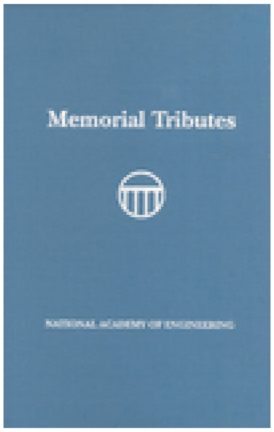
Memorial Tributes

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NATIONAL ACADEMY OF ENGINEERING

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Memorial Tributes

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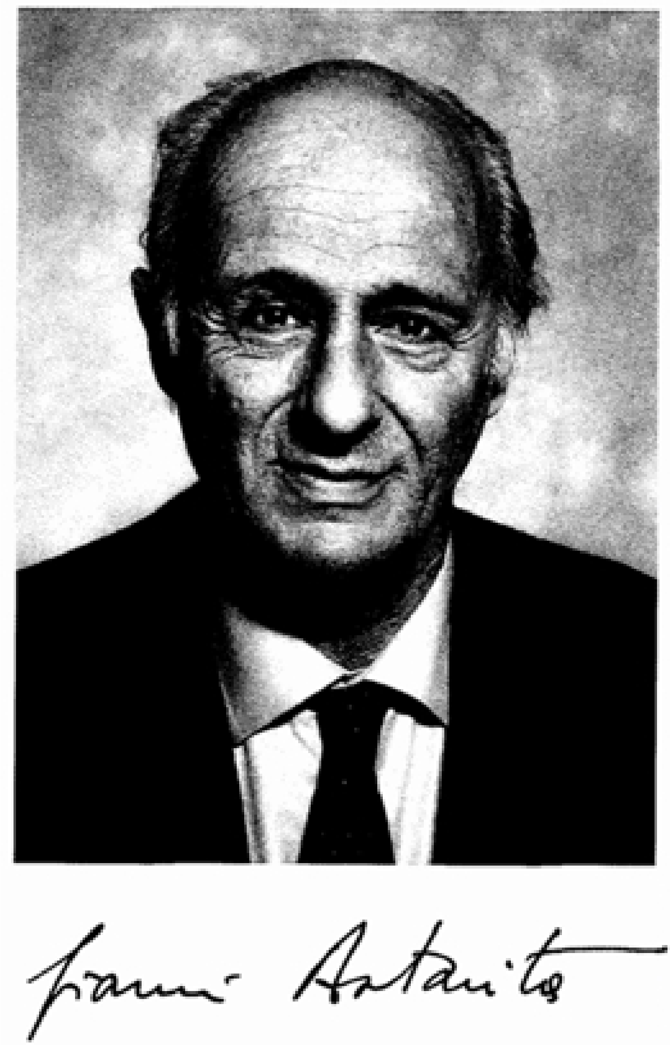
FOREWORD

THIS IS THE NINTH VOLUME in the series of *Memorial Tributes* issued by the National Academy of Engineering to honor the deceased members and foreign associates of the Academy and to recognize their achievements. It is intended that these volumes will stand as an enduring record of the many contributions of engineers and engineering to the benefit of humankind. In most cases, the authors of the tributes are contemporaries or colleagues who had personal knowledge of the interests and the engineering accomplishments of the deceased members and foreign associates.

The National Academy of Engineering is a private organization established in 1964 to share in the responsibility given the National Academy of Sciences under its congressional charter signed by President Lincoln in 1863 to examine and report on questions of science and engineering at the request of the federal government. Individuals are elected to the National Academy of Engineering on the basis of significant contributions to engineering theory and practice and to the literature of engineering or demonstrated unusual accomplishments in the pioneering of new and developing fields of technology.

W. Dale Compton
Home Secretary



Memorial Tributes

NATIONAL ACADEMY OF ENGINEERING

GIOVANNI ASTARITA

1933-1997

BY ARUP K. CHAKRABORTY, GUISEPPEE MARRUCCI, T. W. FRASER FUSSELL, AND ARTHUR B. METZNER

GIOVANNI ASTARITA, professor of chemical engineering and materials science at the University of Naples, Italy, and professor of chemical engineering at University of Delaware for many years, died in Naples on April 28, 1997, following a stroke on April 24, 1997. He was sixty-three years old.

Professor Astarita earned his master's degree in chemical engineering from the University of Delaware and doctorate at the University of Naples in 1957. He was a visiting professor at Delaware during the 1965 to 1966 academic year and annually in the fall semesters continuously from 1973 through 1995: the fall semester of 1996 was spent at the Johns Hopkins University. He received the Alpha Chi Sigma award for research accomplishments from the American Institute of Chemical Engineers in 1992 and was elected a foreign associate of the National Academy of Engineering in 1994. At the time of his death, he was one of only eleven chemical engineers worldwide to hold this honor. In Italy he received, in 1995, the Gold Medal for Excellence in Research from the Federation of Chemical Industries.

Professor Astarita's eight books and more than 200 papers revealed him to be a renaissance scholar as his work spanned the full range of rheological, continuum mechanics and chemical engineering interests. His first book was published in 1967 on the subject of mass transfer with chemical reaction; while it served to organize the literature on this subject impressively, it was even more a philosophical tract on how rigorous analysis of all problems in science and technology should be approached. His insightful analyses of problems have allowed others to see the critical issues in new and frequently much clearer ways. He was a man of broad culture and wide reading who welcomed interruptions—any of us could enter his office at virtually any time to seek his guidance and advice. He would instantly stop his own work and turn to the new issue; the greater the erudition of the issue raised, the greater his enthusiasm for it. Consequently, he was an inspiring mentor for both his students and his colleagues. In the latter stages of his career, he focused on the mentoring of young academic professionals worldwide, the results of which will be with us for many years to come. Perhaps most important, his professional attributes exemplified respect for scholarship, scientific integrity, and the highest intellectual standards.

In the applied physics areas of rheology and polymer processing, he contributed extensively to the early studies of the mechanisms whereby minute concentrations of macromolecules in flowing liquids reduce turbulence and the resulting drag. He discovered previously unexpected discontinuities in the rates at which gas bubbles move through viscoelastic liquids and applied this understanding in later studies of devolatization processes in production of plastics and rubbers. Professor Astarita was one of the first scholars to note the surprisingly high resistance of viscoelastic fluids to extensional deformations, a subject that became one of the core components of much work in rheology in the ensuing three decades. The utility of plastics in many automotive and aircraft applications is critically dependent on their resistance to solvents; Astarita's work in this area served to organize the badly fragmented literature and identified the worthwhile areas for further study.

Professor Astarita conducted short courses and gave seminars at approximately 100 locations in more than twenty countries worldwide. He gave of himself unqualifiedly to a wide variety of professional organizations. He organized and later became president of the Italian Society of Rheology, and he was a member of the research committee of the British Institution of Chemical

Engineers. He was also a member of the National Academy of Sciences, Letters and Arts (Italy), the European Federation of Chemical Engineers, the Associacion Argentina de Reologia, the American Institute of Chemical Engineers, the Society for Natural Philosophy (U.S.), and the Society of Rheology. At the time of his death, he was chairman of a group organizing European polymer engineering into a coherent unit that will replace the many separate and somewhat fragmented national groups. He was president of the International Congress on Rheology from 1980 to 1984 and chaired the assembly held in Naples in 1980.

While Professor Astarita's primary loves were clearly for his family and his profession, he enjoyed being near the water and was an avid boater, swimmer, diver, and spear-fisherman. He spent much of his spare time in a small fishing village, San Marco, on the coast south of Naples. He was also an intense bridge player who attained the rank of Master in the Italian Bridge Federation. All of Gianni Astarita's social interactions were laced with humor and self-deprecating wit. In emphasizing to young scholars the importance of preliminary order-of-magnitude estimates of an answer sought—and how one needn't guess the ultimate answer with too much accuracy for it to be useful—he anecdotally refers to an event in his early professional life. A friend of his father had an option for purchase of a tract of timber and was in a quandary as to its true value. Gianni inquired as to the diameter and height of typical trees, and their spacing, then quickly estimated the probable value of the lumber to be derived from this. Some months later, on meeting his father's friend again, this individual thanked Gianni exuberantly for the earlier estimate: he had based his purchase price on this, but the total lumber harvested proved to be severalfold greater than predicted and he hoped all of Gianni's subsequent order-of-magnitude estimates would be as valuable!

We mourn the loss of a long-standing and esteemed renaissance scholar, colleague, and friend. We are left enriched by his presence among us. In the words of his friend and frequent collaborator, Rutherford Aris, “Gianni knew the difference between excellence and success. He achieved both and was spoiled by neither.”

J. LELAND ATWOOD

1904–1999

BY GENERAL B. A. SCHRIEVER, USAF (RETIRED)

J. LELAND ATWOOD, former president and chief executive officer of North American Aviation, died on March 5, 1999, at the age of ninety-four. He was born in Walton, Kentucky, on October 26, 1904. He attended Hardin-Simmons University and received a bachelor of arts degree. In 1928 he received a bachelor of science degree in civil engineering from the University of Texas.

It is difficult to write anything about "Lee" Atwood that has not been written before. He was an outstanding pioneer not just in aviation, but also in the field of long-range missiles and space. I personally got to know Lee in 1939 when he was North American Aviation vice-president for engineering and also assistant general manager. I had been assigned to Wright Field as a test pilot in 1939 when it was common in the aviation industry for a military test pilot to know the company's top echelon intimately— which I did. Lee Atwood had become Dutch Kindelberger's right arm. He had also become broadly known as "a chief engineer's chief engineer". His technical acumen was the driving force behind the company's evolution into an aviation and space leader, which produced more military aircraft during the 1940s and 1950s than any other company. Among those aircraft were the P-51 Mustang, which was a swift, agile World War II fighter with the most impressive record in the aerial wars in Europe. Other aircraft included the B-25 Mitchell bomber, which was used by

Jimmy Doolittle and his Tokyo Raiders and turned the tide of the war in the Pacific; the T-6 Texan in which almost every U.S. and British World War II pilot trained; and the F-86 SabreJet fighter, which exhibited a superiority of 10-to-1 or better against Russian MIGS in Korea.

From this record it is clear how, as one of the founders of North American Aviation, Inc., in 1934, Lee Atwood became a living legend early in his aerospace career. This career is the more outstanding when one considers that it was built with wood, fabric, and the slide rule as the engineering tools for producing airplanes.

Following World War II, I had the good fortune of working closely with both Dutch Kindelberger, the North American chief executive, and Lee Atwood. The two made a perfect team. Dutch, the dynamic leader, dropped and broke a few platters during the early days of long-range missile and space history. Fortunately, Lee quietly mended each of Dutch's broken platters. Lee used his technical vision and managerial skills to establish his company as an indispensable national asset in new high-technology fields such as rocket propulsion, intercontinental ballistic missiles, and the Apollo moon-landing program. In 1960 he had become chief executive officer of North American Aviation at the retirement of Dutch Kindelberger, and in 1962 became chairman of the board.

The quarter century that followed World War II saw an explosion of science and technology. It required great risks that were fully justified and were a major factor in bringing down the Berlin Wall and winning the Cold War. I speak from personal experience of this most challenging period. There is no question in my mind that Lee Atwood was a major contributor to winning the Cold War.

It is perfectly clear by his record that he was an engineer at heart. This is clear from his outstanding contribution during World War II, followed by his postwar aviation record and by his outstanding long-range missile and space contributions. For example, Lee insisted throughout the Cold War that engineers were the nation's primary defense. Trying to maintain military supremacy “man for man and gun for gun” against countries with exploding populations, he said in a 1955 interview, could bankrupt the United States.

Lee Atwood was a hands-on aviation leader for forty-two years, beginning when he joined the Army Air Corps at Wright Field in Dayton, Ohio, straight out of college in 1928. Lee in every respect earned the honors and awards that he received during his lifetime. Among them were:

- Presidential Certificate of Merit given by President Truman for contributions during World War II – 1948;
- University of Texas, College of Engineering, Distinguished Graduate Award – 1960;
- National Aeronautics and Space Administration Public Service Award – 1969;
- Air Force Association Hap Arnold Trophy – 1970;
- National Aeronautic Association Elder Statesman of Aviation Award – 1976;
- American Institute of Aeronautics and Astronautics, Wright Brothers Memorial Lecturer – 1976;
- National Management Association, Management Hall of Fame – 1982;
- National Aeronautic Association Wright Brothers Memorial Trophy – 1983;
- National Aviation Hall of Fame Enshrinement Medal – 1984;
- National Medal of Technology given by President Reagan, who said "America's greatest resource is the genius of its people" – 1988; and
- International Aerospace Hall of Fame – 1984.

Honorary degrees:

- Eng.D., Stevens Institute of Technology;
- LL.D., Pepperdine University and Clark University;
- Litt.D., Wayland Baptist College; and
- Sc.D., National University.

He was an honorary fellow in the American Institute of Aeronautics and Astronautics, a member of the Air Force Association, and a member of the National Academy of Engineering.

No one I know is more deserving of the honors and awards bestowed upon J. Leland Atwood over his years of service to his country. We as a nation should listen carefully to what may well be his most important words of advice as we move into the twenty-first century: “There appears to be only one course that will provide security without economic ruin,” he said, “and that is to maintain qualitative superiority. The research, design and industrial engineering necessary to provide superior weapon quality on a continuing basis is the most challenging problem engineers have to face. It is literally a problem of survival.”

PHILLIP BARKAN

1925–1996

BY THOMAS H. LEE

PILLIP BARKAN, professor of mechanical engineering at Stanford University since 1977 and former leader in research and development at the General Electric Company, died on June 21, 1996. He was survived by his wife, Susan; his daughter, Ruth Barkan; and his son, David, and daughter-in-law, Nancy Melrose.

Phil was born in Boston, Massachusetts, on March 25, 1925. He earned a bachelor's degree in mechanical engineering at Tufts University in 1946, a master's from the University of Michigan in 1948 and a Ph.D. from Pennsylvania State University in 1953. While at Penn State, he also worked first as a research assistant and then as assistant professor of engineering research. In 1953 he joined GE as a senior research engineer in the Switchgear and Control Laboratory in Philadelphia. He was promoted to the position of manager for mechanical engineering and circuit interruption in 1965 and to the position of manager for applied physics and mechanical engineering in 1972. He left GE in 1977 to become a professor in mechanical engineering at Stanford University, where he served until his death.

Most of the fifty-one patents issued in his name came during the period between 1953 and 1977. Therefore, it is important to review his inventive work during that period. Even though circuit breakers have been in existence for a long time, a great number of advances occurred in that period in three different areas:

1. The dynamics of the mechanical operation systems.
2. The dynamics of fluid mechanics and high-pressure arcs in circuit breakers during the important but brief period of circuit interruption.
3. The development of new types of circuit breakers

Phil made major contributions in all three areas. In the area of operating mechanical systems, he introduced scientific method into the design of mechanical linkages. For that effort, his operation was designated as the Center of Research for Transient Dynamics by the General Electric Research Laboratory. There were about ten such centers in the General Electric Company and their responsibility was to share their competence throughout the company with organizations that have comparable problems. While such a designation is an honor, the real purpose is to strengthen GE's capabilities in key technical areas.

Circuit interruption, although an important function in the operation of modern power systems, was and still is more an art than a science. A great deal of cut, try, and testing was needed, because the physics of high-pressure arcs is still far from adequate to allow designers of circuit breakers to handle their job analytically. Some of the phenomena involve high-pressure turbulent flow in a very complex way: even qualitative understanding can be invaluable to development engineers. In applying the science of fluid dynamics and the science of high-temperature plasma, Phil was able to bring understanding to the dynamics in oil circuit breakers, which helped designers tremendously.

Phil was also a major contributor to the development of vacuum circuit breakers, an idea conceived by Milikan and Sorenson in the early 1920s, but the commercial development of which did not occur until 1960. To bring that idea into practicality, one had to rely on the knowledge of rapid diffusion in a freezing liquid mixture. This made possible the invention of a special alloy, which was needed to bring vacuum circuit breakers to reality. I had the pleasure to be a close associate of Phil's because I was in charge of that project. Phil and I were co-inven tors of that alloy. As the person in charge of research and development for that group in GE of which Phil's operation was a part, I have said to many senior GE executives that Phil Barkan was one of the most creative engineers we have seen in GE for many years. Of course, GE demonstrated its appreciation by giving him three managerial awards and made him the first recipient of the Charles P. Steinmetz Award, the highest honor for technical excellence in GE. In 1972 the Institute of Electrical and Electronics Engineers designated him a fellow for contributions to circuit breakers, particularly in the areas of dynamics of mechanical systems and protection. Recognition of his talents and contributions finally culminated in his election to the National Academy of Engineering in 1980.

The best way to describe Phil's work, I believe, is to quote some of his students who participated in his memorial service:

A group of four students said, “In Stanford, he basically started all over again. Phil continued to innovate and look for new challenges. While at Stanford, he moved into concurrent engineering and design for manufacturability and became a leading expert in the field and a highly sought after speaker in industry, where he maintained close ties. He developed Stanford's curriculum in design for manufacturability, a cornerstone in the mechanical engineering graduate design program, and passed on his successful design course sequence to one of his former doctoral students. His other former doctoral students are either successfully teaching in universities or are implementing his concepts in leading industry and government positions and are the best examples of the “rewards” he came in search of at Stanford University.”

Another student said, “Phil's course in design for manufacturability was the foremost course of its kind in the country. At the time he started his early work in manufacturing, there was desperate interest on the part of industry to have good courses that would help allow industry to reduce manufacturing costs through the design process.”

Another student said, “Phil was one of the greatest designers I have ever met. If his instinct didn't point the way to an answer, Phil would immediately start brainstorming ideas on a yellow sketch pad (if he could find it), do back-of-the-envelope calculations, and think of quick experiments to get to the right answer."

Finally, I will quote what the dean of GM's Technical Education Program said, "General Motors' association with Phil Barkan spanned a decade. Ten years ago, he listened to leaders at GM discuss high-level concepts about designing for manufacture, and later built these concepts into a two-quarter graduate-level course. Phil Barkan was a pioneer in design for manufacturability. The course, which was first delivered eight years ago, is still unequaled today by any other university. This forward-thinking course has been critical to GM's success as a manufacturing company."

I will end this tribute by talking about Phil as a person. I would like to start by recalling a conversation I had with my wife after my initial interview with the Switchgear and Control Laboratory. Phil joined that organization in 1953, and I was interviewed for a parallel level job to develop vacuum circuit breakers. Phil was one of the interviewers. After spending an afternoon with him, I told my wife that I had met a person with whom I would really like to associate. He was not only technically smart but a real man of principle. The fact that we were supposed to work closely together greatly influenced my decision to accept the offer. Even though, later, I was given the responsibility of running the entire laboratory, we remained close friends even after I was transferred to the GE headquarters and Phil left for Stanford in 1977. Before 1974 we used to play tennis together every week.

Phil was active in school boards in Rose Valley and was president of the Middletown Township Democratic Club. Phil's first wife, Hinda, who died of cancer shortly after he joined Stanford, shared much of Phil's dedication to civic activities. Of course only those of us who knew Phil in the early days remember how Phil and Hinda shared their interest in nature and in their sense of personal responsibility to society and to the needy.

His students testified to his compassion for people in a different way. Let me quote just a couple:

"Phil was a wonderful human being. He offered me respect, affection, and support throughout our association."

"Phil was immensely generous with his time and willingness to help and be involved in the finest detail. Phil's tremendous commitment to his students and the teaching process, even with his progressing illness, will never be forgotten."

This was the Phil I knew.

MARCEL LOUIS J. BARRÉRE

1920–1996

BY STANFORD S. PENNER

AFTER A DISTINGUISHED CAREER AS A RESEARCHER, teacher, and administrator, Marcel Barrére died of a heart attack at his vacation residence in Saint Tropez, France, on August 25, 1996, in the company of his lifelong companion, scientific collaborator, and spouse, Simone. He is also survived by two grandsons for whom Marcel and Simone had provided a home since the untimely death of their only daughter, Hélène, about five years ago.

Marcel was born on August 19, 1920, at Saint-Lys, France. He obtained his first degree from the Université de Toulouse in 1942 and his doctorate at the Centre Supérieure de Mécanique de Paris in 1951. He began his professional career soon after the end of World War II at the Office National d'E'tudes et de Recherché Aéronautique (ONERA), (later Aérospatiales) serving successively as research engineer (1944 to 1954), head of a research group (1958 to 1970), chief of the Chemical Propulsion Division (1958 to 1970), coordinator for propulsion systems (1970 to 1972), head of the Energetics Department (1972 to 1979), director of research (1979 to 1985), and subsequently as senior adviser until the time of his death. He was a frequent and widely acclaimed teacher during his periodic services as professor lecturing on combustion and rocket propulsion at the École Nationale Superieure de l'Aéronautique (1958 to 1970), on the same topic renamed (by Theodore von Kármán) aerothermochemistry at the École Nationale des Mines de Paris

(1965 to 1974), on thermoeconomy at the Institut National Polytechnique de Toulouse (1970 to 1975), and on combustion and transport phenomena at the Université Libre de Bruxelles (1960 to 1985). He also carried an academic title at the École Polytechnique de Paris (1970 to 1984).

Marcel was a tireless worker, a highly original researcher, an outstanding teacher, a superb administrator, and a kind and generous friend to his numerous students, associates, colleagues, and visitors. These traits and abilities allowed him to serve in many important capacities as his research interests encompassed larger areas of knowledge, including energy uses and supplies, renewable energy technologies and irreversible thermodynamics, as well as his primary areas of research in combustion and propulsion. He was author or coauthor of seven books and 117 original research papers.

His administrative services included terms as vice-president of the International Academy of Astronautics, president of the International Aeronautical Federation, chairman of the French Section of the International Combustion Institute, president of both a solar energy laboratory and a wind energy committee. The importance of his original research contributions was acknowledged by election as a corresponding member of the French Academy of Sciences (mechanics section), foreign associate of the National Academy of Engineering, and full member of the International Academy of Astronautics. He served on editorial advisory boards and as associate editor of several publications. His list of honors attests to the importance of his contributions and includes the following: Chevalier de la Légion d'Honneur, Officier du Mérite National, Officier des Palmes Académique, Médaille de l'Aeronautique, Médaille de l'Université Libre de Bruxelles, and Prix Plumey (1960) and Prix Paul Doistau-E'mile Blutet (1975) from the French Academy of Sciences.

Marcel became an internationally recognized leader of the combustion and propulsion research and development community during the early 1950s. He did so with his first appearance at a conference of the NATO Advisory Group for Aeronautical (later Astronautical) Research and Development (AGARD), which had been formed under the direction of Theodore von Kármán during the early 1950s. As one of the first two members of the U.S. contingent of the Combustion and Propulsion Panel, I remember well the beautiful lecture Barrére delivered so clearly and detailed so explicitly that no translator was needed to amplify his meaning. In his early lectures, Marcel developed the approach to the superb 846-page exposition, *Rocket Propulsion,* of which he was senior author in collaboration with his Belgian colleagues and friends (A. Jaumotte, B. Fraeys de Veubeke, and J. Vandenkerckhove). This publication appeared during the period 1960 to 1962 in French, German, and Russian editions and remains a classic in the field to this day. Of comparable impact was the 791-page 1967 AGARD publication on *Fundamental Aspects of Solid Propellant Rockets* (coauthored with F.A. Williams and N.C. Huang). These publications were soon followed by other distinguished monographs dealing with shock waves and various combustion topics. Barrére's research publications during the period 1952 to 1990 are pacing summaries of our improving understanding of combustion and propulsion phenomena.

During the last decade of his career, Marcel became interested in energy management, energy supplies, and associated issues and published a number of incisive contributions on these topics while maintaining his active research programs on propulsion issues and advances, turbulent combustion, and other frontier research areas of aerothermochemistry.

Marcel and his wife, Simone, were wonderful hosts and made many visitors enjoy the special charms of Paris from a glass of nonalcoholic sherry at Le Lapin a Gil to a gourmet dinner on the West Bank. His calm, considerate, intelligent, and efficient management of personal and business affairs will be remembered and missed by his many friends and colleagues. His scientific and research contributions will continue to enrich the lives of his former students and collaborators and benefit new generations of researchers who study his publications.

ROBERT BROMBERG

1921–1999

BY PETER STAUDHAMMER

ROBERT BROMBERG, thermodynamicist, pioneer architect of atmospheric reentry, and leader in aerospace engineering, died on January 25, 1999, at the age of seventy-seven.

Bob was elected to the National Academy of Engineering in 1969 with the citation: *For engineering achievements in space systems, plasma and microwave processes, remote sensing, instrumentation and their application to commercial systems.* Because of concern with military secrecy at the time, Bob's most significant contributions to the understanding and development of missile reentry systems remained silent in his citation. His work was not only of immediate value to the national defense but also provided the basic understanding for the later development of reentry vehicles to return astronauts from space missions. For his direct technical contributions and his subsequent engineering leadership, he was recognized by election as a fellow of both the American Institute of Aeronautics and Astronautics and the American Association for the Advancement of Science and by membership in the National Academy of Engineering.

Bob was born in Phoenix, Arizona, on August 6, 1921, to Max and Rae Bromberg, both emigrants from Russia. Early on, Bob developed an interest in mechanics and electronics and became a ham radio operator. From these early interests stemmed a strong desire to pursue a career in engineering. When he graduated from Phoenix Union High School in 1939, his family moved to Berkeley, California, so that he and his brother, Harold, could attend the University of California, Berkeley.

At Berkeley, Bob majored in mechanical engineering, with emphasis on thermodynamics and heat transfer. He worked under L.M.K. Boelter, later to be the founding dean of the College of Engineering at the University of California, Los Angeles. In 1943 he graduated with a B.S. degree. That same year he married Hedwig Ella Remak, an émigré from Germany, whom he had met while a student at Berkeley. Bob and Hedy had their first daughter, Robin Jean, in 1945. The following year, Bob received his M.S. degree in mechanical engineering from UC-Berkeley and then moved to UCLA as a lecturer and Ph.D. candidate. He continued his work in heat transfer, concentrating on thermal radiation, boiling, and associated instrumentation. He also became the project leader for the design and construction of an analog thermal analyzer capable of simulating and solving complex conductive, convective, and radiative thermal transport problems.

While at UCLA, Bob and Hedy continued to build their family with a second daughter, Janice Lynn, born in 1948, followed by a son, Kenneth, in 1951. The family was to remain the inspiration and the single most important part of Bob's life.

In 1951 Bob received his Ph.D. in engineering from UCLA. His thesis, titled, *A Thermodynamic Analysis of Some Thermoelectric Systems,* foreshadowed his lasting interest in energy conversion and in the application of thermodynamics to a wide range of engineering problems. He remained at UCLA as assistant and then associate professor of engineering for the next three years. He also served as assistant director of the UCLA Institute of Industrial Cooperation, with oversight for a wide range of externally supported research activities in the College of Engineering.

In 1954 Bob joined the Ramo-Wooldridge Corporation (later to become TRW) as a member of the technical staff. This was a critical time for the defense of the United States. The USSR had achieved making its own atomic bombs and was then embarked on building an intercontinental ballistic missile (ICBM) for bomb delivery to the U.S. mainland. In response, the United States started its own ballistic missile development program and charged Ramo-Wooldridge with systems engineering and technical direction. Bob came to join that national effort.

One of the most difficult and unresolved problems of the ICBM was reentry of the missile back into the earth's atmosphere. At that time, aircraft had flown a little above Mach 1, but reentry required some twenty times as high a Mach number, with shock-induced temperatures far above the capability of any solid materials. The challenge was to understand—from theory, as no experimental data existed—what the reentry conditions would be and how the nose cone could survive.

Though part of a larger team, Bob was at the center of the issue, developing models for shock dynamics, thermochemistry, and convective and radiative heat transfer. Bob was particularly central to calculating boundary layers and heat transfer in the presence of ablation and ionization. His work was significant in completing the reentry vehicle development on schedule, thereby giving the U.S. a ballistic missile capability more than a year ahead of the USSR—a crucial advantage that kept the Cold War cold.

The understanding of hypersonic flow and heat transfer from the ballistic missile reentry problem formed the foundation for the design of the reentry bodies later used on the Mercury, Gemini, Apollo, and space shuttle vehicles. It also contributed greatly to the development of the theory of hypersonic boundary layers, reacting flows, high-density plasmas, and ablation.

Beyond his direct personal contributions, Bob also demonstrated his abilities for engineering leadership. In fact, what really set Bob apart throughout his career was his keen ability to see the crux of issues, to imagine constructive approaches, and to motivate teams to work together. He rose rapidly in management positions at TRW, first in direct technical management and later in general management. He had his first supervisory position in 1957. By 1962 he was appointed vice-president, first of the Mechanics Division, and progressed to the Applied Technology Division that encompassed aerosciences, propulsion, software, and information systems and TRW's central research laboratory. Under his management, the company developed the

Apollo Lunar Module Descent Engine that soft-landed the U.S. astronauts on the moon, the Viking Biology Instrument that searched for life on Mars, various other instruments for Venus, Mars, Jupiter, Saturn, and Earth observation, and through the research laboratories launched TRW's work in high-energy lasers, high-speed gallium arsenide microelectronics, optoelectronics, and superconductive electronics. In each of these areas, the company achieved leading national stature. Bob retired from TRW in 1982 as vice-president for research and engineering of TRW's Space and Defense Group, where he guided the overall planning and direction of the group's research and development program and served as its principal interface to the external community.

Throughout his life, Bob was deeply concerned with engineering education. As reflected in his own work, Bob advocated broad, fundamental understanding as the core of engineering practice. He was a member of the American Society of Engineering Education, a trustee of the UCLA Foundation, and chairman of the University of California Engineering Advisory Council. He was honored by being named the 1969 UCLA Engineering Alumnus of the Year.

To all of us who worked with Bob Bromberg, he was a constant inspiration. His enormous breadth and depth across practically all fields of engineering made him both a sought-after counselor and a formidable opponent, should there be a difference in views. But it was just these differences that created new understanding and learning for us all. It is with great personal sadness, but also with extreme professional pride, that we observe his passing.

G. EDWIN BURKS

1901–1994

BY PHILLIP S. MYERS

GEORGE EDWIN (ED) BURKS, former vice-president of research and engineering at Caterpillar, Inc., died March 16, 1994, at Methodist Medical Center in Peoria, Illinois. He was a member of the Westminster Presbyterian Church, where memorial services were held. His body was donated to medical science. He was survived by his wife, Chloe Bernice Burks, and several nieces and nephews. He was preceded in death by four brothers and one sister.

Ed was born on April 10, 1901, in Phillipsburg, Montana, to Frederick Carlyle and Elisabeth Fulton Gabell Burks. He attended grade school and his first two years of high school in Phillipsburg, Montana. He finished his last two years of high school in San Francisco. Circumstances dictated that he obtain his formal education beyond high school primarily at night—he went to night school for seven years. He took extension courses in engineering at the University of California. In 1972 he was awarded an honorary doctoral degree from Bradley University in Peoria, Illinois. In 1961 he was given honorary membership in Pi Tau Sigma and in 1964 an honorary membership in Tau Beta Pi. In addition to his engineering and personal skills, he was a talented writer, producing many technical and nontechnical papers.

In 1920 Ed started his engineering career as a draftsman for the Western Telegraph Company in San Francisco. In 1923 he became a designer for the Schmeizer Manufacturing Company in Davis, California, where he worked until 1928, when he became a designer and field engineer for the Western Harvester Company in Stockton, California.

In 1929 he started his thirty-eight-year career with Caterpillar, Inc., as a member of their engineering staff in the San Leandro plant. In 1930, by marrying Chloe Bernice Schweitzer in Davis, California, he started another career that was to last until his death.

At San Leandro, Ed advanced from chief draftsman to supervisor of experimental and research engineering. In 1938 he was offered, and accepted, the position of assistant chief engineer, engine design, at Caterpillar headquarters in Peoria, Illinois. In 1942 he was promoted to chief engineer. In 1954 he was promoted to director of engineering and research and in 1955 to vice-president of engineering and research, a position he held until his retirement in 1967. During the twenty-five years that he was the predominant factor in Caterpillar engineering, the company experienced a tenfold growth in sales and a twentyfold growth in earnings. The output of heavy-duty diesel engines used in earthmoving equipment increased by four to fivefold through a continuing program of development of each component, continuing redesign, and laboratory research. Ed led the effort with a number of innovative patents. After his retirement he continued as a consultant to Caterpillar, Inc. Ed has contributed, perhaps more than anyone else, to Caterpillar's international stature and to U.S. leadership in the field of earthmoving machinery. This technology has been of great importance both in peace and in war.

Ed also found time to serve his profession through his publications and his service in professional engineering organizations. He was a fellow of the Society of Automotive Engineers and in 1966 was elected as national president. He was a member of the American Society of Mechanical Engineers, American Society of Metals, American Ordnance Association, and Corps of Engineers Advisory Council. In 1978 he was elected to membership in the National Academy of Engineering.

Ed also used his engineering background and good judgment to serve his country. In 1960 he served on the Advisory Commit tee for Construction for the state of California. He chaired a United States Scientific Advisory Committee from 1966 to 1968. From 1969 to 1970 he chaired a United States Special Committee to study the M551 tank. From 1970 to 1972 he served on the United States Scientific Advisory Committee to the Secretary of Defense. From 1970 to 1976 he served on the United States Construction Safety Advisory Committee to the Secretary of Labor.

Ed also contributed time and resources to society. He served on the board of trustees of Bradley University from 1956 until 1988 and again from 1989 to 1994. He was vice-chairman of the board in 1979. In 1990 he and his wife received the Bradley University President's Award. The Burks Design Center in Jobst Hall at Bradley University was named in his honor in 1993. He served as adjunct professor of senior engineering students. The G.E. Burks Religious Studies Scholarship was established in his honor. His philanthropic gifts to Bradley University total more than $330,000 from 1971 through 1994. Other philanthropic interests included WCBU public radio, the Bradley University Chiefs Club, Boy Scouts of America, and Westminster Presbyterian Church.

PAUL F. CHENEA

1918–1996

BY CHARLES AMANN

DR. PAUL FRANKLIN CHENEA died in Wayne, Maine, on March 25, 1996. During the early part of his career, he gained recognition as a distinguished university educator and administrator, rising to the level of vice-president for academic affairs at Purdue University. He then moved into industry, where he spent thirteen years as vice-president of the General Motors Research Laboratories. He was born in Milton, Oregon, on May 17, 1918.

Dr. Chenea began his college education at the University of California, Berkeley. He graduated in 1940 with a bachelor's degree in civil engineering and became a project engineer with Contractors Pacific Naval Air Bases. His duties involved stress analysis and structural design. On January 17, 1941, he married Katherine L. Bullock.

That same year he joined the U.S. Army as a second lieutenant, serving with the Ordnance Department. His initial assignments placed him on the West Coast and in Alaska. He was later transferred to the office of the Chief of Ordnance in Detroit. He separated from the army in 1946 with the rank of lieutenant colonel.

Upon leaving the army, Dr. Chenea enrolled in graduate school at the University of Michigan. At the same time, he served as a part-time instructor to help the university to cope with a large influx of World War II veterans studying engineering under the GI Bill. He taught courses in statics, dynamics, strength of materials, fluid mechanics, and vibration analysis. He earned the M.S. degree in engineering mechanics in 1947, followed by a Ph.D. in the same field in 1949. The topic of his doctoral thesis was “The General Theory of a Continuous Medium.” He continued at the University of Michigan as an assistant professor and was promoted to associate professor in 1950.

In 1952 Dr. Chenea became a professor of engineering mechanics at Purdue University. From 1953 to 1956 he served as assistant dean of engineering and also head of the division of engineering sciences. In 1956 he was named associate dean of engineering, and the following year accepted the additional assignment of acting head of electrical engineering. During the 1958-1959 academic year, he was the Webster Visiting Professor in the Electrical Engineering Department at the Massachusetts Institute of Technology. Upon his return to Purdue, Dr. Chenea started a two-year assignment as head of the School of Mechanical Engineering, and from 1960 to 1961 served concurrently as head of the Division of Mathematical Sciences.

From 1961 to 1967 Dr. Chenea was vice-president for academic affairs. In that position he was involved in the selection and promotion of faculty, supervised the university libraries, guided the audiovisual center, and oversaw the development of Purdue's microwave television facilities. During the 1962 – 1963 academic year, he was also acting dean of the School of Science, Education and Humanities.

During his years in academia, Dr. Chenea participated on many national committees, often as chairman. Among the organizations he served were the American Society for Engineering Education, the National Science Foundation, the American Society of Civil Engineers, and the National Research Council. He was also a consultant to various government and industrial organizations. He authored or coauthored two books and a number of papers in the fields of engineering mechanics and engineering education. In 1959 he was awarded a patent on a separator for an antifriction bearing.

When Dr. Chenea formally left the academic world in 1967, Purdue President Fred L. Hovde said of him, “During the postwar years, no other individual has served Purdue University with greater distinction and academic leadership than Dr. Paul Chenea. He goes . . . with the sincere thanks of the entire university constituency for his remarkable ability to generate and guide the process of continuous improvement of every function of this university with which he was directly or indirectly concerned."

John W. Hicks, executive assistant to the president at Purdue, said, "The best way to get something accomplished was to tell Paul it hadn't been done yet."

Felix Haas, Purdue's executive vice-president, said of Dr. Chenea, "He had outstanding intellectual qualifications and communications skills, and he understood what makes a university tick."

Upon leaving Purdue, Dr. Chenea joined the General Motors Research Laboratories at the Corporate Technical Center in Warren, Michigan, as scientific director. In that position he was responsible for technical programs of both the mathematical sciences and the basic and applied sciences groups. In 1969 he rose to the position of vice-president of research, the post he held until his retirement in 1982.

In his first year as vice-president, Dr. Chenea articulated his management style: "Recruit first-rate talent. Indicate the direction you want them to go. Then get out of the way." That was indeed the way he operated. He was proud of the fact that during his tenure, the population of Ph.D.'s on staff rose from ninety-eight to 344.

During the first year of his vice-presidency, he also said, "General Motors is irrevocably committed to finding solutions to automotive emissions at the earliest possible time. And in seeking solutions we will have no hesitation in using a power source other than the internal combustion engine, if it will meet the needs of our customers, at a price they can pay, and still solve the emission problem."

Dr. Chenea pursued that promise. Thanks in large measure to his dedicated support, his researchers were able to make significant contributions to the production divisions of the corporation. To satisfy exhaust emissions standards, they provided important inputs on combustion-engine improvements, the ef fects of fuel and lubricant compositions, the chemistry and physics of the oxidizing catalytic converter, and the next-generation three-way catalytic converter and its essential closed-loop electronic control system. In case such measures should come up short, alternative propulsion systems that avoided the intermittent combustion of the piston engine—such as the gas turbine, the steam engine, and various electric drive systems—were studied. Emissions reactions in the atmosphere, emissions transport, and air quality were studied to ensure that emission control measures were satisfying their intent.

When the 1973 oil embargo occurred, evaluation of alternative fuels was intensified. As fuel-economy standards were promulgated, researchers provided analyses of vehicle energy consumption, a better understanding of aerodynamic drag, and design techniques for reducing vehicle weight. The direct-injection gasoline engine became a subject of intense investigation. When one of GM's divisions embraced the diesel engine as an approach to improved fuel economy, studies of particulate matter and its health effects were undertaken. In addition to these many environment-centered activities, Dr. Chenea ensured that his researchers remained on the forefront in safety, transportation studies, computer technology, and materials.

Dr. Chenea was a good listener. His broad academic background enabled him to follow and evaluate the wide variety of projects being carried out at GM. Whenever possible, he encouraged the use of analytical approaches to problems. Expanded application of finite element analysis and advances in computational fluid dynamics marked his term. Within corporate constraints, he provided researchers with the facilities, instrumentation, and modern equipment needed to finish chosen projects. He strove to transfer fresh research technologies into the production divisions of the corporation as those technologies became ready.

Dr. Chenea served on the board of trustees for Rensselaer Polytechnic Institute, the Thomas Alva Edison Foundation, Hutzel Hospital in Detroit, and the Engineering Society of Detroit. He has been on the board of visitors at the Duke School of Engineering and on visiting committees for the engineering department at the Massachusetts Institute of Technology, the School of Engineering at Oakland University, the Mechanical Engineering Department at the University of Michigan, the Division of Engineering at the California Institute of Technology, the School of Engineering at Purdue University, the School of Engineering and Applied Science at the University of Virginia, and the School of Civil Engineering at Princeton University. In 1969 Dr. Chenea was elected to the National Academy of Engineering in recognition of his contributions to creative machine and systems design. He served on the Academy's governing council from 1973 to 1975. He was also a member of the American Society of Civil Engineers, the American Institute of Physics, the Society of Automotive Engineers, the American Society for Engineering Education, and the Directors of Industrial Research. He was made an honorary member of the American Society of Mechanical Engineers and a fellow of the American Academy of Arts and Sciences, the Engineering Society of Detroit, and the American Association for the Advancement of Science. He was inducted into Sigma Xi, Tau Beta Pi, Chi Epsilon, Sigma Pi Sigma, and Pi Tau Sigma. He was a registered professional engineer in Michigan and Indiana.

Several honorary degrees were bestowed on Dr. Chenea: Sc.D. from Rose Hulman Institute, D.Eng. from Purdue University, D.Eng. Science from Tri-State College, D.H.L. from Clarkson College of Engineering, and D.Eng. from Drexel University. He received an Outstanding Achievement Award from the University of Michigan, a Distinguished Professional Achievement Award from the College of Engineering at that university, and was named a Distinguished Engineering Alumnus by the Alumni Society at the University of California, Berkeley.

Dr. Chenea was an avid reader and maintained a large home library. He and Mrs. Chenea were world travelers. As a wood-working hobbyist, he had a well-equipped home workshop. He also kept a collection of guns. He was an enthusiastic hunter of gamebirds. On occasion, guests at the Chenea home were treated to a meal featuring the fruits of his marksmanship.

When Dr. Chenea retired in 1982, Alex Mair, GM's vice-president in charge of the technical staffs, said, “Probably the most significant technical advances that occurred during Paul's period were the highly successful use of catalysts and electronic engine controls to reduce exhaust emissions . . . (and) computerized methods for predicting and optimizing structural integrity and crashworthiness of GM vehicles."

According to William G. Agnew, who served under Dr. Chenea as technical director, he brought excellent balance to his job, "bringing together a perfect blend of academic, scientific, and practical experience."

Upon retirement, Dr. Chenea announced his intent to move to the Southwest. There, he said with characteristic humor, he wanted to "fish the streams empty and decimate the quail." He and Mrs. Chenea built a new home on the edge of a forest near Prescott, Arizona. Mrs. Chenea died in 1992. Dr. Chenea finished his days in Maine. At the time of his death, he was survived by a daughter, Susanne Williams, of Northport, Michigan; a son, Paul, Jr., of Wayne, Maine; six grandchildren and two great-grandchildren.

JEROME B. COHEN

1932–1999

BY STEPHEN H. CARR, KATHERINE FABER, LYLE H. SCHWARTZ, AND JULIA WEERTMAN

JEROME B. COHEN, Englehart Professor of Materials Science and gineering and former dean of the McCormick School of Engineering and Applied Sciences at Northwestern University, died at home November 7, 1999. He was sixty-seven.

