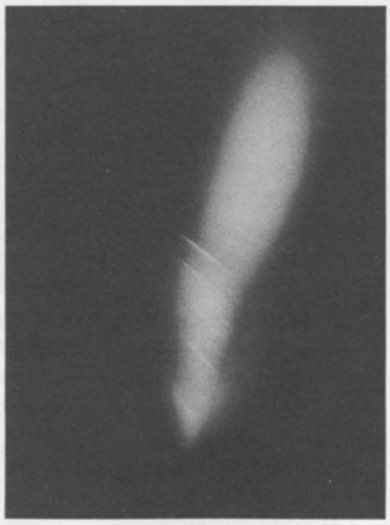
Space-plasma instabilities and scattering from density waves are detected through observations made by incoherent-scatter radars such as the ones at the Arecibo and Jicamarca observatories. Fluctuations in the refractive index of the atmosphere scatter a small but detectable portion of a transmitted radar pulse back to the ground. Proper analysis of the received signal allows determination of many of the parameters of the scattering medium, such as wind velocity, passage of atmospheric gravity waves, turbulent transport rates, electron density, electron and ion temperatures, the ambient electric field, and properties of unstable plasma waves. Similarly detailed information can be obtained by the so-called *in situ* measurements obtained from instruments inserted into a region of interest in the atmosphere, such as an aurora, by means of a launched sounding rocket.

Radar studies provide an ideal way to involve graduate students in space research because projects can usually be carried out from start to finish without undue experimental delays. Sounding-rocket investigations are intermittent and require careful planning, but provide opportunities for both faculty and graduate students to develop and test new instrument concepts, many of which are eventually introduced into undergraduate laboratory instruction.

The principal areas of the Space-Plasma Physics Group research are described in the following four articles.

Principal Investigator: Michael C. Kelly

In studies of the upper atmosphere and the near-space regions of the earth, the Cornell Space-Plasma Physics Group applies research techniques that include collection of space-borne probe data from orbiting satellites, detection of incoherent-scatter by ground-based radars, *in situ* sounding-rocket measurements using probes or artificial barium-ion cloud releases, and continuous monitoring of lower atmospheric winds and temperatures by ground-based lidars (lasers operating as "optical radars").



Barium release over the Gulf of Mexico. The rocket was launched from Eglin Air Force Base in North Florida in November 1977. Photo courtesy of W. Boquist and Michael C. Kelley. Reprinted with permission from Academic Press, Inc.

The Cornell-operated radar-lidar National Astronomy and Ionospheric Center at Arecibo, Puerto Rico, and the Jicamarca Radio Observatory near Lima, Peru, in cooperation with four other radar observatories at various sites around the world, measure wind and wave patterns and other space phenomena from three miles to several thousand miles above the surface of the earth. The combination of the radar-lidar studies with sounding-rocket techniques offers many opportunities for graduate-student involvement in space-plasma research. Six former graduate students who obtained their Ph.D. degrees under the direction of members of the Space-Plasma Physics Group have become professors of space physics at other institutions in the last decade.

Professor **Michael C. Kelley** is the special advisor for atmospheric science conducted at Arecibo, coordinates the use of satellites and rockets to carry Cornell instrumentation into the space environment, and is a pioneer in the use of electric double probes to study flow velocities of space plasmas. Mike received the Ph.D. degree in physics at the University of California at Berkeley in 1970. Following a period as a postdoctoral researcher at Berkeley, he was a Von Humboldt Fellow at the Max Planck Institute in West Germany until he joined the electrical engineering faculty at Cornell in 1975. He became a full professor in 1982. In 1979 he won the James B. Macelwane Award of the American Geophysical Union. Mike began an intensive study of the equatorial upper atmosphere in 1983 when he led a NASA rocket campaign called "Condor" that launched twenty-nine sounding rockets off the coast of Peru. He led similar projects in Greenland in 1985 and 1987, in the South Pacific in 1990, and in Puerto Rico in 1992. The Puerto Rican and Peruvian launches were conducted in close cooperation with the Arecibo and Jicamarca observatories. Mike has been a member of the National Academy of Sciences Committee on Solar and Space Plasmas; the NASA Management Working Group on Solar Space Plasmas of the Office of Space Science; and the NSF Advisory Committee on the Atmospheric Research Program. In 1981 he won the Tau

continued on page 23

The Jicamarca Radio Observatory

View of the Jicamarca Observatory near Lima, Peru.

Principal Investigator: Donald T. Farley

The "outdoor laboratory" used by the Space-Plasma Physics Group consists of the ionospheric, mesospheric, stratospheric, and tropospheric layers of the earth's atmosphere in descending order of altitude from over 3,000 miles down to sea level. One of the major radar facilities for observing these regions is the Jicamarca Radio Observatory (JRO) located in a dry desert valley in the foothills of the Andes mountains near Lima, Peru. This ISR (incoherent-scatter radar) and MST radar (named for the three lower atmospheric levels), and the Arecibo Observatory in Puerto Rico are the two largest radars in the world, with antennas of about the same area but of completely different design.

The Jicamarca Radio Observatory was built in 1960–61 by the Central Radio Propagation Laboratory of the National Bureau of Standards with the able cooperation and assistance of the Geophysical Institute of Peru (IGP). **Kenneth L. Bowles** '51, who had obtained his Ph.D. degree in the Cornell EE School's Radio Astronomy Program in 1955, designed the observatory and directed its construction. Following several years of management by what is now the National Oceanic and Atmospheric Administration, the facility was transferred to the IGP. From 1979 to the present time, most of the financial support for the observatory operations has been provided through a Cornell subcontract to the IGP. The subcontract is funded by the National Science Foundation (NSF) via a Cooperative Agreement between Cornell and the NSF.

Professor **Donald T. Farley** '56 is the Principal Investigator for the NSF Cooperative Agreement. After receiving the doctoral degree in EE from Cornell in 1960, Don spent a year at Cambridge University, a year at Chalmers University in Sweden, followed by a six-year period at JRO as physicist and then director of the observatory, before joining the Cornell faculty in 1967. In 1985 he returned to Sweden for a year as the Tage Erlander Visiting Professor at the Uppsala Ionospheric Observatory. At present he is on leave for a year at the Max Planck Institut für Aeronomie in Lindau-Harz, Germany, as an Alexander von Humboldt Foundation Senior Scientist. He is a fellow of the IEEE, and a member of the American Geophysical Union (AGU), the International Scientific Radio Union (URSI), and the American Association for the Advancement of Science (AAAS).

The 49.92 MHz radar at Jicamarca feeds a 1,000-foot-square horizontal antenna array, as shown the photo above right, consisting of 18,432 half-wave dipoles arranged into sixty-four separate modules of 12 x 12 crossed dipoles. Each antenna module can be phased and fed separately, or connected in a variety of modes to provide great flexibility. The radar transmitter is composed of four independent modules, each with a peak-power output of approximately 1.5 MW. These transmitter modules may be operated together or separately, and can achieve pulse durations from 0.8 microseconds to 2 milliseconds. Four phase-coherent receivers for the radars feed into data-taking Harris computers designed for real-time radar applications. The observatory has experienced helpful and competent collaboration with an MST radar at the University of Piura, and with other space-physics sites in Peru.

Jicamarca is considered to be the only true MST radar and the most sensitive one in the world because of its long (six meter) wavelength and the largest power-aperture product of any VHF radar. One reason for locating the observatory in Peru is that the earth's magnetic field is nearly horizontal there so that the almost-vertical JRO radar beam can be pointed perpendicular to the field. Consequently, the Doppler shift of signals scattered back from the ionosphere can be measured with extremely high accuracy. These shifts allow minute, naturally generated electric fields in the ionosphere to be determined to an accuracy of plus-or-minus twenty-five microvolts/meter, which is far better than can be done with other radars.

Because of its location and the radar geometry, Jicamarca is also the premier observatory in the world for studying unstable ionospheric plasma waves—waves generated by natural electric currents, much as the wind generates ocean waves—that occur primarily at equatorial and auroral latitudes and can seriously affect satellite and other radio communications.

Many of the investigations performed at Jicamarca by Professor Farley and his associates and graduate students are done in cooperation with other radars elsewhere, with orbiting space satellites, and with appropriate launches of sounding rockets. In order to facilitate some of these multi-experiment "campaigns," the Cornell Space-Plasma Physics Group has built a portable coherent-scatter radar system (including a collapsible antenna) that is housed in a Winnebago van. This unit, known as the Cornell University Portable Radar Interferometer (CUPRI), was designed by Dr. **Wesley E. Swartz,** senior research associate and lecturer in the EE School, and operates under his direction. Wes, who is also a co-Principal Investigator on the NSF Cooperative Agreement, received the Ph.D. degree in electrical engineering at Pennsylvania State University in 1972 and came to Cornell as a research associate that year. He is a senior member of the IEEE, a life member of the American Geophysical Union, and a member of URSI and AAAS.

The CUPRI staff and graduate students have participated in space-research activities around the world, including sites in Sweden, Puerto Rico, the Kennedy Space Center, Canada, Greenland, St. Croix, and most recently, from August through November 1994, in northeastern Brazil, with the NASA sounding-rocket Guará Campaign, named for a brilliantly colored red bird, the guará, that inhabits the area near the site of the Brazilian Alcantara launch facility.

Ionospheric Plasma-Wave Research

Principal Investigator: Paul M. Kintner

The Cornell Space-Plasma Group conducts experimental studies of the earth's ionosphere to investigate plasma-wave phenomena created by collisions of the solar wind with the earth's magnetic field lines. (The solar wind consists of highly ionized plasmas of protons and electrons that stream away from the Sun). The research approach is based on measurements of electric and magnetic fields within the ionosphere at appropriate auroral locations in both Northern and Southern Hemispheres. Heavily instrumented high-altitude balloons, sounding rockets, and orbiting satellites probe the regions of interest and transmit voluminous data to radio receivers in the test area.