Jerry was born in Brooklyn, New York, on July 16, 1932. He received his B.S. and Sc.D. degrees in metallurgy at Massachusetts Institute of Technology. He cut his teeth on diffraction in Professor Warren's group at MIT, whose lab was the first in this country to use diffraction broadly in the study of defects in materials. He then went on to do a postdoc with André Guinier, the brilliant French physicist. Guinier, together with the English scientist Preston, was the first to use diffraction to study defects in aged aluminum copper alloys. These studies revealed the coherent zones of copper atoms that give rise to the age-hardenable behavior of these important structural alloys. These defining experiences with two of the giants in diffraction were to influence the career-long course of Jerry Cohen's research on the structure of materials.

Jerry had a special zeal for research and extending the power of x-ray diffraction in the study of all materials. Naturally his students had to take the appropriate courses first, and those courses, with their independent lab experiments, were killers. Students from other advisers in the materials department were no surprise in Jerry's labs, but students from physics, chemistry, several engineering departments, and (later) biology also came to know diffraction as a versatile tool with quantitative sensitivity appropriate to their problems. As for his own graduate students, they often would find little notes on their desks in the morning with his comments about their previous day's work and suggestions of options to consider for the next day. It took them all some time to realize that they were being tested for maturity, for their ability to differ with Cohen's positions (he wasn't *always* right), and for their skills in setting their own directions as a measure of their readiness for the Ph.D.

Cohen's research may be characterized as thematic; he picked broad topical areas and probed them in depth, pushing as far as the technology of the time would allow. Sometimes he moved on, only to return later when the x-ray scattering technology had improved again. In this trait he was no different than many other researchers, but in the number of themes and the innovative approaches he mastered, Cohen was remarkable. An incomplete list of these themes includes short-range order, clustering (these two merged into a broad study of local atomic arrangements in ceramics and alloys), stacking faults and twins, residual stress in metals, structure of catalysts, and (in collaboration with others) defects formed as a result of deformation at high temperatures. He authored or coauthored four textbooks, and he coedited another two. His name appears on more than 300 publications in these areas. His insight into intellectual property issues came first-hand as a result of his development of a portable x-ray device for measuring residual stresses in the field (e.g., the Alaska oil pipeline). This instrument is still sold commercially. He computer-automated the apparatus in his labs long before most others; he used facilities available at various laboratories to do neutron diffraction studies; and he used extensively the various synchrotron x-ray sources. Following his years as engineering dean, he had looked forward to working at the Advanced Photon Source at nearby Argonne National Laboratory. His energy and innovative ideas had already been instrumental in the development there, together with DuPont and Dow, of the Dupont-Northwestern-Dow Collaborative Access Team (DND CAT) line.

Undergraduate education was a passion with Cohen. The Materials Science and Engineering Department offered its first formal undergraduate degrees while he was chairman of the department. He was the driving force behind an experimental effort in group teaching which began in 1970 and which challenged the traditional methods of teaching math, physics and chemistry as independent subjects. Cohen had to browbeat a conservative faculty to accept his ideas. With or without them, he was determined to transform the freshman engineering experience. In this first great experiment, he marshaled the energies of several faculty members in three engineering departments and a few colleagues in math and physics. Teaching was done in teams, with freshman courses reorganized so that math, physics, and engineering were taught for integral blocks of time. Topics were properly sequenced so that students could understand the value and interdependence of these diverse concepts. It was only an experiment, lasting a few years and touching only a fraction of each freshman class, but it was the precursor and motivator for Cohen's successful transformation of the undergraduate engineering curriculum while he was dean.

During Jerry Cohen's time as engineering dean at Northwestern, virtually every aspect of the programs was scrutinized and changed. As described by former Northwestern President Arnold Weber, “Cajoling, scolding, exhorting, he worked with the faculty to bring the McCormick School into the front ranks of engineering education and research enterprises.” The national reputation of the school grew steadily. The school's overall rank among all U.S. engineering schools in the *U.S. News and World Report* rankings rose from thirty-seven in 1990 to thirteen in 1998. Jerry Cohen was able to advance engineering at Northwestern to the point of being an “engineering school second to none”—the challenge put to the school in the 1940s by its major benefactor Walter P. Murphy.” The faculty improved in strength, with more than 60 percent of the current McCormick faculty recruited during his thirteen-year tenure. Women and underrepresented minorities were notably increased across all its ranks. The quality of the student body increased significantly under Cohen's leadership. McCormick attained the third highest percentage of African-American students in the "Big Ten" and one of the highest graduation rates of all engineering schools. The percentage of female students was the second highest among major engineering schools. Research activity, as judged from external support, grew by a factor of nearly three. He was a tireless fund-raiser, bringing in the needed $125 million for the Technological Institute building reconstruction. As former President Weber noted, "He skillfully managed the complex, often frustrating, process of transforming the Tech building from a Dickensian labyrinth to a modern engineering and science education facility which made a bold statement about the University's aspirations in these areas." A large annex building to house the Materials Science and Engineering Department was constructed. In curricular issues, Cohen was the driving force for the imaginative Engineering First *p*rogram, where students experience directly the elements of thinking as an engineer, rather than take a number of courses on basic subjects, each studied in isolation. "Jerry believed traditional engineering curricula turned people off," said Northwestern President Bienen. The undergraduate Cooperative Engineering Program breathed new life, with participation raised to nearly a third of the undergraduates. Working with the deans of other schools within Northwestern, Cohen helped to develop joint degree programs with other schools of the university: management, medicine, law, journalism, education, and the graduate school. An internship program and seminars on career development and intellectual property issues were initiated to enhance graduate programs.

We are fortunate to work in a profession that strives to recognize its leaders during their lifetime, and Jerry Cohen received such recognition in abundance. His awards include the American Institute of Mining, Petroleum and Metallurgical Engineers Hardy Medal in 1960, the George Westinghouse Award of American Society for Engineering Education for excellence in teaching and research in 1976, the American Society of Metals (ASM) International Henry Marion Howe Medal in 1981, the Barrett Award in X-Ray Diffraction in 1989, the Minerals, Metals and Materials Society (TMS) Institute of Metals Lecturer and Robert Franklin Mehl Award in 1992, and the Acta Metallurgica Gold

Medal in 1992. In 1993 Cohen was elected to the National Academy of Engineering and was made an honorary member of the Japan Institute of Metals in 1999. Cohen was elected to fellow status in both TMS and ASM International. In 1994 he received the honorary degree *Tekniks Doktor* from the Linkoping Institute of Technology in Sweden. Cohen served on the Academic Advisory Board of the NAE and on several National Research Council boards and committees. His professional society participation was capped by the presidency of the American Crystallographic Association in 1982.

Personally, Jerry Cohen enjoyed lifelong learning and “living on the edge.” His self-instruction on the piano and the classical harmonica (not too successful), his Porche racing (a hobby taken up rather late in his professional career), and his travels with his wife, Lois, to exotic locales (like the Arctic and the Galapagos Islands) left many wondering what was next. Indeed, his next adventure was to have been in a fighter landing on an aircraft carrier—yet one more indication of his trust in engineering and in the materials selection for a relatively small metal hook!

Jerry Cohen is survived by his wife, Lois, a daughter, Elissa Halpern, a son, Andrew, a sister, Rita Copperman, and four grandchildren. “Jerry loved Northwestern,” said Lois Cohen. “He was proud to be associated with the school for the past almost forty years. His contributions were legendary. There are not enough words to describe the loss his family feels.” As former Northwestern President Arnold Weber noted in the memorial service, “The deep void created by his sudden passing offers vivid evidence of the prodigious talents and expansive reach that Jerry Cohen brought to his family, friends, colleagues and Northwestern University. He served almost all of his professional career, more than forty years, on the faculty of Northwestern and was the finest representation of the values and traditions of the University.”


Neville G. W. Cook

NEVEL G. W. COOK

1938–1998

BY DOUGLAS W. FUERSTENAU AND RICHARD E. GOODMAN

A DISTINGUISHED EXPERT ON MINING and the mechanical behavior of rocks, Neville G. W. Cook, professor in the Department of Materials Science and Mineral Engineering of the University of California, Berkeley, died of cancer on March 3, 1998, at his home. Although he had suffered from non-Hodgkins lymphoma for a number of years, he remained professionally active essentially to the end of his life. He was known internationally for his contributions to rock mechanics, the design of deep mines, and study of underground nuclear waste repositories. A skilled teacher and researcher, Cook was also an able administrator, serving on many committees to help shape the College of Engineering, the Berkeley campus, and his field of study.

Born in Pretoria, South Africa, on January 29, 1938, Neville Cook received his B.Sc. degree in engineering in 1959 and his Ph.D. in geophysics in 1962 from the University of Witwatersrand. In his dissertation research, Neville initiated a study of the failure of the rock surrounding underground excavations, with particular reference to the seismic description of rock bursts in the deep mines of the Rand, including an inventive physical model for locating the sources of rock burst events.

Neville Cook's remarkably productive professional career began in 1962, when he served for a year as a research fellow in the Department of Geophysics and Geochemistry of the Australian National University, Canberra. During this time he wrote the classic book *Fundamentals of Rock Mechanics* with the distinguished Professor J.C. Jaeger, F.R.S. This book is now in its fourth edition. In 1963 and 1964 he served as visiting assistant professor of mining engineering at the University of Minnesota, and since 1968 was adjunct professor at that institution. In 1964 Cook was appointed the first director of the Mining Research Laboratory of the Chamber of Mines of South Africa, an industry collaborative-organization. During the next decade under his lead, the laboratory grew markedly. During 1974 Cook became the principal architect of the technical content for a much expanded research and development program for the Chamber of Mines as well as of the organization to handle it in the capacity of research and development consultant to the Chamber of Mines. In this role he was responsible for the overall technical research and development program and for the coordination of work done by its constituent laboratories. As inventor or coinventor, he was awarded some twenty patents, ceded to the Chamber of Mines. When Cook left the Chamber of Mines to join the Berkeley faculty, the Mining Research Laboratories at the Chamber of Mines had grown from its initial ten persons to 500. It was largely due to Cook's efforts that it had developed into one of the finest centers of excellence of its kind in the world.

In South Africa, Cook's professional activities ranged over many different aspects of mining and related disciplines, including rock mechanics, rock properties and rock breaking, the design of mining machinery and mining systems, rock bursts and earthquake seismology, and tectonophysics. Although most of Cook's original work was concerned with gold mining, during his latter years at the Chamber of Mines, his efforts also turned to coal mining. Neville Cook received international acclaim for his studies on rock bursts in the deep gold mines of South Africa. That program completely changed the thinking worldwide on the study of rock bursts and possibilities for the reduction of their severity. Beginning with that work, he remained a recognized authority on seismic source mechanisms.

Before coming to Berkeley, Neville Cook had already received several prestigious awards: the Central Mining-Rand Mines Award of the South African Institution of Mechanical Engineers, 1966;

Research Medal of the South African Institution of Mechanical Engineers, 1968; American Institute of Mining and Metallurgical Engineers Rock Mechanics Award (with Professor J.C. Jaeger), 1969; Gold Medal of the Associated Scientific and Technical Societies of South Africa, South Africa's premier award for outstanding contributions to science and technology, 1971; Research Medal of the South African Institution of Mechanical Engineers, 1975; and the Rand Mines Award of the Institution of Mechanical Engineers, 1975.

Berkeley had had a long tradition in mining education, and in 1975 the program in mining engineering was reinstituted in the Department of Materials Science and Mineral Engineering. A thorough and prolonged search brought Neville Cook to the department as professor of mining engineering. He quickly became involved in the development of new courses in mining and rock mechanics. Examples of courses were mining and mineral resources, rock breaking, fundamentals of mining engineering, fundamentals of rock mechanics, advanced rock mechanics, and energy and nonrenewable resources. Professor Cook's teaching was always characterized by well-organized, lucid, stimulating, and forcefully presented lectures. He was invited widely to present keynote lectures around the world. In 1988 he became the first holder of the Donald H. McLaughlin Chair in Mineral Engineering.

Upon arriving in Berkeley, he rapidly initiated an active research program, much of it through Lawrence Berkeley Laboratory where he was faculty senior scientist in the Earth Sciences Division. His first major research project involved rock mechanics problems associated with the underground storage of nuclear wastes. Examples of his subsequent research included subsidence resulting from underground coal mining, effects of stresses and pore fluids on the velocities and attenuation of seismic pulses, microcrack growth in crystalline rock, deformation and fracture processes around bore holes, the behavior of wetting fluids in porous and fractured rock, and transport in fractured rock. Professor Cook was actively involved in research with graduate students and postdoctoral researchers and exceptionally close to them. During his twenty-two years at Berkeley, nineteen stu dents completed their Ph.D. degrees under his supervision, and nine students their M.S. degrees.

In addition to his active role in teaching and research at Berkeley, Neville Cook put a great deal of energy into service, not only to the university but also to government and professional societies. He contributed a broad outlook and informed opinion that often uplifted the level of the discussion and approach being taken. On the Berkeley campus, he was chairman of the faculty of the College of Engineering, 1988 to 1990; vice-chair, Department of Materials Science and Mineral Engineering, 1990 to 1997; chair, Committee on Research, Berkeley Division of the Academic Senate, 1989 to 1991; member, Divisional Council, Berkeley Division of the Academic Senate, 1989 to 1993; director, Berkeley Engineering Fund, 1988 to 1990; and director, Berkeley Engineering Alumni Society, 1988 to 1990. In 1993 he was also named professor in the Department of Civil Engineering (where he assisted in developing a long-range plan), and in 1994, professor in the Department of Nuclear Engineering. From 1994 until shortly before his death, he also served as chair in the Energy and Resources Group at the University of California, Berkeley.

Neville Cook published extensively the results of his research—some 200 total publications. In addition, he served extensively on the editorial boards of professional journals in his field. He was editorial adviser, *International Journal Rock Mechanics Mining Sciences and Geomechanics Abstracts;* associate editor, *Journal of Geophysical Research;* member, editorial board, *International Journal of Geotechnical and Geological Engineering,* and member, advisory editorial board, *International Journal of Mining and Geological Engineering.*

After coming to Berkeley, Cook continued to receive recognition from his peers. In 1988 he was elected to the National Academy of Engineering. Subsequent awards included distinguished member, Society of Mining Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers; Basic Research Award, U.S. National Committee for Rock Mechanics; Jaeger Memorial Dedication Lecturer, 29th U.S. Symposium on Rock Mechanics; Basic Research Award, National Re search Council's (NRC) Commission on Geosciences, Environment and Resources' (CGER) U.S. National Committee for Rock Mechanics; and Müller Lecturer, Eighth International Congress of the International Society for Rock Mechanics, Tokyo, 1995 (the Society's Premier Award for outstanding contributions to the theory and practice of rock mechanics and rock engineering).

Neville Cook also found time to serve on national and international committees and panels on mines and rock mechanics and on setting environmental standards for radioactive waste management and respirable dust in mines. He did this until he was advised for health reasons not to travel by air. Neville Cook always ran well-organized, tightly controlled meetings—he was an excellent and dedicated committee chair. To illustrate the range of his role, we cite a few examples: chairman, NRC's National Materials Advisory Board Committee on Measurement and Control of Respirable Dust in Mines; member, CGER's Panel on the Waste Isolation Pilot Plant of the Committee on Radioactive Waste Management; member, CGER's U.S. National Committee for Rock Mechanics Panel for Defining Critical Rock Mechanics Research Requirements, Subpanel on Rock Fragmentation and Drilling (1979 to 1980); chairman, CGER's U.S. National Committee for Rock Mechanics Panel on Domestic and International Activities; chairman, CGER's U.S. National Committee for Rock Mechanics; member, Office of Nuclear Waste Isolation Earth Sciences Review Group, Battelle, Columbus, Ohio; member, Geosciences Advisory Panel, Los Alamos Scientific Laboratory, Los Alamos; member, Office of Nuclear Waste Isolation, Engineering Review Group; chairman, Workshop on the Containment of Underground Nuclear Explosions, Office of Technology Assessment, Congress of the United States; member, CGER's Board on Earth Sciences and Resources; and chair, joint CGER and Commission on Engineering and Technical Systems' Committee on Advanced Drilling Technologies. Cook controlled his time well and was able to do all of this while maintaining his university commitments.

Despite being devoted to his intellectual work, Cook pursued other interests. Early on he spent considerable time building a racing car that he had designed himself. The home-built car with Neville Cook at the wheel was the fastest in South Africa, helping him to earn the title of "South African Hillclimbing Champion." Throughout his life, Cook retained his love of cars and steam trains and continued to build them—often from the frame up. That mind of his always reasoned out solutions to problems, according to his wife, Jennifer, who once opened her dish-washer and found a brake drum inside. Neville had reasoned it was the best place to clean the drums on the car he was rebuilding.

Neville married Jennifer Reay in 1959. They had two children, a daughter, Anne-Marie, and a son, Paul. Their daughter, (Anne-Marie Cook-Polak) and their son-in-law (James Polak) all received master's degrees in mineral engineering from the University of California. Neville and Jennifer felt lucky to be living in the United States and spent many vacation weeks traveling throughout the United States in their camping van. They also enjoyed bicycling from their base in Lafayette. Neville often said that the two most important decisions in his life were first and the most important, to marry, Jennifer, and second to join the faculty of the University of California.

In October 1998 an international conference was held in Professor Cook's honor at Lawrence Berkeley Laboratory, the proceedings to be published as the Neville G.W. Cook Memorial in a special issue of *the International Journal of Rock Mechanics and Mining Science.* This is indicative of the high respect and esteem in which his name is held, and will continue to be held, in the world community of engineering scientists.


Wallace H Coulter

WALLACE HENRY COULTER

1913–1998

BY MICHAEL R. SFAT

ON AUGUST 7, 1998, Wallace Henry Coulter, inventor, entrepreneur, and pioneer bioengineer, died in Miami, Florida, due to complications from pneumonia.

Wallace was born on February 17, 1913, in Little Rock, Arkansas, and spent his early years on a farm in nearby McGehee where he acquired a lifelong interest in plants, expressed in later years by acquisition of farms, including units in the Miami area and in Nicaragua.

As a child, Wallace also developed a passion for electricity and crystal radio sets, probably augmented by adulation of his two heroes, Thomas Edison and Guglielmo Marconi. Determined to become skilled in radio electronics, after high school in Munroe, Arkansas, and one year at Westminster College in Fulton, Missouri, he enrolled in electrical engineering at Georgia Institute of Technology. Since the great depression of the 1930s made it impossible for him to continue his formal education, he elected to acquire his skills in industry, a common occurrence in those years. This phase began in 1934 as a radio station engineer-announcer.

In 1937 he joined General Electric X-Ray, as a sales and service engineer covering Manila, Singapore, Shanghai, Bangkok, Sumatra, and Malaysia. While on a visit to Singapore, it was invaded by the Japanese army, forcing him to escape to Java and return to the United States via a one-year circuitous trip through India, Africa, and South America.

From 1942 until the end of World War II, he worked in electronic development for Press Wireless in New York City, and later for Raytheon Manufacturing Company in electro-medical instrumentation development.

In 1946 Wallace went to Chicago to work for the Illinois Tool Works and the Mittelman Electronics Division of Century Steel. It was in 1948 that Wallace set up a basement laboratory to begin his seminal exploration of combining engineering and biology, a truly pioneering event in the history of bioengineering. His specific accomplishment was the discovery of the Coulter Principle. In view of its potential to size blood cells at a rate of several thousand a second, the U.S. Department of Naval Research and the National Institutes of Health provided grants to develop the Coulter Counter instrument. Wallace was joined by his younger brother Joseph, an electrical engineer, in the creation of the instrument, and a patent was awarded in 1953. The two brothers began a one-by-one production of a commercial automated instrument to measure cells and particles, and in 1958 launched Coulter Electronics, Inc. In 1961 they moved operations to Miami, Florida.

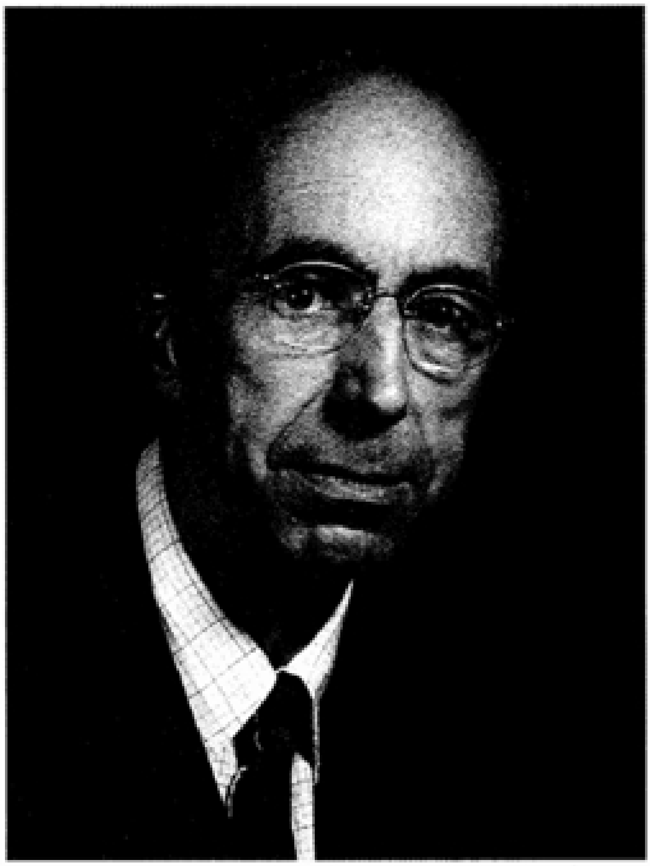
Since the early 1980s, the Coulter brothers and the Coulter Corporation have been leaders in flow cytometry: instruments that identify cells by their “signatures” when passed through a laser, thus identifying malignancies and viral activity.

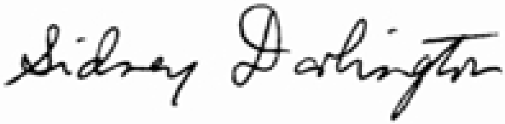
As an outgrowth of his intense focus on the character and behavior of cells, Coulter pioneered the development of monoclonal antibodies used in the diagnosis and treatment of cancer, leukemia, and lymphoma and in early detection of AIDS. The B-1 antibody recently developed under his guidance is proving in clinical tests to be the first viable means to treat non-Hodgkin's lymphoma successfully, providing hundreds of patients with hope and improved quality of life.

The Coulter Corporation grew into a multinational business employing 5,500 people and was run like a family under the paternity of Wallace. In October 1997 it was acquired by Beckman Instruments, Inc., and is now identified on the New York Stock Exchange as Beckman Coulter, Inc., a global provider of instrumentation.

Industry, academia, and government have recognized Wallace's contributions as follows: In 1960 he received the John Scott Award for scientific achievement, bestowed previously on Thomas Edison, Guglielmo Marconi, Marie Curie, Jonas Salk, and other scientists whose discoveries benefited mankind; seventy-seven patents; honorary degrees from many universities, including Clarkson University, Westminster College, Georgia Institute of Technology, University of Miami, Wharton School of Business, and Barry University. He also received the Institute of Electrical and Electronics Engineers' Morris E. Leeds Award in 1980, the 1988 Florida Industrialist of the Year Award, the 1989 M.D. Buyline's SAMME Lifetime Achievement Award, the 1989 America Society of Hematology's Certificate of Distinguished Achievement, and the 1989 Association of Clinical Scientists Gold Headed Cane Award. In 1991 Wallace Coulter and the Coulter Corporation were named a trustee of the Center for Health Technologies in Miami, and, in 1993 he was elected a founding fellow of the American Institute of Medical and Biological Engineers. In 1998 Wallace was elected a member of the National Academy of Engineering under the classification of bioengineering.

Wallace Coulter is survived by his nieces, Laura Coulter Jones, Elizabeth Ann Morgenthau, Mary Susan Donovan, and nephew, Joseph R. Coulter, III.





SIDNEY DARLINGTON

1906–1997

BY IRWIN W. SANDBERG AND ERNEST S. KUH

SIDNEY DARLINGTON, one of world's most creative and influential circuit theorists, died at his home in Exeter, New Hampshire, on October 31, 1997, at the age of ninety-one. He was a man of uncommon depth and breadth whose first love was circuit theory. He made important and widely known contributions in several areas, including network synthesis, radar systems, rocket guidance, and transistor networks.

Sid was born in Pittsburgh, Pennsylvania. He received a B.S. degree in physics (magna cum laude) from Harvard College in 1928, a B.S. in electrical communication from the Massachusetts Institute of Technology in 1929, and a Ph.D. in physics from Columbia University in 1940. In 1929 he became a member of technical staff at Bell Laboratories, where he remained until he retired in 1971, as head of the Circuits and Control Department, at the then-mandatory retirement age of sixty-five. He was a member of both the National Academy of Engineering and the National Academy of Sciences. In 1945 he was awarded the Presidential Medal of Freedom, the United States' highest civilian honor for his contributions during World War II. The award was established in that year by President Truman to reward notable service during the war. He received the Institute of Electrical and Electronics Engineers (IEEE) Edison Medal in 1975 and the IEEE Medal of Honor in 1981.

In Darlington's early days at Bell Laboratories, there was much interest in electrical filter theory, mainly in connection with the exacting needs of systems using frequency-division multiplexing. At that time, filter theory differed from what it is today in that it was marked by adhoc techniques in which complex filters were designed by cascading less complex filter sections whose attenuation characteristics were specified in graphical form. This was often unsatisfactory for several reasons. For example, the theory available did not adequately take into account the loading of the various sections on their predecessors. Sid's brilliant contribution was to recast the filter design problem as two problems—approximation and network synthesis—and to solve each problem. The first problem is to approximate the desired, typically idealized filter characteristic using a real rational function of a complex variable, and here Darlington made significant pioneering contributions involving the use of Tchebyscheff polynomials. His main contribution, which concerned the exact synthesis of a two-port network that realized (i.e., implemented) the rational function, was the introduction of his well-known insertion-loss synthesis method. This work by Darlington led to his beautiful structural result that no more than one resistor is needed to synthesize any RLC impedance.

It is interesting that his results were not widely used until many years after they were obtained. This occurred partially because more exacting computations were required than for the earlier “image-parameter” filter designs. Also, because of its novelty, it was not easy for filter designers at the time to fully appreciate Darlington's contributions. This is easier to understand in the context of the history of the development of lumped-constant filter theory, which originally was an extension of the theory of transmission lines, and in which originally the concepts of a propagation constant, characteristic impedance and reflection factor played a prominent role. Sid's work also profoundly influenced electrical engineering education. After World War II, the Darlington synthesis of reactance two-ports was taught to a generation of graduate students who learned that linear circuit design could be formulated precisely in terms of specifications and tolerances, and that the problems formulated could be solved systematically. With concurrent advances in communication and control theory, electrical engineers began to appreciate that higher mathematics was a powerful tool for advanced study and research. This helped pave the way for the introduction of system theory and system analysis, and thus further broadened the scope of electrical engineering education.

During World War II Sid was heavily involved in several studies of military systems. These studies concerned mainly the development of computers for antiaircraft gun control and bomb-sights. For a seven-month period beginning in 1944, he took a leave of absence to join the United States Office of Field Service. He was assigned to the 14th Antiaircraft Command in the southwest Pacific, where he served as a consultant and technical observer. It was this work that led to his being awarded the Medal of Freedom.

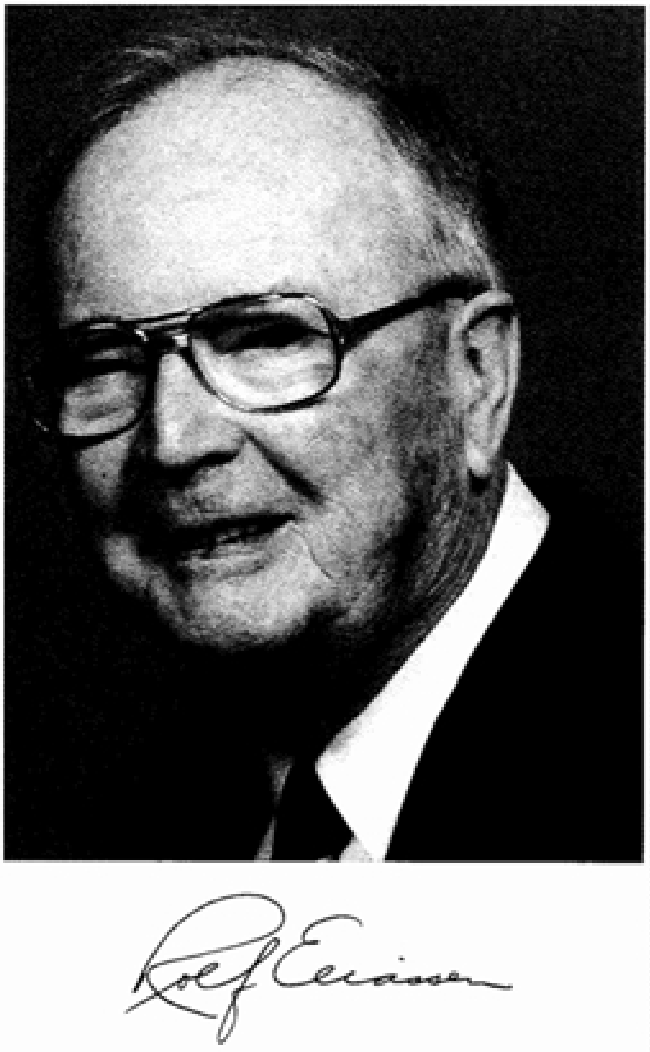
In addition to never losing interest in circuit theory, Sid retained an interest in military systems—and related systems— throughout his tenure at Bell Laboratories. One of his most important contributions is the invention of what is called chirp radar. The chirp idea is a way to form a pulsed radar's transmitted signal so that relatively high peak power is not needed to achieve long range and high resolution. This involves transmitting long frequency-modulated pulses. The corresponding reflected and received ("chirped") pulses are "collapsed" into relatively short pulses using a network that introduces a time delay that is frequency dependent. The idea has been widely used, and there has been much interest in the design of the needed delay networks—not only at Bell Laboratories, but at many other companies and at universities. Darlington's IEEE Medal of Honor citation reads: "for fundamental contributions to filtering and signal processing leading to chirp radar."

Sid also did influential work concerning rocket guidance. In 1954 he ingeniously combined radar-tracking techniques with principles of inertial guidance to develop the highly effective Bell Laboratories Command Guidance System, which has launched many of the U.S. space vehicles, including NASA's Thor Delta booster and the Air Force Titan I missile. The system has proved to be remarkably reliable and has played a central role in placing into orbit many satellites, including the Echo I communications satellite, Syncom, and Intelsat.

Darlington is best known for an idea that he probably developed very quickly—the Darlington transistor—a simple circuit made up of two or more transistors, which behave like a much-improved single transistor. As is well known to the circuits and systems community, this idea is widely used and has had a great impact on the design of integrated circuits.

Sid was a visiting professor for periods of time of from one to six weeks at the University of California, Berkeley, between 1960 and 1972. In 1978 he was a visiting professor at the University of California, Los Angeles, for a month. He gave many lectures and very much enjoyed these visits. Colleagues and students often remarked among themselves about how impressed they were with his keen physical insights, sophisticated mathematical talent, and pursuit of definitive results. After Sid retired from Bell Laboratories, he became an adjunct professor at the University of New Hampshire, where he received an honorary doctorate in 1982. He was a consultant to Bell Laboratories from 1971 to 1974. Darlington held more than forty patents and was active in professional society activities. During 1959 and 1960 he chaired the IEEE Professional Group on Circuit Theory, and in 1986 he received the Circuits and Systems Society's first Society Award.

Sid was a man of great personal and professional integrity. He was an intense but gentle man who was surprisingly modest. He was also a gregarious person who knew a lot about many things and had much to say. A colleague once commented that, “Asking Sid Darlington a question was like trying to take a drink from a fire hose.” Sid is survived by his wife, Joan, of Exeter, New Hampshire; two daughters, Ellen and Rebecca; and his sister Celia.



ROLF ELIASSEN

1911–1997

BY PERRY L. MCCARTY

ROLF ELIASSEN, Silas H. Palmer Professor Emeritus of Civil Engineering at Stanford University and founder of Stanford's environmental engineering program, died in Palo Alto, California, on Friday, March 14, 1997.

Rolf was born in Brooklyn, New York, on February 22, 1911. He earned his bachelor's degree in civil engineering in 1932, a master's degree in 1933, and a doctor of science degree in sanitary engineering in 1935, all from the Massachusetts Institute of Technology. After graduating in the depths of the Great Depression, he held a variety of positions such as design engineer with J.N. Chester Engineers, Pittsburgh, Pennsylvania, and sanitary engineer with Dorr-Oliver, Inc., Stamford, Connecticut. He began his teaching career in 1939 as assistant professor of civil engineering at the Illinois Institute of Technology (in Chicago), and then in 1940, he moved to New York University as associate professor of sanitary engineering.

Rolf married the former Mary Hulick of Easton, Pennsylvania, in 1941. Shortly thereafter, World War II erupted, and he left university life for four years to serve as a major in the U.S. Army Corps of Engineers, supervising sanitary engineering facilities at army installations in the United States. Returning to New York University after the war as professor of sanitary engineering, he directed his research toward finding safer ways to dispose of the enormous quantities of solid wastes generated in

New York City and methods for controlling the city's growing air pollution problems.

In 1949 Rolf moved to become professor and head of the Sanitary Engineering Division at the MIT, where he developed a nationally renowned program. His teaching skills were recognized early through receipt of the George Westinghouse Award of the American Society for Engineering Education. He realized that one of the major problems with the emerging nuclear power industry was the production of radioactive wastes, so he turned his research activities toward finding ways to stabilize such materials through vitrification for safer storage or disposal. This approach is now being used at U.S. Department of Energy facilities. From 1960 to 1961 he served as acting head of MIT's Civil Engineering Department.

In 1961 Stanford University invited Rolf to join its Department of Civil Engineering to form a new program in environmental engineering. His early research with solid wastes, air pollution control, and radioactive waste disposal suggested to him that environmental problems were rapidly expanding beyond the traditional framework of water supply and wastewater disposal. A much broader approach to their solution was needed, one that involved interdisciplinary collaboration between engineering and the social and natural sciences. Rolf felt that Stanford provided a unique climate for such cooperative activities. He founded a new and flexible environmental engineering program that permitted students with a wide range of backgrounds and career goals to obtain a graduate education that met their individual needs. This approach proved to be most successful, and his program continues to serve as a model for programs throughout the country.

Rolf believed that environmental quality should be the concern not only of civil engineers but also of the community at large. Acting on this belief, he developed an undergraduate course in 1961 called CE 170: “Man and His Environment,” a course that continues to be offered at Stanford today, thirty-six years later. This 8:00 a.m. elective course quickly became popular, attracting hundreds of students from all disciplines each year, an attendance so large that the course eventually was held in a large auditorium. Preceding by several years the popular environmental movement symbolized by Earth Day in 1970, his course provided the nation's first integrated approach to the environmental problems of air, water, and solid wastes.

Rolf was a favorite among students, who often were found in long lines at his office for counsel, not only about the content of his courses, but also about personal choices, problems, and career goals. He was always most considerate and supportive of staff and students alike, and was an exceptional mentor for his younger colleagues. He and his wife, Mary, were frequent and cordial hosts for students in their home. He became the Silas H. Palmer Professor of Civil Engineering in 1969, and emeritus professor of civil engineering in 1974.

But academic life did not represent his sole endeavor. Rolf was an active engineering consultant and adviser to the federal government throughout his career. He was a registered professional engineer in six states and was a partner from 1961 to 1967 of Metcalf and Eddy, Engineers, one of the largest and oldest environmental engineering firms in the country. He subsequently became senior vice-president, vice-chairman of the board, and then chairman of the board in 1973. His consulting experiences provided a rich source of material that enlivened his classroom teaching and enhanced his mentoring of graduate students.

With his broad experience and knowledge of environmental matters, Rolf was frequently sought as an adviser to federal agencies, including the Office of Science and Technology, Executive Office of the President; the Atomic Energy Commission; the Department of the Interior; the Department of Commerce; the Department of Defense; the Energy Research and Development Administration; the Public Health Service; and the Federal Power Commission. His international assignments were equally broad, including projects with the Agency for International Development, the World Health Organization, the United Nations, and the International Atomic Energy Agency. His many important contributions to the environment have been broadly recognized and earned him election to the National Academy of Engineering, the American Academy of Arts and Sciences, the American Academy of Environmental Engineering, and honorary mem bership in the American Society of Civil Engineers.

Memorial services were held on March 18, 1997, at the First Congregational Church, Palo Alto, where Rolf had been an active member for many years. He is survived by his wife, Mary, of Palo Alto; his two sons, Thomas Eliassen of Carlisle, Massachusetts, and James H. Eliassen of Colorado Springs, Colorado; and five grandchildren.

RICHARD W. ENGELBRECHT

1927–1996

BY WILLIAM J. HALL AND VERNON L. SNOEYINK

DICK ENGELBRECHT was a pioneer in the field of environmental pollution control, particularly the development of solutions to microbiological problems associated with water quality management, including drinking water and wastewater treatment. He was an "institution" nationally as well as internationally, and in the National Research Council he was known as "Mr. Water."

Dick Engelbrecht was born on March 11, 1926, in Ft. Wayne, Indiana, and died on September 1, 1996, in Urbana, Illinois. He received an A.B. degree in zoology from Indiana University-Bloomington in 1948, after which he pursued graduate studies in microbiology and biochemistry at the same institution. Subsequently he received M.S. and Sc.D. degrees in sanitary science from the Massachusetts Institute of Technology in 1952 and 1954, respectively. Among the many professional organizations in which he was active were the American Association for the Advancement of Science; the American Society for Microbiology; the American Water Works Association (chairman, Illinois Section, 1970, life member); the Water Environment Federation, formerly the Water Pollution Control Federation (president, 1977); and the International Association on Water Quality, formerly the International Association on Water Pollution Research and Control (president 1980-1986). Dick held numerous posts in these organizations in addition to those cited.

Dick joined the Department of Civil Engineering at the University of Illinois in Urbana-Champaign in 1954 as an assistant professor. He held the rank of professor of environmental engineering from 1959 until he retired in 1992, when he became professor emeritus. From 1987 to 1989 he held the Ivan Racheff Professorship of Environmental Engineering, and from 1979 to 1991 he was director of the UIUC Advanced Environmental Control Technology Research Center. For a period of time in 1973, he was visiting professor at the Technion-Israel Institute of Technology, Haifa, Israel.

Dick's forte was public service. He served on numerous national and international committees, commissions, boards of governmental agencies, and professional societies. He was a member of the Ohio River Valley Water Sanitation Commission (ORSANCO) from 1976 onward, serving as chairman of the Commission from 1980 to 1982 and again from 1993 to 1994; at the time of his death he had just been appointed to another term by Illinois Governor James Edgar. He served on numerous committees, panels, and boards of the National Research Council and was a member of the Water Science and Technology Board from 1982 to 1986. He also served as a consultant to the U.S. Environmental Protection Agency, the World Health Organization (WHO), the National Science Foundation, and many other governmental and private agencies; among the latter were the American Forest and Paper Association and Kurita Water Industries, Ltd., Tokyo, Japan. His active participation in these important bodies, especially the WHO, and his associated technical contributions to public health led to many demands on his time and required much travel over the entire globe.

His contributions to the solution of societal problems led to an immense number of professional awards. Among these were the Harrison Prescott Eddy Medal for noteworthy research (1966) and the Arthur Sidney Bedell Award (1973), both from the Water Pollution Control Federation; the George W. Fuller Award (1974) and the Publication Award (1975), both from the American Water Works Association; and the Eric H. Vick Award (1979) from the Institution of Public Health Engineers (UK). Dick was elected to membership in the National Academy of

Engineering in 1976, and to honorary membership in Abwassertechnische Vereiningung (West Germany) in 1978. In 1974 he received the Radebaugh Award, and in 1985 the George J. Schroepfer Award from the Central States Water Pollution Control Association. The Benjamin Garver Lamme Award of the American Society of Engineering Education was bestowed upon him in 1985.

In 1986 he was elected to honorary membership in the Water Environment Federation and was awarded the Gordon Maskew Fair Medal by the same organization in 1987. He was elected to honorary membership in the International Association on Water Pollution Research and Control in 1990. In 1992 he received a Certificate of Appreciation from the Japan Sewage Works Agency. Because of his long involvement with many environmental projects and his help to Japanese graduate students at the University of Illinois, he received a national decoration from the Emperor of Japan in 1993, namely the Order of the Sacred Treasure, Gold Rays with Neck Ribbon. The Association of Environmental Engineering Professors honored him in 1993 with its Founders' Award for sustained and outstanding contributions to environmental engineering education. A month before his death, he had been awarded the Warren A. Hall Medal from the Universities Council on Water Resources.

Dick was a member of Sigma Xi and was listed in *Who's Who in America* as well as numerous similar publications. He was the author or coauthor of more than 122 articles, proceedings, papers, and chapters in books. Like many other outstanding engineers, Dick was an *early to bed and early to rise man,* accomplishing much of his most creative work in the early morning hours. Consistent with this mode of operation, he frequently faded early in the evening, but at intimate social gatherings, quite often, humorously wore a large badge that read, " *I* am *awake, and having fun."*

Dick's death leaves a large void in the profession. He provided strong, well-directed leadership and served as a role model for others, who through similar professional services worked for the betterment of society. Dick Engelbrecht will long be remembered by his friends and associates worldwide.

Dick was a genuine family man, seeing to it that all members of his family, including especially his daughters-in-law (whom he called his girls) and his grandchildren, received special attention at all times. He is survived by his wife, Mary; his two sons, William of Louisville, Kentucky, and Timothy of St. Louis, Missouri; and five grandchildren.

MICHAEL FERENCE, JR.

1911–1996

BY JULIUS J. HARWOOD

MICHAEL FERENCE, JR., former presidential science adviser and retired vice-president of research for Ford Motor Company, died in San Antonio, Texas, on July 24, 1996. He was eighty-four years old.

Mike Ference was born in Whiting, lndiana, on November 6, 1911, one of three sons. Following local public school education, he attended the University of Chicago where he earned his bachelor's degree (1933), master's degree (1934), and Ph.D. in experimental physics (1936). His academic record led to his election to Phi Beta Kappa and to Sigma Xi.

He began his career teaching physics at his alma mater, remaining at the University of Chicago for ten years. Starting as an instructor, he rose to the rank of associate professor of physics and meteorology in 1944. His teaching skill was recognized with the award of the $1,000 Prize for Undergraduate Teaching. Among the various research interests he pursued during that period, he concentrated in the fields of spectroscopy, meteorology, and physics of the upper atmosphere. His numerous publications attest to a productive decade of academic research.

His specialization in atmospherics led to his appointment in 1946 with the Signal Corps Engineering Laboratory as chief of the meteorological branch. His research expertise and managerial skills soon led to his position of chief scientist of the Evans Signal Laboratory in 1948, with the responsibility for directing the laboratory's research and development programs. In 1951 Mike was made technical director of the laboratory. At the time he left the Signal Laboratory, Mike was granted the army's Exceptional Civilian Award in recognition of his numerous contributions to the service.