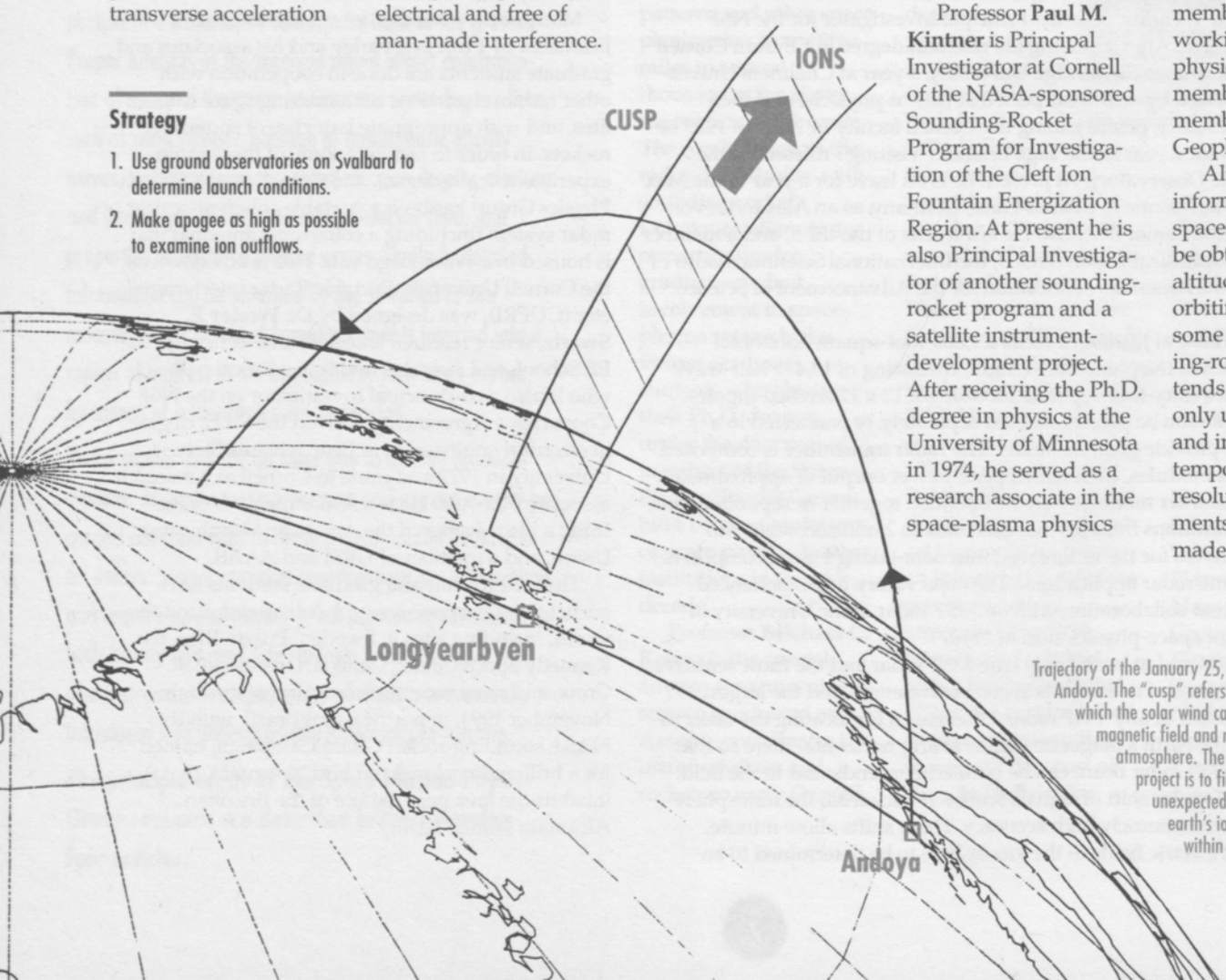
The fundamental scientific motivation for these activities is to study basic plasma physics in boundless space. The uncontrolled exchange of energy and momentum through fluctuating electric or magnetic fields in collisionless space plasma results in transverse acceleration of ions and the production of auroral ion and electron beams. The practical aspect of this research is to discover the impact of these phenomena on our atmospheric environment at altitudes of about 100 miles and beyond. At these levels the region is precisely electrical and free of man-made interference. It is therefore possible to determine how space plasma waves affect the propagation and amplification of electromagnetic signals, both man-made and natural (as from lightning). The impact on the Van Allen radiation belt can also be studied from a purely scientific viewpoint as well as to obtain information that is important in the design of radiation protection for space satellites. Another benefit derived from these experimental probes comes from the fact that the nearby plasmas are cosmic in nature and may be used as astrophysical "stand-ins" for conditions that exist in planetary and outer space. Thus it is possible, for example, to study certain phenomena in the atmosphere of planet Jupiter in our own backyard.

Professor **Paul M. Kintner** is Principal Investigator at Cornell of the NASA-sponsored Sounding-Rocket Program for Investigation of the Cleft Ion Fountain Energization Region. At present he is also Principal Investigator of another sounding-rocket program and a satellite instrument-development project. After receiving the Ph.D. degree in physics at the University of Minnesota in 1974, he served as a research associate in the space-plasma physics groups at the University of Iowa and at Cornell University before joining the electrical engineering faculty at Cornell in 1981. He became a full professor in 1991. Paul's research has centered on understanding the exchange of energy and momentum in collisionless, cosmical plasmas primarily through wave-particle interactions, interests that have led him to develop a variety of new techniques for the measurement of plasma waves. He has participated in many NASA review panels and is a member of two NASA working groups in space physics. Paul is a senior member of IEEE and a member of the American Geophysical Union.

Although useful information about space-plasma waves can be obtained from high-altitude balloons and orbiting satellites, in some cases the sounding-rocket technique tends to provide the only unequivocal data, and in other cases the temporal and spatial resolution of measurements far exceeds those made from spacecraft,

Strategy

1. Use ground observatories on Svalbard to determine launch conditions.
2. Make apogee as high as possible to examine ion outflows.



Trajectory of the January 25, 1995, rocket launch from Andoya. The "cusp" refers to an aperture or slot into which the solar wind can penetrate the earth's magnetic field and reach the top of the earth's atmosphere. The goal of this research project is to find an explanation for the unexpected outward movement of the earth's ionized atmosphere (ions) within the cusp.

principally because of the difficulty of obtaining good information from fast-moving satellites. Every sounding- rocket experiment, however, requires an operational strategy that involves a series of compromises. The key to a successful strategy is a launch of the payload at the right moment to intersect the desired phenomena, which, in turn, involves the selection of a trajectory and a scheme for detecting the desired phenomena.

For the past several years, Paul's group has conducted plasma-wave experiments on sounding rockets launched from sites in Alaska, Canada, Antarctica, and Greenland. The most recent launch occurred on January 25, 1995, at Andoya, an island off the coast of northern Norway, at 7:24 a.m. Norway time. The successful launch, as depicted in the sketch on page 8, was the culmination of a three-year cooperative program involving Cornell University, University of New Hampshire, University of Alaska, University of Oslo, and the Marshall Space Flight Center in Huntsville, Alabama. At the time of the launching, Paul, as Principal Investigator of the NASA-sponsored project, was located under the expected rocket apogee at Longyearbyen, on the island of Svalbard. At that position he could select the correct moment for the launch and give the go-ahead order to Andoya by radio telephone. Cornell senior engineer **Steven P. Powell** '82 and EE graduate student **John W. Bonnell** were present at the launch site. The six-ton, seventy-foot-long, four-stage Black Brant XXII rocket launched a 200-pound payload that traveled about 1000 miles, reached a height of 900 miles, and fell into the sea about 100 miles short of the North Pole.

A Cornell scientific experiment does not usually attract worldwide attention, but the Andoya launch was a notable exception. Although the Norwegian government had informed the Russian government of the intended rocket launching, the Russian news agency, Interfax, issued an urgent report that their military forces had shot down a combat missile launched from northern Norway. The report created immediate worldwide concern among NATO nations, but the "crisis" was soon resolved when the Russian military officials denied that a shootdown had occurred, and the news agencies reported that the "missile" was a research vehicle designed to study the Northern Lights.

Analysis of Space-Plasma Data

Principal Investigator: Donald T. Farley

Investigations of plasma-wave phenomena in the earth's upper atmosphere by the Cornell Space-Plasma Physics Group result in voluminous amounts of data obtained from radar observatories, sounding rockets, and orbiting satellites. Organization and analytical examination of these data may provide a desired result for a specific experiment, explain or corroborate observations from previous experiments, confirm or refute a given theory about certain phenomena, or reveal completely new and hitherto unexpected information that either can be readily interpreted from known principles or cannot be explained in terms of standard theory. Everyone in the group participates in these analytical studies, but certain members have specific responsibility for the formulation of pertinent theory and the development of computer simulations.

Studies in space-plasma physics are concerned with the coupling of the earth's ionosphere and magnetosphere through electrodynamic processes involving waves that propagate between these regions. The primary goal of this research is to understand certain aspects of the phenomenon known as the aurora. There is particular interest in the electron acceleration process that produces the Northern Lights, and in the dynamical motion of the magnetospheric and ionospheric plasma that is responsible for the complex space and time structures in auroral displays.

Interpretation of space-plasma phenomena at Cornell is based on a three-pronged approach involving experiment, theory, and simulation. Data obtained from an experiment or a "campaign" are applied to the development of a mathematical theory for derivation of an approximate model of the observed phenomena. The basis for the structure of the model may vary from the well-understood behavior of a single particle in a magnetic field to the complex behavior of a complete three-dimensional representation.

The analysis is focused on some aspect of the data that is not well understood, reasonable assumptions are adopted to ensure the production of a relatively simple model, and a computer simulation of the applicable differential equations is performed, interpreted, and compared with the experiment. This approach has resulted in considerable success in matching computer output data with actual data obtained from experiments, thereby providing an understanding of the observed physical phenomena.

The recent sounding-rocket launch from Andoya, Norway, provides another opportunity for the theorists in the Space-Plasma Physics Group to interpret phenomena that cannot be understood through the application of known theory. The caption to the sketch on page 8 refers to the unexpected outward movement of the ions within the cusp. Analysis of the accumulated data from the launch offers a challenge to the theorists to use their techniques and resultant computer simulations to produce a rational explanation for this mysterious ion behavior.

Professor **Charles E. Seyler, Jr.,** provides the Space-Plasma Physics Group with much of the expertise required in the application of physical theory to experimental data for the development of simulations of the observed phenomena. Charles received the Ph.D. degree in physics and astronomy from the University of Iowa in 1975. Following two years at the Courant Institute of Mathematical Sciences of New York University, he transferred to Los Alamos National Laboratory, where he worked as a research scientist in the controlled-fusion group. He joined the electrical engineering faculty at

continued on page 23

• Professor **Joseph M. Ballantyne** (optoelectronic devices and materials), director of the Semiconductor Research Corporation (SRC) interdisciplinary Program on Microscience and Technology at Cornell, and his group have made major advances in the understanding and fabrication of monolithic semiconductor ring lasers. Excellent low-threshold, high-output power, spectral purity, and high beam quality have been achieved for this class of devices. Weekly experimental demonstrations of key concepts in course EE 210 were established with the valuable assistance of professor emeritus **Nelson Bryant.**

• Professor **Toby Berger** (information theory and communications) and his students have developed a video-compression facility that has produced improved algorithms for compressing, transmitting, and displaying very low bit rates for desktop video and videophone applications. His joint paper with professor Zhen Zhang of USC, entitled "Multiple Description Source Coding with Excess Rate," was honored with long-paper status at the 1994 IEEE International Symposium on Information Theory, held in Trondheim, Norway, in June 1994.