In the early 1950s, Henry Ford II with his then-director of the Ford Laboratory, Andrew Kucher, embarked on the challenge of creating for the Ford Motor Company a leading corporate research and development laboratory. The goal was to create a research institution to provide scientific underpinning to the Ford engineering establishment, be responsive to scientific research opportunities, and ensure Ford's technological future leadership. Kucher was successful in persuading Ference to join the Ford Scientific Laboratory in 1953 as assistant director. In 1957 he was made laboratory director and in 1959, executive director. In April 1962 he was elected vice-president, scientific research staff. Subsequently, the responsibility for engineering research was added to his charter.

Mike Ference retired from the Ford Motor Company in 1970. In the seventeen years of his leadership of the Ford Scientific Laboratory, he was instrumental in shaping it into one of the nation's leading industrial research laboratories, with a worldwide reputation. The scientific literature, particularly during the period from 1960 to 1970, in the fields of physics (both experimental and theoretical), chemistry, physical electronics, and metallurgy and materials was filled with the contribution of the talented cadre of scientists who joined the Ford Scientific Laboratory, achieving thereby the early vision of creating a “Bell Laboratory of the Automotive Industry.” One of the pioneering features that Ference implemented, with the support of Henry Ford II, was to provide the laboratory with a five-year budget to enable a long-range perspective and firmly establish the commitment to continuity and excellence in research programming. To the best of my knowledge this was a “first” in industrial research and certainly was an enviable asset in recruiting top-quality people to join the Ford Laboratory.

On a personal note, I had the privilege of being on Mike Ference's management team, and the 1960-to-1970 time period at the Ford Scientific Laboratory was one of the most stimulating and exciting experiences of my professional career.

Over and above the scientific and technical achievements of the laboratory during the Ference years, Mike Ference left an additional legacy for Ford Motor Company, a legacy generally unrecognized by corporate management. Over the years, a significant number of the leading scientists left the laboratory to pursue career opportunities within the Ford engineering, production, and management system. A respectable number achieved top corporate positions having a major impact on Ford vehicle and business decisions, including, for example, president of North American Operations, executive vice-president of technology and engineering, director of advanced vehicle technology. Thus, the early laboratory policy to recruit top-quality scientific personnel paid unexpected dividends to the Ford Motor Company.

Mike was elected to the National Academy of Engineering in 1971 in recognition of his research accomplishments, his leadership in management of industrial research and development, and his public service contributions to the U.S. government.

During the administrations of both President Johnson and President Nixon, Ference was a member of the President's Science Advisory Committee. He also served on the President's Air Quality Advisory Board. Among his numerous other appointments were the position of advisor to the Bureau of Public Roads and membership on the U.S. Weather Bureau Advisory Committee, Special Advisory Committee to the U.S. Department of Commerce, the Governor's Science Advisory Board for the State of Michigan, and various panels and committees of the National Academy of Engineering and the National Research Council, including the Highway Research Board.

Ference's public service also included the board of trustees of the Rand Corporation and the Carnegie Institution of Washington, and the board of governors of Wayne State University (1960 to 1964), with a term of chairman of the board in 1967. In 1968, by invitation of the National Academy of Sciences, he visited Taiwan as a member of the U.S. panel “Workshop on Applications of Science and Technology to Industrial Development of Taiwan." His deep commitment to public service also extended to chairing the 1968 Michigan Cancer Fund Drive and his membership on the Advisory Executive Committee to the Mayor's Committee for Economic Growth for the City of Detroit.

Ference was a member of numerous professional and scientific societies, including the American Physical Society, Institute of Electrical and Electronics Engineers (IEEE), the American Institute of Aeronautics and Astronautics, the Engineering Society of Detroit, Society of Automotive Engineers, director of Industrial Research and others. He served as director-at-large of the governing board of the American Institute of Physics and was a fellow of the IEEE and a member of the executive advisory committee of the Engineering Society of Detroit. In June 1969 he received an honorary Sc.D. degree from Kenyon College.

His career achievements and professional and public service activities led to his listings in *American Men and Women of Science, Who's Who in America, Who's Who in the Midwest, Who's Who in Engineering,* and the *World Who's Who in Commerce and Industry.*

At the time of his death, Mike Ference was survived by his wife, the former Margaret W. Wilfinger, of San Antonio; five children, Lois Finissly of Ann Arbor, Michigan, Carole Ference of Los Angeles, California, Michele F. Klussan and Richard H. Ference of Greenwich, Connecticut, and Michael Ference III of San Antonio, Texas; nine grandchildren; three great-grandchildren; and two brothers, Albert Ference of Tillia Park, Illinois, and Dr. Edward Ference of Springfield, Illinois.

The life of Michael Ference was a testament of a man dedicated to the pursuit and support of science and technology and their application to the national and industrial betterment. To this he added a deep commitment to public service and service to his government.

DONALD GLEN FINK

1911–1996

WRITTEN BY DONALD CHRISTIANSEN

SUBMITTED BY THE NAE HOME SECRETARY

AS THE CAPSTON to a long and distinguished career, Donald Glen Fink became the first general manager and executive director of the Institute of Electrical and Electronics Engineers (IEEE) in 1963. He was instrumental in helping pilot the IEEE through its first years, during which many of its members expressed a growing interest in nontechnical issues like the economic and social implications of engineering work. In 1972 he drafted a proposed amendment to the IEEE constitution that added to the organization's traditional scientific and educational purposes a “professional” purpose. Don authored a document called *Blueprint for Change* that was distributed to all IEEE members, in which he explained the history leading to the need for an expanding role for IEEE and the implications of such a change.

When overwhelmingly approved by the membership, the new constitution would signal an era in which the institute would concern itself with standards of qualification and ethical conduct, and in which “The IEEE shall strive to enhance the quality of life for all people throughout the world through the constructive application of technology in its fields of competence.”

Don came to the challenge well qualified through prior experience and with a well-developed ability to distill from a variety of positions strongly held by colleagues one that would embody the most worthy characteristics of each.

He was born in Englewood, New Jersey, November 8, 1911, and attended Englewood schools. His boyhood interest in things technical led him to apply for admission to the Massachusetts Institute of Technology, where he graduated with a B.S. degree electrical engineering in 1933. He became a research assistant at MIT in the electrical engineering and Geology departments.

In 1934 Don joined the editorial staff of *Electronics* magazine, published by McGraw-Hill. He earned his M.S. degree in electrical engineering from Columbia University in 1942. During World War II, on leave from McGraw-Hill, he joined the MIT Radiation Laboratory, where he became head of its Loran Division. From 1943 until 1946, still on leave from McGraw-Hill, he was named Expert Consultant to the Office of the Secretary of War. He was an observer of the atom bomb tests at Bikini Atoll. Returning to McGraw-Hill after the war, in 1946 he was named editor-in-chief of *Electronics* magazine, a position he held until 1952. It was during this period, in 1948, that he married Alice Marjorie Berry in Cranston, Rhode Island. They established their home in Tenafly, New Jersey.

Don became widely recognized for his expertise in the still-young field of television. He had written *Principles of Television Engineering* (McGraw-Hill) in 1940, and in 1950 he was appointed vice-chairman of the National Television Systems Committee. When agreement could not be reached on the resolution standard, he proposed 525 lines and it was accepted by the committee. The Federal Communications Commission endorsed the standard and monochrome television was off to a flying start. In 1952 Don joined Philco Corporation as director of research, a position he held until 1960, when he was named vice-president for research. In 1962 he became director of the Philco-Ford Scientific Laboratories.

Other books on television written by Don were *Television Engineering* and, with a coauthor, *Physics of Television.* He was the editor *of Television Standards and Practice, Color Television Standards,* and the *Television Engineering Handbook.*

He was also the author *of Computers and the Human Mind, Engineering Electronics, Microwave Radar,* and *Radar Engineering,* as well as some 150 papers and articles published in technical journals and periodicals.

Don was named a fellow of the American Institute of Electrical Engineers (AIEE) in 1951 and a fellow of the Institute of Radio Engineers (IRE) in 1947. He was a member of the IRE board of directors from 1949 to 1951, and again from 1956 to 1960. In 1956 and 1957 he served as editor of the IRE *Proceedings,* and in 1958 was elected president of the IRE. His IRE fellow citation read "In recognition of his espousal of high standards of technical publishing and for his wartime contributions in the field of electronic aids to navigation." When the IRE and the AIEE began merger discussions, it was no surprise that Don became involved. He served as secretary of the merger committee, and when the new organization, IEEE, was formalized, he was named its general manager, in 1963, a position he held until his retirement in 1974, when he was appointed director emeritus for life. Over the next two years he served as executive consultant to the IEEE and as operations director for the Association for Cooperation in Engineering.

Not content with retirement, Don remained self-employed as a registered professional engineer. He continued his activities in television as chairman of the Society of Motion Picture and Television Engineers Study Group on High Definition Television, and also remained active as an editor. In 1975 he had created the *Electronics Engineers' Handbook,* the most widely used reference book in the field, and was instrumental in updating its subsequent editions. The *Standard Handbook for Electrical Engineering,* also edited by Don, by 1993 was in its 13th edition.

Don was elected to the National Academy of Engineering in 1969. He was chairman of the National Research Council's Commission on International Relations Board on International Organizations and Programs and chairman of its Committee on International Scientific and Technical Information Programs. From 1976 to 1981 he chaired the United Nations Economic and Social Council science programs.

Don received many awards. For his contributions during World War II, in 1946 the U.S. Department of War bestowed its Medal of Freedom; he received the Presidential Certificate of Merit in 1948. He received the Outstanding Civilian Service Medal of the U.S. Department of the Army in 1972.

His work in television was recognized through the IEEE Consumer Electronics Award (1978), the Journal Award of the Society of Motion Picture and Television Engineers (1955), the Outstanding Service to Television Citation of the International Symposium on Television (1971), and the Progress Medal of SMPTE (1979).

IEEE recognized his many contributions with its Founders Medal (1978) and its Centennial Medal (1984). A long-time member of the Radio Club of America, he was elected a fellow of that organization, which awarded him its Sarnoff Citation (1979), Ralph Batcher Memorial Award (1988), and Allen B. DuMont Citation (1990).

Don's academic prowess was recognized through his election to Sigma Xi, Tau Beta Pi, and Eta Kappa Nu. Eta Kappa Nu named him an "Outstanding Young Electrical Engineer" in 1940 and an eminent member in 1965.

In 1971 Don was named to the presidential select advisory Committee on Redeploying Scientists and Engineers in the Health Care Field.

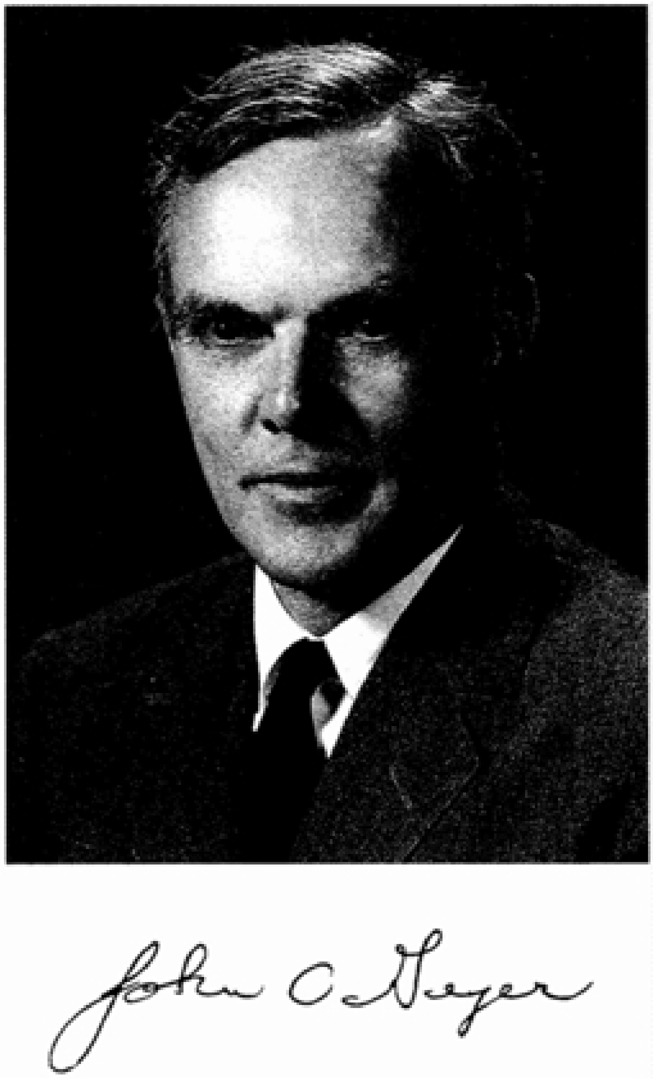
In 1980 the IEEE established the Donald G. Fink Prize Paper Award in his honor. It is awarded annually for the best tutorial, review, or survey paper published in any IEEE journal.

Don was frugal, particularly with his time. At IEEE he would often spend his lunch hours closeted in his office, hard at work on some particular project. Beneath his serious demeanor was a sense of humor. A twinkle in his eye would foretell that it was about to break through. He kept several unusual historical electrical artifacts on his office bookshelves and would challenge visitors to identify them. His vocational interests included photography and astronomy, and when he combined the two and came up with a particularly impressive celestial photograph, his delight was unrestrained.

He enjoyed spending time with his family—his wife, Alice "Sally"; daughters, Kathleen and Susan; son, Stephen; and his four grandchildren. A particular pleasure of his was camping in New Hampshire.

Upon his death on May 3, 1996, he left a legacy that is reflected in the respect and high regard of his friends and col leagues. In his honor, his friends initiated the Donald Glen Fink Project for the study of ethics in engineering and engineering management.

Don was held in high esteem by those who worked for him. I was fortunate to be a member of his staff at the IEEE. An engineer's engineer, he was technically astute, quick-witted, and an outstanding mentor and manager.



JOHN C. GEYER

1906–1995

WRITTEN BY JOHN KNAPP

SUBMITTED BY THE NAE HOME SECRETARY

JOHN C. GEYER, for many years professor of environmental engineering and chairman of the Department of Geography and Environmental Engineering at the Johns Hopkins University, died in Baltimore, Maryland, on May 2, 1995. He is survived by his wife, Andy, a daughter, Joellen, and a legion of former students and professional colleagues who found their lives enriched by the example of this gifted teacher and engineer.

Johnny Geyer was born in Neosho, Missouri, on August 11, 1906. He attended Drury College in Springfield, Missouri, 1925 to 1927, transferring later to the University of Michigan, where he was graduated in 1931 with a bachelor's degree in civil engineering. He then entered Harvard University to study under Gordon Fair and while there taught half-time on an Austin Teaching Fellowship. He completed a master's degree in 1933 and went to the University of North Carolina at Chapel Hill (UNC) in 1934 as an instructor and later assistant professor of sanitary engineering. In 1937 he joined Abel Wolman at the Johns Hopkins University, where he would spend the rest of his professional career, except for leave during World War II. He spent the year 1942 to 1943 in Washington, D.C., as assistant chief engineer for the Health and Sanitation Division in the Office of Inter-American Affairs, before accepting a commission in the U.S. Naval Reserve. As a lieutenant and later as a lieutenant commander, he served in preventive medicine for the Bureau of

Medicine and Surgery until 1946 when he returned to Johns Hopkins. He had earned his doctorate in engineering in 1943, and in 1948 he was promoted to full professor. In 1957, after spending the previous year on leave in Santiago, Chile, with the World Health Organization, he succeeded Abel Wolman as chairman of the Department of Sanitary Engineering and Water Resources. He continued as chairman until 1970, which included the early years of a creative combination of faculties into the current Department of Geography and Environmental Engineering. Active for another ten years in consulting and public service, he accepted emeritus status in 1980 and retired. One of the highlights of those last active years was serving as a trustee of Drury College, where he had begun his collegiate career with a grounding in the liberal arts. In 1969 the college conferred on him an honorary doctorate of science.

The scope of Johnny Geyer's professional interests and accomplishments was astounding; it ranged over the entire field of water and wastewater engineering-municipal and industrial, wells or rivers or estuaries, from statistical hydrology to nuclear reactor safety. He was the principal investigator or research adviser for pioneering studies of residential water use, small sewer design, urban storm water management, radioactive waste disposal, low flow augmentation, and thermal discharges from power plants. The results of these studies continue to be sought by investigators and practitioners throughout the world. He published widely over a forty year period, often in collaboration with his students. However, his most acclaimed work came with the publication of *Water Supply and Waste-Water Disposal* (John Wiley and Sons, New York, 1954) when he and Gordon Fair collaborated to bring the profession its first modern textbook, one that presented “principles rather than practice . . . rationality rather than rule of thumb.” This book was followed in 1966 and 1968 by two volumes when Fair and Geyer were joined by their colleague, Daniel A. Okun, of the University of North Carolina as third author. Again, the approach was to present primarily the underlying science while not neglecting the art and culture of practice. By means of these texts, including single volume editions intended for undergraduate instruction, the authors endowed several generations of young professionals, well beyond the ambit of Harvard, Johns Hopkins, and UNC.

Geyer was constantly in demand to serve on study commissions and advisory panels—for the city, the state, the federal government, and many of the professional organizations to which he belonged. Those that emanated just from Washington, D.C., included the National Research Council, the National Institutes of Health, the Atomic Energy Commission, the President's Scientific Advisory Committee, the Hoover Commission, a Senate Select Committee, and the Departments of Housing and Urban Development and of Health, Education, and Welfare. His longest continuous service, perhaps, was seventeen years, 1948 to 1965, on the Interstate Commission on the Potomac River Basin. He gave long and faithful service to the American (and Maryland) Society of Civil Engineers and to the (then) Water Pollution Control Federation. The Federation presented him the Harrison Prescott Eddy Medal in 1952. Capping his list of honors was election to the National Academy of Engineering in 1970. In 1973 he served as a member of the Panel on Coastal Waste Management Practices for the NAE.

At a memorial service soon after his death, seven speakers extolled John Geyer's virtues; some were his former students, some were faculty associates, and others had worked with him outside of the university. All gave testimony of two salient human qualities: the force of his intellect and the warmth of his personality. There was abundant evidence that he raised the quality of every endeavor, that he always inspired better work. More than one mentioned that their decisions today are colored by an inner voice that asks—how would Johnny Geyer handle this. Fittingly, the final note in the program was that “his almost hidden hand let others find their own paths to achievement.” Consummate teacher and brilliant engineer, he was truly a giant among men.

MARTIN GOLAND

1919–1997

BY CHAUNCEY STARR

MARTIN GOLAND, president of Southwest Research Institute, died on October 29, 1997, at the age of seventy-eight. Mr. Goland was born in Brooklyn, New York, on July 12, 1919. In 1940 he received an M.E. degree from Cornell University, where he graduated summa cum laude and in 1968 an L.L.D. (honorary) from St. Mary's University in San Antonio. Martin Goland was an instructor in the Medical Engineering Department at Cornell from 1940 to 1942. He headed the Applied Mechanics Section at Curtiss-Wright Corporation from 1942 to 1946. In 1946 he was recruited as chairman of the engineering mechanics division at Midwest Research Institute in Kansas City, Missouri, where he met and married his wife of forty-nine years. In 1955 he accepted a position as vice-president of Southwest Research Institute, and in 1959 he was elected president, the position he held at the time of his death. He was a member of the National Academy of Engineering; an honorary member of the American Society of Mechanical Engineers (ASME); a fellow, past president, and director of the American Institute of Aeronautics and Astronautics; a fellow of the American Association for the Advancement of Science; and a member of two professional honor societies, Sigma XI and Tau Beta PI.

Active in numerous scientific advisory groups at the national level, he had broad experience in aircraft design, applied mechanics, and operations research. He authored more than sixty published papers on structures, aerodynamics, mathematics, engineering analysis, research administration, and other subjects.

He received numerous professional awards in his discipline, one of the most recent being the prestigious Hoover Medal, given annually by the ASME and other professional societies to the individual "who contributed maximally to the goals and ideals of the engineering profession." During more than five decades of service to the research and development community, he received hundreds of advisory appointments to blue ribbon civilian and military boards and committees. He chaired the National Research Council Board on Army Science and Technology and was a member of the Army Materiel Command Production Management Review Board, the National Agenda for Career-Long Education of Engineers, the Texas National Research Laboratory Commission, and the Office of Japan Affairs' Working Group on Symmetrical Access. In addition, he was a member of the board of directors of the Southern Methodist University Foundation for Science and Education, the Gulf States Utilities Company, the National Bank of Commerce and National Bancshares Corporation of Texas, and the Southwest Foundation for Biomedical Research. He has been a member of the St. Mary's University Board of trustees, the advisory board of the Cornell University College of Engineering, and the San Antonio Medical Foundation.

Other awards during his career included the ASME Spirit of St. Louis Spirit Award (1944), the ASME Junior Award (1946), the ASME Alfred Noble Prize (1946), the U.S. Army Outstanding Civilian Service Award (1972), the San Antonio Exchange Club Golden Deeds Award (1981), the American Association of Engineering Societies National Engineering Award (1985), and the Air Force Association's Walter W. McAllister, Sr. Patriotism Award (1986). From 1972 to 1982, while continuing to serve as Southwest Research Institute president, he was president of the institute's sister organization, the Southwest Foundation for Biomedical Research, one of the world's foremost biomedical research institutions. In the 1970s he was instrumental in the establishment of the Southwest Research Consortium, an organi zation comprising military, scientific, education, and medical organizations collaborating on a number of biomedical research programs.

During the presidency of Martin Goland, the Southwest Research Institute achieved worldwide prominence in the fields of nondestructive performance evaluation of utility power plants, both fossil and nuclear, in fire technology, and in engines, fuels, and lubricants. Goland was an active participant in the developments within the engineering community, both nationally and internationally, and he was committed to furthering the contribution of technology to society's quality of life. His membership in the numerous policy committees of professional societies and government agencies was a reflection of the wide recognition of his quality as a statesman.

Extremely active throughout his career in community and business affairs in San Antonio, Goland was past president and chairman of the board of directors of the Greater San Antonio Chamber of Commerce, vice-president of United Way of San Antonio, a member of the Salvation Army Advisory Board, a member of the board of trustees of Keystone School, and chairman of the United San Antonio Business/Community Network for Education. In 1989 he was instrumental in helping the Alliance for Education at the University of Texas at San Antonio bring Project 2061 to San Antonio. That effort is a national test program to revitalize the teaching of science, mathematics, and technology in the nation's secondary school system. He was chairman of the alliance's community advisory committee and assisted the organization in winning a multimillion-dollar National Science Foundation contract to apply advanced science and technology teaching concepts in a thirteen-county area reaching from San Antonio to the Rio Grande Valley. The National Employees Services and Recreation Association named him the 1993 Employer of the Year. He was active in hundreds of other organizations including the YMCA, the United Negro College Fund, the San Antonio World Trade Council, public television, and the Governor's Texas Aerospace and National Defense Technology Development Council.

He is survived by his wife, Charlotte (Nelson) Goland; his two sons, Lawrence J. Goland, San Antonio, and Nelson S. Goland, Honolulu, Hawaii; his daughter, Claudia Goland Guy and her husband, Dale, Sacramento, California; his brother and sister-in-law, Dr. and Mrs. B.A. Nelson, Kansas City, Missouri; and several nieces and nephews.

JAMES P. GOULD

1923–1998

BY RALPH B. PECK

JAMES P. GOULD, retired partner of Mueser Rutledge Consulting Engineers, died of lung cancer on Christmas Day, 1998. He was seventy-five. His professional career was devoted to the analysis, design, construction, and behavior of engineering works in the great variety of geological materials left by nature.

Jim was born in Seattle, where his father, James Edward Gould, was dean of men at the University of Washington. Jim's father had taught mathematics and astronomy after acquiring degrees in mathematics from Washington, Harvard, Berkeley, and Berlin, as well as a degree in architecture. With this family background, and the experience of helping his father build a summer house on a steep slope on Puget Sound, Jim acquired a taste for the branch of civil engineering later known as geotechnics, a taste that led him into a career that he found totally satisfying.

An only child, Jim lived with his mother after his father died when Jim was still in high school. He attended the University of Washington and was placed in World War II's V-12 program. He joined the U.S. Army on graduation, was trained as a combat topographer, and was sent to Guam to await the invasion of Japan. Hiroshima led to his discharge.

Jim returned to his studies, first to the Massachusetts Institute of Technology for a master's degree in civil engineering in 1946, then to the University of Washington for graduate studies in geology. Under Arthur Casagrande at Harvard, Jim received master's and doctor of science degrees in soil mechanics in 1948 and 1949. His D.Sc. thesis, on the analysis of pore pressure and settlement observations of the dredged clay fill at Logan Airport in Boston, set the tone of much of his future work on the behavior of major geotechnical projects.

From 1950 to 1953, Jim was employed in the Earth Dams Section of the U.S. Bureau of Reclamation, where he analyzed the bureau's pioneering observations of the pore pressures that developed in recently constructed embankment dams.

In 1953 Jim began his long career with the firm now known as Mueser Rutledge Consulting Engineers of New York City, whose roots originated with Daniel E. Moran, one of the foremost foundation engineers of the last century. He became an associate of the firm in 1955 and a partner in 1973, and retired as senior partner in 1994. He continued actively consulting until his death.

His assignments with the firm included charge of the work on an imposing list of major projects. Many were located in the nation's capital. These included the reconstruction of the east front of the Capitol Building from 1955 to 1960; underpinning the House of Representatives wing from 1962 to 1964; the addition to the National Gallery of Art from 1970 to 1972; the rehabilitation of the Key Bridge in 1982; the South Quadrangle Development of the Smithsonian Institution from 1984 to 1986; the Canadian Chancery foundation from 1986 to 1988; and underpinning the Freer Gallery from 1989 to 1990. Most notable, however, was his long activity in connection with the exploration of subsurface conditions, advising and monitoring geotechnical design and construction, and serving as a member of the Board of Engineering Consultants for the Washington Metropolitan Area Transit Authority, in support of one of the great underground projects of our times.

Elsewhere, he directed the firm's work on foundations for several major buildings in New York City, including the Chase Manhattan Bank from 1958 to 1960, the North River Waterfront Redevelopment Project from 1965 to 1968, the Battery Park City Development from 1970 to 1976, and the Park Avenue Tunnel

Rehabilitation from 1988 to 1989. He investigated the landslides at Pacific Palisades, Los Angeles, from 1958 to 1960, the locks on the Tennessee-Tombigbee Canal in Mississippi from 1972 to 1978, Dry Dock No. 4 at Newport News from 1979 to 1981, and a variety of other challenging works. He served on numerous consulting boards for subway projects, the Superconducting Super-Collider, and the Channel Tunnel.

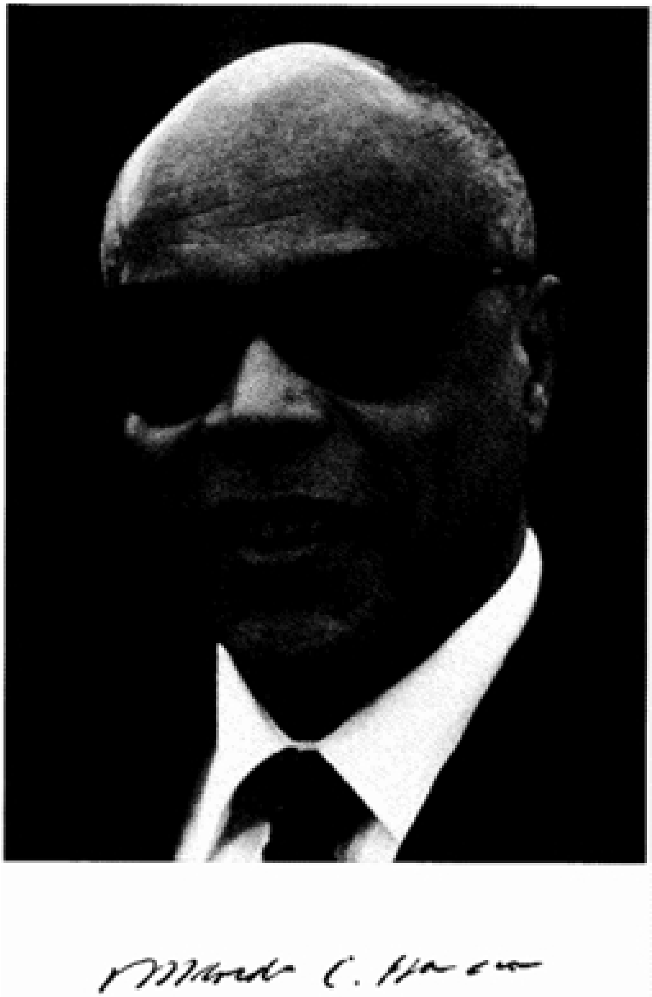
Jim was active in the American Society of Civil Engineers. He was installed an honorary member in 1990 at the annual meeting in San Francisco, where he also delivered the prestigious Terzaghi Lecture. Over the years he had served on the executive committee of the Geotechnical Division and as a member of the technical committees on Earth Retaining Structures, Grouting, Tunnel Lining Design, and Groundwater. He was a member of the Transportation Research Board, the Underground Technology Research Council, and the American Arbitration Association. He was an honorary member of the New York Academy of Sciences, and in 1988 was elected to the National Academy of Engineering. A long-time member of the Moles, an organization of workers in heavy construction, he received its Distinguished Member Award in 1992. He was a fellow of the American Consulting Engineers Council.

His forty publications included the first version of the U.S. *Navy NAVFAC Design Manual DM-7,* “Soil Mechanics, Foundations and Earth Structures,” a document that set the practice of subsurface engineering in design offices worldwide when it appeared in 1971. His papers were never trivial; they grew out of personal experience with complex design and construction projects in geologically complex situations. His oral presentations were lively, full of information, and delivered with vigor and a characteristic, often salty, humor.

Jim married while a graduate student at MIT and Harvard. He and his wife, Penelope, moved to Denver while Jim worked for the Bureau of Reclamation, and where his daughter, Diane, and son, James Edward, were born. The marriage ended in divorce in 1972. In 1984 he married Kristin Osterholm White, who survives him. He gave to his family and his hobbies the same intensity of devotion as he gave to his profession. He was a fine amateur painter who went on sketching trips overseas; he loved music, especially George Frideric Handel, and regularly attended chamber-music presentations or operas with Kristin. But his main hobby was a combination of military history and artistic skill. During his extensive stays in the Washington, D.C., area, he visited Civil War battlefields and historical exhibits. He could speak authoritatively on Napoleon and the Duke of Wellington, on the engineering accomplishments of the Roman Legions, and on the influence of the terrain on the battles of the American Revolution and the Civil War. Yet, his main interest was in the history of the British Army, from the War of the Roses through World War II. In his later years, Jim traversed the battlefields of World War I, particularly those at Gallipoli, Turkey, which he visited four times, mapping and sketching.

A long-time hobby, combining his love of history and his artistic skills, was assembling and restoring the pieces in what became one of the great personal collections of miniature lead soldiers. His encyclopedic knowledge of the details of military dress, his familiarity with history, and his skill in restoration earned him the respect of leading collectors. He traveled with Kristin to the major auctions of these mementos in London, often twice a year, as well as to Gallipoli where he felt obliged to equip himself with the best maps from the British War Museum in order to retrace faithfully the British Army's movements through the difficult terrain.

In his wife's words, he bore his last illness stoically, but resented being unable to finish the jobs on which he was working.



MEREDITH C. GOURDINE

1929–1998

BY ALLEN F. RHODES

MEREDITH C. GOURDINE, president of Energy Innovation, Inc., died at age sixty-nine on November 20, 1998, at St. Joseph's Hospital in Houston, Texas. Born September 26, 1929, in Newark, New Jersey, Dr. Gourdine was a pioneer in the field of elecrogasdynamics. He received a B.S. degree in engineering physics from Cornell University in 1953 and a Ph.D. in engineering physics from the California Institute of Technology in 1960. Elected to the National Academy of Engineering in 1991, he was a leader in promoting science and engineering careers to African-Americans.

Meredith grew up in Brooklyn, New York, where his father worked as a painter and a janitor. After classes at Brooklyn Tech High School, Meredith worked eight hours a day with his father, who he recalled saying, “If you don't want to be a laborer all your life, stay in school.”

During his high school and college days, Meredith was an accomplished athlete, first as a swimmer and later as a track star. At Cornell he competed in sprints, low hurdles, and long jumps. His culminating experience in sports came in the 1952 Olympics, where he won a U.S. Olympic Silver Medal in the long jump.

After graduation in 1952, Meredith became a naval officer, and in 1960, on a Guggenheim fellowship, earned his doctorate from CalTech. In his last three years there, he was already a senior research scientist of its Jet Propulsion Laboratory.

After working in private industry for Plasmadyne Corporation and Curtis-Wright Corporation, Meredith started his own company, Gourdine Systems in Livingston, New Jersey, to do research and development in the field of energy generation. He made use of his specialty to invent practical applications using the motion of gas molecules that had been ionized under high pressure.

Meredith's seventy U.S. and foreign patents related to electrostatic precipitators to remove smoke from burning buildings and fog from airport runways, acoustic imaging, electrogasdynamics in circuit breakers, air monitors, and coating systems. Focusing his efforts on heating and cooling systems based on the transfer of thermal energy, Meredith later formed Energy Innovations, Inc., headquartered in Houston, Texas.

In addition to his athletic, academic, and business accomplishments, Meredith found time for civic activities such as New York Mayor Lindsay's Task Force on Air Pollution, President Lyndon Johnson's Advisory Panel on Energy, and President Richard Nixon's Task Force on Small Business. He was a member of the Black Inventors' Hall of Fame, the Army Science Board, and a trustee of Cornell University.

I had the privilege of knowing Meredith Gourdine during the 1960s and 1970s when we were members of the American Management Association's Research and Development Council. We called him “Flash” Gourdine after the famous comic strip hero.

Meredith Gourdine reportedly suffered from diabetes, the loss of a leg and his vision, and was on dialysis when he succumbed to a series of strokes. He was survived by his wife, one son, three daughters, five grandchildren, and a sister.

ROBERT HERMAN

1914–1997

BY R. S. SCHECHTER

PROFESSOR ROBERT HERMAN (Bob to his legions of friends) passed away on February 13, 1997, at his home in Austin, Texas, after a battle with cancer. I lost a dear friend and the world lost a remarkable scientist and engineer, whose diverse interests ranged from cosmology to the practical problems of vehicular traffic flow and control. All of his life Bob struggled constantly toward creative achievement. That his endeavors were fruitful may be measured by the substantial recognition that has been accorded to him by the scientific and engineering community. I had met Bob several times at various conferences but really came to know him well after he joined the University of Texas faculty in 1979. It became our practice to share a brown bag lunch about twice each week. During these confabulations Bob would tell me about the wonderful people that he had worked with, and he would also share some touching and humorous moments in his life. I enjoyed these sessions immensely, grew to respect his intellect, and now miss him very much. Preparing this memorial was a difficult task for me for I felt a great need and desire to convey to the reader something of Bob's human qualities as well as his scientific and engineering achievements. I was not a participant in Bob's intellectual accomplishments. I was simply a confidant. I hope, therefore, by sharing some of our conversations to convey my wonderful memories of Bob, the profound sense of sadness that I felt on his death, and the importance of his many accomplishments.

Robert Herman was born on August 29, 1914, and grew up in the Bronx area of New York City. Bob entered the City College of New York in 1930 majoring in physics. He told me that there was an excellent student body at the City College in those days, including many of the best students from the New York City high schools, who for economic reasons had little choice but to go to the free city colleges. With the high quality of the student body, you can imagine the intense discussions that regularly took place over coffee in the college cafeteria. These no doubt ranged from the most esoteric to the very pragmatic. Political issues were of course a serious topic. In my many heated discussions with Bob that encompassed debatable issues, my view would seldom prevail because his debating skills had been so well honed in the crucible of the City College cafeteria.

At the City College, Bob studied with (in Bob's words) “that wonderful pedagogue Mark Zemansky” who became world renown for his textbook on thermodynamics. Bob and Mark Zemansky developed a special relationship. When Bob learned that I.C. Maxwell (the great British scientist) had, upon reading the Gibbs papers on thermodynamics constructed in plaster a Gibbs surface [coordinates: U(energy)-V(volume)-S(entropy)] for water, he embarked on a similar project. Bob's Gibbs surface was displayed in his first publication a (1936) paper coauthored with Zemansky. Unlike Maxwell's, Bob's surface was color coded and quite artistic (additional comments on Bob's artistic leanings follow.)

Upon graduation, cum laude, with special honors in 1935 and spending one additional year at City College as a graduate teaching assistant, Bob entered Princeton University in the fall of 1936. His friend, Robert Hofstadter [Nobel Prize in 1961], had enrolled the previous year and immediately introduced Bob to his research supervisor, Edward Condon, a brilliant theoretical physicist. Bob began working on infrared molecular spectra and judging from the publication record, he and Hofstatder worked closely together. Bob told me that he and Hofstatder were able to estimate the lengths of the two bonds flanking the hydrogen atom in dimers of acetic acid. These findings were published and to his pleasure cited as the definitive value by Linus Pauling in his classic book *The Nature of the Chemical Bond.* Based on his work on molecular spectroscopy, Bob received a Ph.D. in physics from Princeton in 1940. He spent the academic year 1940 to 1941 working on a Bush differential analyzer at the School of Electrical Engineering, University of Pennsylvania, and the next year teaching physics at the City College of New York.

He left City College in 1942 to join the staff at the Department of Terrestrial Magnetism, the Carnegie Institution of Washington, and the Applied Physics Laboratory of the Johns Hopkins University, all research centers for the war effort. He worked on the proximity fuse for naval antiaircraft fire. This device was effectively deployed during the war. Bob was especially proud of his experimental program that the development of the fuse required. In 1945 he received the Naval Ordnance Development Award in recognition of his contributions.

After the war, Bob spent another decade at the Applied Physics Laboratory, at first continuing his research in spectroscopy. During this period he met Ralph Alper, who was also employed at the laboratory. Alper worked at night toward his doctorate in physics at George Washington University under the tutelage of George Gamow. Professor Gamow was among the earliest scientists who seriously accepted the concept of a very hot, dense early universe now known as the "the big bang." His student, Alper, was working to relate the observed abundance of the chemical elements in the universe to the conditions of the early universe. At some point Alper must have interested Herman in his research and they initiated a collaboration that would continue throughout Bob's life. Bob's publication record indicates a substantial interaction between them. In 1948 they jointly published a paper predicting that there should be a low-temperature residual black body radiation pervading the universe. The existence of this relic radiation would provide evidence for a "big bang." In 1967, some twenty years after their publication predicting the background black body radiation, R.W. Wilson and A.A. Penzias detected the residual radiation. For this discovery they received the Nobel Prize in 1978.

Bob Herman and Ralph Alper received a number of awards in recognition their remarkable intellectual achievement. In 1980 they shared the John Price Wetherhill Gold Medal of the Franklin Institute. In 1981 Herman and Alper received the New York Academy of Sciences Award in Physical and Mathematical Sciences for their pioneering work in understanding the early phase of the Big Bang Universe. In 1993 they received the prestigious Henry Draper Medal of the National Academy of Sciences. The citation of the Draper Medal Committee stated that the award was given “for their insight and skill in developing a physical model of the evolution of the universe and in predicting the existence of a background microwave radiation years before this radiation was serendipitously discovered; through this work they were participants in one of the major intellectual achievements of the twentieth century.”

Herman also received the Magellanic Premium of the American Philosophical Society, the oldest scientific award in the United States, in 1975, and the eighth quadrennial George Vanderlinden Prix of the Belgium Academy in 1975.

I must add at this point that based on his publication record, it is clear that Bob frequently collaborated with a number of scientists on a variety of research problems. I believe that this was the case because of Bob's deep insight into many aspects of physics and into the complexities of the human enterprise. Thus his assistance and collaboration were often sought by those scientists who came to know him. Bob's criticism and help were highly valued because they were was never pernicious and often pointed to new directions for research or to issues incompletely addressed. Bob's collaborators seemed to find renewed inspiration as a result of his enthusiastic and often passionate input. His ability to work harmoniously and productively with others on a variety of topics is, I think, one of the important hallmarks of Bob's career.

In 1956 Bob joined the General Motors Research Laboratory as head of the Basic Science Group, later renamed the Theoretical Physics Department. Bob's record of publications indicates that he initially continued to work on matters that might be properly termed physics, collaborating with R.W. Wallis and R.J. Rubin on papers dealing with spectroscopy, electron cap ture, and solid state physics. However, in 1958 he published a paper with R.E. Chandler and E.W. Montroll entitled "Traffic Dynamics: Studies in Car Following." Thus his work within the physics department at the General Motors Research Laboratory expanded into a new dimension. He never did tell me just why this transformation took place, but one might imagine that in an environment where the problems facing General Motors are a quotidian issue, that it was a natural, not a mandated, evolution. Bob entered this new field of research, which is now called traffic science, with all of his usual passion and enthusiasm. In his lecture accepting the second Philip McCord Morse Award, Herman stated that he found traffic science intriguing because it is a study of "how human beings interact through a machine— the automobile." The fascination with this subject was to last the remainder of his life. His work launched the field of traffic science. Bob and his colleagues founded the Traffic Science Section of the Operations Research Society of America (ORSA). With Nobel Laureate Ilya Prigogine, Herman developed a kinetic theory of multilane traffic flow based on a Boltzmann-like model of interaction of cars with each other. In recent years, he together with others developed a "two fluid model of town traffic." This model promises to contribute to the development and design of intelligent transportation systems. In recognition of these seminal contributions, Bob was awarded the Geoges E. Kimball Medal in 1976 by ORSA. He was elected to the National Academy of Engineering in 1978 and awarded an honorary doctorate in engineering by the University of Karlsruhe in 1984 for his outstanding research in the mathematical foundations and development of the theory of traffic flow. In 1990 he received the first Lifetime Achievement Award of the Operations Research Society's Transportation Science Section for his research on vehicular traffic science.

Bob retired from General Motors in 1979 and accepted a position as a professor of civil engineering teaching in the transportation group of that department and as a professor in the Physics Department associated with the Statistical Mechanics Research Center. After some time it became obvious that his teaching and research were centered mainly within the Civil

Engineering Department and he was appointed as the L.P. Gilven Professor of Civil Engineering. He then devoted his full attention to the transportation group, where he supervised or cosupervised graduate research and lectured. Bob was an outstanding teacher. The students that studied with him speak of him with great affection. His door was always open to students or faculty in need of assistance. One might imagine that a productive and creativity researcher such as Bob Herman would have little room in his life for humor or family. This was certainly not the case. One of the reasons that I found our periodic luncheon sessions to be so enjoyable was Bob's great sense of humor. He recognized that creative activities are often catalyzed by moments of relaxed humor. He composed limericks and odes and often amused himself by drawing cartoons. He maintained a file of these that he shared with only a few close friends. I remember one in particular that depicted him responding to a request posed by one of his good friends and colleague (a distinguished physics professor) who asked Bob to suggest a name for his recently born ninth child—a son. Bob's cartoon showed Bob (I suppose) suggesting to the professor that an appropriate name would be “neuf.” I am not certain that the professor knew *neuf* is the French word for *nine,* nor do I know if he was offended by Bob's cartoon. I never asked.

I remember once telling Bob that a professor I had visited in France was coming to lecture in Austin and that when I had lectured at his university, he had taken me to the student cafeteria for lunch. Bob suggested that I reciprocate by taking him to Dirty's (a favorite place for many faculty and students near the campus) for lunch. We had great fun trying to find an appropriate French translation of the name of the restaurant so that I could inform my visitor in French where we were going to dine.

Once, after I had returned from a trip to New York where my wife and I had attended an exhibition at the Metropolitan Museum of Modern Art (MOMA), I described the exhibition that had intrigued us. Bob told me that he had often visited that museum as a young boy and had been interested in art. He had, he told me, entered one of his sculptures in soap in a MOMA-sponsored contest. I must have said something that made Bob think that I was skeptical, for the next time I spent an evening with Bob and Helen at their home, he retrieved a shoe box containing among other items a face carved in soap. This face appeared to be that of an American Indian with high cheekbones and a broad nose. The face expressed great sadness. I was most impressed by Bob's work, but even more impressive to me was that he had retained this object of art he had created as a teenager more than seventy years earlier. I found that to be quite remarkable. After having shown me the face and observed my favorable reaction, Bob then began to show me his more recent artistic creations—small abstract sculptures carved in exotic wood. Bob began showing others these small sculptures. The response was very positive, perhaps, I suspect, somewhat to Bob's surprise. An exhibition of his carvings was presented at the National Academy of Engineering in Washington, D.C., in 1994, at the College of Engineering at the University of Texas at Austin in 1995, and at the Leu Art Gallery of Bellmont University in Nashville, Tennessee, in 1996.

Bob was a cultured and modest man who had a wide range of interests that he continued to expand throughout his lifetime. At sometime during his tenure at the General Motors Research Center, he decided to learn to play the cello and began taking lessons. What fascinated him was the bow. He was concerned about the relationship of its curvature and materials of construction to the sound produced. He collected a large number of books on the physics of music and spent a few of his summers in London working in the shop of a master craftsman making cello bows. He showed me his collection of handmade bows, about twenty in all. I cannot comment on the overall quality of these bows, as Bob never did play his cello in the presence of others. In fact several of his friends tell the following story. After much pressure by the members of his department at General Motors he finally agreed to give a cello recital one evening. He purchased a rather inexpensive cello and began to play. With each sour note emitted, he would strike the cello until, after a few minutes, it was totally destroyed and the recital terminated. Punishing the instrument for producing sour notes is reminiscent of a Victor Borge skit in an old movie that I saw many years ago.

Apparently Bob's recital was a success because his colleagues never pressed him for a repeat performance. His ability as a cellist remains a deep secret. Only his instructor knows.

Robert Herman was a multifaceted man deeply devoted to his family, to his friends, to his science, and to the betterment of the human condition. He was a model of integrity and modesty for all of us who were fortunate enough to get to know him. He is survived by his wife of fifty-eight years, Helen, and three daughters. Jane B. Herman and Lois E. Herman live in Farmington Hills, Michigan. Dr. Roberta Herman lives in Austin with her husband, Ron Humphrey, and their two sons, Brandon and Parker.

EIVIND HOGNESTAD

1921–2000

BY IVAN M. VIEST

EIVAND HOGNESTAD, an internationally recognized leader of structural development, died in Evanston, Illinois, on February 16, 2000. Before his retirement in 1989, he devoted his entire professional career to the planning and execution of research and development in the field of reinforced concrete structures. For most of that time he worked for the Portland Cement Association and its latter-day creation, the Construction Technology Laboratories, Inc., where he attained the position of the director of technical and scientific development.

Born at the Hognestad farm in Time parish in Norway on July 17, 1921, Eivind was raised in a country house located on Gandsfjord about five miles from the city of Stavanger. He received his early schooling in a little country grade school and his religious upbringing in a one-room country church. From there he went to the Cathedral School in Stavanger and graduated in 1940. During the "country years" Eivind developed a great love of music and the ocean. The first led to his learning to play the violin and to a life-long interest in concerts and the opera. The second led to craving for a boat. After learning to swim and demonstrating it was to his parents by swimming across the fjord, Eivind was permitted to use a small boat that he built with his own hands. In later life, he became the "Mr. Fix-it" for his family and friends, and an ingenious experimenter in the research laboratories. Sailing taught him how to use a map and a compass. A few years later when he was fleeing German-occupied Norway for Sweden, this skill saved his life.

From Sweden he was sent to England. Following a thorough British Naval training, he served in the Royal Norwegian Navy as a quartermaster radar mechanic for the remainder of the war. Upon completion of the military service, Hognestad entered the Norwegian Institute of Technology (NIT) at Trondheim, Norway, to continue studies that had been interrupted by the war. He received the civil engineer diploma (Sivilingeniør) in 1947 and departed shortly thereafter for the University of Illinois at Urbana-Champaign. As a research assistant to Professor Frank E. Richart, he was first involved in the nearly completed series of tests of reinforced concrete column footings. He also continued his studies, obtaining an M.S. degree in theoretical and applied mechanics in 1949. He then embarked on an extensive investigation of reinforced concrete columns subjected to combined bending and axial load. Hognestad submitted the results of the investigation to NIT as a doctoral dissertation and later made a trip to Norway to defend it. Upon a successful defense, he was awarded the D.Sc. degree in 1952. When Professor Richart suffered a disabling stroke, Hognestad was assigned most of Richart's research projects and shortly attained the rank of assistant professor. Later, he was promoted to associate professor.

Dr. Hognestad's dissertation made a major contribution to the understanding of the behavior of reinforced concrete. It provided a basic interaction relationship for determining the short-time strength of reinforced concrete columns. As a part of the defense of the dissertation, his attention was directed also to the problem of the strength of long reinforced concrete columns. Even earlier, he had studied the problem of the shear strength of reinforced concrete beams. Furthermore, an extension of Dr. Hognestad's dissertation was concerned with the effect of time on the strength of columns. All these investigations were sponsored by the Reinforced Concrete Research Council (RCRC) with the goal of establishing a scientific base for improvements in the design of reinforced concrete structures.

In 1953, the Portland Cement Association offered Dr. Hognestad the position of the manager of their structural devel opment section. His assignment was to design, staff and manage a new state-of-the-art structural laboratory. He first visited leading structural testing laboratories in North America and Europe, then went ahead with the design and construction of the facility near Skokie, Illinois, on the grounds shared with the main office building of the association. Just about that time, there was a national epidemic of failures caused by the lack of knowledge of the shear strength of reinforced concrete. Dr. Hognestad saw to it that several investigations of this problem were carried out. He served as chairman of a national committee that correlated all investigations and developed a solution to the failure problem. The results of these efforts continue to be used today in the design of reinforced concrete structures for shear.

The publication in 1956 of the American Concrete Institute's (ACI) *Building Code Requirements for Reinforced Concrete* was a major milestone in Dr. Hognestad's work. The code contained an appendix titled, *"Abstract of Report of American Concrete Institute-American Society of Civil Engineers Joint Committee on Ultimate Strength Design"*. This six-page document was the predecessor of the strength design that is today in universal use for the design of reinforced concrete structures in the United States. The acceptance of the strength method by the profession was in no small measure due to the Dr. Hognestad's steadfast, effective leadership. Other major contributions by Dr. Hognestad were his studies of high strength reinforcement, prestressed concrete and high strength concrete. Although his studies were aimed at implementing even higher levels of the strength of the reinforcing bars, the minimum yield strength of 60,000 psi used universally today represents a 50 percent increase from the levels in general use prior to Dr. Hognestad's investigations. These advancements were among the keys to enormous increases in the maximum height of modern reinforced concrete buildings and in the maximum length of spans of modern concrete bridges.

In addition to directing major research programs in reinforced and prestressed concrete, Dr. Hognestad served as consultant on several pioneering construction projects. In the early stages of the development of the oil fields in the North Sea, the application of reinforced concrete to off-shore structures ap peared to offer potential economies. However, no accepted design procedures were available. Dr. Hognestad was retained to work with the designers and regulators from Norway and the European community to develop suitable methods of design. As a result of this effort, reinforced concrete offshore structures are now in common use throughout the world. His other major consultations involved the designs of nuclear power plants and of silo structures for ballistic missiles, and an investigation of reinforcement corrosion in marine structures.

Dr. Hognestad was elected a member of the National Academy of Engineering in 1973. He was also elected a member of the Royal Norwegian Academy of Science and an honorary member of the ACI. He was the recipient of many professional awards. His first and last awards were the 1955 Walter L. Huber Research Prize of the American Society of Civil Engineers (ASCE) and the 1990 University of Illinois Alumni Award for Distinguished Engineering Service. Among those received in-between the two were such coveted honors as the Alfred E. Lindau Award of the ACI and the Arthur J. Boase Award bestowed by the RCRC.

Dr. Hognestad was a leading participant in the work of many technical and administrative committees. He was a member of the ACI Committee 318 during the development of the 1956, 1963 and 1971 B*uilding Code Requirements for Reinforced Concrete* and was chairman of the ACI Committee on Offshore Concrete Structures. In the ASCE he chaired the Administrative Committee on Masonry and Reinforced Concrete, and served as a member of the RCRC. He chaired the Technical Activities Committee of the Prestressed Concrete Institute, and participated in the work of the European Concrete Committee and of the International Prestressing Federation.

Dr. Hognestad became active in national society work at a time of major progress in the basic understanding of the behavior of civil engineering structures. His charismatic personality, his facility with the spoken word, and his deep understanding of the appropriate roles of science and experience in practice helped him to inspire the post-war code writers to adopt rapidly the latest scientific advancements in developing the rules for the design of reinforced concrete.

A prolific writer, Dr. Hognestad authored and co-authored well over 100 papers and reports published in technical journals on subjects dealing with structural engineering and construction. Perhaps his most significant publication was the *University of Illinois Engineering Experiment Station Bulletin 399, "A Study of Combined Bending and Axial Load in Reinforced Concrete Members",* issued in 1951. This was the subject submitted to NIT as his doctoral dissertation. His other papers of particular note covered such topics as the ultimate strength design; shear strength of beams, slabs and walls; rigid frame failures; and high strength reinforcing bars.

Dr. Hognestad was a talented linguist. He was fluent in five languages and had limited working knowledge of another two. This proved especially useful in his studies of technical literature in his extensive contacts with the engineering community abroad.

Since 1560 the Hognestads have been buried in the same little country churchyard near Dr. Hognestad's home in Norway. In accord with Dr., Hognestad's last wish, his ashes were buried alongside the graves of his ancestors. He is survived by his wife, the former Andreé Stryker; daughter, Kirsten (Mrs. David J. Gordon); son, Hans; six grandchildren; and a sister, Bolette Lea.

JOE ESTES HOUSE

1923–1998

BY R. RAY BEEBE

AT THE TIME OF HIS DEATH on May 1, 1998, Joe House had been retired as vice-president of Henkel Corporation's Mineral Industry Division for nearly twelve years, yet he still stood at the pinnacle of his field, solvent extraction, consulting for mining and chemical companies throughout the world. Solvent extraction of metals was literally “a multimillion-dollar global business built from an idea,” as Joe himself once characterized it.

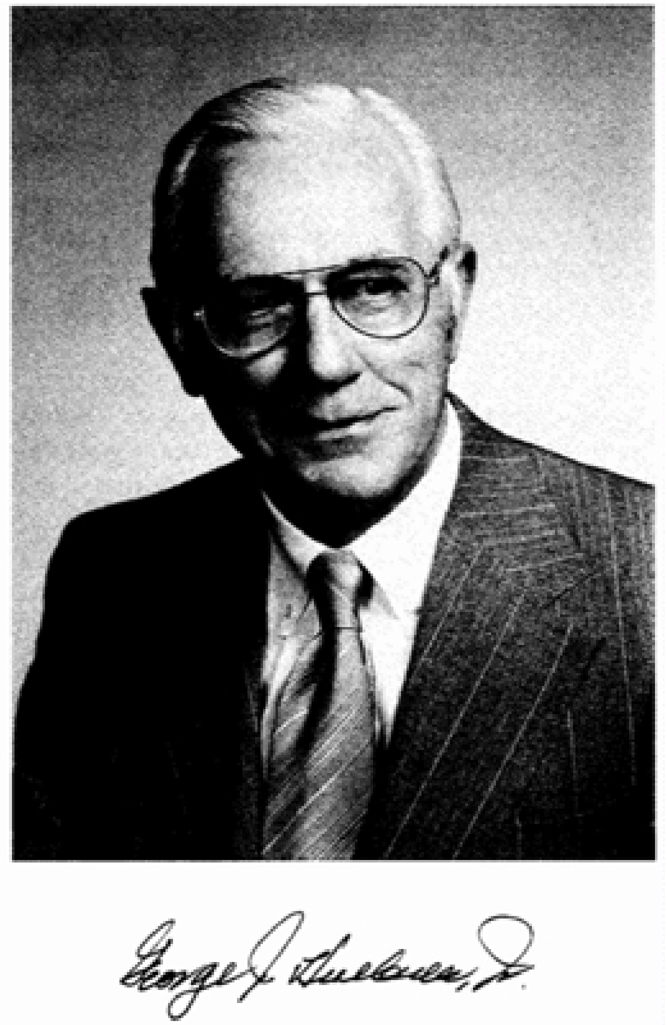
Joe House was born in Newtonia, Missouri, and received his primary and secondary education in Missouri and California. He earned A.B. and B.S. degrees in chemistry from Southwest Missouri State University, an M.S. degree from the University of Oklahoma, also in chemistry, and an MBA degree from Washington University in St. Louis. From 1947 until 1956 Joe taught chemistry at secondary and college levels, and in 1956 he joined the research and development department of General Mills Chemical Company. He was destined to spend the next thirty years with that company and its successor, Henkel Corporation. He was assigned to work on development of mining chemicals and almost immediately introduced new amine reagents for nonmetallic flotation. In 1958 he synthesized the first tertiary amine for uranium extraction and participated in its commercialization: soon this regeant accounted for some 85 percent of Free World uranium production. In 1960 Joe introduced an extractant that could be used in alkaline circuits for vanadium, molybdenum, and tungsten, and in that same year began work on a completely new concept: the solvent extraction of copper.

Joe House's work on copper over the next several years captures his unique combination of inspired technical expertise and down-to-earth business sense. Before 1963 several copper producers and reagent manufacturers had tried and failed to apply the then-common technique of resin-based ion exchange to inplant waste streams and leach solutions from low-grade oxide ores. Joe House translated his chemical knowledge into a vision that persuaded his employers to back development work that required the utmost ingenuity, since the reagents required did not then exist. Joe's perseverance succeeded not only in the laboratory, but also in a long up-hill struggle to gain acceptance for solvent extraction and electrowinning (SXEW) as a tool for the copper industry to lower costs and make use of ore reserves too small to justify investment in conventional smelters and refineries.

It took four years, but in 1968 a small company, Ranchers Exploration and Development, built a modest plant in Arizona at a mine whose name became legendary: Bluebird. The following year a somewhat larger company, Cyprus Minerals, built a plant at its Bagdad mine, also in Arizona. Both plants used a General Mills reagent named LIX-64. “LIX” stood for “liquid ion exchange” and 64 for the year it was offered for sale: the name had been copyrighted for General Mills by Joe House, and the nomenclature was used for successor formulations for many years. Even so, the larger U.S. copper companies still shied away from SXEW, leading Joe and his colleagues to Zambia, where they established the largest SXEW plant in the world! By then Joe House was vice-president of General Mills Chemicals, and he and his fellow engineers continued to improve the LIX reagents, not only to make them more efficient for copper, but also to adapt variants to recovery of other metals. SXEW was gradually adopted by the world's biggest copper companies, and by the early 1980s its products were generally recognized to be at least as good as—and sometimes better than—conventionally electrorefined copper. Several years before this, Joe House had assumed responsibility for all international LIX research and development, in addition to production, sales, and services.

In 1977 Henkel (Germany) bought General Mills Chemicals' mining chemicals business, and in 1982 Joe House helped arrange acquisition of Shell Chemicals' oxime technology for a new family of extractants. Having overseen the establishment of a new mining chemicals plant in Cork, Ireland, Joe was being urged to relocate to Henkel's headquarters in Germany. He chose to remain at his long-time family home near Minneapolis, and so retired from Henkel in 1986, only to find he was in immediate demand as a consultant. Joe, often accompanied by his beloved wife, Marydella, traveled the world, but somehow seemed to get to London for the theater season most years. He still consulted for Henkel, but he was scrupulous in avoiding conflicts of interest with his other clients.

During his career Joe House won too many awards to be listed here, but the common thread that ran through many citations was the word “perseverance.” He was certainly perseverant, but he was also unfailingly generous in giving credit to his colleagues and, as I learned, even his friends. One night in Washington, D.C., after a National Academy of Engineering meeting, he said he intended to take me to dinner. We had an excellent repast at the Willard, and I asked what the occasion might be. Joe said, “When we first met in Minneapolis in the early 1960s, I told you about my troubles with the copper reagent. You encouraged me at a time when I really needed encouragement.” Coming from Joe, that was my greatest compliment!



GEORGE J. HUEBNER

1910–1996

WRITTEN BY JAMES W. FURLONG

SUBMITTED BY THE NAE HOME SECRETARY

GEORGE J. HUEBNER, JR., one of the foremost engineers in the field of automotive research, was especially noted for developing the first practical gas turbine for a passenger car. He died of pulmonary edema in Ann Arbor, Michigan, on September 4, 1996.

George earned a bachelor's degree in mechanical engineering at the University of Michigan in 1932. He began work in the mechanical engineering laboratories at Chrysler Corporation in 1931 and completed his studies on a part-time basis.

He was promoted to assistant chief engineer of the Plymouth Division in 1936 and returned to the Central Engineering Division in 1939 to work with Carl Breer, one of the three engineers who had designed the first Chrysler vehicle fifteen years earlier. George was especially pleased to work for Breer, whom he regarded as one of the most capable engineers in the country.

Breer established a research office in 1939 and named George as his assistant. It became evident to George that he should bring more science into the field. When he became chief engineer in 1946, he enlarged the activities of Chrysler Research into the fields of physics, metallurgy, and chemistry. He was early to use the electron microscope.

George also was early to see the need for digital computers in automotive engineering. Largely in recognition of this pioneering work, he was awarded the Buckendale Prize for computer-based engineering work by the Society of Automotive Engineers in 1959.

George's research work covered a wide range of activities, including development of adhesives, use of radioactive isotopes, design and test of a sonic oil well drill, basic research on exhaust catalysts, and the development of standard instruments for accurate measurement of hydrocarbons and carbon monoxide in exhaust emissions. He held about forty patents and wrote seventeen technical papers. In 1960 he became president of the Chrysler Institute of Engineering, a postgraduate school for engineers. He held this position until his retirement.

George's work in engines was impressive. His group designed a large liquid-cooled inverted V-16 fighter aircraft engine in the late 1940s. Under a 1949 U.S. Navy contract, he was responsible for the design and development of a 1,000-horsepower turboprop aircraft engine with a recuperative heat exchanger. He was also responsible for the design of the first automotive V-8 engine with a hemispheric combustion chamber.

George saw the gas turbine as the future engine for automobiles. Automobile turbines can be small, light, and durable and have 80 percent fewer moving parts than a piston engine. They can burn almost any liquid fuel and need no oil changes or radiators. However, little of the experience with aircraft jet engines can be applied to ground vehicles. Instead of operating near maximum power, an automobile engine spends most of its life at 10 to 15 percent load, and its duty cycle consists of constant accelerations and decelerations. Aerodynamic components of automobile turbine engines are extremely small, but must be proportionally as accurate as those in large jet engines and operate at much higher rotational speeds. The engine must be produced at low cost and have excellent fuel economy.

The first prototype turbine was built in 1953 and installed in a production Plymouth car. It was the first of six generations of experimental turbines. In 1963 Chrysler put fifty gas turbines in hand-built vehicles for public assessment. Thirty thousand letters were received from people who wanted to be part of the test. A marketing program selected 203 representative drivers in forty-eight states and the District of Columbia. Each driver evaluated the engine for three months. The reception among typical potential buyers was enthusiastic. However, the engine needed to be produced at a low cost. George directed the development of low-cost alloys, and his rotary regenerator had solved the fuel economy problem.

Because George normally worked ten to twenty years ahead of production, obtaining funding was a constant problem. Once, the turbine was being shown in Europe, but it was not certain if the development would be continued, even though the public wanted these engines. A delegation of Chrysler directors was convinced of its possible impact when they saw President Charles de Gaulle, of France, kneeling to inspect the vehicle.

Although the engine had met initial air quality standards, with exceptionally low emissions of carbon monoxide and hydrocarbons, it still needed work to reduce the oxides of nitrogen, which are typically a sign of combustion efficiency. Development of the engine was given a low priority because of a downturn in the industry, even though the U.S. Environmental Protection Agency was willing to underwrite some of the cost of further work. George then directed a program to design and test a battery-powered passenger car for the U.S. Department of Transportation.

In 1962 the American Society of Mechanical Engineers cited George “for his leadership in the development of the first automotive gas turbine suitable for mass-produced passenger cars.”

Just as the first gas turbine was being built early in 1953, the U.S. Army Ordnance Corps awarded Chrysler a development contract to produce intercontinental ballistic missiles. George was named executive engineer of the missile branch while still serving as executive engineer of research. He organized a complete missile facility, including research, engineering, testing, and production. The Redstone that was produced was the country's first large liquid-fueled missile. All flew without a single reliability failure. The first U.S. satellites launched into orbit and the first manned space flights used these missiles. George relinquished his missile duties after two years to concentrate on the increased scope of his automotive research.

George was long involved in the activities of the Society of Automotive Engineers. He served for twenty-five years on the

Coordinating Research Council, the research interface between the automotive and petroleum industries, and was elected president of that group twice. He also served as a member of the Automotive Council, the technical board, the executive committee of the Automotive Council, and the Research Council. He served as chair of the Safety Research Advisory Council for two years and also on the board of directors for two years. He was international president of SAE in 1975. The organization awarded him the Elmer A. Sperry Award for engineering contributions that had advanced the art of transportation. He was elected a fellow of the society in 1977.

George was constantly involved in activities of the University of Michigan. He was named a distinguished alumnus, chaired a major fund-raising campaign, and was given the University's Sesquicentennial Award. His wife, Trudy, an early veteran of national advertising, was the only woman elected regent of the University in the state election of 1967. She is involved in activities of the University on an almost daily basis. At his retirement dinner in October 1975, she gave George a lunch pail with the admonition that she married him for better or worse, but not for lunch. Taking the hint, George assumed the chairmanship of the Environmental Research Institute of Michigan, a nonprofit scientific research company, which is the foremost developer of remote sensing systems for spatial and radar systems. This organization developed the prototype for all earth measurement satellites. The institute developed sensors for acquiring data, the attendant computers, and image processing. *Science* magazine praised the organization for “the foremost sensor research and development in the western world.” He also served on several boards of directors in Michigan and Sweden. He did power plant consulting in the United States, Europe, and Japan.

George was honored for his work many times. He was elected to Tau Beta Pi (honorary engineering fraternity), and Sigma Xi (honorary science fraternity). He served on President Nixon's Council on Environmental Quality and the U.S. Army Science Advisory Panel. He was given the Leadership Award of the American Society of Mechanical Engineers. He was also awarded an honorary doctor of science degree by Bucknell University. He served as a trustee of the Edison Foundation.

George's interests were not confined to his work. He was skilled in woodworking, even designing the shop in his home to be opened to the adjoining garage through a wide door so that he could handle large work pieces. He was skilled in oriental cooking. He spent a great deal of time skin diving and skiing. He played the piano and accordion and was a member of the Explorers Club. He will be remembered by his friends and associates for his skill, dedication, humor, enthusiasm, and an ability to direct the activities of large groups of skilled engineers and scientists.

LAWRENCE E. "LARRY" JENKINS

1933–1996

BY ROBERT A. FUHRMAN

LAWRENCE E. "LARRY" JENKINS, retired vice-president and general manager of Lockheed Corporation's Austin division, died at his home in Austin, Texas, on April 5, 1996.

Larry was born on March 12, 1933, in Salt Lake City, Utah, the son of Lawrence Eugene Jenkins, Sr., and Grace Edith Crabbe. Larry had a great interest in science and mathematics, and he entered the University of Utah as a prospective electrical engineer. He graduated "with honors" in 1955 and received a bachelor of science degree in electrical engineering.

Larry proceeded directly into graduate work at Utah, receiving a master's degree in electrical engineering in June 1957. His master's thesis probably foretold his future career in space. It was called, "Projectile Deceleration Through Use of Electromagnetic Fields."

Larry joined a relatively new organization after graduation— the Lockheed Missiles & Space Company's Space Systems Division which was forming in Palo Alto and Sunnyvale, California, in a partial response to the launch of *Sputnik* and the start of the "Space Race." He was assigned to the very critical development of a complex precision, three-axis control system for the *Agena* satellite. This represented a first-of-a-kind system incorporating innovative techniques for flexible, yet precise attitude control, along with features to enhance reliability and lengthen operational life.

This development satisfied one of the highest-priority national missions of what is now known as the National Reconnaissance Office, or NRO. Larry performed this effort in an exemplary manner, and in 1963, he was named manager of space systems guidance and controls. Here his work formed the foundation for control of increasingly sophisticated military satellites. As these programs developed, Larry's technical contributions broadened to encompass digital communications, command and control, specialized sensors and signal processing.

He also made major contributions to satellite systems operations by developing techniques to enhance the lexibility of on— orbit operations. He subsequently added to his technical and management accomplishments through the direction of tactical data fusion programs and command—and—control systems.

In 1965, in recognition of his technical and management potential, Larry was named a Sloan Fellow at Stanford in executive management. His Sloan research paper was entitled, "From Pillbox to Pillbox, a Study in Interpersonal Communications."

His subsequent career at Lockheed included assignments as manager of space systems technology and assistant chief engineer for technology, where he was responsible for systems engineering as well as the design of space vehicles and ground systems, and then chief engineer for all of Lockheed's space system activities.

He was later program manager and general manager for the development and deployment of one of the nation's most advanced classified space programs. Larry led this activity through conceptual and detailed design to an outstanding, successful flight demonstration. This accomplishment was considered a quantum advance in military satellite technology and resulted in a special citation from the secretary of the air force for unique personal contributions.

In recognition of his demonstrated technical and engineering management skills, Larry was elected to the National Academy of Engineering in 1984. He received the prestigious U.S. Air Force Significant Achievement Award for his contributions to the U.S. space program.

In 1981 Larry became the first vice-president and general manager of Lockheed's new Austin, Texas, division. Here he led the companies activities in tactical command, control and communications and remotely piloted vehicles designed to support the command and control functions. He also contributed greatly to his community's cultural, educational and business institutions. He was 1987 chairman of the board of directors for the Austin Chamber of Commerce and also chaired the board of the Creative Rapid Learning Center, a program to help school dropouts. He had several associations with the University of Texas and was executive advisor for Lockheed's Key Schools program at the university.

Larry chaired the Governor's Task Force on Vocational Education in 1987 and in 1988 was named chairman of the Governor's Select Committee on Education to develop a new system of financing Texas' public schools and improving their performance. Among the many other organizations he served were the Austin Private Industry Council, Austin Community College, United Way and Austin Symphony Orchestra. In 1989 he received a Community Service Award presented by the *Austin Business Journal* as well as an Austin Community College Award.

Larry is survived by his wife, Roberta Muirhead Jenkins, and three children.

An inspiring leader in technology, management, education and community development, Larry Jenkins will be greatly missed by all who knew him.

REYNOLD B. JOHNSON

1906–1998

BY ARTHUR O. ANDERSON

REYNOLD B. JOHNSON, International Business Machines Corporation Fellow, long-time IBM employee, prolific inventor, and president of Education Engineering Associates, died in Palo Alto, California, on September 15, 1998. His leadership earned him national recognition in test scoring machinery and random access disk files and a determining role in the building of IBM West Coast Research and Development.

Rey was born near Dassel, Minnesota, on July 7, 1906, ninth of ten children, with seven sisters and two brothers. His father and mother, John and Elizabeth, were Swedish immigrants, and Rey was raised on a farm, where from the beginning he showed a keen mechanical talent. At an early age he built a submersible submarine, which he exhibited in the horse trough. After completion of his early schooling in Dassel, Rey attended and graduated from the Minnehaha Academy High School in Minneapolis. His older sisters are said to have taken a keen interest in his education.

He then went on to the University of Minnesota, where he received a bachelor of science degree in (science) education administration in 1929. He completed his degree with a strong conviction that measurement of educational performance was critical to teaching. He obtained his first job at Ironwood High School on the Michigan Peninsula, where he taught mathematics and science.

Having entered teaching with those strong convictions about testing, Rey soon began to review his and fellow teachers' textbooks and their quizzes with the belief that there must be a way to automate the grading task. His first experiments and models made use of holes that students could punch out on perforated test sheets combined with an electrical contact system that switched on lights where answers had been correctly identified. While carrying this idea to application in a potential product, with the investment of much time and effort, he suddenly remembered that pencil marks are conductive and discarded the first path in favor of a better approach using pencil marks to identify the correct answer on the test sheet. This experience of a better idea making obsolete a good idea underlies his subsequent insistence that all possible solutions to a problem must be examined to find the best solution. Critical to his “machine” in its earliest stages was the use of close tolerance, separate answer sheets where pencil marks could be read by machine within wide tolerances for the resistance of the pencil marks themselves. All this testing and modeling was taking place while Rey was teaching school. In 1933 he lost his job as the school was scaled back to a depression era budget. The next many months were hard times even though his ideas had attracted national attention. His efforts were assisted by his fiancée, Bea, who became his wife.

Fortunately, Professor Wood at Columbia University, head of the Bureau of Education Research, and Thomas J. Watson, president of IBM, had built a strong relationship, starting in 1929, based on Columbia's desire to use accounting and punch card machinery in education and research and on Watson's belief that these desires should be supported through the donation of machines and talent. Wood was a proponent of automatic testing and had been working with IBM, unsuccessfully, to design a machine for this purpose. Rey knew of Wood's interest in testing and was able to provide a description and a model for him. Wood informed Watson that the concepts were sound. Rey and Bea were brought to New York City for the evaluation of his ideas and his model. After weeks of discussion, and while Watson was on vacation, Rey was informed that an analysis showed that his concepts were not acceptable. While Rey prepared to demonstrate that the analysis was incorrect, Wood took a different route and called Watson to inform him that IBM was about to make a mistake. However, the concepts were still sound. Shortly thereafter, IBM purchased Rey's invention and hired the unemployed high school teacher as a senior engineer in Endicott, New York. The test scoring machine, the IBM 805, was announced in 1937. Rey went on to a prolific career in Endicott, where he had fifty-three patents, mostly in the area he called input, before leaving for San Jose, California, in 1951.

Rey was approached that year with an offer, that was to change his life and work and to have a major impact on IBM and the computing world. He was asked to move to California to head a new laboratory where IBM would have a better chance to hire the engineers needed to move into the technical areas just being established and to provide closer contact with IBM's most innovative customers. Rey was given a charter to define his own programs so long as they did not duplicate the programs of others and he was expected to devote some of his efforts to adapting IBM machines to special customer needs. With Rey's background in data input, then mainly punched cards, programs were soon directed at means of automating the input function. The massive input data source he addressed was the punched-card tub file from which, for each transaction, cards were pulled identifying customer, inventory, pricing and so forth for subsequent punch card processing. The tub file was that eras' data source with random access to the data. Many configurations were addressed for machine access to stored data. They included magnetic data storage on rigid rotating disks, on drums, on tape strips, and on wires. Early in the life of the new lab, Rey became convinced that disks offered significant advantages over the other alternatives and, despite obvious unsolved problems, directed the laboratory in that direction. His belief in the inventive capabilities of his staff was rewarded when in a relatively short time, from present perspectives, air bearings were providing close spacings to rotating (and wobbling) disks, the electronics of read-write heads was taking shape, and the disk and its magnetic coating were in early definition. The new disk file was then defined as a five million-character machine, and the IBM 350 Random Access Method of Accounting and Control was established.

The product was transferred from Rey's lab to a new development lab and subsequently was shipped in 1956, with a total volume of 1,000. The product did what it was intended to do, replacing the tub file system. But it had become clear that a new era had dawned with this introduction of a transaction processing system. From those early beginnings, the pressure for rapid evolution the disk file and its components were on. The improvements in the technology since that time have provided the storage and access to storage underlying the modern computer with its large databases, formidable operating systems, and extensive application programs.

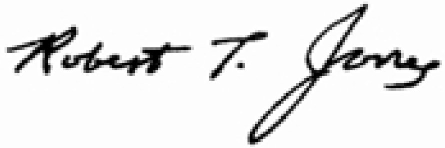
In Rey's laboratory there were many other activities aimed in various ways at input of data or response to human beings. These activities included analog-to-digital conversion projects, nonimpact printing, voice recognition, communication technology, and somewhat later projects directed toward random access to image files to replace paper files. Although storage for image files was on film of one sort or another, the drive to automate showed Rey's continued devotion to solving problems involving large data input and information retrieval. As a special effort an image file, dramatically modified and extended, was used to produce a random access trillion-bit file system. Rey's early establishment of Random Access Method of Accounting and Control (RAMAC) follow-on programs, his laboratory's continued innovation, his building of technical capabilities, and his address to new problems made his laboratory a challenging and exciting place in which to work. He insisted on open communications across projects, cheerful and extensive help when asked, thorough examination of alternatives, and respect for all ideas. He built an environment of cooperation across technical boundaries and inspired a research-development relationship that has served IBM well.

Rey turned over a part of his laboratory to research in 1959 as he formed a new Advanced Systems Development Laboratory. Both laboratories grew from that point, the research lab carrying on many of his interests in advanced support of storage, nonimpact printing, and physical sciences. The new laboratory continued the exploration of his many “new territory” exploratory developments. In 1965 Rey was made an IBM Fellow. He then devoted himself to concepts, such as a learning center which developed the form factor for the present videocassette, which he felt could have an impact on education. After retirement he and his wife, Bea founded Education Engineering Associates and explored numerous ideas, including a small plastic disk that could be built into books and read by a handheld reader to supplement reading in textbooks with audio, could be used to play bird sounds for bird watcher books, or could be used for reading and talking language books; the *Talk to Me Books* microphonograph was acquired by Fisher Price. One of Rey's last projects was a Chinese-language typewriter. His inventions continued throughout his career in IBM and after, with the total number running into the nineties and with the span varying from test scoring to Data Recording to Education Systems.

Reynold B. Johnson believed in being a member of organizations that supported his many and varied interests. These included professional societies, educational societies, and civic societies, including the National Academy of Engineering, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers (IEEE), the American Education Association, Association for Education Data Systems, the Commonwealth Club of San Francisco, and the Silicon Valley Engineering Council.

Rey was elected to the National Academy of Engineering in 1981. He received numerous awards for his work, including the president's National Medal of Technology in 1986, the Founder's Gold Medal from the Educational Records Bureau in 1997, the Computer Pioneer Award from the IEEE in 1987, and the Magnetics Society Award for Information Storage in 1989.

Reynold B. Johnson is survived by his wife, Beatrice; sons, Philip and David; four grandchildren; two great-grandchildren; a sister; and two brothers. The original farm is still run within the family.



ROBERT T. JONES

1910–1999

BY WALTER G. VINCENTI

ROBERT THOMAS JONES, one of the premier theoretical aerodynamicists of the twentieth century, died on August 11, 1999, aged eighty-nine, at his home in Los Altos Hills, California. At the time of his retirement in 1982, Jones worked as a senior research scientist at the Ames Research Center of the National Aeronautics and Space Administration in nearby Mountain View. Following formal retirement, he served until 1997 as a consulting professor at Stanford University.

Jones—"R.T." to his friends and coworkers—was born on May 28, 1910, in the farming-country town of Macon, Missouri. Writing about his days in Macon High School in an unpublished autobiographical article, he pays tribute to "a wonderful mathematics teacher . . . who took us along the intricate path of exponents, logarithms, and trigonometry." Like so many of his generation, he also built model airplanes, radios, and electronic gadgets. More important for his later work, he "devoured eagerly" the technical articles appearing in aeronautical magazines and the technical reports from the National Advisory Committee for Aeronautics (NACA). These experiences would influence him for life.

Following high school, R.T. attended the University of Missouri, dropping out after an unsatisfying freshman year. Returning to Macon, he joined the locally based Marie Meyer Flying Circus, a stunt-flying group typical of the time. Here he received flying lessons in exchange "for carrying gas and patching wing tips," though he did not solo for another fifty years. As things turned out, he never went back to the university, and his only college degree would be an honorary doctor's degree.

In 1929 the fledgling Nicholas-Beasley Airplane Company of the nearby town of Marshall found itself without its one engineer, Walter Barling. An owner of the flying circus, aware of R.T.'s self-education, recommended him for the job, and he was hired immediately. He thus found himself nineteen years old, a college dropout, and chief (or only) engineer at a salary of $15.00 a week. In his new position, he helped with production of the Barling NB3, a new type of two-person, low-wing, all-metal monoplane. The airplane experienced some success, but in the Great Depression of the 1930s the company, like many others, did not survive.

Finding himself thus jobless in the depths of economic adversity, R.T. got a ride with some neighbors to Washington, D.C. In the nation's capital, Macon's local congressman found him a "wonderful" job as an elevator operator in the House Office Building. Intent on becoming an engineer, R.T. spent his spare time in the nearby Library of Congress studying mathematics from original sources and visiting occasionally with A.F. Zahm. Zahm, a well-known aerodynamicist, was in charge of the library's aeronautics collection and had been a member of the NACA. R.T. also attended night classes taught at Catholic University by the brilliant but difficult German theoretical aerodynamicist, Max M. Munk, who had studied with the great Ludwig Prandtl at Göttingen. Munk's general approach and specific work played an important role in R.T.'s later achievements.

In 1934 the new Public Works Program, begun to help combat the depression, made available a number of nine-month positions at the NACA's Langley Aeronautical Laboratory near Hampton, Virginia. With recommendations from Zahm, Munk, and a congressman who had been referred to him by Zahm for tutoring in mathematics, R.T. obtained one of these positions. When the nine months were up, his supervisors wished to retain him in a permanent appointment. This at first appeared impossible, since the beginning civil-service grade called specifically for a college degree. The problem was solved, however, when someone noticed that the next higher grade, which was ordinarily attained by promotion, had no such specific requirement. There could thus be no objection to his appointment at that level. Except for a period in the 1960s, R.T.'s career with the NACA and its successor NASA would occupy him until retirement in 1982. Langley remained his workplace until 1946, when he moved to the new Ames Laboratory in California.

At Langley, R.T.'s work dealt mostly with airplane stability and control, on which he became a recognized authority. Here he pioneered the introduction of operational methods in theoretical analysis of the transient motions of aircraft following a disturbance. He also extended the theory of oscillating airfoils to wings of finite span and analyzed the operation of a new type of airplane with only two controls (elevator and ailerons).

R.T.'s most renowned contribution came near the end of his Langley period with his theory of sweepback as a means for avoiding the high drag of straight wings at transonic speeds. The planform of every high-speed transport one sees overhead embodies R.T.'s idea. The same concept had been arrived at several years earlier in wartime Germany, but this fact did not become known in the United States until after R.T. had made his discovery. Because of objections by Langley's eminent senior theoretical aerodynamicist, who did not believe the result possible in the supersonic speed range, NACA management held up publication of the findings until confirmed by experiment. A bit earlier, R.T. had also produced a relatively simple but far from obvious theory, valid throughout the speed range, for wings with a planform long and narrow in the flight direction. With characteristic generosity, he attributed both of his important developments to thinking prompted by the writings of Max Munk.

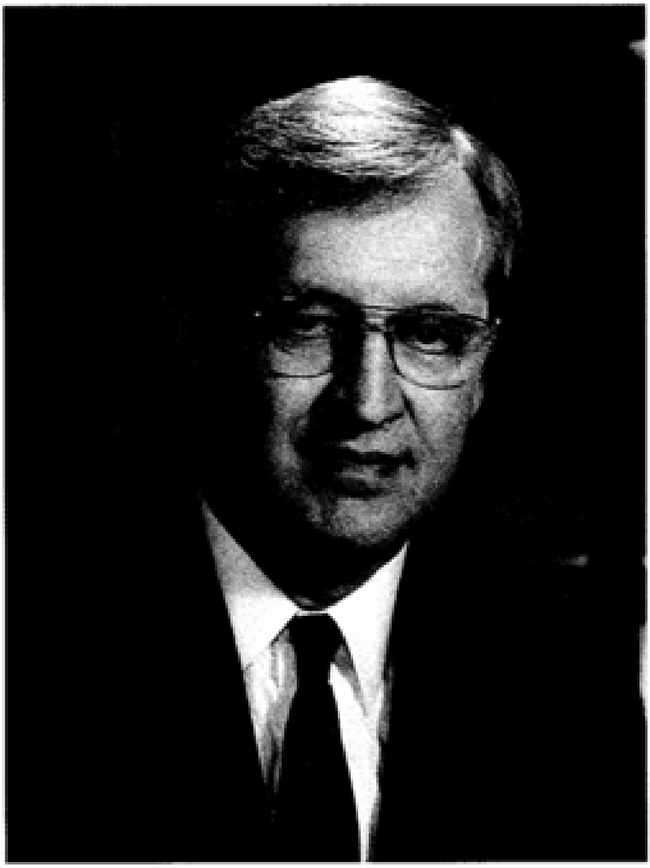
After moving to Ames, R.T. worked on the understanding and improvement of narrow and swept-wing performance at supersonic and high-subsonic speeds. This work included his startling (and still unexploited) concept of the oblique, asymmetrically swept wing, that is, swept forward on one side and rearward on the other. He cooperated in tests of this idea with people at Ames and later with faculty and students at Stanford. He also produced (with Doris Cohen) a comprehensive work, *High Speed Wing Theory* (1960), and, later, his small but inclusive book entitled simply *Wing Theory* (1990), described by the noted aerodynamicist William R. Sears as, “surely . . . one of the most important books on aerodynamics to be written in our time.”

In a complete change of focus, R.T. devoted his absence from Ames from 1963 to 1970 to problems of blood flow as senior scientist at the Avco-Everett Research Laboratory in Massachusetts. Here he was responsible for scientific direction of the development of cardiac-assist devices, including one of the early artificial hearts. He also published a number of articles on bioengineering in regard to blood flow.

R.T.'s creativity, however, was not limited to fluid mechanics. In his spare time in the 1950s, he devised and constructed an improvement on a type of reflecting telescope and published a number of related articles. In this connection, he formed and operated an instrument company that produced and sold some 40 six- and eight-inch telescopes of this kind. At Ames in the late 1950s and early 1960s, he worked and wrote on accelerated motion in relation to the theory of relativity. And in the early 1950s, when one of R.T.'s daughters needed for her musical studies a better but discouragingly expensive violin, he undertook to make one for her. After experimental study of violin acoustics and one failed but instructive attempt, his second effort was a notable success. His daughter has since used the instrument in recitals and in performances with the La Jolla Symphony. He went on to build more than a dozen fine violins and violas.