EE SCHOOL RESEARCH FUNDING SUMMARY

Total research funds expended in 1991–92
$14,087,788

Total research funds expended in 1992–93
$12,077,185

Percent decrease
14.27%

Total research funds for 1993–94 (as of June 30, 1994)
$11,202,647

• **Adam W. Bojanczyk** (computer engineering, parallel architecture, and algorithms for signal and image processing) was promoted to associate professor on November 1, 1994. In the past year he developed a parallel code for Space-Time Adaptive Processing that runs on commercial message-passing computers. Adam is on sabbatical leave for this academic year with projected visits to Stanford, Berkeley, University of Illinois, Argonne Laboratory, and the Australian National University.

• Associate professor **Geoffrey M. Brown** (concurrent systems, communications protocols, and hardware synthesis) has developed a working prototype of a high-speed network for embedded sensors, including development of a custom network interface chip. Geoffrey was selected as a visiting scholar at Wolfson College, Oxford University Computing Laboratory, and spent a sabbatical leave there in the 1993 fall term with the objective of fostering collaborative research in provably correct hardware compilation.

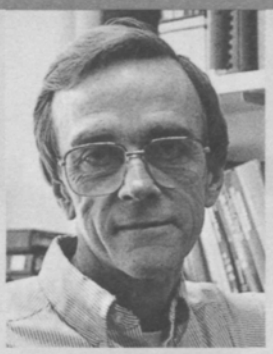
• Associate professor **Hsiao-Dong Chiang** (analysis and control of nonlinear systems with applications to electric-power networks) is working on development of theory and application for a network-preserving binary-counting-unit method for direct power-system-transient-stability analysis. During a sabbatical leave in the 1993 fall term he directed the work of his research group and lectured at several institutions in China, at Berkeley, and in Ithaca.

• **Richard C. Compton** (millimeter and microwave integrated circuits) was promoted to associate professor on November 1, 1994. During the past year in the Millimeter and Microwave Laboratory at Cornell, he performed research on a series of 60 GHz oscillators and a millimeter-wave transmitter that have commercial application in radar and broadband wireless communications. He received the 1993–94 Ruth and Joel Spira Excellence in Teaching Award for his development of course Eng. 114, Introduction to Engineering Design. On sabbatical leave during this academic year, Rick is working on a collaboration project with industry on microwave quasi-optics, and writing a textbook on the subject.

• Associate professor **David F. Delchamps** (control and system theory) has continued his study of the dynamical properties of commonly used oversampling analog-to-digital converters. His ultimate goals are to understand the statistical properties of their error sequences, and the stability of higher-order architectures. David was elected as the 1994 Best Professor by the Cornell student branch of IEEE.

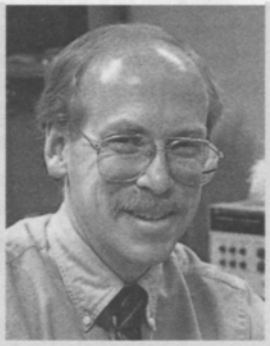
• **Lester F. Eastman** (compound semiconductor materials, devices, and circuits), the John LaPorte Given Professor of Engineering, has entered into phased retirement with teaching duties in the fall term and research in the spring. His recent research is concerned with integrated gallium arsenide metal-semiconductor-metal photodetectors for detection of light that is modulated at high frequencies by short-gate heterojunction field-effect transistors. In June 1994, Lester received the Humboldt Research Award "in recognition of his past achievements in research."

• Professor **Donald T. Farley** (radio-wave and upper-atmospheric physics), a member of the Cornell Space-Plasma Physics Group, is on sabbatical leave for the full 1995 calendar year at the Max Planck Institute for Aeronomy in Lindau-Harz, Germany, as an Alexander von Humboldt Senior



DONALD T. FARLEY

MICHAEL C. KELLEY



PAUL M. KINTNER

CHARLES E. SEYLER, JR.

Scientist. During the past year, in collaboration with former graduate student **John Sahr** (now an assistant professor at the University of Wisconsin), Don published some new ideas concerning auroral-zone ionospheric plasma instabilities.

• Professor **Terrence L. Fine** (information theory, inference and decision making in the presence of uncertainty) has continued his research on the problem of assessing the trade-off between the complexity of a neural network, as measured by the number of connections, the amount of training data, and the ability of a trained network to generalize to new input data. In the past year, Terry has developed a new theory of the relationship between these three parameters that he hopes will make an important contribution to the practice and understanding of the use of neural networks.

• Associate professor **Chris Heegard** (communication, information, and coding theory) has been named a fellow of the IEEE "for development and analysis of families of efficient codes." He served as president of the IEEE Information Theory Society during the 1994 calendar year. Chris has continued his research on the Digital Audio Research Environment (DARE) project and has applied the results to his successful spring-term course EE 320, The Audio Engineering Laboratory.

• Professor **C. Richard Johnson, Jr.** (adaptive control and signal processing), developed 1) the first global stability proof of a finite-length, fractionally spaced blind equalizer, and 2) a new adaptive calibration algorithm for a synchronized chaos scheme for secure communication. As the plenary/survey speaker at the 10th International Federation for Automatic Control (IFAC) Symposium on Identification and System Parameter Estimation, in Copenhagen, Denmark, in July 1994, Rick presented a paper on "Interplay Between Recursive System Identification and Adaptive Filtering in Communication Systems."

• Professor **Michael C. Kelley** (upper-atmospheric and ionospheric physics), a member of the Cornell Space-Plasma Physics Group, volunteered to teach calculus to those freshmen who did not have the subject in high school. The group participated in Mike's Academic Excellence Workshops in Math 191, and every one of them moved on to Math 192. Mike was the recipient of the 1994 Dean's Prize for Excellence and Innovation in Teaching and Advising.

• Professor **Paul M. Kintner** (atmospheric plasma physics), a member of the Cornell Space-Plasma Physics Group, is on sabbatical leave for the 1995 calendar year. Paul was the principal investigator for a sounding-rocket program that culminated in a successful launch from Andoya, Norway, in January of this year. He will be coordinating other proposed launches in Norway and Alaska, and plans to update and broaden the material and teaching techniques in course EE 486, Space Science and Engineering. Paul was selected to chair the Science Review Team for the Student Demonstration Explorer Initiative funded through the University Space Research Association by NASA.

• Associate professor **Ronald M. Kline** (history of technology and electrical engineering) made progress on a projected book on the social history of the telephone, automobile, radio, and electric light and power in the United States. During his sabbatical for the 1994–95 academic year, Ron plans to continue work on his book under a grant from the National Science Foundation (NSF).

• Professor **J. Peter Krusius** (solid-state electronics, semiconductor devices and systems, and electronic packaging) completed development of a packaging architecture simulator, AUDiT, version 4.4, that simulates the physical characteristics of digital electronic systems from integrated circuits to full systems. On his sabbatical leave during the spring 1995 term, Peter is teaching a special course at the Royal Institute of Technology (KTH) in Stockholm, Sweden, and conducting collaborative research at KTH with circuit and system designers on system integration and system packaging for digital computing and telecommunication applications.

• Assistant professor **Miriam E. Leeser** (VLSI design and computer engineering) continues her research as the recipient of the 1992 NSF National Young Investigator Award. In the past year, Miriam designed, implemented, and began to verify a nonrestoring subtractive square-root divider.

• Professor **Richard L. Liboff** (physics of microsemiconductor devices and solid-state plasmas) has proposed a new notion of "heavy boson superconductivity." In this suggested process, magnetically driven deuterons in a single-crystal loop of

continued on page 14

A SAMPLING OF COURSE OFFERINGS

JUNIOR LABORATORY (SUPERLAB)

Equipment: 16 workstations with Hewlett-Packard PCs, digital oscilloscopes, and function generators.

FALL 1994

EE 315 Electrical Engineering Laboratory I.

Enrollment: 78 (fall 1994)

Lecturer, fall 1994: Professor Paul M. Kintner (atmospheric plasma physics)

EE 315 (revised for fall 1995) Computer Circuit Design.

Lecturer, fall 1995: Professor J. Peter Krusius (solid-state electronics, semiconductor devices and systems, and electronic packaging).

This required course for electrical engineering juniors provides laboratory experience in design of electronic circuits for applications such as computers, signal processing, communication, microelectronics, optoelectronics, measurements/sensing, power electronics and control. The laboratory environment includes the following computer-aided functions: design; instrumentation; data acquisition and analysis; simulation, verification, and testing; reporting and presentation. The following new equipment has been acquired for each workstation of this laboratory through the generosity of corporate donors:

- Intel Corporation has donated 20 new personal computers with Pentium microprocessors.
- Tektronix has provided a generous grant to help purchase 18 new digital oscilloscopes and digital voltmeters that may be interfaced with the Intel PCs, 18 accompanying power supplies and function generators, and four curve tracers.

SPRING 1995

Engr 114 Introduction to Engineering Design.

Enrollment: 37

Lecturers: Professors Charles E. Seyler and Michael C. Kelley (space-plasma physics and ionospheric physics, respectively)

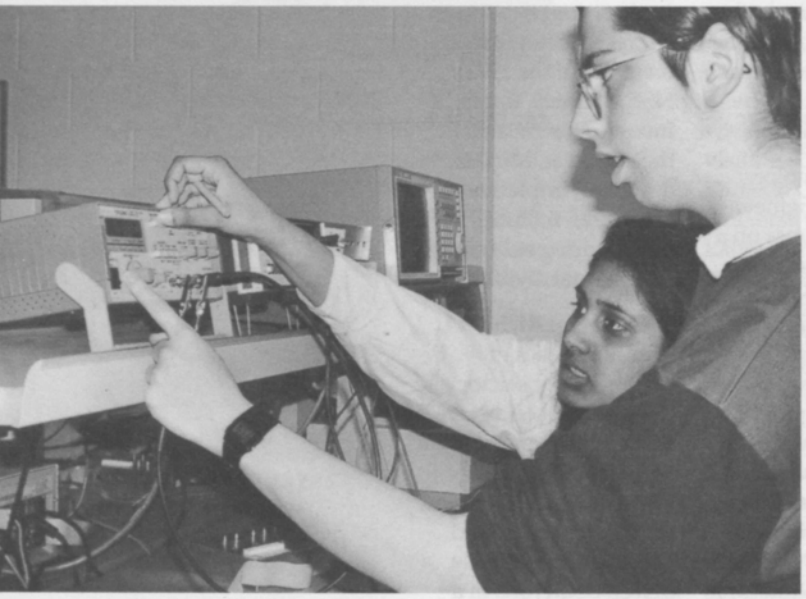
This freshman-level course, geared to students with an interest in electrical engineering, introduces the physics of electricity, circuit-analysis concepts, and elements of design. Students work together in small groups on a series of linked design projects that require a hands-on approach to the physical achievement of a hybrid fiber-optic transmitter/receiver system.

EE 215 Electrical Systems Laboratory I.

Enrollment: 125 (laboratory sections meet in alternate weeks)

Lecturer: Associate Professor J. Richard Shealy (development of compound semiconductors)

This new required course introduces an electrical-systems laboratory into the EE curriculum at the sophomore level. The syllabus includes basic electrical and electronic instrumentation, measurements, and design of simple transistor amplifiers involving circuits with both active and passive elements. The personal computer is introduced as a laboratory aid. Proper laboratory-notebook and technical-writing procedures are stressed. This course is designed as a companion to sophomore theory course EE 210, Introduction to Electrical Systems.



A measurements experiment in EE 215.

DIGITAL-CIRCUITS LABORATORY

Equipment: 20 workstations with Intel 486 (66 MHz) PCs and associated Altera software.

FALL 1994, SPRING 1995

ENGRD 230/EE 230 Introduction to Digital Systems.

Enrollment: 136

Lecturers: [fall] Professor Christopher Pottle (computer engineering, parallel processors,VLSI technology) [spring] Associate Professor Geoffrey Brown (concurrent systems, communications protocols, hardware systems).

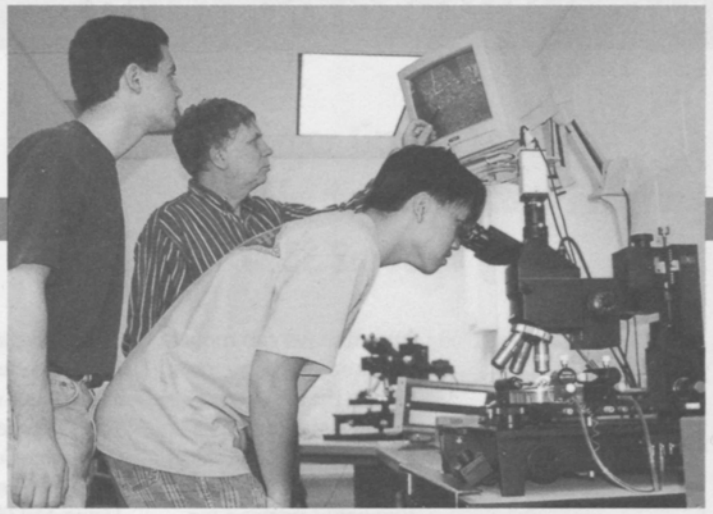
This engineering distribution course, open to all interested engineering sophomores and required for all EE-bound students, offers an introduction to design techniques and methodologies of digital and computer systems including computer structure,

An experiment in EE 476: interfacing into th
Intel 80C196KB microcontroller.

**Details of the new undergraduat
of Engineering (Electrical) teachin
the EE School were outlined in t
Connections. In this issue we
scriptions of some of the cour
in the fall and spring terms
The new facility has be
stringent requirements
design of the laborato
instrumentation, and
computer equipmen
conditioned rooms
the EE undergrad**

the

Use of the "prober" equipment in EE 554 to measure voltages and currents inside a microchip.



combinational circuits, integrated circuits, and processor design. The former Logic-Works software has been replaced with new Altera software and programmable logic devices that make it possible for students to design logic circuits and obtain output devices in the form of real chips that are tested in real circuits.

FALL 1994

EE 475 Computer Structures.

Enrollment: 78

Lecturer: Associate Professor Geoffrey Brown (concurrent systems, communications protocols, hardware systems)

This upper-level elective course presents methods of designing digital computers and the hardware-software interface to the systems with which they function. Topics include types of control sequencers, memory and I/O organization and interfacing, interrupt-hardware design, floating-point hardware, and basic architectural alternatives. Laboratory groups design and build a small digital computer. User-programmable logic devices are employed for circuit implementation.

SPRING 1995

EE 476 Digital-Systems Design Using Microcontrollers.

Enrollment: 55

Lecturer: Professor Emeritus Norman Vrana (digital systems, central processor design, microprocessor systems)

This upper-level elective course is concerned with the design of real-time digital systems using microprocessor-based embedded controllers. Students working in pairs design, debug, and construct several small systems that illustrate and employ the techniques of digital-system design acquired in previous courses. The laboratory environment is that of EE 475 enhanced with the addition of a single-board computer based on the 80C196KB microcontroller chip. This course prepares students who may wish to return to this laboratory to undertake M.Eng. projects in digital-system design.

- Intel Corporation has recently enhanced the effectiveness of this course by a donation of two fuzzy-logic 80C196KD-based development systems.

ate and Master
ing laboratory in
the 1994 issue of
e present brief de-
rses that were taught
s of this academic year.
een found to meet the
s set forth in the original
ry in utility, overlapping of
d ease of scheduling. The new
ent, modern benches, and air-
s have improved the quality of
aduate laboratory environment.

SOLID-STATE ELECTRONICS LABORATORY

Equipment: 4 workstations with Hewlett-Packard simulation and data-logging apparatus, and four probe stations with Hewlett-Packard instruments.

SPRING 1995

EE 497 Radio and Radar Engineering.

Enrollment: 22

Lecturer: Adjunct Professor Jon Hagen (director, laboratory operations, NAIC Ithaca)

This upper-level elective course treats the theory and the real-world practical aspects of radio-frequency circuitry for radio, television, radar, and wireless-data communication. The course emphasizes design tradeoffs, engineering problems, and behavior of various devices in practice. Topics include: receivers, transmitters, modulators, filters, detectors, transmission lines, television standards, microwave-circuit elements, radio/radar astronomy, and related subjects.

EE 554 Advanced VLSI Circuit Design.

Enrollment: 40

Lecturer: Assistant Professor Yosef Y. Shacham (VLSI technology, nanoelectronics, process integration)

This upper-level elective course is concerned with recent innovations in VLSI circuits as related to the integration of building blocks on chips, including feedback circuits, operational amplifiers, digital-to-analog and analog-to-digital converters, switched-capacitor circuits, dynamic and static memories, and programmable logic and gate arrays. Systems on chips, such as microprocessors and wafer-scale integration, are analyzed and designed.

FLEXIBLE LABORATORY

Equipment: 12 Macintosh workstations to accommodate a variety of experiments.

SPRING 1995

EE 320 The Audio Engineering Laboratory.

Enrollment: 82 (twice weekly)

Lecturer: Associate Professor Chris Heegard (communication, information, and coding theory)

This junior elective course provides an introduction to audio signal processing through hands-on laboratory experience in applying signals and systems concepts. Students are paired into teams; each team designs, constructs, and tests simple analog and digital audio circuits and programs that help build intuition in signal processing for audio, general communication, and control systems.

Faculty—continued from page 11

palladium fall to a superconducting state at sufficiently low temperature. Richard's text, *Introductory Quantum Mechanics*, now in the sixth printing of the second edition, was recently translated into Korean. In all, it has been adopted at universities in eleven countries outside the United States.

• Assistant professor **Yu-Hwa Lo** (optoelectronic materials and devices, and integrated optoelectronic circuits) has demonstrated long-wavelength vertical-cavity surface-emitting lasers with strain-compensated multi-quantum-well structures. His group is the first in the world to demonstrate such devices. These lasers have important applications in optical communications.

• Professor **Noel C. MacDonald** (micro-electromechanical and nanoelectromechanical systems) is directing his research group on nanoelectromechanical systems during his sabbatical leave in the 1994–95 academic year. In March of this year, Noel and his doctoral students announced the development of the world's smallest scanning tunneling microscope (STM). A 200-micron-sized motor (about the diameter of a human hair) can move a one-micron-diameter silicon tip in six directions. A similar microelectromechanical (MEM) STM with many tips could be used for etching a pattern in a chip surface. An array of MEM STMs with thousands of tips could possibly be able to pattern circuits on chips at production speeds.

• Professor **Paul R. McIsaac** (microwave theory and techniques), coordinator of graduate studies in the School of Electrical Engineering, developed a general theory for the current excitation of reciprocal bi-directional waveguides. This method uses the waveguide modes as the basis of functions to represent the excited magnetic fields, and is applicable to uniform and periodic waveguides.

• Professor **John A. Nation** (electromagnetic fields and waves) continues to focus his research on ultra-high-power microwave traveling-wave-tube amplifiers. Earlier fledgling application of ferroelectrics as cathodes has grown into their extensive use as electron-beam sources in X-band amplifiers at current densities of up to about 100 amperes/cm^2. Life studies of the cathodes are also being pursued.

• Professor **Thomas W. Parks** (signal theory and digital-signal processing), together with five co-authors, completed work on the textbook *Computer-Based Exercises for Signal Processing Using MATLAB*. The book was published by Prentice-Hall in April 1994.

• Associate professor **Alfred Phillips, Jr.** (quantum mechanical devices, optical switches, and process modeling), presented the optical-switch project work of his 1993–94 Master of Engineering (Electrical) students at the International Semiconductor Device Research Symposium, and their work on diffusion modeling before the American Physical Society. In the past year, Al taught course EE 457, Silicon Semiconductor Devices, and course EE 558, Compound Semiconductor Devices.

• Professor **Clifford R. Pollock** (lasers and optoelectronics), associate director of the School of Electrical Engineering and the Ilda and Charles Lee Professor of Engineering, has completed his textbook *Fundamentals of Optoelectronics*. The hardcover edition was published in November 1994. The book was developed around his course EE 530, Integrated and Fiber Optics. His research on mode-locking solid-state lasers has been well received.

• Professor **Christopher Pottle** (computer engineering, parallel processors, VLSI technology), with the help of gifts from Intel Corporation, has developed the infrastructure for constructing stand-alone applications of Intel 80C 196 microcontrollers. Chris is the resident academic director of the Cornell Abroad Program in Hamburg, Germany during the 1995 spring term. He will be teaching course EE 210, Introduction to Electrical Systems, to eighteen Cornell sophomores who are in residence there.