R.T. was elected to both national academies, the National Academy of Engineering in 1973 and the National Academy of Sciences in 1981. His many other honors included the Sylvanus Albert Reed Award of the American Institute of Aeronautics and Astronautics, the Langley Medal of the Smithsonian Institution, an award shared with such aviation notables as the Wright brothers and Charles Lindbergh, and the Prandtl-Ring of the Deutsche Gesellschaft für Lüft und Raumfahrt. His honorary doctorate came from the University of Colorado in 1971.

R.T.'s friends knew him as a modest, considerate person of absolute integrity. According to an associate at Stanford, “Those of us privileged to call him a colleague . . . were continually surprised and inspired by this maverick scientist who contributed so much to our understanding of flight. In addition to his well-known technical contributions . . ., he captivated a generation of students with fresh insights and new ways of looking at problems ranging from hang-glider dynamics and optimal bird flapping to supersonic aircraft." Most important for his various activities, he seemed to have a quiet confidence that he could accomplish whatever he set out to do— even if it was to make a fine violin. We do not see his like very often.



JERRY R. JUNKINS

1937–1996

BY MARK SHEPHERD, JR.

JERRY R. JUNKINS, chairman, president, and chief executive officer of Texas Instruments Incorporated (TI), died on May 9, 1996, of a heart attack while on a European tour of TI manufacturing facilities.

Jerry was born December 9, 1937, in Fort Madison, Iowa, to Ralph and Selma Junkins. He was one of four children the couple reared in Montrose, Iowa, a town of about 600 that hugs the Mississippi River. During the summers, Jerry worked at his father's automotive garage, fixing tires, polishing cars, and pumping gas. During the school months, he played on the school baseball team and delivered the town newspaper.

He graduated salutatorian among a class of twenty-five students. His future wife, Sally Schevers, was valedictorian. The couple was married for thirty-seven years at the time of his death.

Jerry earned a bachelor's degree in electrical engineering from Iowa State University in 1959, and a master's in engineering administration from Southern Methodist University in 1968. He also received an honorary doctorate of engineering from Rensselaer Polytechnic Institute in 1989 and was member of the National Academy of Engineering.

Jerry worked his entire adult life at Texas Instruments in Dallas, Texas. Joining TI in 1959, Jerry spent most of his operational career in the company's defense business as a manufacturing engineer and supervisor, and he eventually became manager of the entire business. Over the years, he was responsible for radar projects and systems, the Shrike missile program, assembly and test functions, and others.

His commitment to quality and excellence and his ability to build teams where ordinary people produced extraordinary results continued to lift him through the management ranks.

By the early 1980s, Jerry had assumed broader management responsibilities, with several additional TI businesses reporting to him. TI's data systems, industrial systems, consumer products, and the company's worldwide information systems network were under Jerry's direction.

Jerry became president and chief executive officer in 1985, and chairman in 1988. Under his leadership, TI executed a series of strategic transitions to reposition each of its major businesses to better compete in the 1990s and beyond. And, in 1992, the company's defense business won the Malcolm Baldrige National Quality Award.

“TI's most valuable asset is its people, and if we forget that, we are destined to be something less than we are capable of being,” Jerry said. “The challenge is to make this company a human place, a place where people like to work, and still do what's right for the company, the shareholders and our future.”

Jerry served on the board of directors of Caterpillar Inc., the Procter & Gamble Company, and 3M. He was also a member of the board of directors of the U.S.-Japan Business Council and the Dallas Citizens Council, and a member of the board of trustees of Southern Methodist University. He was a presidential appointee to the Advisory Committee on Trade Policy and Negotiations and was a member of the Business Council.

At the time of his death, one of Jerry's business-related passions was furthering international free trade ideals. He served as chairman of the Business Roundtable's International Trade and Investment Task Force. He believed that free trade worldwide in today's business market economy was vital to global business success. He worked diligently to help pass the North American Free Trade Act, and he served as chairman of the Alliance for GATT NOW, a business coalition formed in 1994 to secure passage of the GATT Uruguay Round Agreement.

Jerry was deeply committed to the furtherance of educational opportunity at many levels, and his support was uncommonly strong. His most passionate civic involvement was in the area of education of our young people, where he believed that every child can learn. His literacy efforts focused on seeing that every child in Texas was reading at grade level when they left the third grade.

As chairman for many years of the Dallas Citizens Council Education Committee, he was a leader in education reform efforts in the Dallas Public Schools, in Head Start programs, and in statewide education reform efforts.

In November 1995, Jerry received the John B. Connally Award from the Just for the Kids Foundation for his work in education, and in December 1995, he was presented the International Leadership Award from the U.S. Council for International Business. He was a guardian angel for Paul Quinn College, a predominantly African-American college in Dallas that recognized him as one of its Outstanding Supporters.

Jerry embodied strong ethical and business values. He valued the contribution of every TI employee and encouraged creativity and innovation. His commitment and integrity extended beyond his work at TI. He gave unselfishly of his time to support education, government, and civic affairs while always remembering his first priority—his family. Surviving Jerry is his wife, Sally; daughter, Kirsten, and son-in-law, Mike Kerrigan; daughter, Karen Junkins; and two grandchildren.

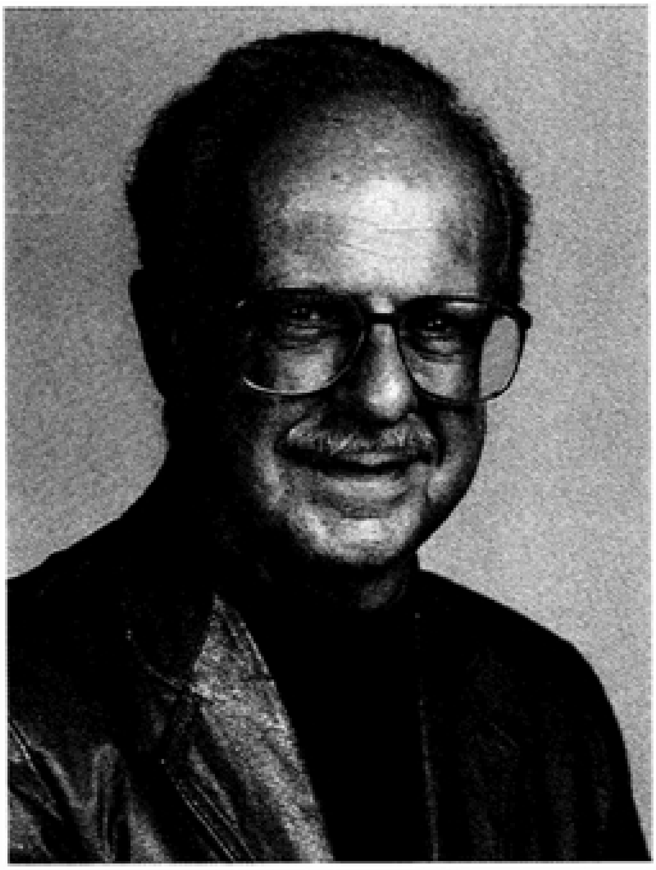
Jerry viewed his role as the chance to make a difference. “Why be here if you can't make a difference,” he said.

The things he practiced, put in place, and believed in still touch people's lives today:

- a company poised to take advantage of a networked world,
- young people who were given a head start in their education and lives,
- a community that came to expect the best from TI and its leadership,
- a global economy where free trade set the stage for a networked society, and

- a workforce that grew stronger as it came to value its diversity, and a workplace where people knew they were expected to do the right thing.

And throughout his career, Jerry displayed a quality most rare among leaders: the vision to lead and the humility to listen.



ROBERT M. KENEDI

1921–1998

BY EUGENE F. MURPHY

ROBERT MAXIMILIAN KENEDI, professor emeritus of the University of Strathclyde in Glasgow, had a productive and distinguished career in several branches of engineering and applications both to conventional engineering fields and to plastic surgery. He also worked effectively in numerous countries, cultures, and continents. In 1976 he was elected a foreign associate of the National Academy of Engineering.

Born March 19, 1921, in Budapest, Hungary, Kenedi completed elementary school with distinction in an outstanding school in Budapest. He then moved to Glasgow, Scotland, where he began a first phase of education and striving for certified professional status. He graduated with first class honors in civil engineering at the University of Glasgow. He earned a diploma with distinction and associateship of the Royal Technical College (RTC) in civil engineering and a Ph.D. in structural engineering at the University of Glasgow. In 1956 the Royal Technical College in Glasgow changed its title to the Royal College of Science and Technology. In 1964 it became the University of Strathclyde. He received British naturalization in 1947.

When Kenedi graduated in civil engineering during World War II, because of his Hungarian birth, he was classified as an “enemy alien”; therefore, employment opportunities were limited. Fortunately in 1941 he was offered a position as “temporary research assistant” in mechanical engineering at the RTC.

The work covered a variety of vibration problems (including that of the first all-welded ships' "singing propeller"). His first appointment was followed at the RTC by a series of staff posts of increasing seniority, including teaching of day and evening classes, and research, together with expanding industrial consulting, all on the civil, structural, and mechanical engineering areas.

By 1950 he had attained the appropriate academic and professional status as indicated, respectively, by the Ph.D. in structural engineering and the corporate memberships of the Institute of Mechanical Engineers and the Royal Aeronautical Society. The latter arose from a developing interest in application of the concepts of aircraft structural design to light civil engineering (prefabricated factory, school, and house building), naval architecture (ship superstructures), and nuclear engineering (reactor containment buildings). These interests, associated with the general topic of experimental stress analysis, formed the mainstream of his activities.

In the second period of Kenedi's professional life (1950 to 1962), he worked on mechanics of materials and structures and experimental stress analysis. He continued at the RTC as a senior lecturer with increasing freedom and encouragement to initiate and develop innovative activities in teaching, theoretical analysis, research, experiments, and industrial consultancies. During this period he had numerous invitations to lecture and to consult in foreign countries, primarily on thin-walled structures. He was appointed as a consultant to the Industrial Cold Rolled Sections Association. There he developed and designed codes for structures fabricated from such components. The concepts evolved and were extended to thin shells and applied to the design of nuclear reactor containment structures. He built up a section of the department of mechanical engineering, which was eventually established as a separate department of mechanics of materials.

In a third significant period (1962 to 1980), Kenedi collaborated with a distinguished plastic surgeon, Professor Tom Gibson, to develop a dynamometer to measure forces in the skin to close operation wounds or overcome deformities. Kenedi and Gibson developed such ingenious and clinically valuable ideas that they became a full-time research group of the relatively newly reorganized University of Strathclyde, including the university that was formed from the Royal Technical College. Kenedi was encouraged to expand his bioengineering activity, mainly in mechanical and chemical engineering and, to a lesser extent, electrical engineering components. Others, particularly John Paul and John Hughes, also worked in bioengineering on theoretical and practical problems of the fitting of artificial limbs and orthotic devices. The bioengineering group for decades has housed a series of conferences on biomechanics of such devices.

I remember hearing Kenedi and Gibson in New York in 1963 at a joint lecture they presented at the local section of, I think, the Human Factors Society. They presented fascinating ideas on the experimental aspects of the skin dynamometer and the interrelationship of skin tension and or overcome deformities. Kenedi and Gibson developed such ingenious and clinically valuable ideas that they became a full-time research group of the relatively newly reorganized University of Strathclyde, including the university that was formed from the Royal Technical College. Kenedi was encouraged to expand his bioengineering activity, mainly in mechanical and chemical engineering and, to a lesser extent, electrical engineering components. Others, particularly John Paul and John Hughes, also workedeering concurrently with the exercise of equitable judgment as a member of the overall Directorate in evolving and implementing policy for the Polytechnic as a whole!" He found Hong Kong to be a "genuinely dynamic place" leaving his mark at the end of his stay with the establishment of a significant collaboration between the Polytechnic and the medical/surgical departments of the Hong Kong and Chinese Universities.

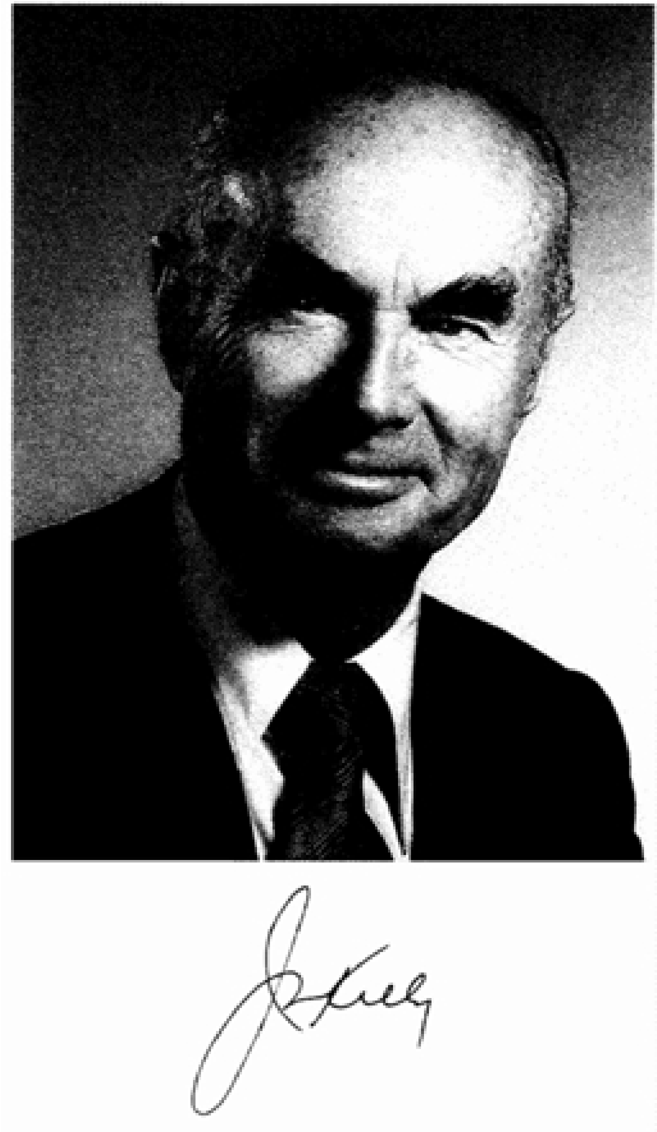
Upon returning to the United Kingdom, Kenedi was invited to join the principal's office as adviser on external relations. During the next six years his commitments included the establishment of the European Office as an expansion of the University's International Office and the Learning in Later Life (3L) program (leisure enhancement and training of new skills for the over-fifty age group) that resulted in the Senior Studies

Institute.

Kenedi's professional life took him to many parts of the globe to present programs and to consult. He worked in Peru, the Netherlands, Germany, Scandinavia, Japan, Italy, Yugoslavia, South Africa, Belgium, France, Turkey, Israel, the United States, and Australia. These only begin the list of destinations in his almost forty-year careen Kenedi enjoyed and benefited from his relatively long periods in different cultures, languages, and areas of engineering. He worked intensively wherever he was and attained a stature, authorship, and awards to prove that he was not a dilettante. He was a member of numerous professional institutions and government committees.

Versatility in choosing theory, experiment, or appropriate combinations, skill in organizing groups to use novel attacks, and formation of self-perpetuating systems for long-term projects were characteristic of Kenedi's five activities.

His writings include authorship and coauthorship of forty-eight scientific and technical papers in the areas of theoretical and experimental stress analysis, structures constructed of cold-formed thin-walled sections and thin-walled shells. In addition, he authored or coauthored fifty-eight scientific and technical papers in the areas of tissue biomechanics as applied to reconstructive surgery, rehabilitation engineering, and bioengineering. Kenedi was editor or contributor to nine books. He was married to Jean Johnstone.



JOHN R. KIELY

1906–1996

BY STEPHEN D. BECHTEL, JR.

JOHN ROCHE KIELY, a preeminent engineer, business executive, and member of the National Academy of Engineering, passed away at his home in Woodside, California, on January 10, 1996, at the age of eighty-nine. He had retired from the board of directors of Bechtel Corporation, Bechtel Incorporated, and Bechtel Power Corporation in 1974 following a distinguished thirty-two year career, during which Bechtel grew from a major regional builder to one of the world's leading engineering and construction firms.

Over the course of more than four decades with Bechtel, Kiely proved to be a uniquely talented executive blessed with a rare blend of skills. Possessed of a first-rate intellect and highly developed technical expertise, he was gifted with uncommon common sense and practical ability. A manager of great scope and vision who oversaw vast technical enterprises, he understood and cared about individual human concerns. A methodical administrator and fierce financial manager, he was an entrepreneur who often took major risks based more on insight and instinct than on hard numbers.

“He was a real entrepreneur,” said one colleague. “He never lost his individuality, even in the great corporate structure. He was always imaginative and saw opportunities in areas where other people hesitated to take the plunge.” Kiely once won a job by offering to build a steam generating plant for 25,000 man-hours less than a competitor, no matter what the competitor's final total was. Although he had studied the competitor's operation carefully, Kiely later admitted, “I had no detailed cost estimates. I was winging it. My neck was way out on that one.”

Born in Berkeley in 1906, Kiely earned his civil engineering degree from the University of Washington in 1931. He had begun working for Rayonier, Incorporated, in high school, and after college Kiely joined the firm as an engineer, quickly rising to oversee construction of all the firm's pulp mills and steam power plants.

Continuing what would prove to be one of the most distinguished engineering careers of the century, Kiely joined Bechtel shortly after the outbreak of World War II as a department manager with California Shipbuilding Corporation in San Pedro, California. He was quickly put in charge of all outfitting, and his major contribution came in developing techniques to apply mass production assembly-line methods to the rapid shipboard fitting of mechanical and electrical installations. The methods he helped develop revolutionized shipbuilding. Calship's Victory Ship Program turned out 467 ships, reducing the electrical and piping man-hours required to build a ship by eighty percent in the course of the program.

After the war, Kiely chose the cream of the Calship workers to undertake a major frequency change for Southern California Edison, modifying the frequency of electric current from 50 to 60 Hertz, to match the rest of the country. The project was an important breakthrough for Bechtel, cementing a long-term relationship with Southern California Edison while establishing its reputation in the growing field of electrical power generation. With the successful conclusion of the frequency change, Kiely negotiated a contract with Southern California Edison that would last more than a decade and generate 3,054 separate projects, including some of Bechtel's first big hydroelectric projects.

Kiely went on to play a pioneering role in the development of nuclear power, heading Bechtel's nuclear energy group for two decades in the 1950s and 1960s. Kiely made a number of personal contributions to early nuclear designs and remained intimately associated with subsequent developments in the field. He played a major role in most of the landmark early achievements in nuclear power, including the first privately financed nuclear power plant, the first all-nuclear power plant, and several of the world's largest power plants.

While he was working at the forefront of the new nuclear technology, Kiely personally oversaw the design and construction of Vermillion Dam for Southern California Edison. The dam was the forerunner of a series of more than four hundred hydroelectric and water supply projects executed under his direction, including the $200 million American River Basin Development in California and the $200 million Wells Hydroelectric Project on the Columbia River in Washington.

As a member of the office of the president of the Bechtel group of companies from 1967 to 1971, Kiely was the executive sponsor of a broad range of thermal and hydroelectric projects that catapulted Bechtel to the front rank of the power industry. Among the projects under Kiely's guidance during this period was the Churchill Falls Hydroelectric project in Labrador, one of the most immense civil engineering projects ever undertaken. Always eager to take on a new challenge, Kiely went on to oversee the James Bay project, which was even larger than Churchill Falls and had to be done entirely in French.

Along with his groundbreaking work in power generation, Kiely was active in the design and construction of facilities for the basic metals industries. Having studied new technologies for iron ore beneficiation and pelletization, Kiely concluded that plants incorporating the processes would be required to bring large deposits of low-grade iron ore into use. While pressing new research into other alternative technologies, he directed the construction of a number of major iron ore beneficiation and pelletization plants.

Throughout his career, indeed, throughout his life, John Kiely was constantly probing the frontiers of technology both through his own research and as a research manager. In 1960 when Bechtel decided to organize a Scientific Development Department within the company to speed the commercial application of new technology, Kiely was chosen to supervise its formation.

At his instigation and under his supervision, studies were conducted in sea water desalination, nuclear fuels processing, space simulation facilities, water and air pollution, and many other areas.

Kiely's research efforts nearly always produced results. Among the breakthroughs generated by research he sponsored were poststressed concrete containment vessels for nuclear power plants, a 300-million-gallon-per-day desalination plant for the Metropolitan Water District of Los Angeles, the space simulation chamber of the Manned Spacecraft Center, and the Lunar Propulsion Facility at the Lewis Research Center.

Kiely chaired the Board of Control of the joint venture that designed and built the San Francisco Bay Area Rapid Transit Project. He had a personal hand in the development of advanced engineering concepts for the new system and, at the request of the Transit District, served as their consultant on major engineering decisions.

One of Kiely's special joys was working with young engineers, many of whom he had brought into the company, and whose subsequent careers he followed with keen interest. He worked to develop training programs that would allow individual employees to enhance their skills and advance their careers. And he was a strong voice for openness and public disclosure.

Kiely was named manager of Bechtel's Power Division in 1948 and elected a vice-president in 1951, a director in 1954, and a senior vice-president in 1957. He became a member of Bechtel's Executive Committee in 1959, a member of the office of the president in 1967, and was also elected an executive vice-president in 1967. He retired from full-time management in 1971 but continued to be a valued consultant to the Bechtel organization for many years.

Active in many professional societies, Kiely was a member of the National Academy of Engineering, American Institute of Mining, and Metallurgical and Petroleum Engineers and was a fellow of the American Society of Civil Engineers and American Society of Mechanical Engineers. He served as president of The Beavers, a worldwide organization of builders of heavy construction projects, and president of the Engineers Joint Council. He was active for many years in the leadership of the World Energy Conference and served as chairman of the U.S. National Committee. He was a Knight of Malta and a member of Phi Beta Kappa, Sigma Xi, and Tau Beta Phi.

Kiely served as a director of the Homestake Mining Company and the French Bank. He was a member of the Board of Governors of Thomas Aquinas College and a trustee of the Santa Catalina School Foundation.

He is survived by his wife, Margaret Lee Kiely; five children, John III of Dundee, Michigan; Peggy Harris of New York City; Michael of Spring Valley, New York; Kathy Felix of Woodside, and Mary (Sister Maria) of Westfield, Vermont; and thirteen grandchildren.

KOJI KOBAYASHI

1907–1996

BY MICHIYUKI UENOHARA

DR. KOJI KOBAYASHI, chairman emeritus of NEC Corporation, died at age of eighty-nine in a hospital in Tokyo on November 30, 1996.

Dr. Kobayashi was born in Hatsukari village, Yamanashi Prefecture, on February 17, 1907, the fourth boy among nine children, five boys, and four girls. His village was a poor mountain village, and the nearest middle school was eight kilometers away through narrow, mountainous paths. All his elder brothers took jobs in remote cities after they finished the six years of education at the village primary school. He was a very bright boy and kept the top grade throughout the six years. He was so anxious to study further and finally got permission to continue his studies for two more years at the higher class of the same village primary school. He taught himself the middle school curriculum, while taking the regular courses and was admitted into the third-year class (ninth grade) of Tsuru middle school. To save money, he walked sixteen kilometers to school every day, rain or shine. Since he attained the grade average of ninety-four out of a perfect hundred, he was awarded a scholarship. He was determined to work after middle school, but his brothers volunteered to support his school expenses and he advanced to Matsumoto High School in Matsumoto city, where he met many brilliant friends from all over Japan. Fortunately he was awarded the Nomura Fellowship from the Nomura Foundation. He gradu ated from the Department of Electrical Engineering of Tokyo Imperial University in March 1929 with a B.E. degree. He received a doctor of engineering degree from Tokyo Imperial University in March 1939 for his study on feedback amplifiers.

Dr. Kobayashi accepted a position at the NEC Corporation in April 1929. When he joined the company, NEC remained strongly the business practice it had been since it was founded. The NEC Corporation originated in 1899 as the Nippon Electric Company, Limited, through a joint venture between Japanese investors and the Western Electric Company, Incorporated, then a subsidiary of the American Telephone and Telegraph Company, to manufacture telecommunications equipment in Japan. His initial jobs were mostly the transcription of original product drawings into Japanese versions, far from his desire to create new products. He developed new ideas and proposed them to top management while pursuing his routine jobs. His first successful development was electric power line carrier telephone equipment with a different design concept from that used by giant foreign companies. In 1934 he sold it by himself since no one was willing to sell a product different from the foreign design. His second big challenge was development of a nonloaded cable carrier telephone system at a time when the world standard was the loaded cable system. The research for this national project started in 1932 and ended in 1939 with the completion of a six-channel long-distance nonloaded cable carrier telephone system with circuits between Tokyo and Shenyang, a central city in former Manchuria (now the northeastern part of the People's Republic of China). His contribution was the development of a stable high-gain, low-distortion repeater amplifier, which was the most critical technology in the system. This work resulted in his doctor dissertation and more than a hundred patents.

After the Second World War and complete devastation in Japan, Dr. Kobayashi advised the top management of NEC to place greater emphasis on technological development. He believed that communications should not be restricted by national boundaries, but should have a larger mission of connecting remote parts of the world. He strongly promoted the development of microwave communication systems, troposcatter communication systems, and satellite communication systems. He was elected a member of the board of directors of NEC in 1949, while managing the operation of the Tamagawa plant. He was promoted to senior vice-president in 1956, executive vice-president in 1961, senior executive vice-president in 1962, and president in 1964.

Dr. Kobayashi was not only an excellent technical leader but also a strong business leader of global vision. He visited more than 100 countries, met numerous government and industrial leaders, and exchanged opinions on global and environmental problems. He always said to me that he gained many new ideas from his friends around the world. However, as many of his friends told us, he also gave them many valuable ideas. The forewords contributed by Jerome B. Wiesner in his book *Computers and Communications* (MIT Press, 1986) and by Peter F. Drucker in *The Rise of NEC* (Blackwell Publishers, 1991) express how valuable his communications had been with those scholars. To pursue his dream of connecting remote parts of the world, he helped 144 countries to build a communications infrastructure by selling NEC products and by establishing forty-seven local companies and twenty-five manufacturing plants in twenty-one countries.

During the Second World War almost all of NEC's research and development resources, over 1,000 scientists and engineers, were put in requisition for military purposes. To change their military mind-set to a civilian, market-oriented mind-set, Dr. Kobayashi advised the president of NEC to dissolve the central laboratories and relocate them to business divisions. His advice was put into action in 1949. Research and development engineers effectively contributed to building up the development capability of business divisions to meet the needs of rebuilding the communications infrastructure in Japan, and they gained reasonable business minds. Appreciating these facts and recognizing the rapid development of new technology, Dr. Kobayashi reassembled the central research laboratories in 1953 and imposed a three-tiered decentralized system of research and development activity in 1965. Because the business division is most sensitive to current market needs, its engineering unit has the responsibility of developing technology for today while the de velopment laboratories within each operating group have the responsibility for research and development into technology for tomorrow. Finally, primary responsibility for research and development for the "day after tomorrow" belongs to the central research laboratories, which are detached from the central corporate staff and placed on a par with line operating groups, stressing closer communication and collaboration with business divisions. This structure was based on Dr. Kobayashi's belief that the ultimate aim of research and development rests not with new products per se but with products that satisfy customers and make them want to buy.

With his future business vision, Dr. Kobayashi energetically pursued his corporate strategy to establish the corporate foundation for the new era of a highly information-oriented society. He sensed the importance of semiconductor and computer technology for the future as early as the advent of the new technology. He nurtured them as core businesses in addition to the traditional core business of NEC. This resulted in Dr. Kobayashi's concept of C&C (computers and communications). I clearly remember the days when he often assembled key members in a company clubhouse and discussed his idea again and again in the early part of the 1970s. In 1977 he disclosed his idea at the INTELCOM 77 exposition held in Atlanta, Georgia. His vision and strategic management helped NEC to grow nearly fortyfold from sales of 70 billion yen in 1964 when he became president to 2.8 trillion yen a quarter of a century later when he became chairman emeritus in 1988. He always dreamed of the days when anyone in the world could talk to anyone else, overcoming geographical and language barriers. He watched tenderly the basic research activity for an automatic interpretation telephone system in the central laboratories. He jokingly said to us that if we could bring the system about, world peace would be greatly advanced and NEC would be the greatest company in the world.

Dr. Kobayashi received many awards and medals from many countries for his technical and public contributions. He was elected a foreign associate of National Academy of Engineering in 1977 and devotedly worked to improve understanding between Japan and the United States during the 1980s when U.S.-Japan trade frictions faced a crisis. He married Keiko Noda in 1935, and they were blessed with four children, a boy and three girls. Their son died in 1964 at the age of twenty-seven, and Keiko passed away after Dr. Kobayashi. A strong leader and a man of humanity, Dr. Kobayashi was loved and respected by many people.

WALTER F. KOSONOCKY

1931–1996

BY JAMES E. CARNES

WALTER F. KOSONOCKY, distinguished professor of electrical computer engineering, holder of the Foundation Chair in Optoelectronics Research at New Jersey Institute of Technology, and former fellow of the technical staff at RCA Laboratories, died suddenly of heart failure while dancing at a party on November 2, 1996. Walter loved to dance.

Walter was born in Sieradz, Poland, on December 15, 1931. Although his father was Ukrainian, Walter was very proud of his Ukrainian heritage. Growing up in Poland, Walter had been advised by a counselor, after taking an aptitude test, that his optimum profession would be as a sheet metal worker. Obviously Walter did not follow that advice. A young boy when the war started, Walter was forced to flee his home and repeatedly came into harm's way during the war years. At one time he literally begged for his life as soldiers killed all the males found hiding in an attic. Walter was spared because of his age. He also told of being barred from an air raid shelter as bombs fell around them. Somehow surviving, Walter and his father finally found their way to the Regensburg Refugee Camp at the end of the war, and in 1949 they emigrated to the United States.

Passing on the sheet metal advice, Walter enrolled at the Newark College of Engineering (now New Jersey Institute of Technology, NJIT) and received a BSEE degree in 1955 and an MSEE degree in 1957. He was then selected for the RCA Laboratories

Research Trainee Program and in 1965 he received his doctorate in electrical engineering from Columbia University.

As a young researcher at RCA Labs, Walter worked on a series of projects in solid-state electronics and computer memory technology. But as MOS (metal-oxide semiconductor) devices became practical in the mid-1960s, Walter focused his efforts toward the imaging applications of this technology.

By 1969, already well-entrenched in MOS imager work, Walter immediately understood the advantages and immense implications of a new device structure announced by Bell Labs researchers, the charge-coupled device (CCD). While Walter was not the inventor of the CCD concept, he immediately dropped all other work he was doing and focused his considerable energy, intellect, and experience on this new technology. He invented new gating structures, novel charge input and signal read-out devices, and numerous novel applications of CCDs. Many of Walter's fifty-six patents are related to CCD technology and applications, especially in the area of visible and infrared imaging. He quickly established himself as an international leader in the CCD field.

As an inventor, Walter was prolific. Interestingly, he was not an analytical, linear thinker. In some cases, not even logical. Rather his creativity was intuitive. He would sometimes suggest approaches that initially appeared to his colleagues to be mysterious, but which, after careful analysis by those same colleagues, turned out to be excellent ideas that opened up new avenues of investigation and progress.

After a thirty-year career with RCA, Walter joined the faculty at NJIT as distinguished professor of electrical engineering and NJIT Foundation Chair for Optoelectronics and Solid State Circuits. There for another nine years he taught and mentored graduate students, continuing to invent new CCD and MOS imaging structures.

Walter was an extremely active member of the Institute of Electrical and Electronics Engineers (IEEE), serving as chair of numerous conference committees, including the IEEE Executive Committee for Symposia on VLSI Technology (1972 to 1992); Symposium on VLSI Technology (1981); IEEE/ Electron Devices Society (EDS) J.J. Ebers Award Committee (1986 to 1989); Tech nical Programs, International Solid State Circuits Conference (1979); IEEE/EDS VLSI Committee (1979 to 1982); IEEE/EDS Integrated Circuits Technology Committee (1974 to 1978); and the IEEE/Circuits and Systems Society, Solid State Circuits Committee (1973 to 1977).

Walter authored or coauthored over ninety publications, and he served as associate editor for image sensors and displays for the *IEEE Transactions on Electron Devices,* where he was editor of five special issues.

In addition to being a Fellow of the IEEE, he was also a member of Academy of Engineering Sciences of the Ukraine, Society for Imaging Sciences and Technology, the International Society of Optical Engineering, and the National Academy of Engineering (1992).

Beyond those distinctions already mentioned, Walter received awards from many institutions, including the David Sarnoff Award for Outstanding Technical Achievement (RCA's highest technical honor) twice, in 1981 and 1984; the New Jersey Inventors Congress and Hall of Fame “Inventor of the Year” Award in 1989; the NJIT Foundation Harlan J. Parlis Award for Excellence in Research in 1989; and the prestigious J.J. Ebers Award from the IEEE in 1985.

But beyond all of Waiter's considerable accomplishments, his patents, papers, committee chairs, and honors, more important than all of that was Walter, the friend and mentor, Walter, the loving husband and adoring father. Many of us were fortunate to have Walter as a friend and mentor—to learn from him and to laugh with him, for Walter always had a broad smile and a positive outlook. He always had a special project that he was excited about, whether it was a new device he had just invented or his new ten-speed bike!

Walter was married to his wife, Sinaida, for many years and was the proud father of four children, George, Stephen, Maria, and Anna and three grandchildren, pictures of all of whom he was quick to show.

All of Walter's considerable circle of friends and colleagues around the world admire him and miss him.

Sheet metal worker, indeed!


Jai Krishna

JAI KRISHNA

1912–1999

BY GEORGE W. HOUSNER

JAI KRISHNA, professor emeritus of Roorkee University, passed away on August 27, 1999, in Roorkee, India, a university town approximately 100 miles north of New Delhi, India. He was born on February 14, 1912, in Muzaffarnagar, a small town approximately fifty miles north of New Delhi. He obtained his bachelor's degree at Roorkee University, with honors, in 1935. He obtained his doctoral degree in civil engineering from the University of London in 1954. From 1935 to 1939 he worked in the State Public Works Department, and in 1939 he joined the Department of Civil Engineering at Roorkee University. He rose to the rank of professor in 1960, and in 1971 he was appointed the vice-chancellor of Roorkee University, thus becoming the first professor of that institution to be elevated to that high office.

Professor Jai Krishna made many pioneering contributions as educator, researcher, innovator, and institution builder. While on a visit to the California Institute of Technology in 1956, he developed a close relationship with the late Professor Donald Hudson and me. This association resulted in the starting of a teaching and research program in earthquake engineering at Roorkee University in 1960, and this is the only program of its kind in India even today. Professor Jai Krishna was the first in India to introduce courses in soil mechanics in 1948 and in structural dynamics in 1958. He was the prime motivating force behind the formulation of Indian standards for earthquake resis tant design of structures that was published by the Bureau of Indian Standards. This standard is used extensively and is one of the most comprehensive in the world. His work brought original ideas to the design of earthquake-resistant structures and has led to the evolution of economic and safe construction practices in India. He was also responsible, as consultant, for the earthquake-resistant design of many important engineering projects in India. The widespread application of the results of his research in India and abroad is evidence of his great scholastic abilities.

There was hardly any seismic data available for design of structures in India until the 1960s when Professor Jai Krishna initiated work on design, fabrication, and installation of structural response recorders and strong motion accelerographs to collect such data from earthquakes in India. This activity picked up momentum with the installation of numerous instruments and has begun to yield useful data for seismic design of important engineering structures. His outstanding contributions to the development of facilities for laboratory and field testing led to independence from foreign equipment and consultancy on such problems.

Professor Jai Krishna published extensively in various national and international journals as well as in the proceedings of earthquake conferences. Over his long career he won many prizes and awards from national and international organizations. Some of the notable awards were the Thomason Prize, Cautley Gold Medal, the Calcott Reilly Memorial Gold Medal, the Bhatnagar Award of CSIR (1966), the National Design Award (1971) of the Indian Institution of Engineers, the Moudgil Award of the Indian Standards Institution (1972), the International Award of Japan Society of Disaster Prevention (1988), and the award for Lifetime Contributions in Earthquake Engineering by the Indian National Academy of Engineering (1997). For his meritorious services to the nation, he was conferred Padam Bhushan by the president of India in 1972. Professor Jai Krishna traveled widely and visited many seismic countries all over the world.

He held several important national and international assignments in various capacities. He was a member or fellow of sev eral professional bodies and academies. Some of the important among these are the Indian National Science Academy, Indian National Academy of Engineering, Institution of Indian Engineers, Third World Academy of Sciences, and the International Association of Earthquake Engineering, of which he was president during the period 1977 to 1980. He was elected to the U.S. National Academy of Engineering in 1979 and was also the founder and president of the Indian National Academy of Engineering. He was awarded honorary degrees by Agra University and Roorkee University.

Professor Jai Krishna was a mentor to generations of earthquake engineers and epitomized the human spirit of inquiry and devotion to academic pursuits, so essential for the development of knowledge. The School of Research and Training in Earthquake Engineering at Roorkee University stands today as testimony to the creativity of Professor Jai Krishna, who was not only instrumental in its creation but also nurtured it till he breathed his last. His life and work will be an inspiration to future generations of engineers in India. He is survived by his son, Professor Prem Krishna at Roorkee University.

ROLF LANDAUER

1927–1999

BY ROBERT W. KEYES

ROLF LANDAUER, the source of much innovative thought about computing and computing devices, died on 27 April, 1999, after a short illness. He is survived by his wife, Muriel Landauer, three children, Karen Walsh, Carl, and Thomas, and three grandchildren. At the time of his death he was an International Business Machines (IBM) fellow emeritus at the IBM Thomas J. Watson Research Center.

Rolf was born in Stuttgart on February 4, 1997. His family left Germany in 1938 and emigrated to New York, where Rolf attended Stuyvesant High School, graduating in 1943. Rolf entered Harvard University, where he was awarded a B.S. degree in 1945. He then served for a brief period in the U.S. Navy as an electronic technician's mate and returned to Harvard, where he was awarded a Ph.D. in theoretical physics in 1950. From Harvard he went to work at the Lewis Laboratory of the National Advisory Committee for Aeronautics, predecessor of the National Aeronautics and Space Administration. Two years later, he joined IBM, which was then building teams of scientists to support the company's transition into the era of solid-state electronics.

Although Rolf was an accomplished theoretical physicist, he was most interested in what physics had to say about technology. Thus, his early work at IBM focused on ferroelectric materials, which were regarded as candidates for electronic memories at that time, and on semiconductors. The latter interest and a fa miliarity with problems in metal physics gained at Lewis soon led him to question current thinking about electrical conductivity in materials other than perfect crystals. An involvement with questions of electromigration in metals also connected with those of conductivity. By 1957 he had formulated and reported at a conference the revolutionary approach to a theory of electrical conductivity that much later earned him the Buckley Prize of the American Physical Society. This important work became widely recognized only after its publication in an expanded form with more detail and in a more accessible place in 1970 and its conceptual basis gained fame as the "Landauer formula."

During the late 1950s and early 1960s, when there was still uncertainty about the future of transistor logic, other approaches to computing were also studied in IBM. One depended parametric amplification of oscillators with a negative resistance element. Another used the negative resistance of the recently invented Esaki diode to form a circuit with two metastable states. Boolean logic depended on switching the circuit between these states. Perhaps prompted by this multiplicity of possible courses, Rolf sought a fundamental device-independent physical understanding of logical operations. He conceived of information as the position of a particle in a potential well in generalized coordinates that can be manipulated to perform logical operations. His report on this effort in 1961 proposed that a minimum dissipation of the order of the thermal energy, kT, is associated with each logical step and that the energy is dissipated when information is discarded to reset a device for another use, a thermodynamically irreversible operation.

Rolf extended the study of the physics of information to its representation with dissipative states. He used the metastable tunnel diode circuit as an example and asked how stable the states really are and how stability could be measured. Analogies he developed with the problem of a particle in a potential well led to a quantitative dynamic model of stability. A lifelong series of contributions to the theory of stable states far from equilibrium and the role of fluctuations in escape from metastable states followed from this investigation.

Rolf's easily recognized intellect and strong opinions soon led him to be tapped for management responsibility in the rapidly growing IBM Research Division. In 1962 he took the post of director of a Solid State Sciences Department. His first success in this position was the concentration of considerable talent on the development of a semiconductor injection laser. The injection laser was realized in a fairly short time, essentially simultaneously with its invention at the General Electric Laboratory and soon also at Bell Telephone Laboratories.

IBM introduced the 7030 “Stretch” machine in 1960 as the industry's first large transistorized computer, and it was becoming clear in the early 1960s that the future of the computer lay with the transistor. Another of Rolf's managerial achievements was recognition of the implications of the invention of the integrated circuit and silicon field-effect transistor technology for the IBM business. He drew together a group of talented scientists focused on bringing this technology into IBM. The group had many successes, notably the invention of the one-device memory cell and the discovery of quantization in thin-surface inversion layers and its effect on transistor threshold voltages. The advances in silicon technology made by the group were widely copied throughout the industry. Rolf was elected to the National Academy of Engineering in 1978 in recognition of his leadership in the development of MOS (metal-oxide semiconductor) technologies.

Rolf's managerial responsibilities and the scope of his influence on directions of research widened with his appointment as assistant director of research in 1965. IBM Research became recognized as one of the nation's premier industrial research establishments during the time that Rolf shared in its management. However, he had little time for his first love, physics and its relevance to information processing, and in 1969 he gave up management and was appointed an IBM fellow. He immediately resumed contributions to his long-term scientific interests, including wave propagation in nonlinear structures, electrical conductivity in inhomogeneous media, ferroelectricity, the physics of computing devices, and escape from metastable states. Although most of Rolf's work was inspired by questions related to information processing technology, his determination to under stand them at a fundamental level often had far-reaching implications for basic science. His impact on science was recognized by his election to the National Academy of Sciences in 1988.

As an IBM fellow Rolf continued to have an important influence in the Research Division. I was privileged to have an office adjacent to Rolf's for many years and therefore had frequent contact with him. I could not avoid noticing that many other colleagues also visited him to take advantage of his wide knowledge of physics and technology and his managerial experience. He was a good person to talk to because he was a skeptic. He was willing to listen, but hard to convince. Further, Rolf had great integrity. When he listened he made an effort to understand what was being said and to respond candidly, with hard questions. Even after a discussion, he often continued to think about the subject and came back with additional thoughts.

Much attention was attracted by Rolf's thoughts on the dissipation of energy in logical operations. That energy must be dissipated to heat in a logical operation had been accepted as fact since the time of John von Neumann. Rolf returned to his earlier argument that the dissipation occurred when information was discarded in resetting the computing apparatus. He investigated the limits on dissipation when potential wells are used to perform logical AND and OR operations in some detail, including other sources of dissipation. Thinking on this subject was profoundly altered, however, when Charles Bennett demonstrated that logical operations can in principle be performed in a reversible way and that therefore information need not be discarded during the computing process. Rolf accepted this argument as injecting a powerful new notion into the subject of energy dissipation. He arranged that IBM Research hire Bennett. Bennett and Landauer in *Scientific American* eventually explained their combined thinking about the subject for a wide audience. Reversible computing has not been turned to practical use, but the thought has stimulated research into means for recovering part of the energy associated with electrical logic.