• Associate professor **Anthony P. Reeves** (parallel computer systems, computer-vision algorithms) has developed new techniques for the interactive visualization of image sequences. For example, spatiotemporal patterns in the activity of calcium ions in a living biological cell during the process of cell division have been detected through analysis of multiframe microscope imagery.

• Professor **Charles E. Seyler, Jr.** (space-plasma physics, physics of relativistic electron beams), has joined the Cornell Space-Plasma Physics Group to conduct research on the application of new developments in the theory of chaotic dynamical systems to the analysis of experimental data from radar measurements of ionospheric phenomena, and to use the information to formulate dynamical models of the physical processes. Charles and professor **Mike Kelley** are collaborating on the development of a new freshman course, Engr 114, Introduction to Engineering Design.

• Assistant professor **Yosef Y. Shacham** (VLSI technology, nanoelectronics, and process integration) has developed a Si/SiGe quantum-well MOS transistor with an effective gate length of 0.18 micrometers. Yosi is also developing an alkaline-free copper deposition process with a thin-film resistivity of 1.7 micro-ohm centimeters.

• Associate professor **James R. Shealy** (development of compound semiconductors) has been concerned with studies of heterostructure formations involving arsenide/phosphide transitions. His group has been successful in growing structures that heretofore have been cited in the literature as being impossible to synthesize. During his recent sabbatical leave, Dick started interactions on materials growth with the University of California

at Santa Barbara, Hewlett-Packard, Rockwell, Motorola, and Raytheon Corporations, and Hughes Research Laboratories.

• **Ravindra N. Sudan** (plasma physics), the IBM Professor of Engineering, has developed a new theory for resistive magnetohydrodynamics that allows magnetic reconnection without joule losses, and a numerical simulation for the physics of ion-ring formation. The latter work examines the problems associated with building a "compact" fusion reactor. Ravi was awarded the Gold Honorary Medal for Merits in the Field of Physical Sciences by the Academy of Sciences, Czech Republic, in May 1994. During the spring term of his sabbatical leave in the 1995 calendar year, he is coordinating a program on intermittency and turbulence in plasmas at the University of California, Santa Barbara. Following research during the summer session at Cornell, he will collaborate on ultra-intense laser research at the Naval Research Laboratory in Washington, D.C.

• **Chung L. Tang** (lasers, optoelectric devices, nonlinear and coherent optical processes), the Spencer T. Olin Professor of Engineering, has achieved femtosecond optical parametric oscillation in the new nonlinear optical crystal $RbTiOPO_4$ for the first time. The tuning range of femtosecond operation is extended to 3.65 microns. With this new crystal, further extension of the femtosecond tuning range to the very important three-to-five-micron range should be possible in the near future.

• Professor **Robert J. Thomas** (control techniques for large-scale networks, analysis of microelctromechanical systems) continued his research on the Cornell Hybrid Electric Vehicle (HEV) project, and as director of the Engineering Multimedia Research Laboratory he introduced the EE School to the World Wide Web network. During his sabbatical leave in the 1995 calendar year he is working on further development of the HEV, and updating the Energy Research Center proposal to NSF.

• **James S. Thorp** (estimation and control of discrete linear systems as applied to control of electric-power networks), the Charles N. Mellowes Professor of Engineering and director of the School of Electrical Engineering, has developed a technique for synchronizing chaotic systems under a wide range of parametric mismatch. The application is to the area of secure communications using chaotic signals. Previous work in the area assumed unrealistic matches between transmitter and receivers. Jim is also continuing work on the application of real-time phasor measurements to the control of power systems.

• Professor **Hwa C. Torng** (computer architecture applied to design of intelligent communications networks) has initiated research on a new form of caching for superscalars and optical switching, and completed a volume on *Instruction-Level Parallel Processors*, which was published by the IEEE Computer Society Press in November 1994.

• Professor **George J. Wolga** (quantum and solid-state electronics) has been developing a new undergraduate teaching laboratory course based on the CD player. He supervised two senior theses that resulted in two successful laboratory experiments using this technique. George is on sabbatical leave throughout the 1995 calendar year in Ithaca, where he is continuing his research on laser-monitoring of combustion products, under a five-year grant from the U.S. Army's University Research Initiative (URI).

Major Grants Establish Telecommunications Program in EE School

Two corporate foundations have announced major grants to the College of Engineering that will bear directly on the development of a telecommunications and information-technology program in the School of Electrical Engineering. A five-year $1million grant from the GTE Foundation will provide interdisciplinary funding for research and equipment needed by seven new faculty members, five in the EE School and two in the Department of Computer Science. A companion three-year $350,000 grant from the AT&T Foundation will be applied directly to the EE School to aid in the development of this program. In accepting the GTE grant, dean of engineering John Hopcroft said, "We envision a program that will be among the best in the nation, that will make Cornell the institution of choice for students and faculty with interests in the next generation of teleconferencing, information technologies, distance learning, and related applications."

Details of other corporate gifts to the EE School for computing facilities and laboratory equipment are described on pages 12 and 13. In addition, approximately $515,000 has been received by the school in the past academic year in support of faculty research and special projects. Major cash gifts have been received from Applied Signal Technology, AT&T Foundation, Eastman Kodak, Corporation, Hewlett-Packard Corporation, Martin Marietta, Motorola Foundation, PTL Technology, Reliaspeed, Rockwell International, Sematech, and Schlumberger. These commendable grants from corporations and foundations, coupled with equally generous 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.

• Professor emeritus **Nelson Howard Bryant** died at age 77 on December 22, 1994, in Ithaca, New York, after a chronic illness. He obtained the E.E. degree from Cornell in June, 1939, and joined the Westinghouse Lamp Division in Bloomfield, New Jersey, where he developed systems that led to patents on methods of carbonizing thoriated tungsten filaments, and devised ferro-resonant circuits for starting fluorescent lamps. In 1944 he became a U.S. Naval Reserve Electronics Officer, attended radar schools at Bowdoin College and Massachusetts Institute of Technology, and supervised the installation and repair of radar and loran equipment at the Brooklyn Navy Yard and other bases until September 1946, when he returned to Cornell as a graduate student and instructor in the School of Electrical Engineering. He received the M.E.E. degree in June 1949, was appointed an assistant professor in July of that year, became an associate professor in 1953, and attained full professorial rank in 1973. He retired as professor emeritus in 1985, but continued as a part-time instructor designing laboratory experiments and demonstrations for use in the teaching laboratories until the spring term of 1994. During his overall forty-eight-year academic career, Nelson mastered many of the complex electrical engineering technologies that evolved over the years, and formed them into a vital part of his classroom activities.

Consistent with his early interest in the design of electronic circuits and systems, an interest that he maintained throughout his professional career, Nelson's graduate research was concerned with the design, development, construction, and testing of a novel controlled-mercury-arc-rectifier tube that had potential for use as a high-power amplifier. Since the operating principle was based on the characteristics of the mercury-vapor plasma within the tube, Nelson was a very early investigator at Cornell in the field of plasma studies that is now an important area of research in the EE School. As a graduate student, and for several years after his appointment as an assistant professor, Nelson taught in the electrical engineering "service courses," also known as "Electrical Engineering for Non-Electrical Engineers," where he was responsible for the electronic segments of those courses. This work resulted in a collaboration with professor **William H. Erickson** and the publication in 1952 of the first edition of their popular text, *Electrical Engineering, Theory and Practice*. A second edition was published in 1959, followed by a paperback edition in 1975.

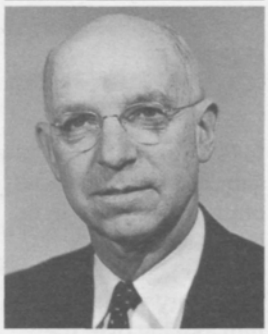
During his academic career, Nelson initiated and taught many courses and directed graduate study in electronic-circuit design, digital-electronic circuits, and control systems. In the early '70s, students in the EE School were expressing great concern about the absence of electronic-design courses in the EE curriculum. Nelson corrected this deficiency by developing two new lecture/laboratory courses in electronic-circuit design that became known for their scholarly rigor and relevance to engineering practice. These two courses were among the most popular in the EE curriculum for many years, formed the basis for the eventual complete overhaul of the EE undergraduate laboratories, and represent one of Nelson's major contributions to the school. In addition to his concern with undergraduate education in the classroom, he was a perennial undergraduate class adviser and a member of the Division of Basic Studies Academic Standards Committee. He was elected to serve three separate terms on the respected EE Faculty Committee, and also served on many university committees. Nelson was a mainstay in the Master of Engineering Program, directed a multitude of M.Eng.(Elec.) design projects, and served on the Master of Engineering Committee in the College of Engineering, where he was a key contributor to the development of the program and its required M.Eng. design project. As a favorite professor among his students, he was runner-up in the 1973 Tau Beta Pi Engineering Honor Society "Excellence In Teaching Award," was one of the top ten contenders for the same award in 1976, and received the IEEE School of Electrical Engineering "Excellence in Teaching Award" in 1978 and also in 1982.

Nelson took his first sabbatical leave in 1955–56 at Stanford University, where he studied radio-wave scattering phenomena from a turbulent atmosphere. Upon his return to the campus, he became interested in the design and development of electronic instrumentation for the measurement of biological phenomena, thereby becoming one of the first Cornell faculty members to work in the field of bioengineering. In 1962–63 Nelson took another sabbatical at the University of Pennsylvania Johnson Foundation for Medical Research. Through 1967 he continued to work in bioengineering and directed a number of master's theses and senior projects with special emphasis on blood-chemistry instrumentation applied to automated differentiation of white-corpuscle types and the control of oxygen content in the blood. In later years, as a consultant to Powers Manufacturing Company in Elmira, New York, his knowledge of solid-state microprocessors and electronic-control methods enabled him to transform previously limited purely mechanical techniques into a modern system for automatic quality control in the manufacture of bottles. The variety of problems he encountered in this work significantly influenced the design of the laboratory classwork for his students in the EE School.

Nelson was a member of the American Institute of Electrical Engineers and served as chairman of the Ithaca Section in 1956–57. When that organization became the Institute of Electrical and Electronic Engineers (IEEE), he continued his membership and was named a life member of IEEE in 1983. He was elected to the engineering honor societies Tau Beta Pi and Eta Kappa Nu, and was a member of the American Association for the Advancement of Science and the American Association of University Professors.

In addition to his academic interests, Nelson was a naturalist, particularly of plant life and birds, and an enthusiastic gardener. Hiking was a favorite pastime, and he often went on camping trips in the Rocky Mountains and the Adirondacks with friends and colleagues. He was an accomplished musician, and played the trumpet with the Cornell University Orchestra and the Ithaca Concert Band for many years. As an early-jazz aficionado, he derived considerable pleasure from introducing present-day "rock-and-rollers" to the delights of Dixieland and noting their immediate reaction and declaration that "this is the right stuff." EE School members who used to bowl in the old Franklin Hall League recall that Nelson achieved the top all-time average in that energetic group.

Nelson measured his accomplishments by the long-term success of his students, particularly those whom he inspired to pursue careers in bioengineering. He was uniquely able to recognize creative and unusual students, and encouraged them to acquire the kind of deep fundamental understanding that contributes to a sense of accomplishment—even a sense of competence and power. Nelson became the mentor of several of these students and formed long-term friendships with them. He was technically thorough, imaginative, possessed an analytical mind, and had a remarkable ability to visualize the physical behavior of electronic circuits. His mastery of first principles made him a valued resource to colleagues and students. Highly regarded by everyone who knew him, Nelson was warmly admired for his personal attributes of complete integrity, honesty, patience, and good-humored generosity of time and effort.



• Professor emeritus **True McLean** died at age 95 on June 10, 1994 in Naples, Florida, after a short illness. Following his graduation from Staten Island Academy in 1916, he entered Cornell University that year as a student in the Department of Electrical Engineering, which at the time was part of the Sibley College of Mechanical Engineering, but his studies were interrupted by service in the Navy during World War I. When the war was over he returned to Cornell and received the degree of Electrical Engineer in 1922 from the newly established School of Electrical Engineering. Upon graduation, True went to work in New York City for the Western Electric Company in their development and engineering-research department that eventually became the Bell Telephone Laboratories. In 1923 he was persuaded by professor **William C. Ballard** to return to Cornell to take an instructorship in the EE School, a decision that marked the beginning of a forty-three-year academic career at Cornell. True was an instructor for seven years, was appointed as an assistant professor in 1930, became an associate professor in 1944, and attained full professorial rank in 1946. He retired as professor emeritus in 1966.

Throughout his teaching and industrial career, Professor McLean's principal interests were in the electromagnetic communications field and associated electronic circuitry. He taught courses in communications engineering theory, advanced communications laboratory, and elements of acoustical and radio engineering. He was particularly effective in the classroom because of his extensive practical engineering background and developmental experience in these fields. During World War II years, True was deeply involved in the College of Engineering instructional program for service personnel, but in this same period he found time to assist professor **Elmer S. Phillips,** of the Department of Communication in the College of Agriculture and Life Sciences, in the production of high-quality long-playing audio disks and instructional motion-picture films for the War Department. Throughout his career he was a consultant on radio-engineering problems for a variety of companies and organizations. In 1949–51, he had a particularly exciting task at Brookhaven National Laboratory, where he made important contributions to the design of a high-power radio-frequency power amplifier that was to be used as the electric drive for their large proton synchrotron.

In the field of audio engineering, True had a very interesting assignment as a technical consultant to the Cornell Ornithology Laboratory, when he assisted professors **Paul Kellogg** and **Arthur Allen** in the recording of bird songs. True, together with Elmer Phillips, Bill Ballard, and Arthur Stallman of the well-remembered downtown-Ithaca audio electronics establishment, converted an abandoned Greyhound bus into a portable audio-control studio that was invaluable in recording the popular long-running WHCU program "Know Your Birds." That bus also did double duty as the audio power source for the early public-address system for football games in Schoellkopf Stadium.

In 1923, professors Bill Ballard and **B. K. Northrop** obtained a

In Memoriam: Joe Rossen

Papa Joe Fund Incorporated into Joseph L. Rosson Memorial Fund

As we go to press, we are saddened to report the death of professor emeritus **Joseph L. Rosson** at age 75 on April 1, 1995, in Memphis, Tennessee, after a long illness. Joe came to the EE School as a graduate student in 1947, joined the faculty as assistant professor in 1951, and became a full professor in 1969. A full account of Joe's distinguished career at Cornell will appear in the next *Connections*.

When Joe retired in 1986 as an emeritus professor, the "Papa Joe Fund" was established in Joe's honor in recognition of his dedicated service to the EE School. At the time, Joe requested that the proceeds from the fund be used to support the work-study program for EE undergraduates. We are incorporating the Papa Joe Fund into the newly established Joseph L. Rosson Memorial Fund, with the proceeds to continue to be used in accordance with Joe's original wishes. Alumni who would like to contribute to the Fund should contact professor James S. Thorp in care of the School of Electrical Engineering, Room 224, Phillips Hall.

standard broadcast license for Ithaca's first radio station, then called WEAI ("We Educate And Instruct"). On his return to the campus that year, True joined the station and began a long association with the radio broadcasting field. From 1928 to 1955 he was engineer, and then chief engineer, of the Cornell radio station WHCU (and its predecessors WEAY and WESG), with responsibilities for the design and supervision of the construction of all its AM and FM transmitters. In that period he also was a consultant in the establishment of an FM relay network that brought the New York City classical radio station WQXR broadcasts into Ithaca.

On his last sabbatic leave in 1963–64, True pursued one of his major interests, precision in instrumentation. He had all of the standard instruments of the EE School calibrating room rechecked at the Bureau of Standards, and visited the Bureau at Washington, D.C., and at Boulder, Colorado, to confirm the recalibration. For many years after his retirement, True would return to Phillips Hall in the summer and recheck all of the instruments in the standards room. A familiar sight in the laboratory was to see him looking over the shoulder of a student (or a professor!) who would be about to connect an instrument in an experiment. Invariably, True would take out a small screwdriver and proceed to adjust the instrument.

True enjoyed soaring sailplanes and flying his small private airplane, a single-engine Lascombe 8-F. He was an official of the National Soaring Championship in Elmira, New York, in 1963, and together with his longtime friend and fellow aviation enthusiast, professor **Arthur Muka** of the Department of Entomology, he worked on the barograph certification for regional and national sailplane competitions in Elmira. He flew his plane in New York State for many years and would frequently surprise an invited guest in Ithaca by taking him to lunch in Syracuse! After retiring and moving to Florida, True joined the Naples Squadron of the Civil Air Patrol and participated in their twilight flights (the Sundown Patrol) along the Gulf Coast looking for pleasure boats in trouble. He engaged in this activity until he was forced by age (at 87!) to give it up, which he did reluctantly. True often said that his hobbies of astronomy, flying, and music had profound impacts on his professional and teaching careers. Astronomy and flying combined with radio engineering led him to develop a popular course in radio aids to navigation. Astronomy and radio engineering inspired him to take a deep interest in the absolute determination of time. His appreciation of music helped him in acoustics and radio broadcasting.

True was a member of the American Institute of Electrical Engineers and the Institute of Radio Engineers before the two organizations were combined into the Institute of Electrical and Electronic Engineers (IEEE). In 1965 True was named a fellow in IEEE "for contributions to engineering education and research in acoustics, communication, and electrical measurements." He was a licensed professional engineer in New York State, and served two successive terms as president of the Ithaca Chapter of the New York State Society of Professional Engineers. From 1959 until his retirement he was a member of the Board of Directors of the Cornell Research Foundation, the organization responsible for university patent activities. He was a member of the honorary societies Eta Kappa Nu and Sigma Xi, and of the American Association for the Advancement of Science, and the Civil Air Patrol.

The history of EE School radio-astronomy activities, described elsewhere in this issue, would not be complete without an account of how True solved the mystery of the case of the wayward solar telescope. The electronic controls of the turntable were designed to make the antenna follow the Sun across the sky faithfully, but after several days of operation the telescope would be found to be off-track and would have to be reset. When True was asked to look into the problem he found that the reference signal chosen for the control system was the 60 Hz power frequency, a standard that he knew was highly variable. True set up a new reference based on a 100 KHz crystal-controlled oscillator and associated circuitry that kept the telescope on-target for the multiyear lifetime of the project. Once again his reputation for precision measurements was confirmed.

In this issue we are continuing the "Positive Feedback" feature of previous years. The first three 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 purple dots (•) attached to some of the names in the following listing refer to respondents who contributed interesting stories that are contained in "More Tales from the Past ," page 21.

Notice for Internet surfers: the EE School has entered the information superhighway (also known as the "infobahn") via the World Wide Web.
The EE Homepage may be found on our uniform resource locater (URL):
[http://www.ee.cornell.edu]. The College of Engineering URL is:
[http://www.engr.cornell.edu].
Note: Our alumni file is somewhat incomplete. If you know of EE alumni who are not receiving *Connections*, please urge them to send their names and addresses to Jeanne Subialka, Engineering Public Affairs, 248 Carpenter Hall, Ithaca, NY 14853.

• **Otto J. Glasser** '40, Lt. General, U.S. Air Force, retired in Sarasota, Florida, recalls his thirty-three-year career in the Air Force and thirteen years as an international vice president for General Dynamics, and always attributes his success to his four years as an EE at Cornell.

• **Douglas B. Whitney** '43, retired from MIT Lincoln Laboratory, writing from Lexington, Massachusetts, recalls his early World War II days at Cornell, and notes that times have really changed: tuition for a B.E.E. degree was $225 for the first term, and $180 for the second term!

Joseph C. Logue '44 is retired from IBM and lives in Poughkeepsie, New York. He writes that he is enjoying *Connections*.

Anthony Prasil '44 is retired from Eastman Kodak in Rochester and is engaged as the curator of the Hoffman Clock Museum, in Newark, New York.

Jerrier A. Haddad '45, retired from IBM, and living in Briarcliff Manor, New York, has been named president of the Accreditation Board for Engineering and Technology (ABET) for 1995.

• **Robert W. Johnston** '46, writing from Potomac, Maryland, relates some interesting stories about the V-12 Program and his professors. He includes a wry commentary on those days: as a senior he corrected papers and lab reports and performed odd jobs in the school for the princely sum of $10/week!

Lawrence R. (Dick) Dows '48, retired from General Electric Company, writes from Bon Air, Virginia, that he now a gentleman farmer.

Irwin M. Jacobs '56, (chairman and CEO of Qualcomm, Inc., San Diego, California), received the U.S. National Medal of Technology, the nation's highest honor in technology, in December 1994.

Alexander M. Prochazka '57, retired and living in Owing Mills, Maryland, writes that he is now in business as a specialty farmer. He recalls his adventures with the old Power Network Calculator in the then brand-new Phillips Hall, and reports that he still sports a beard after 42+ years.

William J. Balet, Jr., '58 (executive director, New York Power Pool in Schenectady, New York) spoke at the Cornell Energy Engineering Seminar on September 29, 1994, on "New Developments in the New York Power Pool."