Rolf also enlisted a few postdoctoral collaborators in his research as an IBM Fellow. James Woo participated in work on escape from metastable states. Martin Buttiker worked with Rolf on a variety of problems, including one that had puzzled physicists for a long time: the traversal time for a particle tunneling through a barrier. Rolf also worked with Thierry Martin on additional aspects of the delay in tunneling events.

His observations about energy dissipation and the way that it is manifested in physical models convinced Rolf that it is wrong to think of information abstractly, independent of its physical representation. He had expressed this thesis in 1967 in a contribution to the Institute of Electrical and Electronics Engineers (IEEE) magazine *Spectrum* entitled *"Wanted: A Physically Possible Theory of Physics"* and much later in a work *"Information is Physical,"* a phrase that became enduringly associated with his name. He insisted that the use of energy and other physical resources in computing limits man's knowledge of the world and called for a science that did not demand infinite accuracy of its fundamental concepts, such as the value of p.

To the suggestion that quantum computation is possible and offers great advantages in some areas, Rolf naturally responded by developing his own views. He saw many difficulties with quantum computation and did not hesitate to call attention to them. Advocates of quantum computation recognized the validity of his criticism and worked to invent ways around them; although a skeptic, he had an essentially positive influence on the field.

Rolf received many honors in addition to his election to the two national academies and the 1995 Oliver E. Buckley Condensed Matter Physics Prize. He was awarded the 1992 Stuart Ballantine Medal of the Franklin Institute, the 1993 Centennial Medal of Harvard University, and the 1998 Edison Medal of the IEEE. He received an honorary degree from the Technion in Israel and was elected to membership in the European Academy of Arts and Sciences.

A memorial symposium at the IBM Research Laboratory in September 1993 attended by many colleagues and friends honored Rolf's long career. He will be missed.


Clarence E Larson

CLARENCE EDWARD LARSON

1901–1999

BY ALVIN M. WEINBERG

CLARENCE EDWARD LARSON died of pneumonia at the age of eight-nine on February 15, 1999. Larson was one of the original scientists whose life was largely devoted to nuclear energy.

I first encountered Clarence Larson in 1945, when I moved from the Chicago Manhattan Project to the X-10 plutonium plant in Oak Ridge, Tennessee. Clarence, a chemist, had been a member of Ernest Lawrence's team that designed, built, and supervised the operation of the Y-12 electromagnetic U-235 separation plant. The core of the Hiroshima bomb was almost entirely made of U-235 that had been separated at the Y-12 plant. Clarence Larson, as the senior chemist on the Y-12 team, contributed massively to the success of the laborious, atom-by-atom separation of the fissile core of the Hiroshima bomb.

My sister and brother-in-law, Fay and Irving Goleman, had been colleagues and friends of Clarence and his first wife, Jerry, at the College of the Pacific in Stockton, California. Clarence had been the chairman of the Chemistry Department at the College of the Pacific from 1939 to 1942, when he joined Lawrence's team. So when I arrived in Oak Ridge in May of 1945, I had already been told to look up the Larsons.

Clarence, while a graduate student in biochemistry at the University of California, Berkeley, had studied the clotting of blood. In the course of these studies, he devised a glass electrode for measuring the pH of flowing solutions. His glass electrode proved to be a most useful device.

Larson's pH meter illustrates his sound grasp of chemistry, as well as his ability to improvise. This latter trait was demonstrated when Clarence was director of the technical staff for the Tennessee Eastman Corporation, which by this time (1943 to 1946) was operating the Y-12 plant. The separated U-235 was caught in stainless steel and graphite receiving dishes; once caught, U-235 would be purified chemically. Because the yield was so low, the Y-12 plant was not successful until Clarence Larson suggested that all the stainless steel be replaced by copper. Ernest Lawrence told Larson he had to make the replacement in twenty-four hours—which miraculously Clarence and his team succeeded in doing. (In those days we realized that every minute we delayed meant more soldiers would lose their lives.)

Union Carbide Corporation replaced Tennessee Eastman as contractor for the Y-12 plant in 1946. At this time the X-10 plant became the Oak Ridge National Laboratory (ORNL), also operated by Union Carbide. Clarence served as director of research and development, and then superintendent of the Y-12 plant between 1946 and 1949; and then in 1950 he became director of ORNL. I was the research director of ORNL. During this time I came to understand how Clarence, with his broad technical grasp and his talent for improvisation, was able to accomplish goals of importance to national security. Two projects stand out: the production of hafnium-free zirconium for use in naval and commercial power reactors, and the separation of the Li^6 isotope for use in the hydrogen bomb. Both these tasks were completed at the Y-12 plant under Clarence's supervision.

Clarence served five years, from 1950 to 1955, as director of ORNL. During this time ORNL developed widely used methods of extracting plutonium from irradiated fuel elements; as well as designing the core of the materials test reactor—a small water-cooled research reactor that generated 40,000 kilowatts of heat and possessed the highest slow neutron flux in the world. During this time the Oak Ridge Biology Division acquired a worldwide reputation as a leading exponent of the new style of big biology.

Clarence left the laboratory in 1961 to become the vice-president for research for the Carbon Products Division of Union

Carbide Corporation; and then in 1961 he returned to Oak Ridge to become the top executive of the nuclear branch of Carbide that operated all three Oak Ridge Installations: K-25 (gaseous diffusion); Y-12 (electromagnetic separation); and X-10 (Oak Ridge National Laboratory).

Clarence Larson's reputation as a knowledgeable and judicious administrator led him to become commissioner of the Atomic Energy Commission in September 1969. Clarence held this post until 1974. This was the period when nuclear energy became embroiled in political uncertainty.

After Clarence retired from active involvement in nuclear energy policy, he carried out many original and useful projects. He and his second wife, Jane, collaborated on a video living history of major scientific figures from the Manhattan Project and other wartime projects. As a chemist he created colored glazes, which his wife used to color her well-known ceramic tiles. He became expert in computers and built several early television sets and even an electric car. Altogether, Clarence's last days were devoted to these hobbies, which had become highly sophisticated avocations.

Clarence Larson is survived by his wife, the former Jane Warren, and by two of his three sons, Robert and Lawrence. (His third son, Lance, died tragically while doing experiments in a basement laboratory.) To all who knew him, Clarence was a wonderfully ingenious chemist, a skilled administrator, and a steadfast friend.

GERALD A. LEONARDS

1921–1997

BY MILTON E. HARR

GERALD A. "JERRY" LEONARDS, or "Gal" as he signed his memos, professor emeritus of civil engineering at Purdue University, died at 12:48 p.m. on February 1, 1997, of an apparent heart attack while playing tennis.

Professor Leonards was born on April 29, 1921, in Montreal, Quebec, Canada, of immigrant parents from Russia. He became an U.S. citizen in 1960. To earn extra money while in high school, among other jobs, as he liked to tell, he worked in his uncle's soda straw factory. He obtained his B.S. degree in civil engineering in 1943 at McGill University in Montreal, where he excelled both in academics and in athletics. Upon graduation (1943 to 1944), he began his career as a structural designer at G.L. Wiggs & Company in Montreal. He then served as chief of a survey party for the Canadian Department of Mines and Resources in Ottawa (1944 to 1945) and as soil engineer (1945 to 1946) for the Canadian Department of Transportation. In the winter of 1944 he also participated as a lecturer at McGill and presented his first formal instruction in soil mechanics. It was the beginning of an illustrious career.

On May 13, 1945, he married Beryl Freed in Montreal. Realizing the importance of the burgeoning field of soil mechanics and foundation engineering, Jerry and Beryl moved in 1946 to Lafayette, Indiana, where he joined the staff at Purdue University as an instructor and began work on graduate degrees with

Professor Ralph Fadum. Their two children, David and Helen, were born in Lafayette. He received the M.S. and Ph.D. degrees in civil engineering from Purdue in 1948 and 1952, respectively. His Ph.D. thesis was a seminal work on the strength of compacted clay, demonstrating the effects of the prior history of loading. Dr. Leonards was promoted to the rank of assistant professor in 1952, associate professor in 1955, and professor in 1958. He was head of the School of Civil Engineering from 1964 to 1968.

His lectures were inspiring and at the cutting edge of the profession. His depth of knowledge was phenomenal. His “Advanced Foundation Engineering” and “Applied Soil Mechanics” courses are considered classics by former Purdue graduate students, which number in the hundreds. The student body voted him “best civil engineering teacher” in 1976. The book *Foundation Engineering* that he edited was published by McGraw-Hill in 1962 and quickly became a standard reference worldwide. He was the author or coauthor of ninety-six professional papers that not only spanned geotechnical and foundation engineering but also contributed to other areas of civil engineering. Although he retired from teaching in 1991 when he was named professor emeritus, he continued to contribute significantly to the research program and the development of graduate students at Purdue.

Professor Leonards' research interests were wide and he made pioneering contributions to knowledge on strength and compressibility of compacted clay soils, analysis and design of shallow and deep foundations, strength and consolidation of natural deposits of soft clay, cracking of earth dams, frost action, flexible and rigid pavement design, analysis of buried conduits, pile foundations, stability of slopes and embankments on soft clays, stress-deformation and liquefaction of sand, and methodologies for investigating failures. He published extensively nationally and internationally. He was much sought after as a technical speaker and gave numerous invited lectures at conferences and institutions here and abroad. The listing would do Rand McNally proud. He was a member of the first USA-USSR Scientific Exchange Delegation in Soil Mechanics and Foundation Engineering in 1959.

Throughout his career, Jerry's insight and expertise were sought on earthwork and foundation projects all over the world, a number of which involved the investigation of failures. He would often say, “We learn more from our failures than our successes.” He was appointed as the only non-European to sit on an official government commission in Italy to investigate ways to stabilize the Tower of Pisa. Jerry was an active participant in the American Society of Civil Engineers (ASCE) (life fellow) and the Transportation Research Board. In 1980 he was honored by the ASCE by presenting the Terzaghi Lecture. In 1988 he was elected a member of the National Academy of Engineering, and in 1989, Dr. Leonards was honored by McGill University in Montreal where he became a doctor of science, honoris causa. He was also presented with the 1989 Terzaghi Award. Over his career he received numerous other awards from professional and technical societies, including the ASCE's highest award, the Norman Medal, which was awarded in 1965. He was a member of Phi Epsilon Alpha, Chi Epsilon, Tau Beta Pi, and Sigma Xi.

From the students' perspective, “Gal” was a dedicated professor and researcher. His geotechnical philosophy is summarized in “understanding the physics of the phenomenon.” Students admired his engineering knowledge and intuition, and the depth and clarity of his concepts. He never missed an opportunity to learn more about his chosen field and to share with students his views on new developments.

In the fall of 1996 he was appointed an adjunct professor at the Georgia Institute of Technology and at the University of California, Berkeley, in addition to his work at Purdue, which at that time spanned more than fifty years. A Gerald and Beryl Leonards Graduate Fellowship in Geotechnical Engineering has been established in their honor at Purdue University.

Jerry Leonards was a charter member of the Greater Lafayette Press Club, a member of the American Contract Bridge League, a Kentucky Colonel, a member of Temple Israel, affiliated with the Sons of Abraham Synagogue, and an arbitrator for the American Arbitration Association. Jerry's other nonacademic interests included archeology, bridge, golf, and tennis.

Jerry's wife, Beryl, died in 1994. Surviving family are a son, David, and daughter, H.H., and four grandchildren. David

Leonards married Rebecca Jacobs of Evansville, Indiana. They live in Indianapolis with their three sons, Gerald, Brett, and Grant. Helen Leonards resides in Washington, D.C., with her son ZZ. On a personal note, I was Jerry's first Ph.D. He was my academic father. We shared forty-three magnificent years together at Purdue, generally with two coffee breaks and lunch, almost every day. Our discussions ran the gamut, from Monday quarterbacking to philosophy and, of course, liberal doses of soil mechanics. It is said the nature abhors a vacuum. The vacuum that Jerry's death left me will never be filled.

FRITZ LEONHARDT

1909–1999

BY BEN GERWICK

FRITZ LEONHARDT, professor and former rector (president) of Stuttgart University, Germany, died on December 30, 1999. He was born in Stuttgart and received his university education at Stuttgart University. He carried on graduate studies at Purdue University in 1932 and 1933, returning to Stuttgart University to obtain his doctorate of engineering in 1938.

In 1939, after his collaboration with Wolfhart Andra, in the successful design of Europe's largest suspension bridge across the Rhine at Cologne, he formed the partnership of Leonhardt Andra and Partners, which became one of the world's best-known designers of major bridges.

Fritz Leonhardt was an active supporter of the major professional structural and concrete engineering organizations in Europe and later, internationally, including the Federation Internationale de la Precontrainte and the International Association for Bridges and Structural Engineering.

He and his firm were always at the forefront of pioneering developments in bridges; from development of a new system for prestressed concrete in 1949 to aerodynamically stabilized suspension bridges as early as 1953, orthotropic steel decks, composite steel and concrete high-speed railroad bridges, and cable-stayed bridges. Although his first love was bridges, he also pioneered the family of prestressed concrete television towers, beginning in 1953 with the famous Stuttgart Tower, which became a symbol for the city. He developed new methods of analyses and design for large tentlike structures with steel cable-supported roofs, and designed the German Pavilion at the Olympic Games in Montreal (1967) and Munich (1972).

Fritz Leonhardt is best known for his design of major bridges, not only in Germany but also in South America (Venezuela and Argentina) and in the United States. The first cable-stayed bridge in the United States, designed in conjunction with Arvid Grant Associates, was built across the Columbia River between Pasco and Kennewick, Washington.

Successful implementation of new structural concepts required extensive research and development in materials, structural performance, and construction methods. Appointed professor of concrete structures at Stuttgart University in 1958, he carried out fundamental developments in the shear and torsional resistance of concrete at the Otto Graf Institute. This work resulted in not only advanced understanding and methods of analysis but also new systems, especially those for transferring shear in composite structures and resisting punching shear.

He pioneered the development of the incremental launching system for prestressed concrete bridges by which the bridge is fabricated at the abutment and shoved by hydraulic jacks across the valley, a system of special application in the harsh seasonal conditions of Europe.

Professor Leonhardt was elected a foreign associate of the National Academy of Engineering of the United States in 1983. He has received a great many awards from national and international bodies worldwide. From the United States, he has received an honorary membership from the American Concrete Institute (1972), the Distinguished Service Award of Oregon State University (1974), the Honor Award of the Washington Roadside Council (1979), the Award for Engineering Excellence of the American Consulting Engineers Council, and the Honorary Distinguished Citizen from the State of Washington (1984).

Fritz Leonhardt loved bridges, not only as an engineer but also for their aesthetic and symbolic qualities. In his later years, he increasingly wrote and lectured on bridge aesthetics, accompanying these lectures with a voluminous collection of personal photos illustrating the beautiful and ugly aspects that are under the control of the bridge designer.

He felt strongly that the basic bridge design was the province and responsibility of the design engineer, and that a good basic design would also be beautiful.

He published extensively, both in journal articles and books, of which his books on *Bridges* and on *Towers* are known worldwide.

One of his outstanding traits, unusual in a highly active and innovative designer, was his personal interest in younger colleagues and students. He always had time to talk and explain, kindling in his listeners much of the quiet fire that drove him.

Contributing to the heritage of enthusiasm and dedication were his associates in his firm, who now carry on his work, and especially his wife, Lisalotte, who "forgave him his love affair with bridges."

ARTHUR LUBINSKI

1910-1996

BY KENNETH A. BLENKARN

BORN IN ANTWERP, BELGIUM, and educated at the University of Brussels, Arthur Lubinski graduated in 1934 with the degree *ingenieur civil mecanicien et electricien.* Before World War II he worked on the development of devices generating motor fuel from coal.

Coming to the United States in 1947, he began a long and distinguished career of engineering development in the petroleum industry. He served in both supervisory and individual researcher roles. At the time of his retirement in 1975, he was special research associate at the Tulsa Research Center of Amoco Corporation, now BP-Amoco. He continued an active development and consulting practice, mainly for equipment manufacturers, until shortly before his death in 1996.

In the early 1950s Arthur focused his thorough grounding in applied mechanics on the behavior and performance of oil well tubulars such as well casing and drill pipe. Many of his findings were strikingly counterintuitive and significantly improved the engineering and operating practices of the industry. Early on, Arthur advocated placement of long strings of large diameter, minimal clearance “drill collars” immediately above the drill bit. Critics called this notion a certain guarantee to cause “stuck pipe,” but Arthur's findings eventually formed standard industry practice, with great economic benefits. *Lubinski's Law* said you can't drill a truly vertical hole, especially in dipping formations. Al most single-handedly, and against strong opposition, Arthur pioneered the industry practice of horizontal placement of the surface locations of a well away from the bottom hole-drilling target. This permits efficient drilling while the inherent drift of the well path carries the hole toward the target.

Arthur's subsequent extension of analytical work produced methods and equipment for controlling well inclination together with industry specifications for allowable hole curvature related to drill pipe fatigue. In later years, he improved approaches to well casing design and set the basis for design of downhole equipment to counter the effect of internal pressure induced buckling of oil well production tubing.

Because of his early accomplishments, Arthur was called to serve on the drilling panel guiding the planned Mohole Project. Later he served in technical education and advisory roles for the Deep-Sea Drilling Project, which documented plate tectonics. After participation in these national efforts, Arthur played a role guiding the industry in melding the latest advances of naval architecture and physical oceanography with industry operating know-how to evolve drilling vessels and safe drilling practices for subsea wells.

The full scope of Arthur's work, on a wide range of topics, is documented in a long list of publications, many republished in several languages. As a reference book, his collected works have been published as a two-volume set. Some critics with academic viewpoints denigrated Arthur's publications as not being mainly in refereed journals. However, one can observe that his publications passed the ultimate “referee test”—they changed the industry.

Elected to the National Academy of Engineering in 1986, Arthur Lubinski was actve in numerous industry groups and professional societies. Often he was the initiator of collaborative efforts to address common challenges. He was a member of the Society of Naval Architects and Marine Engineers, a fellow of the American Society of Mechanical Engineers (ASME), and distinguished member of the Society of Petroleum Engineers. These and other professional societies jointly sponsor the Offshore Technology Conference (OTC). In 1976 Arthur received the OTC's Distinguished Achievement Award for Individuals. More recently, ASME established the Arthur Lubinski Award for the Best Mechanical Engineering Paper for the best paper presented at OTC.

During World War II Arthur served with the French Resistance Forces. Perhaps this experience spawned the determination and tenacity which he displayed in giving voice to his findings and making a difference in industry technology—all these accomplishments from a thoroughly kind and generous man. He is survived by two of his daughters and a host of devoted friends.

ROBERT E. MCINTOSH

1940–1998

BY MERRILL SKOLNIK

ROBERT F. MCINTOSH, distinguished university professor at the University of Massachusetts, died at the age of fifty-eight on July 10, 1998, in Amherst, Massachusetts, following a lengthy illness. He was widely noted for his pioneering work in the use of microwaves for remote sensing of the environment as well as his leadership in making the university he served for more than thirty years internationally recognized as one of the outstanding schools for microwave engineering.

Professor McIntosh was born on January 19, 1940, in Harford, Connecticut. He received the B.S. degree in electrical engineering from Worcester Polytechnic Institute, the S.M. degree in engineering from Harvard University, and the Ph.D. in electrical engineering from the University of Iowa in 1967. He joined the Department of Electrical and Computer Engineering at UMass Amherst in 1967 at a time when few in the electrical engineering profession had heard of the department. Although it takes many devoted individuals among the faculty and the university administration to ensure the success of a university electrical engineering department, there is little doubt about the strong influence that Professor McIntosh had. He brought together an outstanding faculty who worked to establish a vigorous and pioneering engineering research program in microwaves and remote sensing, a program that is highly regarded by his peers. He was also exceptionally effective in developing outstand ing students, an important measure of success of an academic program. His accomplishments as an engineering leader and educator can be attributed to his talent and interest in advancing the knowledge of engineering, his friendly style of leadership, his devotion and compassion for students, his stimulating and caring relations with colleagues, and his unselfish service to the profession of electrical engineering.

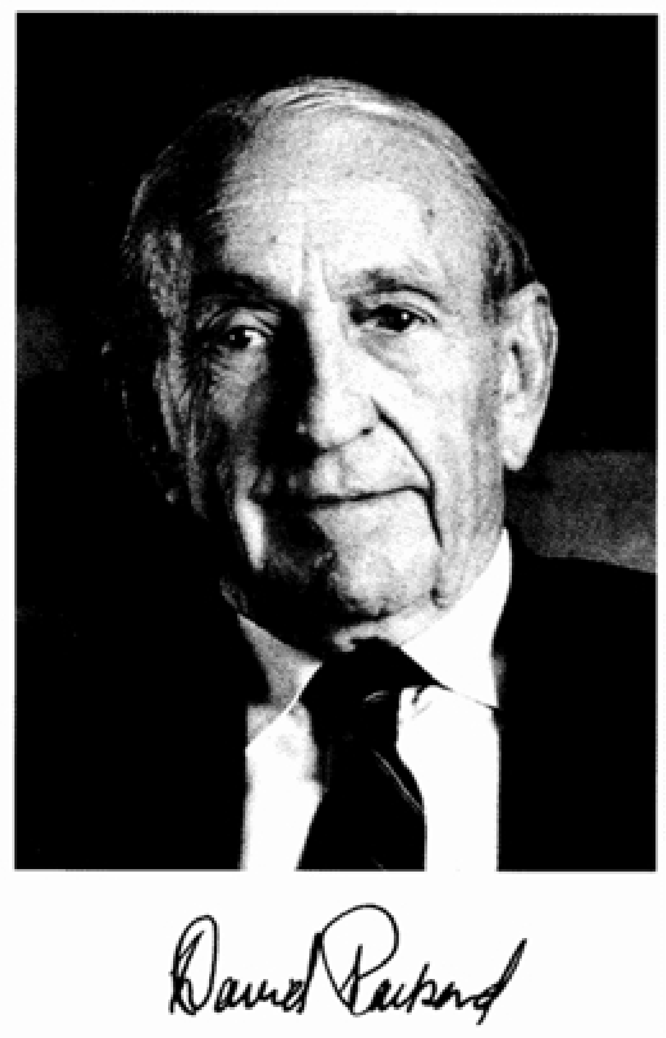
Professor McIntosh's contributions to research were mainly in the use of microwaves and millimeter waves for remote sensing of the sea, earth, and atmosphere. He and his students pioneered in applying millimeter wave radar (up to frequencies as high as 225 GHz) for better understanding the nature of clouds by determining cloud particle size distributions and concentrations, and the composition of atmospheric water and ice important for global warming studies. Other areas of sensing geophysical phenomena were also part of the UMass remote sensing agenda. These areas included determination of the scattering properties of natural surfaces such as foliage and snow-covered terrain, the use of digital high-resolution antenna beam-forming array systems to investigate the microwave scattering mechanisms of the ocean surface, and measurement of ocean wave spectra and ocean surface currents. UMass was the first to use beam-forming techniques to probe the atmospheric boundary layer for investigating clear air turbulence. Professor McIntosh's work involved sensing from ground-based, shipboard, and aircraft platforms. Along with Calvin Swift, his friend and colleague for many years, he founded Quadrant Engineering, Inc., which specializes in the design and manufacture of microwave and millimeter wave systems for remote-sensing applications.

Professor McIntosh was an experimentalist with a passion for the practical aspects of electrical engineering, but also with a broad and deep understanding of the theory that underlies observable phenomena. He wisely imparted this philosophy to his graduate students. His students were not monolithic, but were required to be involved in all aspects of research: from the defining concept of the experiment to the design, building, or assembly of equipment to the use of the equipment to probe the environment (sometimes in a remote location or flying in an aircraft through a hurricane) and from collecting and analyzing the data to determining what new understanding has been acquired. The success of his students is testimony to the success that Bob McIntosh had as an electrical engineer and educator.

Professor McIntosh would sometimes load up his van with his graduate students and drive them to an Institute of Electrical and Electronics Engineers (IEEE) conference and spend several days with them, introducing them to the world of electrical engineering. Other professors might do something similar, but I was impressed that Bob would also stay in the dorms right along with his students.

Many engineers serve their particular professional society in some manner during their careers. Bob McIntosh did more than might be expected. He was one of the few who had the honor of being elected as president of two IEEE societies: the Geoscience and Remote Sensing Society in 1984 and the Antennas and Propagation Society in 1985. He was the editor-in-chief of the *IEEE Transactions on Antennas and Propagation* from 1989 to 1992, associate editor of *Radio Science,* the chair of international conferences, and editor of special issues of journals. He was also well known within the IEEE Microwave Theory and Techniques Society and the International Union of Radio Science, and was known for his leadership in establishing particularly close ties between his university and the microwave industry.

The many honors Bob McIntosh was accorded throughout his illustrious career need not be detailed here. He was a productive and influential engineering researcher, a tireless contributor to his profession and his community, and, perhaps most important of all, he touched the lives of many people with his leadership, teaching, vision, and friendship.



DAVID PACKARD

1912–1996

BY JOEL BIRNBAUM

DAVID PACKARD, cofounder of the Hewlett-Packard Company and one of the nation's foremost business leaders and philanthropists, died on March 26, 1996, at the age of eighty-three.

From humble beginnings in a Palo Alto garage in 1939, Packard and his partner, Bill Hewlett, built an engineering-based company that today is a multinational enterprise with more than 100,000 employees in 120 countries and annual revenues exceeding $40 billion. Its technical prowess, innovative management practices, and consistent commercial success—all legacies of Dave Packard—have made it the prototype of the modern technological company and one of the most widely admired corporations in the world.

Dave was elected to the National Academy of Engineering in 1971 and received its Founders Award in 1979.

He was born September 7, 1912, in Pueblo, Colorado, where his father was an attorney and his mother a high school teacher. He decided in grade school that he wanted to be an engineer— even though his father had hoped he would study law. At Stanford University Dave distinguished himself as a student and athlete. He was elected to Phi Beta Kappa, and at a rangy six-foot-five, he set records in track as a freshman and later played varsity football and basketball.

He studied electrical engineering at Stanford University, and it was there he made two important friendships. One was with

Bill Hewlett, a fellow engineering student, and the other with Frederick Terman, a young professor who became a mentor to Dave and Bill and, even while they were still undergraduates, encouraged them to think about starting a business together. Dr. Terman was a gifted teacher of "radio engineering," as electronics was then known, and Dave described him as "one of the greatest influences in my life." It was at Stanford that Dave met Lucile Salter, his future wife, while serving meals in her sorority dining room. They were married in 1938.

Upon graduation in 1934, in the midst of the Great Depression, Dave took a job with General Electric in Schenectady, New York. It was one of the few jobs available to the engineering graduates. In the same year, Hewlett began graduate study at the Massachusetts Institute of Technology. He and Dave were reunited in Palo Alto a few years later by Terman, who arranged a Stanford fellowship for Packard and found Hewlett a job as well. "I was determined to get these bright young engineers together again," Terman said.

With capital of $538.00, Dave and Bill set up a bare-bones workshop in Packard's rented garage. They had no "grand vision" of specific technological breakthroughs. Instead, they turned their hands to whatever mechanical or electrical equipment customers desired. "We just took on odd jobs," Packard recalled.

Some were odd indeed. They developed a shock machine to help people lose weight and an optical device to flush a urinal automatically. But then they focused their attention on a design developed by Hewlett in graduate school. It was for an audio oscillator, a device for calibrating sound equipment. They sold eight oscillators to the Walt Disney Studios for use in making the movie *Fantasia.* Other sales followed and in 1939, their first full year in business, the partners made a profit of $1,539.00 on sales of $5,369.00. Hewlett-Packard (HP) has been profitable every single year since.

During World War II and on into the 1960s the company grew rapidly. But management was careful not to take on contracts that would require the hiring of many people, only to let them go when the contract ended. "We didn't want to be a hire and fire shop," Packard said. Nor did he and Bill wish to take on any long-term debt. "Having grown up during the Depression, we were determined to fund growth from profit and not to operate on borrowed money." Still another HP policy, faithfully followed right up to the present, is to maintain a relatively high level of investment in research and product development. Over the years the company's annual spending on research and development amounted to as much as ten percent of sales, supporting Packard's contention that "good new products are the lifeblood of this business."

And turn out the new products they did. As time went on there was hardly any part of the market for electronic test and measuring equipment in which HP wasn't the leading, or at least a major, supplier. From that base the company expanded into electronic calculators. In 1972 it introduced a handheld scientific calculator, the model 35. The first device of its kind, it was enormously popular and rendered slide rules obsolete. Then, in the 1970s and 1980s, HP moved aggressively into the computer business and today is among the nation's largest computer companies.

Packard and Hewlett shared many interests. Both were avid outdoorsmen, frequently off on fishing or hunting trips and often asking HP colleagues to join them. They also were co-owners and managers of ranch properties, including working cattle ranches in California and Idaho. When it came to managing HP, their abilities and interests were complementary. Bill devoted most of his time and attention to research and product development. Dave, as chief executive officer, was responsible for day-to-day operations and the overall management of the company.

In 1969 Dave left HP to become the deputy secretary of defense in the first Nixon administration, serving under Melvin Laird for three years before returning to Hewlett-Packard. In 1985 he was appointed by President Reagan to be chairman of the Blue Ribbon Commission on Defense Management, and over the years served as a trusted adviser and a member of several government commissions. Beginning in 1978, Dave helped foster ties with China. He remained actively involved in U.S.-China relations until his death.

Upon Packard's death, Hewlett said Dave's greatest legacy was the “HP Way,” a set of values and management principles that Dave put down on paper more than forty years ago and which, to this day, are at the core of the company's culture. In his 1995 book, *The HP Way,* Dave wrote that one of the objectives of the company was “to maintain an organizational environment that fosters individual motivation, initiative and creativity, and a wide latitude of freedom in working toward established objectives and goals.” From its early years, HP has been notably responsive to workers' needs, providing broad-based profit-sharing and stock purchase programs, an early catastrophic health plan, flexible work schedules, and an open environment that encourages informality and easy communications.

Dave Packard was one of the richest men in the United States and also among the most generous. Over the years he and his wife, who died in 1987, contributed tens of millions of dollars to Stanford and other educational institutions, to various community organizations, to scientific research, health care, conservation, and the arts. The David and Lucile Packard Foundation was founded in 1964 to help direct the family's philanthropic activities. At the end of 1996 its assets totaled $7.4 billion, placing it in the top tier of America's charitable foundations.

Upon retiring, in 1993, Dave Packard was asked a question about his countless accomplishments and honors. Which had given him the most satisfaction?

“I think you get the most satisfaction in trying to do something useful,” he said. “After you've done that, you ought to forget about it and do something else. You shouldn't gloat about anything you've done. You ought to keep going and try to find something better to do.”

EARL RANDALL PARKER

1912-1998

BY DOUGLAS FUERSTENAU AND GARETH THOMAS

EARL RANDALL PARKER, one of the truly great members of the engineering faculty of the University of California, Berkeley, died on May 9, 1999, at the age of eighty-five. He was born in Denver, Colorado, on November 12, 1912.

After earning the degree of metallurgical engineer from the Colorado School of Mines in 1935 he took a position with the General Electric Research Laboratory (GE) in Schenectady, New York. While at GE Earl Parker did pioneering research on the mechanical properties of metals and alloys. His experiments on steel, copper, copper alloys, and silver resulted in some early insights into how variables such as impurity content, alloying elements, strain rate, and grain structure influenced the mechanical properties of metals. As a result of this work, in 1944 he was invited to join a group in the Civil Engineering Department at Berkeley trying to understand the unexpected breaking in half of welded steel Liberty ships often without warning or for any apparent reason. At Berkeley there was a three-million-pound tensile testing machine for testing of full-size steel structures, but this problem seemed to be more related to the properties of the materials than to the design of the structures. The group needed a metallurgical engineer with a basic understanding of the mechanisms of plastic deformation, fracture nucleation and crack propagation. Earl Parker joined the group and after about a year's work, the causes of the catastrophic failures were identified as poor welding technology, residual stresses, inferior steels of inappropriate composition, and some unfavorable design details.

In 1944 he became a University of California faculty member in what is now the Department of Materials Science and Mineral Engineering. During the next thirty-three years, Earl Parker made truly outstanding contributions to teaching, to the university, and to the scientific community of the world.

Science, technology, and engineering have been enriched by his contributions and the inspiration he gave to his students and colleagues. The Parker philosophy for selecting and guiding research projects was always to determine first what fundamental principles are involved by study and research, and then to apply these principles to the solution of a perplexing technological problem—the solution of which would be of benefit to mankind. Recognition of this philosophy and the benefits that have accrued therefrom have been well stated in a number of the citations of his numerous honors. He and his graduate student, Jack Washburn, were the first to demonstrate the existence of dislocations by the etch-pit technique, an achievement for which they were awarded the Champion H. Mathewson Gold Medal Award of the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME). In 1969 Earl Parker was elected to the National Academy of Engineering. His many awards included the Albert Sauveur Award of the American Society for Metals (ASM), the ASM Gold Medal Award, the Vincent Bendix Award with gold medal of the American Society for Engineering Education. He was an honorary member of AIME (there can be only fifty such persons at any time), honorary member of ASM, and also Legion of Honor Member of AIME. In 1970 he was named California Scientist of the Year, and in 1979 he received the National Medal of Science. Upon his retirement as professor of metallurgy in 1978, he received the Berkeley Citation, the highest honor bestowed by the Berkeley campus of the University of California.

His enthusiasm for science and his leadership of the scientific community led to many professional society appointments that included member of the board of trustees, ASM, 1958-1960;

vice-president, ASM, 1966-1967; president, ASM, 1967; chairman, National Materials Advisory Board, 1975.

Earl Parker's active participation in the national and international scientific community was a direct benefit to research at the University of California, Berkeley. It was through his efforts that the Department of Energy established a research program in materials science and chemistry as a new division of Lawrence Berkeley National Laboratory now called the Materials Science Division, which has become one of the most prominent centers of materials science and engineering research in the world.

In spite of all these outside activities, Professor Parker always put supervision of graduate students and teaching of classes first. In 1972 he received the Distinguished Teaching Award from the University of California, Berkeley, and that same year was the faculty research lecturer at Berkeley. During his time as a faculty member he served as chairman of the Department of Materials Science and Mineral Engineering from 1953 to 1957 and 1965 to 1966 and as director of the Institute of Engineering Research, UC Berkeley from 1957 to 1964. He was the thesis research supervisor for more than a hundred Ph.D. and M.S. students, and he along with his students published more than 150 technical papers in scientific journals.

In the period from 1946 to 1961, Earl Parker, his students, and associates made major contributions to experimental verifications of the rapidly developing dislocation theory. Fundamental understandings of the mechanisms of yield strength strain hardening, fracture, creep, and fatigue of crystalline materials were significantly advanced by understanding the behavior of dislocations. A wide variety of materials were used for these fundamental investigations including refractory metals, zinc single crystals, ionic crystals such as magnesium oxide, and other engineering ceramics.

From 1962 to 1965, the research emphasis of Earl Parker and his group shifted to superconductivity in metals and ceramics and back to his earlier field of interest in mechanical properties of iron-based alloys. In both these fields, his research led to new fundamental understandings of the relationships between crys tal structure, defect structure, microstructure, and properties. His study of superconductivity in ceramic compounds of the NaCl structure predicted that superconducting critical temperatures higher than 17.8 Kelvin were not likely to be found in this class of materials, a conclusion that twenty years later is still valid. New methods were developed allowing practical applications for brittle superconductors.

During this same period, and extending to 1979, the science and technology of ferrous metallurgy (steels) again became the cornerstone of Earl Parker's interest. The importance of this work was that it demonstrated that adequate toughness could be retained in ultrahigh-strength steels by microstructural control. Much of the understanding and knowledge gleaned from his early years of fundamental metallurgical research, and with the improvement of techniques for study of complex microstructures (such as advanced transmission electron microscopy), allowed Earl Parker and his collaborators to make major contributions to the development of new processes and steels with improved properties, such as “TRIP” steels, steels that became tougher as they underwent phase transformations while undergoing deformation.

Earl Parker's enthusiasm for new basic understanding of properties of materials, his consistent translation of these new understandings into improved materials or processes, the encouragement given to his students and collaborators, and his outstanding service to the University of California and the worldwide scientific community will long be remembered.

Earl Parker was predeceased by his first wife, Mary Larkin Parker, whom he married in 1935, and his eldest son, Robert. He is survived by his son, William, daughter, Peggy Sullivan, and his second wife, Agnes.


Donald W. Pritchard

DONALD WILLIAM PRITCHARD

1922-1999

BY ROBERT O. REID

OTHER CONTRIBUTORS TO THIS TRIBUTE ARE WILLIAM C. BOICOURT, CHARLES R. O'MELIA, THELMA A. PRITCHARD, AND WILLIAM J. WISEMAN, JR.

DONALD W. PRITCHARD, an expert in the field of coastal and estuarine physical oceanography, died on April 23, 1999, at the University of Maryland Hospital in Baltimore, at the age of seventy-six. He was professor emeritus of the Marine Sciences Research Center, State University of New York at Stony Brook, Long Island, and remained active as a consultant in marine sciences, coastal engineering, and microcomputer software. He and his wife, Thelma, lived in Severna Park, Maryland.

Don Pritchard was born in Santa Ana, California, on October 20, 1922, to Charles L. and Madeline Siever Pritchard. He was the youngest of five children and the only boy. His father was a successful banker and a very community-oriented person, who was instrumental in forming the Santa Ana Musical Arts Association. Both parents were raised in Fond du Lac, Wisconsin, and their grandparents had roots in Wales and Germany. Don was outgoing like his father. He played junior varsity football in high school and in college. Don attended the private school Principia through his sophomore year, but transferred to Santa Ana public high school in his junior year. It was there that he met his future wife, Thelma Amling, whom he married five years later, after military service.

As with many in Don Pritchard's generation, World Was II profoundly affected his career. His studies in basic and applied physics at the California Institute of Technology (1940 to 1942) were interrupted by America's entry into the war in December 1942. Pritchard volunteered for training as a weather officer in the U.S. Army Air Corps, and was assigned to a six months meteorology program with other air corps cadets at the University of California, Los Angeles (UCLA). Professors J. Bjerknes and J. Holmboe were leading instructors of the class of about one hundred cadets in the program. Another cadet who had interrupted his B.E. degree studies in California was R.O. Reid. This was the beginning of a long association between Pritchard and Reid, which continued during the war years, through their graduate studies at Scripps Institution of Oceanography, and throughout their careers in oceanography and coastal engineering at different institutions.

The capability of forecasting storm-induced waves, and their modification over beaches, was an extremely important factor in amphibious landings in the North African operations during the war. This motivated an improved method of wave forecasting by H. Sverdrup and W. Munk at the Scripps. In the fall of 1943, Lieutenant Pritchard and about ten other officers, including Reid, were selected for special added training in wave dynamics and prediction. Several officers from this group, along with C. Bates and J. Crowell from a prior group, would be involved in forecasting for landing operations in the Pacific and Europe.

Both before and during the June 6, 1944, invasion of Normandy, Pritchard served on a special team with Bates and Crowell to advise the Allied Headquarters for Operation Overlord on weather and wave conditions for the amphibious landings. Pritchard headed Detachment YK of the Twenty-First Weather Squadron, under Colonel T. Moorman's command. Most of the other weather detachments were assigned to different divisions of the advancing Allied ground forces. Detachment YK was assigned to an Army Engineer Command at Omaha Beach and provided forecasts of weather, wave conditions, and tides for the supply operations across the Normandy beaches. With the closing of the beach operations and opening of the French ports in November, the detachment moved to Allied-liberated Paris, to issue forecasts to many of the supply ports. The com manding officer of the Army Weather Service group in Paris was Major H.R. Seiwell, who had been a research scientist at Woods Hole Oceanographic Institution on Cape Cod before World War II.

In the spring of 1945, when the Allied forces were about to cross the Rhine River, Pritchard and Reid were reassigned by Colonel Moorman to the Pacific theater of operations with some time off for rest and relaxation in California. On reporting for duty at Headquarters AFMIDPAC in Hawaii, they learned that their assignment was with a beach intelligence team headed by Major Seiwell. This team consisted of six officers, eight enlisted men, and aircraft suitable for photo reconnaissance. However the war with Japan ended several months later, before this team from its advanced base in Guam carried out any aerial surveillance of Japan's beaches for potential amphibious landings.

Captain Pritchard was discharged from active military service in January 1946, and he completed his B.A. degree in meteorology at UCLA in June 1946. His wartime experience in coastal processes led him to continue studies in oceanography at the University of California's Scripps Institution in La Jolla. He obtained his M.S. degree in oceanography in 1948 and completed his Ph.D. degree in 1951. The Scripps Institution graduate students, in the late 1940s and early 1950s, included many individuals like Pritchard and Reid who had served as weather officers in the army or navy during the war. Several were destined to build new academic and research programs in oceanography in the United States. These included D. Pritchard, D. Leipper, W. Burt, W. Wooster, and J. Knauss. Before 1949, Scripps Institution was the only degree-granting program in oceanography in the country. The principal mentors at Scripps—H. Sverdrup, C. Eckart, and R. Revelle—had a strong influence on the careers of the leaders of the new oceanography programs in America. It was the beginning of a golden era for science and technology, with the creation of federal research-funding agencies like the Office of Naval Research (ONR) and the National Science Foundation (NSF) in about 1950.

In 1949 the Johns Hopkins University in Baltimore was looking for a capable and energetic person to develop a research organization to address estuarine problems in Chesapeake Bay.

At that time Pritchard was working as a research oceanographer with Gene La Fond at the U.S. Navy Electronics Laboratory in San Diego. With recommendations from La Fond and Revelle, Don Pritchard was selected to take on the challenge of creating the Chesapeake Bay Institute (CBI) at Johns Hopkins. Wayne Burt, who later built an oceanographic program at Oregon State University, joined Pritchard in establishing the program at Johns Hopkins in its first few years. The CBI was essentially the research arm of a program that also included graduate education in the newly established Department of Oceanography at Johns Hopkins. Pritchard would lead the institute nearly three decades and chair the Department of Oceanography at Johns Hopkins for nearly two decades, with support largely from ONR, NSF, and the state of Maryland.

The research emphasis at CBI was in the physics and chemistry of the Chesapeake Bay system. Of particular concern were effects of river discharge from many tributaries, significant tidal exchange with the coastal regions, and the interaction of the lower-layer salt wedge with the overriding fresh river water. Pritchard attracted the help of a capable scientific staff in the research and teaching endeavors, including B. Kinsman, A. Okubo, H. Carter, D. Carritt, and J. Carpenter. The focus of CBI was not entirely on estuarine problems; for example, the faculty included R. Montgomery from Woods Hole, who broadened the scope of the oceanographic research to address studies of the currents in the equatorial Pacific. Notable individuals who received their advanced degrees from this program included W. Wiseman, W. Sturges, J. Schubel, S. Wilson, E. Stroup, and W. Boicourt. Their interests were in measurement and analysis of data. Other students or postdoctorals like A. Blumberg, Y. Hsueh, and D.P. Wang were interested in analytical and numerical modeling of coastal and estuarine dynamics. Pritchard's interests spanned all of the above.