David H. Ahl '60 (founder of *Creative Computing* magazine and president of SBI Communications) served in April 1994 as one of three judges in selection of the best presentation by an engineering student at the first annual Roger K. Berman Memorial Oral Presentation showcase sponsored by the Engineering Communications Program.

Donald D. Christiansen '60, publisher emeritus of IEEE *Spectrum*, spoke at an EE School colloquium on April 19, 1994, on "Ethics and the Business Game."

J. Michael Duesing '62, formerly with General Electric Company in the field of information technology, was appointed Director of Corporate Relations in the Cornell College of Engineering on February 19, 1995.

DILBERT®

Benson P. Lee '63 (CEO, Interscience, Inc., and Cornell Trustee emeritus) was honored in March 1994 by the Cornell Asian Alumni Association with the establishment of the Benson P. Lee Tradition Fellowship.

Roger W. Burnell '66 (president, Human Resource International) writes from Los Altos, California that he enjoys *Connections*, and is particularly appreciative of the effort involved in its production since he also edits a publication.

John J. Bzura '66 (principal engineer, Retail Engineering R&D, New England Electric Power Service in Westborough, Massachusetts) writes of his interesting research on photovoltaic cells and other energy-related projects.

Michael Sacarny '76 (director of engineering services, Bioprocess Automation, Inc., Arlington, Massachusetts) reports that he is very happy crafting fermentation control systems for biotech/pharmaceutical applications.

Henry A. Schiemann '79 (network consultant with Telematics International GmBH in Oberursel, Germany) writes that he works with the ATM product line of the company.

Masroor Ahmad Khan M.E.E. '84 (director of technical activities with Syed Bhais, Ltd., in Lahore, Pakistan) reports that he is responsible for manufacturing, engineering, and introduction of new development in the company.

Phillip J. Erickson '87 completed all requirements for the Ph.D. degree in EE at Cornell in January 1995, and has taken a position as a member of the research staff in atmospheric sciences at Millstone Hills Observatory in Massachusetts. The observatory is operated by MIT.

Tom S. Tseng '87 (assistant director, International Public Affairs at Cornell, 55 Brown Road, Suite 220, Ithaca, NY 14850) obtained the M.Eng.(Civil) in engineering management from Cornell in November 1994, and left his former position with the Office of Admissions in the College of Engineering to assume his current assignment. Tom's new responsibilities include overseeing and promoting overseas Cornell Clubs, and developing new alumni activities.

▼ A Distinguished Alumnus

Michael G. Spencer received the B.S., M.Eng., and Ph.D. degrees, all in electrical engineering, from Cornell University in 1974, 1975, and 1981, respectively. Following three years at AT&T Laboratories in Pasadena, California, he returned to Cornell to complete his doctoral studies and then joined the faculty at Howard University in Washington, D.C., in 1981, where he is now professor of electrical engineering. During his graduate studies at Cornell, Michael held the Bell Labs One Year On Campus (OYOC) and the IBM Minority Pre-doctoral Fellowships. At Howard he received the National Science Foundation (NSF) Presidential Young Investigator (PYI) Award in 1985, the Allen Berman Research Publication Award in 1986 from the Naval Research Laboratory in Washington, D.C., and in 1987 he was selected by NSF to be director of the first Minority Center of Excellence. He was also the recipient of the White House Initiative Faculty Award for Excellence in 1988 and a NASA Certificate of Recognition in 1992.

Since 1979, Michael's research has been concerned with epitaxial and bulk growth of compound semiconductors such as GaAs, SiC, and AIN, microwave devices, solar cells, and electronic materials characterization. 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 has helped to initiate and form the International Conference on Silicon Carbide and Related Materials. He has authored over fifty publications in these areas, and has two patents pending.

Michael writes us, "The electrical engineering education I received at Cornell has had a dramatic and ongoing impact on my career. Additionally, relationships with many of my current associates were formed initially at Cornell. Ironically, I was part of the electric-vehicle team at Cornell and now advise the solar-car project at Howard."

We congratulate Michael on his distinguished career and expect to hear reports of many equally impressive achievements in the future.

More Tales from the Past

In this past year, the "Positive Feedback" feature produced several engaging and informative recollections of early days in the EE School. If a history of the school is ever written, these anecdotes will be invaluable to the author, so keep 'em coming!

***Otto Glasser** '40 writes:*

The recent issue of *Connections* was a real nostalgia trip for me. A great many of my professors were mentioned, although there were several notable absentees. **Everett Strong** was sort-of the Chief Operating Officer of the School while **Bill Lewis** was the CEO! The EE laboratory in Rand Hall was under the authoritarian hand of Professor **Burckmyer,** who had the mien normally expected of British peerage. There were two Professors **Northrop,** one of whom (**B.K.**) was very much involved in "electronics." I worked for B.K. as an NYA [National Youth Administration] student and built a 2" oscilloscope for him! It gave me a chuckle to see your 1950 lab with "standard" (5"?) Dumont scopes. Looks pretty upscale to me! Then there was Mr. **Meserve** (seemed like it should be Mr. *Reserve*), and Mr. **Cotner,** who ran the computation lab on the second floor of Franklin Hall. The third floor was occupied by the Fine Arts Department, complete with nude models for "life" classes. What do the EEs do for fun in Phillips Hall?

The "radio" classes were in the hands of Professor **Bill Ballard** '12, a classmate of my father. He was ably assisted by Professor **True McLean** and Mr. **Bill Moeder,** for whom I worked as an engineer at WHCU (up by Bailey Hall). Electronics was pretty primitive. One of our major pieces of equipment was a glassed-doored cabinet full of Stroger telephone switches! And everyone will recall Professor **Vladimir Karapetoff,** who, when not lecturing on Heaviside Operational Calculus, was a performing cellist [*and played the other strings of a chamber-music quartet as well.—Ed.*]. He was wont to fill the blackboard with several lines of equations and then say, "It can be shown that this reduces to——"! It was left to us to figure out how. Professor **H. G. Smith** also rings a bell but I am unable to recall his specialty except to say he was somehow involved in electronics. [*He worked with transmission lines and antennas.—Ed.*] I was surprised to learn of the role of Dean **Hollister** in developing Phillips Hall. If my memory is correct, he was the CE Dean while I was at Cornell.

But I really wanted to save space for the Delta Club. While I mourn its passing, it is probably just as well. It was great camaraderie but on the wrong basis. Unlike your account, we did not have a banquet. We had a picnic in a rather stony park outside of Ithaca (heaven knows where). The seniors enjoyed staging periodic chug-a-lug contests for the initiates. The first man to finish was allowed to skip the next contest. Beer was consumed from an old-fashioned, tin, quart measuring cup from which the pouring lip had been removed. When the initiates were thoroughly bombed, we were given our last chug-a-lug: a can of beer heavily laced with "Green River" whiskey, with your Delta Club key in the bottom. No fishing out the key! You recovered it by emptying the can! Incidentally, my recollection says that the name, Delta, came from the "Delta-Phase" equipment that was so popular in that day. Remember, although we did have an electronics option, we were all power engineers in those days.

Otto: in response to your query about the five-year program, it was adopted by the College of Engineering in 1945, and continued until the early 1960s, at which time the fifth year became the Master of Engineering Program.—Ed.

***Doug Whitney** '43 has some memories of life at Cornell in the early years of WWII:*

Having made a living over a period of more than forty years "engineering" airborne radar, ground radar, Doppler navigation radar, lunar-excursion electronics, and an FAA traffic-control beacon system, I am amazed that I can only recall one instance in which the concept of "distance-measuring using radio transmission" (early harbor "radar" experiments in France) was mentioned in class in 1940–43. Radar, servomechanisms, transistors, and microchips, as we know them today, were the stuff of Jules Verne books. [*Radar was one of the best-kept secrets of WWII.—Ed.*] And computers—I remember being impressed to pieces with the eight-place capabilities of a hand-cranked Monroe calculator!

Class instruction during the war years was perhaps more informal than later on. Attending Professor **Everett Strong**'s sophomore "Basic Analysis" and Professor **Michel Malti**'s engineering math courses in those days required heavy lugging—Strong's mimeographed course notes were nearly four inches thick, and Malti's nearly as thick (their course texts were not yet published). **Howard Smith** interspersed his classes with comments on his problems of maintaining the WHCU 1-KW AM transmitter, and Professor **True McLean** related stories on the art of piloting small aircraft.

I remember being impressed with Professor **Alexander Berry Credle**'s teaching tricks. In one senior-level lecture, he stopped talking abruptly to say, "If you believe what I've just been telling you, I'll bet I could convince you of anything." He had purposely wandered from the truth to see if we were awake!

***Bob Johnston** '46 remembers his professors and classes as a Navy V-12 student:*

My recollections of the EE School during this period are mixed. It was a most difficult time in Franklin Hall for there was no permanent chairman to lead the school, and an interregnum was in place; some faculty were on leave, new faculty had to be brought in to teach the large V-12 contingent, the trimester system had just been introduced, space and equipment were tight and antiquated, little research was being done by the faculty, and few had their

ALUMNI BREAKFAST

Mark Saturday, June 10, 1995, on your calendar for the annual EE alumni breakfast. The time is 7:45 to 9:30 a.m., and the place is the Phillips Hall Lounge. We hope you and your spouse will join other alumni and members of the faculty and staff for an event that is always a festive and memorable occasion.

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

doctorates. And mixing college training with the requirements of a military environment did not always proceed easily. Even so, the program thrived, and while it didn't provide as rigorous an education as today's students probably receive, it did lay the foundation for those of us in the program to proceed with rewarding careers.

My memories of the EE School involve mainly the teachers and the courses they taught. One of the first EE courses we took was **Everett Strong**'s Basic Electrical Engineering. This was a great beginning since Strong was a dynamic, witty teacher who presented the most intriguing problem sets for us to do. Those problems didn't require elaborate formulae for solution but rather critical basic thinking. I shall never forget the unbalanced ferris-wheel problem he dreamed up for us to solve.

The so-called Rand Hall lab courses were certainly awesome and also a bit disappointing. The teachers—**Burckmyer, Ankrum, Schauss,** and **Logue**—were tough taskmasters, especially Burckmyer, and they tried very hard to make the laboratory a real learning experience. They succeeded in part, but I think the labs were not as closely coupled with the theory courses taught in Franklin as they could have been, and there was an excessive emphasis on rotating machinery to illustrate energy conversion. I don't remember, for example, a single experiment on electrochemical methods.

One of the most important and influential faculty members to us V-12ers was **Eric T. B. Gross.** He was trained in Vienna as a power engineer at the doctorate level, and was at Cornell for all too brief a period. He was our adviser, our protagonist, our mentor, our supporter, and to all of us he was "Poppa." He constantly challenged us to do our best and was very influential in molding many of our careers. He had a favorite saying while lecturing—"Use your heads—no, no, use your brains!" He left Cornell right after the war to join **Bill Lewis** at IIT, and then went on later to establish one of the premier power programs in the country at RPI. What a contribution he could have made to the school and to Cornell had he remained!

I should mention Professor **Stan Zimmerman,** an affable G.E. engineer from Pittsfield, who arrived at Cornell in my senior year to run the High Voltage Lab. I well remember his demonstrating the concept of the Faraday Cage, and inviting any of us to get inside while he directed high-voltage discharges [*a million or more volts!—Ed.*] at it. I don't remember whether any of us accepted his invitation or not—I certainly didn't! Today, the university lawyers would probably require the students to sign all sorts of disclaimers for liability before such an experiment could be conducted!

Bob: You may recall the open-blade control switches on the old power panels in the Rand Lab. Safety rules now require such equipment to be placed inside heavy-wire cages, thereby eliminating student access. Those panels are long-gone from our labs.

—Sam Linke

Staff News

Sally Bird, administrative aide to the Space-Plasma Physics Group for the past eight years, has been at Cornell for fifteen years. She came to the EE School from prior positions with the International Student Office and the Office of Residence Life. Sal has been an expert at embroidery since mastering the art as a little girl. **Beth Ebel** was appointed administrative assistant to the director in August 1994 after a short period as assistant to the director of human resources in the College of Engineering. Beth graduated from Ithaca College with a double major in psychology and business. **Bruce Fingerhood,** research equipment technician, used his photographic skills to produce the laboratory photographs in this issue of *Connections*. **Linda Marie Heegard,** EE undergraduate coordinator since September 1992, came to the EE School after three years with the Cornell School of Continuing Education. Among other interests, Linda enjoys working with computers and associated software. **Francis D. McLeod, Jr.,** '63, B.S. (EE) '65, lecturer in EE, is the manager and coordinator of activities in the new undergraduate teaching laboratory. **Joan Manning,** executive assistant to the graduate faculty representative, will be honored in June at a service-award banquet for thirty-five years of service at Cornell. **Mary Root,** executive staff assistant to the director, had been an administrative aide in the EE School for eight years prior to her present position. She came to Cornell from Norfolk, Virginia, where she held a secretarial position with Seacor Engineering Company. Mary, a native of Schuyler County, near Ithaca, is fond of horseback riding and gardening. **Laurie Shelton,** administrative assistant to the Space-Plasma Physics Group, has been associated with the EE School for the past sixteen years. Laurie has a B.A. degree in voice performance from Bob Jones College in South Carolina, and is now working part-time while studying for her M.M. degree in voice performance at Ithaca College. **Linda Struzinsky,** administrative aide to the M.Eng.(Elec.) Program, has returned from retirement to work part-time for the EE School. **Susan Swartz,** secretary to the Space-Plasma Physics Group, has worked part-time for the past ten years with members of the group who are associated principally with the Jicamarca Observatory. **Paul R. Weber,** technical support specialist, has been appointed computer-operations manager in the EE School. His prior assignments at Cornell have been with the College of Veterinary Medicine and with Mann Library.

Space Plasma—continued from page 9

Cornell in 1981 as an assistant professor and worked with professors **Ravi Sudan** and **John Nation** on fusion-related research before joining the Space-Plasma Physics Group in 1984. He became a full professor in 1993. His interests are primarily in the physics of plasmas at high-altitude atmospheric levels as well as in earth-based laboratory fusion experiments.

Charles served as associate director of the Cornell Laboratory of Plasma Physics from 1986 to 1991, and has been an associate editor of the journal *Physics of Fluids*. He is a senior member of IEEE and a member of AGU and AAAS.

Assistant professor **Niels F. Otani** has worked closely with Charles Seyler and associated graduate students on the development of computer simulations of physical phenomena. Niels received the Ph.D. degree in physics from the University of California at Berkeley in 1986. His thesis research applied the methods of particle simulation to problems in plasma physics. After two years of postdoctoral work at the Courant Institute of Mathematical Sciences at New York University, he joined the electrical engineering faculty at Cornell in 1988 as an assistant professor. His primary interests are in the application of computer-simulation techniques to plasma instabilities in the earth's upper atmosphere and in outer space.

Upper Atmosphere — continued from page 6

Beta Pi/Cornell Society of Engineers Award as the outstanding teacher in the Cornell College of Engineering. Mike is a fellow of the American Geophysical Union.

In recent years, Mike has been using lasers for space research. The specific instruments, lidars, are becoming important diagnostic tools for investigation of the middle portions of the earth's neutral atmosphere. Regular radars are unable to obtain useful information from this region, and satellite and sounding-rocket data are transitory. A Doppler Rayleigh lidar recently installed at Arecibo operates in combination with the radar system to measure the aerosol content of winds and to obtain patterns of clouds, aerosols, and layers of the atmosphere closest to the surface. The lidar technique offers the only way in which winds and temperatures from twelve to fifty miles up can be measured continuously. These experiments are of particular interest because of global-warming concerns stemming from the known expansive heating of the stratosphere due to ozone absorption of solar ultraviolet radiation. Daily variability of winds accompanied by small-scale turbulent structures may have significant impact on the distribution of ozone in the region. Recently, lidars have been able to utilize a fifty-to-seventy-mile-high distribution of sodium atoms in the atmosphere. The sodium is deposited by evaporation of meteors in a process that is not well understood at present. The scatter is very strong for this layer and provides a mechanism to measure winds and temperatures continuously in the region. Observations by a new resonance lidar, scheduled for Arecibo this year, will be devoted to development of theories to explain the characteristics of this phenomenon, and to use it for atmospheric dynamics studies.

Some of the more spectacular experiments performed by the Space-Plasma Physics Group involve the use of barium-ion clouds for the measurement of electric fields in the ionosphere that provide a valuable tracer technique in space-plasma studies. Barium metal is placed in one or more cannisters and carried aloft by a sounding rocket that also contains the necessary measurement devices and radio-transmission equipment. Vaporization of the metal is accomplished by means of a thermite reaction, and an explosive device injects the metal vapor into the region being investigated, either at sunrise or sunset, when the ion cloud will be in full sunlight. The sunlight ionizes the barium vapor and makes the ionized cloud visible by a resonant scattering process. If the barium is released under these conditions, a lingering plasma cloud is formed similar to the display shown in the photo on page 6. Well over 100 releases of this nature have been conducted since the 1960s at altitudes that range from ninety to 36,000 miles. Barium-cloud experiments have been of particular interest in simulating naturally occurring ionospheric turbulence that disturbs radio signals from satellites. In recent years, several barium-release experiments over Wallops Island, Virginia, have produced remarkable displays that were visible along the entire Eastern Seaboard, and as far inland as Washington, D.C., and beyond.

Some of the more spectacular experiments performed by the Space-Plasma Physics Group involve the use of barium-ion clouds for the measurement of electric fields in the ionosphere that provide a valuable tracer technique in space-plasma studies.

Alumni: Please fill out this coupon for the "Positive Feedback" feature and return it to Sam Linke, Cornell University, School of Electrical Engineering, 204 Phillips Hall, Ithaca, NY 14853-5401.

Name_____

Position title_____

I am employed by_____

_____
street

_____
city state zip

My current activities are:

_____

_____

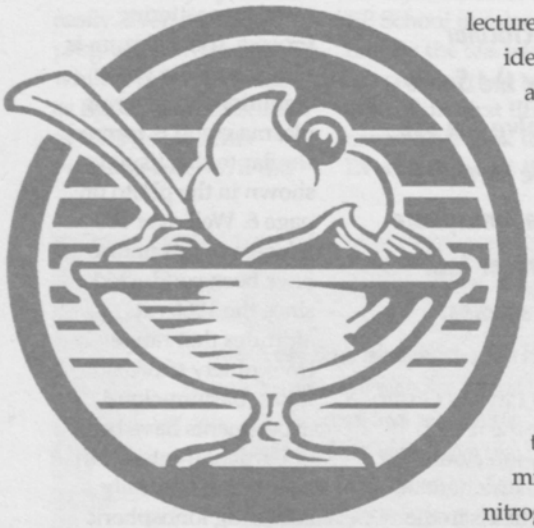
Optional:

I would like to explore possibilities in the following areas:

- ❑ Contributions to the Eminent Professors' Fund
- ❑ Contributions to the Joseph L. Rosson (Papa Joe) Memorial Fund
- ❑ Establishment of one-year fellowships for professional masters students
- ❑ Engineering Cooperative Program
- ❑ Job placement of EE School seniors or graduate students

NEW-FASHIONED EE ICE-CREAM SOCIAL

Visitors to Phillips Hall have undoubtedly noticed a large white Linde storage tank at the rear of the building. The ultra-pure liquid nitrogen in the vessel, used by research groups in the National Nanofabrication Facility (NNF) nearby, gave assistant director and lecturer John Belina '74 a "cool" idea. Recently, John had read an article in the April 1994 issue of *Scientific American* about a daring experiment involving the instant manufacture of ice cream by the simple expedient of pouring a quantity of pure liquid nitrogen into a container of room-temperature ice-cream mix. Armed with a two-gallon bowl of chocolate mix and a dewar of NNF liquid nitrogen, John performed the experiment at a meeting of the Cornell Bioengineering Society by pouring the contents of the dewar directly into the bowl. The "soft ice cream" was indeed instant and palatable, but the product had the consistency of frozen slush. Nothing daunted, John tried the experiment again at his engineering-freshman tutorial class, except this time he made several small batches. This improved technique resulted in true ice cream, "smooth and delectable," that was enjoyed by everyone who was present at this historic occasion.



EMINENT PROFESSORS' FUND

Two years ago the EE School established the Eminent Professors' Fund to honor the memory of notable members of the EE faculty of recent years such as professors **Henry Booker, Nelson H. Bryant, L. A. Burckmyer, Clyde E. Ingalls, M. Kim, Wilbur Meserve, True McLean, B. K. Northrop, Robert Osborn, Joseph L. Rosson, Howard G. Smith, Everett Strong,** and others whom alumni may recall. The objectives of the fund are twofold: (1) to acquire specific grants to improve laboratory and research facilities in the EE School, and (2) 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 new undergraduate computing center and the new 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-masters 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.

CORNELL UNIVERSITY

School of Electrical Engineering
224 Phillips Hall
Ithaca, NY 14853-5401