Early studies by Pritchard laid the foundation for much of the research that has been done in estuaries over the second half of the twentieth century. His seminal monograph entitled *Estuarine Hydrography,* published in the 1952 volume of *Advances in Geophysics,* is still widely referenced. Not only did Pritchard contribute in a major way to the understanding of estuarine dynamics in more than eighty publications, but he also made major contributions in estuarine measurement technology. In 1993, well after Pritchard had retired from academia, Charles O'Melia of the Environmental Engineering Faculty of Johns Hopkins University stated: “He (demonstrated) how advances in engineering and science can be transformed into innovative solutions to society's problems. He made singular contributions to the development of a variety of instruments and techniques that allowed observations in estuaries in new ways. These included dye tracer techniques, the induction conductivity-temperature indicator, the bi-axial current meter, and an early version of a current meter that made use of the Doppler shift principle. Pritchard's pioneering work in the use of dye tracers established it as a tool in the siting and design of sewage treatment plants and power plants with coastal discharges.”

The scientific staff of the Chesapeake Bay Institute was supported almost entirely from research funding from federal sources. Even the Oceanography Building on the Johns Hopkins campus was funded by an NSF grant, thanks to the efforts of Don Pritchard. Curtailment of ONR support for coastal studies, in the 1970s, therefore had a large impact on coastal programs like CBI. Also because of health problems, Pritchard stepped down as director but remained as senior scientist. Some crucial scientific staff, including Jerry Schubel, left CBI because of the continued lack of support from, and the ineffective management of CBI by, the Johns Hopkins University.

By 1978 Schubel had become director of the Marine Science Research Center (MSRC) at the State University of New York, in Stony Brook. This program had strong state funding and, at Schubel's invitation, Pritchard joined MSRC as associate director and professor of oceanography. Some of Pritchard's associates, including Harry Carter and Akira Okubo, also made the move to Stony Brook, as did several of his graduate students. He remained in this position, actively contributing to research issues in Long Island Sound and teaching, until 1986. His last two years of active service with the State University of New York were in the position of director and associate dean of the Marine Science Research Center.

Pritchard was active in service to his profession and to society. He participated as member or chair of several panels of the National Academy of Sciences and the National Research Council on topics ranging from pollution of the marine environment to archiving of oceanographic data. He was a member of the advisory board to the National Oceanographic Data Center from 1960 to 1968, when the U.S. Navy administered it. Radioactive waste disposal into the sea was the topic of several national and international panels in which he served. He and Reid served on several advisory committees to the Coastal Engineering Research Center of the U.S. Army Corps of Engineers. Pritchard devoted a considerable amount of his time as a member of panels of the state of Maryland and of the state of New York dealing with estuarine pollution and many other societal issues. Finally he served on the editorial boards of several professional journals and as president of the oceanography section of the American Geophysical Union (1961 to 1964).

Pritchard was elected to membership in the National Academy of Engineering in 1993. He received many other honors during his career. The first was a Letter of Commendation from Major General C. Moore, chief engineer, U.S. Headquarters in Europe, for providing meritorious service in surf forecasts and surveys of captured Normandy beaches in the summer of 1944. Many years later (1990), he was awarded the Mathias Medal collectively by the Chesapeake Research Consortium, the Maryland Sea Grant College, and the Virginia Sea Grant Program, in recognition of scientific excellence in studies of the Chesapeake Bay. This medal is named after U.S. Senator Charles Mathias, a long-time friend and patron of the Chesapeake Bay. Pritchard was recipient of the 1987 Annual Environmental Award by the U.S. Environmental Protection Agency. He was also awarded an honorary doctor of science degree by the College of William and Mary in Virginia, on the occasion of the 292nd Charter Day Ceremony of the college in February 1985. These are a few of the honors bestowed on a man who had devoted so generously of his time to his profession and to society.

Bill Wiseman offers his recollections of Pritchard's interaction with his graduate students: “Don's classes were always excit ing. He would carefully prepare his lectures and rarely follow the prepared text. He was interested in so many things, always questioning new ideas and attacking new problems that he could not remain true to his prepared notes. I found this to be very beneficial and stimulating. Rather than being presented with clean, antiseptic lectures suggesting that science proceed as a straight path from query to finding, we were privileged to watch how Don's mind attacked a problem. It was not always aesthetically pleasing; we saw all the wrong turns and stumbles. We also saw his insights, the superb grasp that he had for how the natural environment functioned, and his ability to simplify a problem to its fundamentals. This ability to watch Don's mind in action, rather than being presented with a mere tailored version of the results of his inquiry, was extraordinarily edifying and presented a model to which we could only hope to aspire."

Wiseman continues: "I was particularly impressed with Don's willingness to allow students to develop their own approach to research. He would point a student towards a good problem and then get out of the way and allow the student to proceed. The final product was clearly your own work. He was gracious and open with his time, insights, and advice, when asked for it. He did not impose his own approach on students. It was on his way out of the building at 7:00 or 8:00 or 9:00 o'clock at night that he was most likely to stop in at the lab and see what progress was being made. At these times, without the administrative pressures of the department and the Chesapeake Bay Institute weighing on him, he would sit and chat for an hour or more, encouraging, questioning, and suggesting—not imposing—alternative approaches. He must have been a wonderful father!"

Don Pritchard is survived by his wife, the former Thelma Lydia Amling, whom he married on April 25, 1943, in Santa Ana, California; daughters, Marian Caldwell and Jo Anne Mitchell of Severna Park; sons, Albert of Harwood, Maryland, and Donald Jr. of Severna Park; eleven grandchildren; and three great-grandchildren. Another beloved daughter, Suzanne Lebowitz, preceded her father in death in 1994.

WILBUR L. PRITCHARD

1923-1999

BY YVONNE BRILL AND JOHN F. KELLY

DR. WILBUR L. PRITCHARD, a pioneer in satellite engineering and the development of international satellite communications, died in Bethesda, Maryland, on March 18, 1999. Dr. Pritchard was president of W.L. Pritchard & Co., Inc., a Washington, D.C., consulting engineering firm doing technical and economic studies in telecommunications and specializing in satellite communications for clients around the world.

He was born in New York City and as a child had an enormous interest in how things worked, building crystal radio sets, taking apart telephones and clocks, and frequently putting them back together. He graduated in 1939 from Townsend Harris High School, a public school open only to the city's brightest students. He received a bachelor of electrical engineering from the City College of New York and did graduate work at the Massachusetts Institute of Technology. He started his career at the Philco Radio & TV Corporation before joining Raytheon in Massachusetts in 1947. While at Raytheon he helped develop a system for sending information by microwave transmission. Employing microwaves for a different purpose, he was among the engineers who invented the Radarange, the first microwave oven. For microwave ovens to work, difficult problems had to be solved, such as uniform heating and acceptable loading on the magnetrons despite the apparent short circuit presented by an empty oven. Bill and his colleagues solved these problems by a variety of in genious methods, several of which were patented. During this “microwave” part of his career, Bill published a series of papers in the archival literature describing his work and ideas. He managed Raytheon's Wayland Laboratory in Waltham, Massachusetts, before moving in 1960 to Rome, Italy, to create the engineering department of Selenia S.p.A., an Italian engineering company Raytheon had purchased. While there, he developed radar systems for meteorological, navigational, and military purposes.

Bill entered the field of satellite communications in 1962 when he joined the Aerospace Corporation in California. Here, he directed the team that produced the nation's first operational military satellite system and assisted the North Atlantic Treaty Organization with its communications satellite program. Even at this early date, Bill was quick to recognize the potential of satellite communications and perceived their value for the direct broadcast of TV and audio to users with small terminals. Foreseeing the importance of satellites in communications, he urged Congress to keep the military and commercial satellite systems separate.

In 1967 he moved to the Washington, D.C., area to establish the Communications Satellite Corporation Laboratories, the Clarksburg, Maryland, research and development facility for COMSAT. Bill entered every phase of creating COMSAT Labs with gusto and skill. He supervised the construction of the building as well as its furnishings and staffing. The products of COMSAT Labs in its early days under Bill's leadership were prodigious: nickel-hydrogen batteries for satellites, high-efficiency (“violet”) solar cells, microwave filters and integrated circuits, digital multiple access and demand assignment systems, digital TV compression, and mobile and broadcast communications. These products all went from research and development, to design and engineering, then to operational systems. Today, these technologies are used throughout the world not only in satellite systems but also many in terrestrial applications as well. As vice-president of COMSAT, Bill represented the corporation as U.S. signatory to the INTELSAT agreement. He was also the U.S. delegate to the Technical Subcommittee of INTELSAT.

Bill was president of Fairchild Space and Electronics Com pany in 1973 and 1974. He then started Satellite Systems Engineering, Inc., a consulting company that designed communications satellites and did work in the area of cellular mobile telephones. He was an early proponent of using satellites to transmit television programming directly into the home, a vision in the 1970s but now a common capability from such providers as Direct TV and Primestar. At the time of his death he was president of W.L. Pritchard & Co., Inc, a Bethesda-based consulting engineering firm doing technical and economic studies in telecommunications for private firms and governments.

The author of more than fifty conference articles and technical papers, Bill also cowrote four books, including *Satellite Communications Systems Engineering,* a standard textbook in the field. He taught courses in satellite communications at George Washington University and the Polytechnic University of New York. In 1993 he was awarded an honorary doctor of science degree by the City College of New York and in 1995 was elected to the National Academy of Engineering. He gave his expertise freely for public service. He was a member of a number of study groups and task forces on the uses of space: the National Research Council's (NRC) Engineering and Technical Systems Board of Telecommunications/Computer Applications; the NRC's Division of Engineering Space Applications Summer Study Panel 10: Broadcast; the National Aeronautics and Space Administration's Space Applications Advisory Committee and Earth Sciences Advisory Committee Task Force; and the NRC's Engineering and Technical Systems Committee on Antennas, Satellite Broadcasting and Emergency Preparedness for the Voice of America. He was a founder and past chairman of the board of the Society of Satellite Professionals International and was inducted into that organization's Hall of Fame in 1997. He was a member of the International Academy of Astronautics and actively supported it and the International Astronautical Federation (IAF) since their founding in the 1960s. He was elected a fellow of the Institute of Electrical and Electronics Engineers, the American Institute of Aeronautics and Astronautics (AIAA), and the British Interplanetary Society. He was a trustee of the American University of Rome and served on the advisory com mittee in the City College of New York's School of Engineering. He belonged to Washington's Cosmos Club, was a member of the club's chess team, and was its 1998 cochampion. A contributor to numerous charitable causes, he was especially interested in preserving African wildlife and made several trips to Africa.

Bill was the recipient of many national and international awards in recognition of his outstanding contributions in the field of communication satellites. Notwithstanding, a shared Pritchard family anecdote relates that while Kathleen Pritchard was hospitalized for back surgery, daughter, Sarah who was fourteen at the time temporarily took over the task of household laundry. Bill liked to carry a fresh linen handkerchief in his pocket daily and Sarah directed him down to the basement where the handkerchiefs were said to be folded on top on the dryer. Seconds later Bill came bounding up the stairs with the query, "Sarah, which one is the dryer?" Sarah exclaimed, "Imagine the designer of global communication satellite systems not recognizing a clothes dryer!"

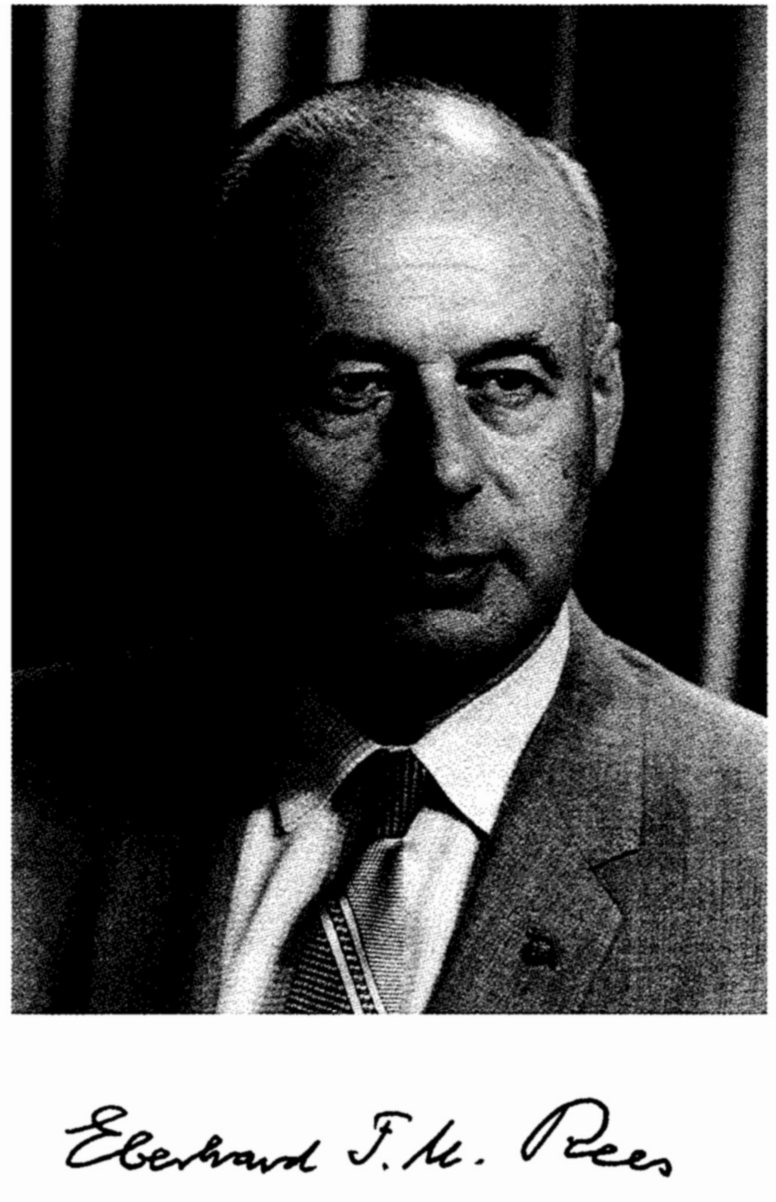
Bill had a unique and exceptional range of skills and talents. He was active in a large number of diverse fields, and contributed strongly in each one. He was an amateur astronomer and had traveled to observe and photograph five total eclipses on three continents. Bill's avocations included playing the banjo and the mandolin. While in California he studied under Sam Freeman (whose instrument can be heard on "Lara's Theme" in the film *Dr. Zhivago*) and played in the Los Angeles Mandolin Orchestra. In the Washington area he played with the Takoma Mandoleers. He made his first trip to China in 1979 with an AIAA-organized group of experts to survey space technology in China just as that country emerged from its Cultural Revolution. It was one of the first Western engineering groups to visit. At every stop, every evening for three weeks, there was a multicourse and multibeverage banquet in a formal setting with a rigid program. To liven things up, Bill and several American colleagues put on an American Act, with Bill on the mandolin and his long-time friend and colleague Burt Edelson on the harmonica. To this accompaniment, others from the AIAA group sang songs like "Red River Valley" and "Doe, a Deer" (from *The*

Sound of Music). The Chinese hosts loved it and responded by singing “People's Republic” propagandistic words they had been taught to the familiar American tunes. Similiarly, impromptu musical performances by Bill Pritchard playing the mandolin and Bill Hilton playing the ukulele accompanied by audience sing-alongs became the standard welcomed “plus performance” through the years at many IAF meetings. (Dr. William Hilton first proposed 63-65 degree elliptic orbits for communication satellite systems, an orbit quickly adopted by the Russians as the *Molniya Orbit.*)

Bill Pritchard was also a collector of historic scientific and navigational instruments and of rare clocks and watches. He was a fellow of the National Association of Watch and Clock Collectors and often repaired broken timepieces in a fully functioning basement workshop. Bill was fluent in both Italian and French. When COMSAT Labs were consulting on Italian spacecraft, Bill insisted that his staff learn Italian. He is known to have dropped in on the Italian courses being taught to view progress and to the astonishment of the class, replacing the regular instructor to give an all-Italian lesson!

Survivors include his wife of nearly fifty years, Kathleen (Moss) Pritchard; and their son, Hugh, of College Park, Maryland; daughters, Sarah, of Santa Barbara, California, and Ruth of Silver Spring, Maryland; his brother, Hubert, of Matawan, New Jersey; and four grandchildren.

Bill Pritchard's death was untimely but his skills and talents, his spirit and wisdom live on as an inspiration to those who had the privilege of knowing him and to many others who have benefited from the implementation of his pioneering vision of satellite communications.



EBERHARD F. M. REES

1908-1998

BY ROBERT C. SEAMANS, JR.

EBERHARD EM. REES, a member of Wernher von Braun's team that designed the rockets used for the lunar landing in 1969, died April 2, 1998, one month short of his ninetieth birthday at a hospital in Florida. Eberhard was born in Trossingen, Germany, on April 28, 1908. He received the bachelor of science degree from the Technical University, Stuttgart, in 1931 and the master of science degree from the Technical University, Dresden, in 1934. After graduation he became an engineer at a steel foundry in Leipzig, Germany, where he gained experience as a manager of technology.

During the same period that Eberhard was matriculating and commencing his first job, a team headed by Captain Walter Dornberger and Dr. Wernher von Braun were experimenting with liquid-fueled rockets first at Kummersdorf near Berlin and then on Usedom Island in the Baltic. What had been the small fishing village of Peenemunde at the northern end of the island became a full-scale center for developing a variety of missile systems. Throughout most of World War II, Dornberger split his time between Berlin and Peenemunde, and von Braun was the full-time technical director of the missile center. By 1940, Germany had conquered Poland and was at war with England and France. By then at Peenemunde, a number of missiles were under development including a ballistic missile designated A-4 by the Germans and V-2 by the Allies. Eberhard Rees was in charge of prototype manufacturing.

Throughout the war, life at the center was chaotic. Hitler's support vacillated, the SS Secret Police under Hitler infiltrated the center, the Allies bombed periodically, and the war went from apparent victory to crushing defeat. The V-2 with its advanced technology was successfully developed, manufactured, and deployed, first attacking England and later on the Netherlands.

In early 1945, there were over 4,000 at Peenamunde when the last test V-2 was fired. The center was under orders to head south in the face of the oncoming Soviets from the north, but clandestinely a small group of 110 scientists and engineers carrying key drawings and documents were speeding toward a successful rendezvous with the American army.

During the later part of the decade, this select technical group found itself in El Paso, Texas, at the White Sands Proving Ground assisting the U.S. Army in the assembly and test of the V-2 rockets but not with warheads but with scientific instruments. In the late 1940s, the German team was taken across the border into Mexico so that they could legally enter the United States. Their families were brought over from Germany and they moved to Huntsville, Alabama. There in 1950 Eberhard became deputy chief of the U.S. Army's Guided Missile Development Division. He became a naturalized citizen in November 1954.

Many in the United States were surprised by the Soviet show of technical capability when *Sputnik* went into orbit in October 1957. In the next few months there ensued a discouraging series of attempts to launch a U.S. satellite until President Eisenhower turned to the army's missile division for the hurried but successful orbiting of the *Explorer* satellite. Eberhard's team had provided the rocket that placed the Jet Propulsion Laboratory's *Explorer* into orbit. The National Aeronautics and Space Administration (NASA) was established in late 1958, and the army's missile development division was brought into the fold in the fall of 1960 and was renamed the Marshall Space Flight Center.

I had become the associate administrator of NASA in the late summer of 1960 and was asked to address its senior management at a retreat in Williamsburg, Virginia. Somewhat in jest I started by commenting on the informality of the corporation I had left and the formality of NASA. First names and nicknames had been de rigueur for me, and now at NASA titles and last names were expected. Afterward Eberhard introduced himself, called me Bob, and said that only the day before, Wernher had said that in the future he could be called Wernher. I was incredulous and asked whether he had been working with Wernher for twenty years while calling him “Dr. von Braun”. Eberhard said no, “Herr Dr. von Braun.” Wernher was the visionary, the spokesman, the salesman, Eberhard was the inside man who made certain the work got done and the quality was high.

Six months later in May 1961, John F. Kennedy was president and Yuri Gagarin had just orbited the earth. Alan Shepard was aboard the Mercury capsule waiting to be propelled by a Redstone rocket, one of Eberhard's army missiles adapted for spaceflight. A great deal was riding on the launch, not only the safety of the astronaut but also the prestige of the nation. The success was a great tribute to the competence of Eberhard's team working under extreme pressure.

The great lunar adventure officially started three weeks later, when President Kennedy went before Congress recommending a manned lunar landing before the end of the decade. In six years the Marshall Center would have to develop a launch capability 100 times that of the Redstone. As Eberhard said in a talk given at the World Management Congress in Munich in 1972, “The project management had to be extremely flexible and capable of meeting unforeseen demand. It was also apparent that determination, resoluteness and faith would be vital if the goal were to be achieved.” The result was Saturn V, the most powerful launch vehicle ever built. After two successful unmanned test flights, this vehicle provided the lifting capability for two manned circumlunar flights, six manned lunar landings, and one orbital laboratory.

Initially the emphasis on the Apollo program was to recoup U.S. prestige following the Soviets' successful launching of a satellite and then in rapid succession a variety of spectacular missions, including the orbiting of a cosmonaut and then two-man and rendezvous flights. As information was gathered from the lunar surface, first from unmanned and then from manned flight, it became obvious that a great deal more could be accomplished if the astronauts could traverse along the lunar surface beyond the landing site. In addition to Eberhard's major role in the development of the Saturn vehicles, he then led the project that designed and constructed the lunar rover. The lunar lander in the final three missions carried a vehicle designed specifically for travel along the lunar surface. It permitted the astronauts to inspect the rims of craters, to implant instruments, and to gather rocks, all at a distance from the landing site. This exploration would not have been possible without the indefatigable and imaginative leadership exercised by Eberhard and his crew.

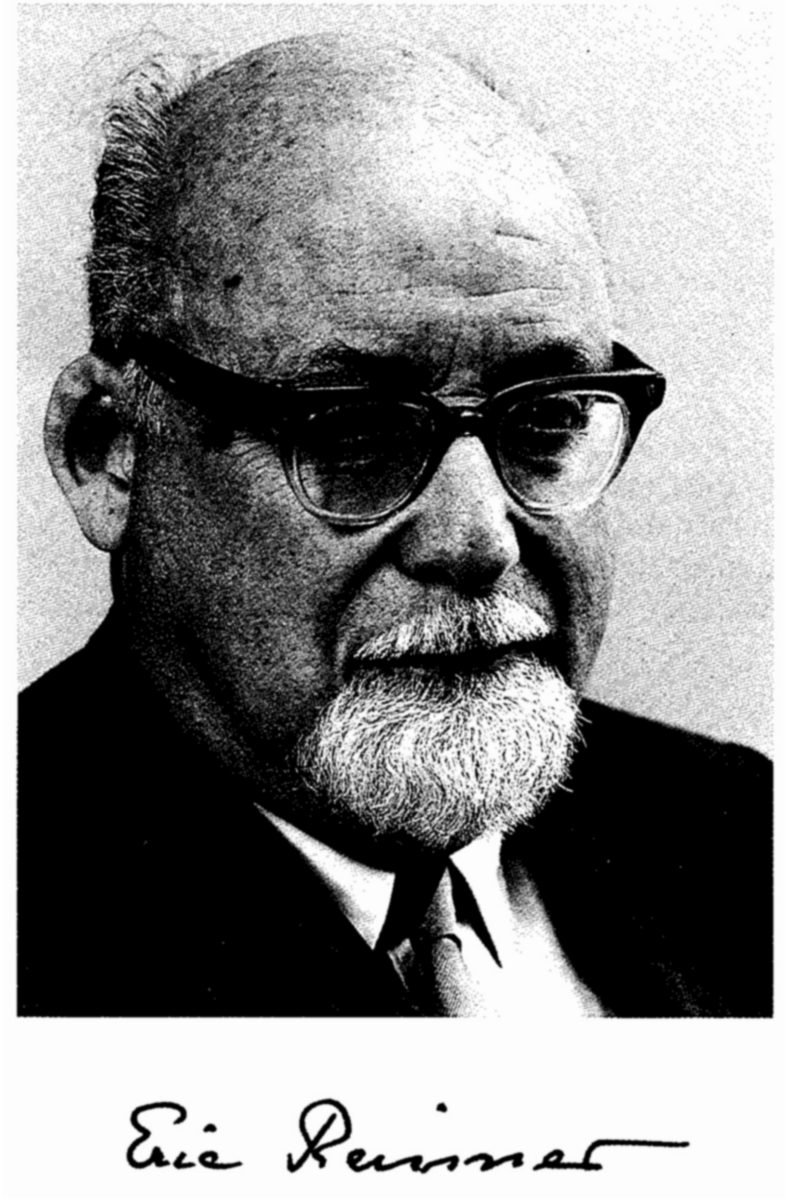
He was also a major contributor in the redesign of the Apollo capsule following the tragic fire that killed three astronauts. Following an intense review of all the factors that led to the accident, the contractor was directed to make major changes not only in the design but also in the procedures used during manufacturing and testing. Eberhard spent time at the contractor's plant both as an adviser and as an inspector, a difficult role that few but he could have performed. The ultimate performance of Apollo benefited greatly from his extensive experience in rocket technology as well as his thoughtful human qualities.

When Wernher was invited to NASA headquarters to assist in long-range planning, Eberhard became the director of the Marshall Space Flight Center. The Apollo lunar landing missions were completed during his tenure and a unique mission was initiated. The first two stages of Saturn were used to place *Skylab* in space. The laboratory was fashioned from the third state of the Saturn launch vehicle. The fuel tanks and rocket engines were replaced by compartments for sleeping, eating, exercise, and scientific investigation. A great deal was learned from this mission about the physiology of long-duration flight and the relationship of solar flares to high-intensity radiation and its impact on our environment.

After leaving NASA, Eberhard was a consultant on the so-called Space-Lab Project in Bremen, West Germany. Eberhard was an engineer's engineer. He was seldom in the public eye, but in the engineering community he was widely recognized for his broad experiences with liquid-fuel rocket engines, multistage structures, and reentry heat shields. He knew how to adapt missiles for use in space probes and satellite launchers. He also understood manufacturing, quality control, and testing procedures. And most important, he knew how to achieve national objectives by leading technical teams in these important fields of endeavor.

During his life, Eberhard received many awards. These honors include the U.S. Army's Exceptional Civilian Service Award, the Defense Department's Distinguished Civilian Service Award, NASA's Outstanding Leadership Medal and Distinguished Service Medal, and the Hermann Orberth Award and Holger Toftoy Award from the Alabama Section of the American Institute of Aeronautics and Astronautics (AIAA). He received honorary doctor's degrees from Rollins College and the University of Alabama in Huntsville. He was a fellow of the AIAA and the American Astronautical Society, a member of the National Academy of Engineering, the von Braun Astronomical Society, and an honorary member of the Hermann Oberth Society, Germany.

Eberhard Rees is survived by his wife, Maria Rees, of DeLand, Florida, and his sister, Marianne Haller, of Germany.



ERIC REISSNER

1913-1996

BY Y. C. FUNG, S. S. PENNER, F. SEIBLE AND F. A. WILLIAMS

ERIC REISSNER, noted teacher, researcher, and prolific author, died of cancer on November 1, 1996, in La Jolla, California. He was eighty-three and lived with his wife of fifty-eight years, Johanna, in Solana Beach, near the University of California, San Diego, where he was professor emeritus.

Over a remarkable career spanning more than sixty years, Dr. Reissner expanded the foundations of the theory of mechanics, leading to advances in the design of both civil engineering and aerospace structures. In a recent review of Reissner's *Selected Works in Applied Mechanics and Mathematics,* published in 1996 and edited by four of his former students, Professor A.W. Leissa of the Ohio State University writes, “Professor Reissner is the consummate applied mathematician who, by his vast, useful research accomplishments, has reached the pinnacle among distinguished scholars in solid mechanics.”

Born in Aachen, Germany, in 1913, the son of aeronautical engineering pioneer Prof. Dr. Ing. Hans Reissner and his wife, Josephine, Eric grew up in Berlin, where his father had become a professor at his own alma mater. Eric Reissner always was at ease with mathematics and received his doctorate in applied mathematics from the Technische Hochschule Berlin in 1935. Because of the unpromising political developments in Germany at that time, Eric came to the United States in 1937, where he earned a Ph.D. in mathematics in 1938 from the Massachusetts

Institute of Technology for an analysis of the aeronautical structures problem of tension field theory. He joined the MIT faculty in 1939 and remained there until 1970, when he moved to the University of California, San Diego, where he had previously served as visiting professor in 1967 and as professor-in-residence in 1969. His position was professor of applied mechanics, and he chaired the Department of Applied Mechanics and Engineering Sciences during the period of 1972-1973. He also served in editorial capacities for *the Quarterly of Applied Mathematics,* for the series *Studies in Applied Mathematics,* and for the *International Journal of Solids and Structures.*

Professor Reissner's work contributed to improved understanding of the mechanics of plates, shells, and beams, of the dynamics of structures, and of the theory of elasticity, as well as advancing knowledge of turbulence, aerodynamics, and wing theory. In their preface to his selected works, Professors Atluri (Georgia Tech), Lardner (University of Massachusetts), Simmonds (University of Virginia), and Wan (University of California, Irvine) comment that, “His lectures were always clear, incisive and thorough, exposing both the subtlety of solid mechanics and the subtlety of his thinking. He demanded much of his students because he demanded so much of himself. Yet, for us, on the other side of this keen professional was a generous and caring friend, colleague and mentor.”

Professor Reissner is perhaps best known for the Reissner shear deformation plate theory, which resolved the classical boundary-condition paradox of Kirchhoff, and for establishment of the Reissner variational principle in solid mechanics, for which he received an award from the American Institute of Aeronautics and Astronautics. Professor Reissner also has been honored by the American Society of Civil Engineers with the Theodore von Kármán Medal, by the American Society of Mechanical Engineers with the Timoshenko Medal, and by the University of Hanover, Germany, with an honorary doctorate. He was elected a fellow of the American Academy of Arts and Sciences and the American Institute of Aeronautics and Astronautics, a member of the National Academy of Engineering and the International Academy of Astronautics, and an honorary member of the Ameri can Society of Mechanical Engineers and the German Society for Applied Mathematics and Mechanics (Gesellschaft für Angewandte Mathematik und Mechanik). He wrote nearly 300 articles published in scientific and technical journals and continued these contributions to the advancement of knowledge until the last few months of his illness.

We all knew Eric Reissner as a fine gentleman, scholar, and friend. His exceptionally high standards of excellence in research persisted throughout his entire career. The noteworthy example that he has set will remain with us and will benefit future generations.

RUDOLF SCHULTEN

1923–1996

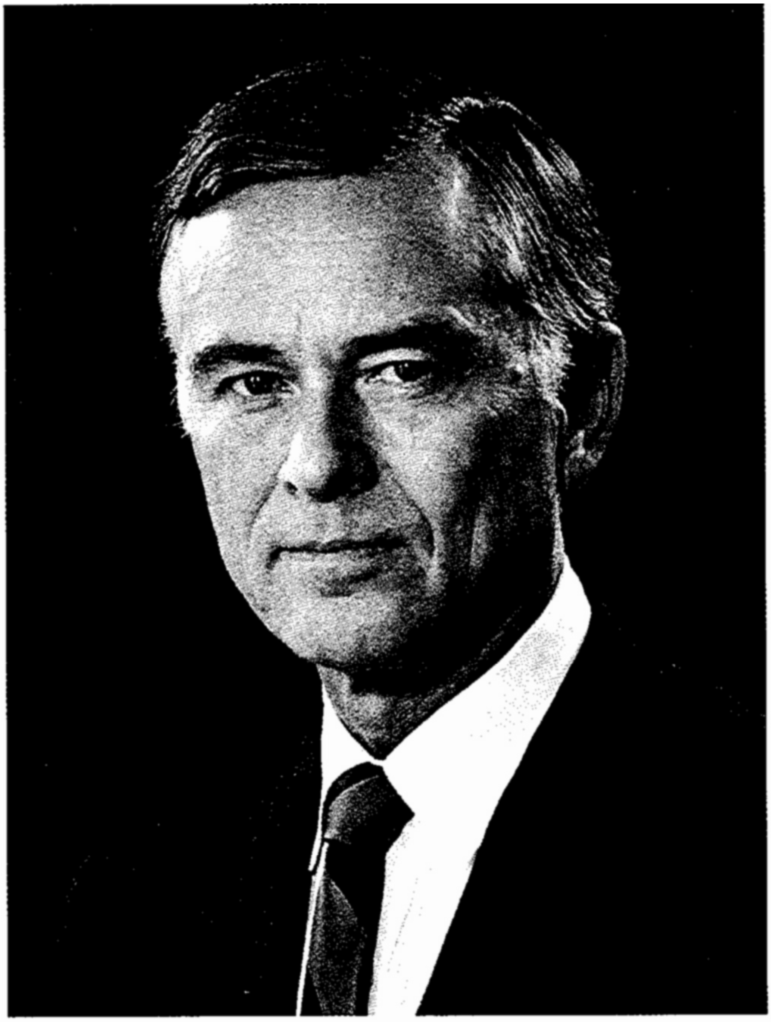
BY WOLF HAFELE

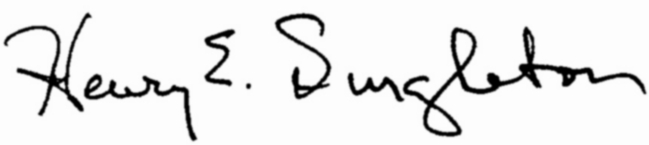
RUDOLF SCHULTEN, professor emeritus of reactor engineering, Technical University of Aachen, and former director of the Institute of Reactor Development of the Nuclear Research Center of Jülich, Dr.rer.nat. and Dr.-Ing. E.h. (honoris causa) died on April 27, 1996, in Aachen, Germany.

Rudolf Schulten was born on August 16, 1923, in Oeding, Germany. He studied physics and mathematics at the University of Bonn from 1946 to 1950. He then went to Göttingen where Professor Werner Heisenberg was director of the recently reestablished Max Planck Institute für Physik. There, under Professor Heisenberg, he took his doctorate degree in 1953. His thesis dealt with the magnetic moments and quadrupole moments of some light atomic nuclei." Thereafter he took a position as scientific coworker of Professor Heisenberg. In 1953 the Federal Republic of Germany became sovereign again and it was then possible to resume work on nuclear engineering at the Heisenberg Institute and elsewhere in Germany. Rudolf Schulten became engaged in that new field immediately.

At first Rudolf Schulten worked on preliminary lattice designs for the first German-built nuclear research reactor, the FR2 in Karlsruhe. But soon he developed his own engineering vision: a nuclear reactor with high temperatures, helium as a coolant, and graphite balls 6 centimeters in diameter instead of the otherwise worldwide-employed cylindrical fuel rods. At that time I shared an office with him and experienced firsthand the strength of his powerful engineering vision. It was not surprising that he left soon to become head of the Department of Reactor Development, Brown Boveri & Cie Company (BBC) in Mannheim. He served in that capacity from 1956 through 1964. BBC developed a strong engineering posture that led to the construction of the 15 MWe experimental reactor AVR at Jülich and later the 300 MWe thorium high-temperature reactor at Schmehausen. In 1964 Rudolf Schulten was offered a chair for nuclear engineering at the Technical University (TU) at Aachen and simultaneously the directorship of the Institute of Reactor Development at the Nuclear Research Centre of Jülich, close to Aachen. So in 1964 Rudolf Schulten went to Aachen/Jülich, and with him, much of the base program for the thorium high temperature reactor. Rudolf Schulten had a major influence both in Aachen and in Jülich. At Aachen be became dean of the faculty of mechanical engineering and from 1983 to 1986 vice-rector of the university. On three occasions at Jülich, he chaired the Scientific-Technical Council of the Research Center and served in numerous additional functions. He supervised more than 300 doctoral theses and significantly influenced international science in the field of THTR development. He was elected foreign associate of the National Academy of Engineering in 1978. Of the many awards and honors he received, the most significant awards were the Werner von Siemens Ring (an honor-ring for merits in science and technology) and the Great Distinguished Service Medal of the Order of Merit of the Federal Republic of Germany (Grosses Verdienstkreuz des Bundesverclienstordens der Bundesrepublik Deutschland).

Rudolf Schulten had not only his own engineering vision but was of a warm, broad-minded nature. One may recall the year 1955, which was so important for Germany with its new sovereignty. At Göttingen, in the new Max Planck Institute, Werner Heisenberg had brought together a group of young physicists for the purpose of not only producing good physics but also contributing to the revival of postwar Germany in a broader sense of the word. Rudolf Schulten had just received his doctorate degree in 1953, was thirty-two years old, and had a will to en gage. This was a fortunate configuration. With his balanced personality, he was able to settle difficult situations in meetings and otherwise. Together with his good physics and engineering, this was the thing that was needed in this breakup situation. He was embedded in his family and had the lasting support of his wife, Anneli. Together they had two sons, Rudolf and Georg, and one daughter, Maria. He was engaged in matters of his church. He was also concerned for the general political health during the restructuring of postwar Germany. He was a gifted scientist and engineer, a responsible citizen, and a dear colleague.





HENRY E. SINGLETON

1916-1999

BY GEORGE A. ROBERTS

HENRY EARL SINGLETON, pioneering cofounder of Teledyne, Inc., and chief executive of this Los Angeles-based conglomerate for three decades, died August 31, 1999, of brain cancer at his West Los Angeles home.

Henry was born on November 27, 1916, on a small farm at Haslet, Texas. He attended the U.S. Naval Academy beginning in 1935 and then matriculated at Massachusetts Institute of Technology, receiving his B.S. and M.S. degrees in electrical engineering in 1940. After working for the Office of Strategic Services in World War II, he returned to MIT to receive a doctorate in electrical engineering in 1950.

After a brief assignment as research associate at General Electric, Henry was recruited by Simon Ramo, acting as a agent for Howard Hughes, to join a team of engineers and scientists at Hughes Aircraft in Los Angeles to apply the most advanced technologies of the coming digital revolution to the electronic control system of the F-102. Henry had demonstrated an ability to design and apply computer technology to a variety of robotic applications at MIT and continued this work at Hughes, North American Aviation, and Litton Industries. In 1952 he led a group at North American Aviation working on inertial navigation systems. When Litton Industries was formed, Tex Thornton attracted Henry to pioneer Litton's work on the lightweight iner tial navigation system still used by military and commercial aircraft worldwide. Henry became director of the engineering of the Electronics Equipments Division in 1957 and vice-president and general manager of the division in 1958. He holds several patents on gyro-stabilized and precision platforms, and accelerometers developed during this time period.

In 1960 he left Litton with George Kozmetsky to found Teledyne, Inc., dedicated to the application of digital technology to other technological fields, including helicopters, space science and exploration, mineral discovery and production, aircraft maintenance, water purification and treatment, medical and dental technologies, and manufacturing processes for electrical and mechanical power equipment. By starting a semiconductor company and acquiring other small companies, he expanded these businesses to 75 million in sales by 1965, then acquired interests in specialty metallurgical manufacturers and military and aircraft engine companies. By 1984 Teledyne was a major U.S. corporation with more than $3.5 billion of revenues from its manufacturing companies, and its specialty metals represented about one-third of its activities.

As chairman and chief executive officer, Henry kept a personal interest in the technical developments within the corporation and encouraged and guided employees and managers in their technical pursuits. He gave up the presidency in 1966 but continued as chairman and as a leader in innovative technical and financial management until his retirement in 1990.

His pioneering activities included adding a diverse group of financial institutions, giving Teledyne contact with, and intimacy with, the capital world. Thrift and loan banks were added by acquisition to units dealing with property, workers compensation, casualty, and life insurance. Henry pioneered a now-common practice of buying back one's own capital stock, reducing Teledyne's outstanding shares over a number of years by more than eighty percent. He also led the way to the practice of spinning off major parts of the corporation to the shareholders, beginning in 1986 with the workers compensation group, Argonaut, Inc, and in 1990 with a major part of the financially related businesses, Unitrin, Inc.

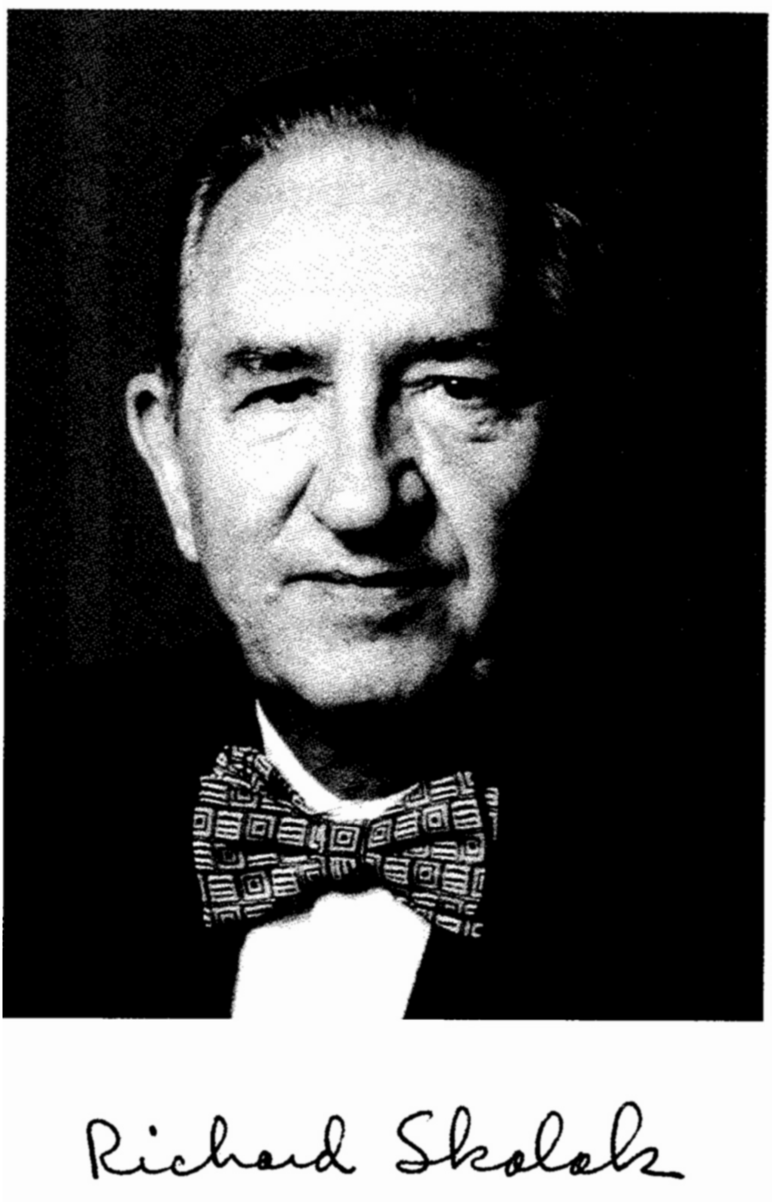
During these years Henry had served as: director of Apple Computers; member of the corporation, MIT (1968 to 1973); trustee of California Institute of Technology (1968 to 1974); member of the U.S. Air Force Scientific Advisory Board (1959); and senior member of the Institute of Electrical and Electronics Engineers. He won the William Lowell Putnam Intercollegiate Mathematics Competition Award in 1939.

He was honored by the Outstanding Achievement Award in Business Management by the University of Southern California in 1972 and by establishment of the Singleton Research Fellowship at the City of Hope Pilot Medical Center in 1970.

His citation for membership in the National Academy of Engineering in 1979 reads, “For his contributions to lightweight inertial navigation systems and his leadership in the creation of a major technological corporation.”

After his retirement, Henry remained eager for new ventures. He bought extensive ranch lands in California and New Mexico and built herds of cattle. He loved these lands and took pride in managing them well. He studied Native American cultures and Western folklore. He played tournament chess, collected fine wines, and loved to hike and camp in the wilderness areas of California. Most recently, he devoted much time to computers, programming algorithms and creating a fine computer game of backgammon for, of course, Macintosh fans.

He is survived by his wife of fifty-seven years, Caroline, five children, and four grandchildren. A book about his love for the ranch San Cristobal in New Mexico and his efforts with local authorities and educational institutions to preserve its history and “petro-treasures” was written by a daughter. When it was my honor to speak at a service after his death, I spoke from knowledge and close friendship of this great engineer for over sixty-four years as I concluded, “Heaven has just gone digital.”


Richard Skalak

RICHARD SKALAK

1923-1997

BY SHU CHIEN

RICHARD SKALAK, an internationally renowned authority in bioengineering, mechanical engineering, and civil engineering, died on August 17, 1997, at the age of seventy-four.

Elected to the National Academy of Engineering in 1988, Richard was a leader in applying engineering principles and techniques to elucidate many important biomedical problems. He had the unique ability to combine elegant theoretical modeling with modern experimental investigations to develop new concepts on the structure and function of living systems in health and disease.

During his career, which spanned more than half a century, Richard published more than two hundred original scientific papers and authored six books. He trained twenty Ph.D. students and a similar number of postdoctoral fellows, most of whom hold key positions in academia and industry. His outstanding research and educational efforts have generated strong effects worldwide in fluid mechanics, biorheology, and tissue engineering.

Richard received his B.S. (1943), C.E. (1946), and Ph.D. (1954) in civil engineering and engineering mechanics from Columbia University. From 1944 to 1946 he served in the U.S. Naval Reserve as an instructor in radar and sonar in Washington, D.C. He was an instructor in the Department of Civil Engineering and Engineering Mechanics at Columbia from 1948 to 1954, while pursuing his Ph.D. study. He was appointed assistant professor in the department in 1954 and a full professor in 1964. Richard was a talented and dedicated teacher; he won the Columbia University Great Teacher Award in 1973. He was appointed James Kip Finch Professor of Engineering Mechanics in 1976. At Columbia, Richard was also director of the Bioengineering Institute (1978 to 1988) and chairman of the Department of Civil Engineering and Engineering Mechanics (1985 to 1988). After forty years of distinguished service at Columbia, in 1988 Richard was recruited by the University of California, San Diego (UCSD), as professor of bioengineering.

Richard's early research at Columbia was focused on fluid mechanics. He made significant contributions to the analysis of water hammer effects and fluid turbulence. In 1960 to 1961 he spent a sabbatical year with Professor George Batchelor in the Department of Theoretical Physics and Applied Mechanics of Cambridge University, studying the statistical theory of turbulence. In the mid-1960s he began to combine engineering mechanics and biomedical sciences in his pioneering investigations with Dr. Alfred Fishman and colleagues at Columbia University College of Physicians and Surgeons on wave propagation in pulmonary circulation.

In 1967 to 1968 Richard spent a sabbatical year in Dr. P.I. Brånemark's laboratory at the University of Gothenburg, where he conducted the classical work on experimental studies and theoretical analysis of the flow and deformation of human blood cells in living microcirculation. Upon returning to Columbia, he initiated a series of imaginative and pace-setting research studies on blood rheology, including the rheological properties of red blood cells and cell membranes, viscoelasticity of white blood cells in the passive and active states, microrheological and molecular bases of cell aggregation and adhesion, blood cell interactions in capillaries and microvascular networks, and flow properties of blood in circulation. These interdisciplinary studies established the biorheological principles of blood flow and have important implications in many disease states.

Richard also made prominent contributions in several other fields of bioengineering, including the biomechanics of craniofacial growth, lung parenchyma, skin replacement, osseointegration, and titanium implants. He played a major role in fostering tissue engineering, in which the principles and methods of engineering and life sciences are integrated to understand the structure-function relationships in normal and pathological tissues and to develop biological substitutes for the restoration, maintenance, or improvement of tissue functions. He organized the first few symposia in tissue engineering and fostered its development as the new frontier of biomedical engineering.

Richard had an outstanding ability to formulate problems by distilling their essence into clear mathematical form and to seek out the subject that is fundamental and important. His analytical approach guided many innovative experimental studies and generated new understanding of biological function. He had an unceasing, unselfish drive to create and innovate, and to teach by example these qualities to students and associates. He was extremely interested in the education of young scientists. Even during the last few weeks of his life, Richard held regular research discussions with his students and fellows; in fact, he made the sessions more frequent to provide as much guidance as possible.

In recognition of his outstanding achievements, Richard received many awards and honors. These included the Alza Medal from the Biomedical Engineering Society (1983), the Poiseuille Medal from the International Society of Biorheology (1989), and the Theodore von Kármán Medal from the American Society of Civil Engineers (1987). The American Society of Mechanical Engineers bestowed on him the Centennial Service Award (1980), the H.R. Lissner Award (1985), the Melville Medal (1990), and the Applied Mechanics Division Award (1997).

Richard was elected to many honorific societies. He was a fellow of the American Society of Mechanical Engineers, American Academy of Mechanics, American Society of Civil Engineers, New York Academy of Medicine, Society of Engineering Science, American Institute of Medical and Biological Engineering, and American Association for the Advancement of Science. In 1990 he was awarded the Medal of Merit from the Czechoslovakian Academy of Sciences and an honorary M.D. degree from the

University of Gothenburg.

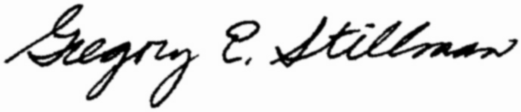
Richard served in many leadership capacities for professional societies and scientific journals. He was president of the Society of Engineering Science and the Society of Biomedical Engineering and editor-in-chief of the *Journal of Biomechemical Engineering*. He was a cochairman of the First World Congress of Biomechanics in 1990, and a cochair of the 1997 Biomedical Engineering Society Annual Fall Meeting.

There were many reasons for Richard's success in life. Particularly noteworthy are his intellectual capacity, dedication to excellence, integrity, sincerity, dependability, generosity, enthusiasm, and vision. He was generous in sharing his ideas and experience. He was always positive and encouraging, and his enthusiasm was contagious. He encouraged his colleagues and students to embark on new areas of investigation that represent the horizon of the future.

Richard was tireless in his working habits, including the efficient use of his time on the airplane and in the hotel during his many foreign and domestic trips. He was remarkable in his administrative ability and inter-personal affinity. As director of the Bioengineering Institute at Columbia University, he laid the foundation for the current development in this field at Columbia. In recognition of his lifelong contribution, a “Richard Skalak Colloquium in Biomedical Engineering” was established at Columbia University in 1996.

From 1992 to 1996, Richard was the founding director of the Institute for Mechanics and Materials established by the National Science Foundation at. In this capacity, he was extraordinarily successful in promoting interactions between the disciplines of mechanics and materials at the national level, the goal set forth by NSF in establishing the institute. At UCSD, Richard contributed importantly to the establishment and advancement of the Institute for Biomedical Engineering and the Department of Bioengineering. A Richard Skalak Memorial Lectureship has been established at UCSD Bioengineering in his memory and honor.

In Richard Skalak's passing, the field of bioengineering lost a great leader and pioneer, all those who knew him lost a wonder ful friend and a superb human being. His spirit, his thoughts, and his deeds have spread to all parts of the world and will be a guiding light for generations to come.


Gregory E. Stillman

GREGORY EUGENE STILLMAN

1936-1999

BY NICK HOLONYAK, JR.

GREGORY EUGENE STILLMAN, professor of electrical engineering and member of the University of Illinois Center for Advanced Study, a renowned researcher on semiconductor materials and devices, died in Urbana on July 30, 1999. His death was caused by metastatic cancer resulting from a melanoma.

Born in Scotia, Nebraska, on February *15,* 1936, Gregory Stillman grew up in rural Nebraska, where he completed his elementary and high school education. He earned his bachelor's degree in electrical engineering in 1958 at the University of Nebraska and entered the U.S. Air Force, where he served (1958 to 1963) as an officer and pilot in the Strategic Air Command. This started his life in flying, everything from the heaviest jets to the smallest single-engine, propeller-driven aircraft. His calm, cool demeanor served him well in taking off with fully loaded KC-135 tanker planes, then flying with inefficient engines at low altitude. In 1963 he entered graduate school at Urbana and completed his M.S. degree in 1965 and Ph.D. in 1967 in electrical engineering. His thesis research in the newly formed laboratory of N. Holonyak, Jr., a laboratory formed because of John Bardeen's wish to expand semiconductor work in Urbana, was concerned with synthesizing and studying III-V compounds and devices (light-emitting devices, lasers, and LEDs). This began Greg Stillman's thirty-five-year involvement with III-V semiconductors and devices and with optoelectronics, where he made important contributions and helped define the field.

In Stillman's Ph.D. work we find the first study and identification of the notorious so-called DX center in III-V alloy semiconductors, a problem beginning in 1960 at General Electric with the prototype III-V alloy laser and LED material GaAsP. This work was done in a masterly manner on crystals grown by Stillman with the help of J.A. Rossi using a vapor phase epitaxial (VPE) process developed earlier by Holonyak at GE (Syracuse, 1960). If there was a “failure” in this work, it was that of inventing a name, i.e., “donor-unknown” (DX), which was a name that came later when other workers, indeed, rediscovered the DX center. This has become a classic, a continuing area of study, a fundamental defect problem in the region of the direct-indirect transition of the energy gap of III-V alloys. Stillman and M.G. Craford in their thesis work (Urbana) were the first to mount an attack on this major problem in wide bandgap III-V alloys. Craford's entry into the field of III-V semiconductor and LED science and technology began with his work with Stillman, who was known for his generosity and was willing to share, as it turned out, the study of a large problem. Stillman and Craford's “DX center” data have stood the test of time for over thirty years.

After his doctoral work, Stillman carried his talents to the Applied Physics Group at Massachusetts Institute of Technology Lincoln Laboratory, to a project led by R.H. Rediker. There he began a series of studies on GaAs and other related III-V materials (optoelectronic and photonic materials) that have taken on the character of a tour de force. He established sensitive techniques for the evaluation of compound semiconductor materials that are now employed universally. Because of problems with the Gunn oscillator, Stillman and his colleague C.M. Wolfe in Rediker's group set out to make ultrapure GaAs and to study its properties. They were the first to achieve purity levels that made possible the observation and identification of the discrete donor in GaAs, the basic III-V extension from Ge and prototype for all the III-Vs. This opened the door in general to rigorous III-V semiconductor characterization. Stillman and Wolfe defined the standards—including magnitude of carrier mobility, far-in frared light emission, low-temperature selection rules, photoconductivity properties, and false indications—that now apply to the whole field of assessing the purity and properties of compound semiconductors. Greg Stillman's interest and background in this area of work led him to the early application of the photothermal method of measurement to study and identify impurities in III-Vs. He was a leader in this field of work. He was known more generally for the elegance of his experimental work and the reliability of his data, as well as for the soundness of his ideas.

Because GaAs and the III-Vs in general are the basic materials of optoelectronics and photonics, it was inevitable that Greg Stillman would contribute also to the problem of making and studying III-V devices. Specifically, he made fundamental measurements and studies on avalanche (photon) detectors and their asymmetry in respect to hole and electron multiplication. He was a ranking expert in this area of work and in the study of photodetectors in general—including quantum well heterostructure devices. Not only was he heavily published and referenced, but also his data were considered the most substantial, least in error, more nearly a standard. He was known for the accuracy of his results, which made him frequently the most cited source, the most sought source of advice. At Lincoln Laboratory his identity as an authority on III-V materials and devices became firmly established, and over the years steadily increased.

In 1975 he returned to the University of Illinois and brought all of these areas of III-V study to Urbana. He was successful in teaching these and other methods and work to forty-two Ph.D. students (electrical engineers, physicists, materials scientists) and continued to expand all of this activity. In 1951 John Bardeen brought semiconductor work to Urbana; in 1963 Holonyak extended this work from Ge and Si to the III-V semiconductors; and in 1975 Stillman expanded the Urbana III-V work even further. Urbana became known as a center of III-V studies. Greg Stillman introduced sophisticated methods (LPE, VPE, MOCVD) into his laboratory to grow and study a whole range of III-V materials and heterostructures. His considerable knowledge of how impurities behaved in III-V semiconductors led him to identify and exploit an important new acceptor in GaAs and in AlGaAs, carbon, which is not usually known as or regarded as a dopant. Carbon doping turned out to be unique in terms of its doping density and stability against diffusion. This made it possible for Stillman and his students to introduce a new family of high-performance microwave heterojunction bipolar transistors (HBTs) that now are of great importance in wireless communications and in digital-analog converters.

Stillman was a rare example of the materials and device scientist who, in building and studying electronic devices, uncovered fundamental properties of crystal systems, specifically the III-V family of semiconductors. He was an internationally known authority on III-V materials and devices. He was one of the most senior organizers of international conferences and meetings dealing with III-V's and their use in optoelectronics. Over the course of his thirty-five years of work and contributions to III-V materials and devices, he witnessed the field (III-V's and optoelectronics) go from a primitive state to a sophisticated multibillion-dollar industry. His life and work were an important part of this development.

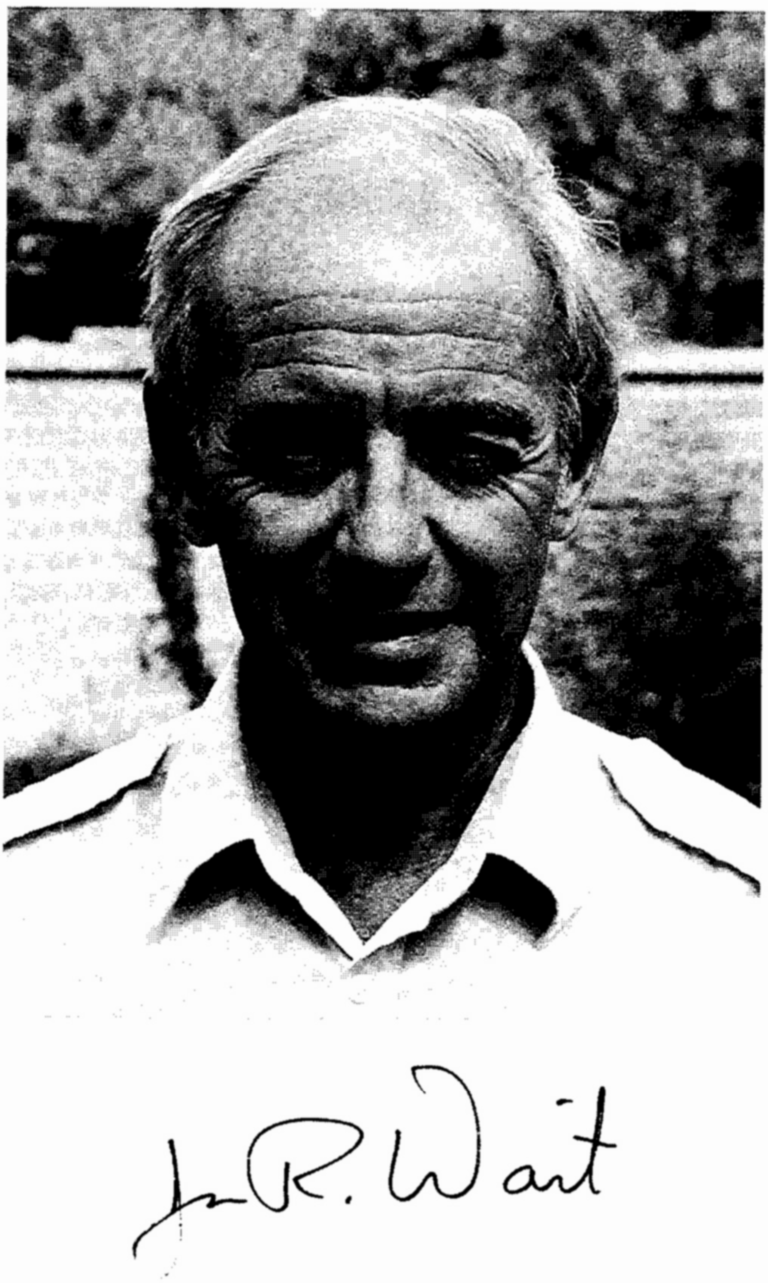
Greg Stillman had a major effect also on teaching, first on his graduate students and, in addition, on hundreds of undergraduates who took his course, a basic course, on semiconductor devices and electronics. His graduate students, under his kind and steady hand, received many awards for their conference presentations, which was directly attributable to how he instructed and guided them. Stillman's lecturing and teaching were known internationally. He was in constant demand to prepare review volumes and chapters on all aspects of III-V materials and devices. His research work resulted in more than 300 publications. He was the coauthor with Wolfe and Holonyak of the textbook and reference, *Physical Properties of Semiconductors* (Prentice-Hall, 1989). He was the editor with M.R. Brozel of the major reference *Properties of Gallium Arsenide* (Inspec, 1996). His was one of the most sought-after voices counseling and leading the field of III-V materials and device study. He was one of the wisest and gentlest counselors of this field of work. He was known for his friendly nature and generosity, products of his small-town upbringing. As stated recently by M. Kikuchi (Sony's retired re search director, 1974 to 1989), "I remember he was a thoughtful person with [a] warm mind."

Greg Stillman was chairman of leading groups and meetings in the field and, for example, served as president (1984 to 1986) of the Institute of Electrical and Electronics Engineers (IEEE) Electron Devices Society. He was an IEEE fellow and for many years helped organize and lead IEEE Device Research Conferences and TMS Electronic Materials Conferences. He was the founding director (1986) of the University of Illinois Microelectronics Laboratory, which in its inception was supported by a National Science Foundation Engineering Research Center grant. He was indefatigable in the search for a microelectronics facility and its project support at the University of Illinois. He understood the argument, and reality, that there would be no electronics without the semiconductor.

In spite of his many scientific and professional activities, Greg Stillman somehow managed to maintain an active interest in flying. Because of his extensive knowledge of flying, as well as electronics, he was called on many occasions for expert testimony in court proceedings involving aircraft accidents, including major airline disasters. He had a strong sense of right versus wrong, worked and lived accordingly, and in his own kindly manner exercised his abilities to the fullest.

Besides receiving the IEEE Jack A. Morton Award and the International Gallium Arsenide Conference Award with Heinrich Welker Gold Medal for his research on III-V materials and devices, in 1985 Greg Stillman was elected a member of the National Academy of Engineering. He served on numerous university, national, and international committees, including the National Research Council. For his teaching he received the Tau Beta Pi Drucker Award, and for his research contributions was made a permanent member of the University of Illinois Center for Advanced Study, the highest position accorded a University of Illinois professor.

Greg Stillman gave much to his fellow man, and, for thirty-five years, to the study of III-V semiconductors. He will be missed. His passing leaves the planet lonelier for all of us.



JAMES R. WAIT

1924-1998

BY C. GORDON LITTLE AND ERNEST K. SMITH

JAMES R. WAIT, professor emeritus of the University of Arizona and a world leader in electromagnetic wave propagation theory, died October 1, 1998, in Tucson, Arizona.

James Wait was born on January 23, 1924, in Canada's capital city, Ottawa, the son of an air vice-marshal, the highest officer's rank in the Royal Canadian Air Force at that time. He enlisted in the Canadian Army in 1942 and served as a radar technician until 1945, at which time he was head of a radar maintenance group in Kingston, Ontario.

Dr. Wait attended the University of Toronto, Ontario, Canada, receiving the B.A.Sc. degree in 1948, the M.A.Sc. in engineering physics in 1949, and the Ph.D. in electromagnetic theory in 1951. His Ph.D. was based in part on research in electromagnetic methods in geophysics carried out in Jerome, Arizona, with Newmont Exploration, Ltd. His research with Newmont led to several patents for electromagnetic and induced-polarization methods of geophysical prospecting.

In 1952 Dr. Wait joined the Defense Research Telecommunication Establishment in Ottawa, Canada, as a section leader. There he conducted research primarily on radiation from electric and magnetic antennas in various media, and also on ground-and surface-wave propagation.

In 1955 Dr. Wait joined the Central Radio Propagation Laboratory (CRPL) of the National Bureau of Standards in Boulder, Colorado. Here, for the next twenty-five years, he conducted a range of theoretical electromagnetic propagation investigations of extraordinary breadth, number, and diversity, publishing over 600 papers and three books. Throughout this period he served as a stimulating colleague, consulting widely among scientists and radio engineers across CRPL's various components as they evolved under successive Department of Commerce reorganizations. Thus, following the division of CRPL into telecommunication-oriented and environmentally oriented components, he was affiliated as senior researcher both with the Institute for Telecommunication Sciences (1967 to 1980), and the Research Laboratories of the Environmental Science Services Administration (ESSA) (1967 to 1970) and its successor agency, the National Oceanic and Atmospheric Administration (NOAA) (1970 to 1980).

During this period, he also developed and maintained strong ties to the University of Colorado. In 1961 he was appointed adjunct professor of electrical engineering at the university. With the formation of the Cooperative Institute for Research in Environmental Science (CIRES) in 1967, a joint venture of the University of Colorado and ESSA/NOAA, he was appointed a permanent CIRES fellow.

By the early 1960s, he had already established himself as a prolific world leader in electromagnetic theory. Of particular significance was his book *Electromagnetic Waves in Stratified Media,* published in 1962 and republished in 1970. This text proved to be a citation classic, with over 1,500 citations in succeeding years. As a result, he received many invitations to visit other organizations. He spent a year (1961) at the Laboratory of Electromagnetic Theory in Copenhagen, Denmark, and the academic year 1966 to 1967 as a visiting professor at Harvard, and May 1971 as a visiting professor at the Catholic University of Rio de Janeiro, Brazil. Other mini-sabbaticals took him to Macquarie University in Sydney, Australia, and to Otago University in Dunedin, New Zealand, in addition to visits to Cambridge, England, and also to India and Egypt.

In 1980 Dr. Wait moved to Tucson, Arizona, where he became professor of electrical and computer engineering, with a joint appointment in geosciences, at the University of Arizona. During this period, Dr. Wait was instrumental in the growth of the Electromagnetics Laboratory into a world-class facility. In addition to electromagnetic applications in geoscience, he was also active in studies of lightning and atmospheric electricity. Some of his last papers were on the effects of "sprites" in the middle atmosphere, the electromagnetic fields produced by lightning, and the coupling of lightning electromagnetic waves to power lines. In recognition of his research and teaching influence, he was appointed to the prestigious position of Regents Professor in 1988. In 1989 he retired from the university to become a private consultant, specializing in electromagnetic methods and their use in subsurface probing.

Dr. Wait was elected to the National Academy of Engineering in 1977. He served as secretary of the U.S. National Committee for the International Scientific Radio Union (URSI) from 1974 to 1978, and as a U.S. delegate to the URSI General Assemblies in Boulder (1957), London (1960), Tokyo (1963), Ottawa (1969), Warsaw (1972), Lima (1975), and Helsinki (1978).

Dr. Wait was also active in editorial duties. He was influential in the formation in 1959 of the new journal *Radio Science,* as Section D of the National Bureau of Standards *Journal of Research,* and served as its first editor for three terms. (This journal is now published by the American Geophysical Union under the sponsorship of URSI.) He was an active member of the advisory board for URSI's (international) Radio Science Bulletin; he served as U.S. coeditor for the Pergamon Press Monograph Series on Electromagnetic Waves; as coeditor of the Institution of Electrical Engineers (UK) Electromagnetic Wave Series, and as a member of the editorial board of Pure and Applied Geophysics (Zurich). He served three terms (1964 to 1969) as associate editor of the *Journal of Geophysical Research.*

The range of Dr. Wait's contributions is well illustrated by the fields from which papers were solicited for a special issue *of IEEE Transactions on Antennas and Propagation* in his memory.

- Geophysical prospecting and induced polarization
- Scattering from cylindrical and spherical objects
- Mathematical methods in wave propagation
- Ionospheric, tropospheric, and ground-wave propagation
- Mixed-path propagation and nonuniform waveguides
- Curved surfaces and whispering gallery modes
- Rough surface scattering
- Propagation in mine tunnels
- Subsurface electromagnetics
- Propagation along conductors and cables
- Wire grids and shielding
- Impedance boundary conditions
- Transient electromagnetics
- Atmospheric electrodynamics

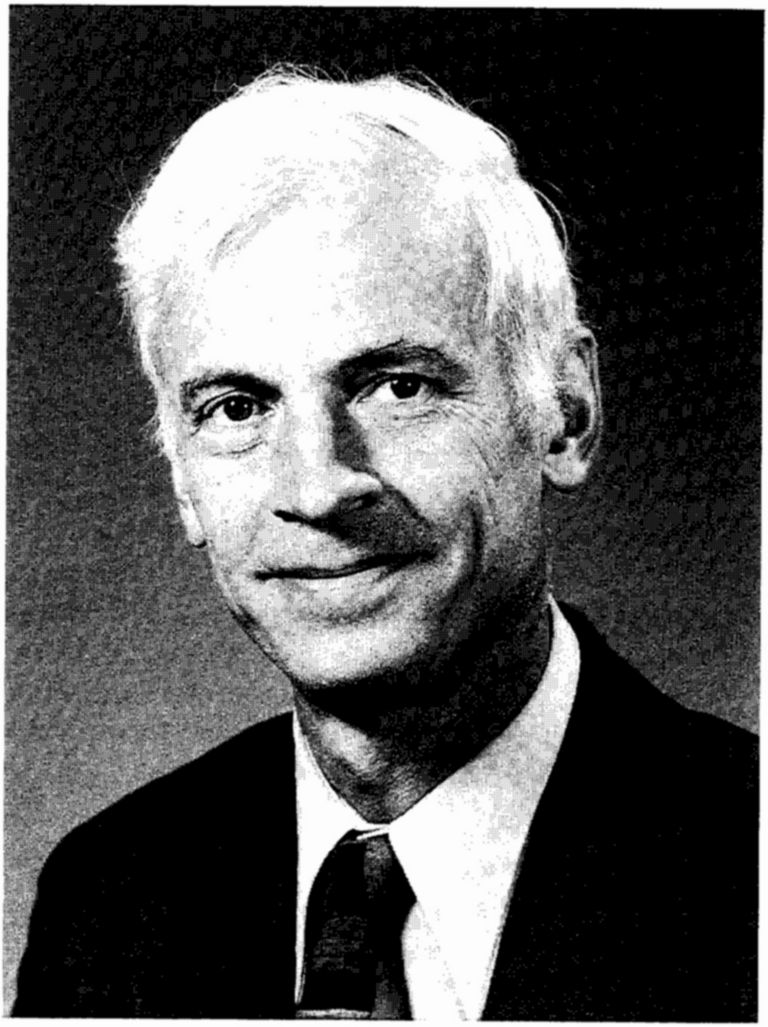
Dr. Wait received numerous awards for his contributions to electromagnetics and to geophysical prospecting. In 1958, only three years after joining CRPL, he was awarded the Department of Commerce's Gold Medal for “highly distinguished authorship in the field of radio propagation.” In 1962 he was elected fellow of the IRE and was awarded the Samuel Wesley Stratton Award of the National Bureau of Standards. In 1964 he received the IEEE Harry Diamond Memorial Award and the Arthur S. Flemming Award of the Washington, D.C., Chamber of Commerce. He was elected a fellow of the Institution of Electrical Engineers (UK) in 1977. He received the URSI Balth van der Pol Gold Medal in 1978, the IEEE Centennial Medal in 1984, and in 1992 the Heinrich Hertz Medal, a prestigious IEEE award that includes a gold medal, a certificate, and a check for $10,000. In 1993 he received the Honorary Membership Award of the Society of Exploration Geophysicists. He also received achievement awards from IEEE specialist groups on geoscience and remote sensing, electromagnetic compatibility, and antennas and propagation.

Though widely recognized as an outstanding leader in his field, he was modest, friendly, unassuming, and exceptionally helpful to, and supportive of, juniors. Though offered promotions to senior management positions, he declined them; instead he whole-heartedly devoted his talents to advancing the broad field of electromagnetic wave propagation in the terrestrial environment, donating generously his time and energy, and achieving huge success as a result.

Dr. Wait worked broadly to achieve his unique impact. First and foremost, he trained himself to work with extraordinary efficiency in the preparation of new scientific papers. As a result, he published over 830 papers and eight books in his 49-year career of writing. Second, he enjoyed interacting with and helping young scientists, whether it was one-on-one in response to some paper they had written, a talk they had presented, or in giving a course of lectures. In this way, he had an important impact on the careers of many young scientists. Third, he recognized the importance of high-quality scientific journals to the field, and therefore devoted considerable effort to national and international editorial duties. Fourth, he worked to stimulate and guide the evolution of each organization with which he was affiliated. And finally (and here we would both like to make personal tribute), he made himself available as a wise and much-valued consultant to colleagues and to management.

Dr. Wait was an avid hiker, biker, swimmer, and expert skier (he had been a member of the University of Toronto ski team as a student). He often encouraged colleagues to join him in these activities; few found they could keep up with him for long! Jim was confident and at ease with his scientific and athletic capabilities and quietly enjoyed his prowess in both fields.

Dr. Wait is survived by his wife, Gertrude; his son, George; his daughter, Laura; and three grandchildren, James, Carolyn, and Connor. He is also missed by scores of one-time colleagues and students, whose lives and careers benefited from his wise counsel and generous friendship, and indeed by all in the radio science community, a community that benefited so greatly from his many important contributions to their field.



ROBERT H. WENTORF, JR.

1926-1997

BY ROBERT C. DEVRIES

ROBERT H. WENTORF, JR., retired staff scientist at General Electric Corporate Research and Development Laboratory, Schenectady, New York, and distinguished professor of chemical engineering at Rensselaer Polytechnic Institute, Troy, New York, died at his home in Easton, New York, of a heart attack on April 3, 1997.

Bob was born in West Bend, Wisconsin, on May 28, 1926, the only son of Robert Henry Wentorf, chief engineer and product designer for the West Bend Aluminum Company, and Sophia Rusch Wentorf. Bob showed strong interest in things mechanical and chemical even as a young boy. He graduated at the top of his class at Northwestern Military Naval Academy and then continued on at the University of Wisconsin, where he was in a U.S. Navy V-12 unit from 1944 to 1945 studying engineering fundamentals. He earned his B.S. degree in chemical engineering in 1948. In graduate school at Wisconsin, Bob switched to physical chemistry and earned his Ph.D. in 1952 with a thesis on critical phenomena in carbon dioxide and sulphur hexafluoride. At Wisconsin he met Vivian Marry, and they were married in 1949.

Bob joined the General Electric Research Laboratory (later GE Corporate Research and Development Center [CRD]) on December 31, 1951, and moved to Schenectady, New York, in 1952 where his creative genius flourished. He became a legend in his own time for his seminal accomplishments in the synthe sis of diamond and other superhard materials under conditions of high temperature and pressure. At General Electric he was hired into a team that had been assembled for the express purpose of synthesizing diamond abrasive grain to become independent of foreign sources. He contributed to the design of apparatus, to the understanding of the chemistry of reactions pertinent to the synthesis of diamond, and to the reduction of the initial processes to production level. In 1957 he was the lone inventor of the process to convert the hexagonal form of boron nitride to a new phase, cubic boron nitride (trade name, Borazon), which is the second hardest material known and substitutes for diamond where chemical reactivity is a problem in grinding or cutting. These products created a new business for the General Electric Company, and the processes were copied throughout the world with the result that today 90 percent of industrial diamond is synthesized.

But the full impact of Bob's inventive genius was yet to be realized. He was the first to invent a process for growing large single crystals of diamond in a thermal gradient; this was brought to such success by others (colleagues Herb Strong, Roy Tuft, Bill Rocco) that synthesized gem-quality diamond is now sold for precision cutting tools, wire-drawing dies, windows, and anvils for high-pressure cells and is becoming a source of consternation to the gem industry. With Bill Rocco, Bob then developed a sweep-through process whereby diamond or cubic boron nitride grains could be sintered to make strong polycrystalline aggregates for cutting tools, drill bits, and wire-drawing dies that have revolutionized these applications. Such compacts could not be found in nature with the controlled properties necessary for numerous machining and drilling tasks. So of the principal products from the synthetic superhard materials industry throughout the world, namely, abrasive grain (diamond and boron nitride), single crystals, polycrystalline sintered bodies, Bob Wentorf alone is responsible for cubic BN, and almost single-handedly for the latter two besides contributing to the original synthesis of diamond. These contributions are described in forty-three published papers and forty-four patents. His definition of research is often quoted: “One of our jobs is to make mistakes as fast as we can, but never make the same mistake twice." In fact, he rarely did the same experiment twice, but he was formidable in gleaning the maximum information from each.

For these accomplishments Bob received the American Chemical Society's Ipatieff Prize in 1965, the American Society for Metals' Engineering Materials Achievement Award in 1973, Eastern New York Patent Law Association's Inventor of the Year Award in 1975 (with Rocco), the American Physical Society's International Prize for New Materials in 1977 (with his colleagues in the high pressure team), the Industrial Research Institute's Achievement Award in 1977, and three IR-100 awards. In 1986 Bob received the Man-of-the-Year Award of the Abrasive Engineering Society for outstanding contributions to abrasives and grinding technology and was specifically cited for his invention and development of Borazon. From 1966 to 1967 he was teaching a course in solid-state physics at the University of Wisconsin as the Brittingham Visiting Professor of Chemistry and Chemical Engineering.

He was elected to Coolidge Fellowship, the highest award of the General Electric CRD Center, in 1972, and to the National Academy of Engineering in 1979, where his citation was "For discoveries and inventions in superpressure technology leading to new materials, knowledge, and products and processes." He received an honorary doctor of science degree from his alma mater in 1981. He was a member of the American Chemical Society, Sigma Xi, American Association for the Advancement of Science, Tau Beta Pi, and Phi Kappa Phi honorary.

Besides high-pressure/high-temperature science and engineering, Bob had numerous other missions. During his retirement he taught both undergraduate and graduate courses at Rensselaer Polytechnic Institute as distinguished professor of chemical engineering. He was also much concerned with population control, energy, and farmland conservation. He studied photochemical reactions and their relation to synthetic fields, analyzed the use of solar energy and alternative fields, and experimented in his own home with a pool for heat storage. He experimented with good farming procedures on his farm and was a member of the Agricultural Stewardship Association and the Easton Planning Board in the area in which he lived as well as the nationally known American Farmland Trust. He served as clerk of the Easton Monthly Meeting of Friends.

Bob was also a soaring pilot, mechanic, outdoorsman, skier, swimmer, humorist, patron of the arts, and a gentle human being whose awareness and concern for the human condition on this earth were infectious and influential. He pursued all these endeavors with enthusiasm, humor, and competence. His synthesis of diamonds from one of his favorite foods, peanut butter (news item: “Diamond directly from Arachis Hypogaea”), probably did more to popularize the accomplishment than all the subsequent papers and ads. While eating peanut butter and crackers at lunch with Bob, one might have the privilege of his reading aloud from archy and mehitabel or Pogo, which were among his favorites for humor and philosophy. We did phase equilibria and crystallization of chocolate (another favorite food) in the same freezer in which he had stored a road-killed ermine retrieved during his bike ride to work. Bob liked to show his prize until it was discovered by the local safety inspector who happened on it and didn't see it in the same light as Bob.

He was totally unafraid of fixing anything mechanical and repaired all of his farm equipment including taking tractors apart. He and his colleague, F.P. Bundy, converted an old Pontiac station wagon into a winch tow for launching gliders, and then they instructed new pilots. In the early days of hi-fi, he converted one end of his living room at home into a gigantic speaker to capture those low frequencies. Bob and his colleague, Herb Strong, swam many miles together in a regular exercise routine. Bob analyzed swimming as he did any problem to maximize his efficiency and pleasure. He died swimming in a pool of his own design in a new home incorporating many of his own ideas for energy conservation. I believe he would qualify for Sir Kenneth Clark's category of “God-given geniuses with whom we are occasionally blessed.”

Bob is survived by a son, Rolf C. Wentorf; two daughters, Jill W. Wright and Laine W. Hills; a sister, Phyllis Nelson; and three grandchildren, Jessa Hills and Catherine and Christopher Wright. Both his first wife, Vivian Marty Wentorf, and his second wife, Frances Gillespie Wentorf, whom he married in 1993, are deceased.

HAROLD ALDEN WHEELER

1903-1996

BY SIDNEY METZGER

IN 1984, AT A SYMPOSIUM celebrating the centennial of the Institute of Electrical and Electronics Engineers (IEEE), Professor Edward C. Jordan, head of the Electrical Engineering Department of the University of Illinois introduced Harold Wheeler as "Mr. Radio." Professor Jordan called Wheeler, "without a doubt the most distinguished living pioneer in the field once called radio, a field which now has developed and broadened into the modern fields of electronics, computers, and communications." Harold Alden Wheeler died on April 25, 1996, in Ventura, California.

He was born in St. Paul, Minnesota, on May 10, 1903, to William Archibald Wheeler and Harriet Marie Alden Wheeler, (a descendant of John and Priscilla Alden, made famous by Longfellow). In 1916 the family moved to Washington, D.C., where his father accepted a position with the U.S. Department of Agriculture. At age thirteen, Wheeler decided on radio engineering as a career. He set up a workshop in his home where he built simple electrical devices, including a crystal detector radio receiver. In April 1920 he received a license for his amateur station 3QK. In 1921 he won a scholarship by competitive exam at George Washington University and majored in physics. His father had advised him to study physics rather than electrical engineering on the grounds that an electrical engineering education at that time was superficial in its treatment of the relevant science. In later years, Wheeler's papers played an important part in transforming radio art into radio science. While an undergraduate, Wheeler continued working in his basement laboratory. He said that he spent more time there than he did studying.

In 1922 Wheeler met Alan Hazeltine, professor of electrical engineering at Stevens Institute of Technology, who was an inventor and pioneer in applying mathematical analysis to the design of radio equipment. Hazeltine had used these methods in his design of a World War I radio receiver for the U.S. Navy, the SE-1420 which they characterized as “the best receiver for general radio reception that the service and probably the world has ever seen.”

Wheeler told Hazeltine that he had successfully built a radio receiver, in his home lab, incorporating a novel circuit that provided a significant improvement over current designs. Hazeltine was greatly surprised and then showed Wheeler a pending patent application for the same invention, which he had made three years earlier but had never built a model. Hazeltine later remarked that, “Wheeler took it very well.” Wheeler was then nineteen years old and had just completed his freshman year at George Washington. They arranged a patent agreement, and it was decided that Wheeler would work for Professor Hazeltine during the summer of 1923. This was the start of a long and fruitful collaboration.

Professor Hazeltine's invention, which he named the “Neutrodyne” went into large-scale production by fourteen manufacturers in 1923, at which time more than 500 stations were broadcasting to about two million listeners. In early 1924 Professor Hazeltine established the Hazeltine Corporation to manage his Neutrodyne patent as well as other patents, and to provide engineering services, mainly advice on product design to licensees. That year, Wheeler became the first employee of the new firm, but on a part-time basis because he was still an undergraduate. After graduation in 1925 with a B.S. degree in physics, he continued studying physics as a graduate student at the Johns Hopkins University. In 1928 he left Johns Hopkins without completing the requirements for a Ph.D. to work full-time for

Hazeltine. The Neutrodyne, with its distinctive three tuning dials, was the dominant receiver for most of the 1920s. In 1928 the introduction of the screen grid tube made the Neutrodyne technically obsolete, but made possible the application of an automatic volume control (AVC) in AM receiver design. This was an invention made by Wheeler in 1925, which maintained a constant sound level from a radio receiver while tuning to various broadcasting signals of differing strengths. AM radio receivers incorporating this AVC circuit came into use about 1930, and it has been included in every set since then. The AVC replaced the Neutrodyne as the key invention in Hazeltine's licensing portfolio.

The decade of the 1930s was a most productive period in Wheeler's career. He was awarded patents for 126 inventions made before World War II. His inventions and papers during that period covered circuits, test equipment, acoustics, antennas, transmission lines, methods of calculation for inductance of coils (included in all relevant textbooks and handbooks since the mid-1930s), skin effect, coupled circuit theory, television scanning theory (analysis of distortions in TV amplifiers using his concept of “paired echoes”), and the analysis and design of wide-band amplifiers for TV. In 1940 he received the Morris N. Liebmann Award of the Institute of Radio Engineers (IRE) “For his contribution to the analysis of wide-band high-frequency circuits particularly suitable for television.”

In the early 1940s, Hazeltine Corporation switched to military projects. Wheeler led a group of engineers in designing an antitank mine detector, replacing an element critical to the operation of previous designs. Models were rushed into service for the North African campaign of 1942, and later production models saw wide use in World War II and in the Korean War. Another project under his direction involved the design of an extensive series of Identification Friend or Foe (IFF) antennas for aircraft, surface vessels, submarines, and ground stations. By the end of World War II, the so-called lifesaver antennas had been placed on all Allied ships. Of his work on IFF Wheeler said, “Antenna design became a new field of expertise which I embraced immediately.”

Accordingly, in 1947 Wheeler left Hazeltine and formed his own company, Wheeler Laboratories. Most of their work was for Bell Labs, designing microwave circuits and antennas for guided missiles. Antenna design and microwave circuits remained an area of special interest to Wheeler for two-thirds of his career: two decades on receivers from 1920 to 1940 and four decades on antennas from 1940 to 1980. He carried on a theoretical investigation of "small antennas," i.e., antennas of dimensions much less than the operating wavelengths. He published several papers on this subject and the theoretical results were applied to practical problems, including submarines, satellites, rocket nose cones, and, surprisingly, the world's largest antenna. Wheeler consulted for the U.S. Navy on this antenna, which consisted of a dozen fanlike arrays of wires covering an area of two square miles and supported by twenty-six towers, each about 1,000 feet tall. Its effective height was approximately 1 percent of its operating wavelength of 20,000 meters (15,000 Hertz), and therefore it was considered a "small antenna" electrically. Wheeler became interested in array radar and phased-array antennas and published several papers on these subjects. His results were applied to the design of antennas then under development by Wheeler Labs for Bell Labs. In 1959 Hazeltine acquired Wheeler Labs, and Harold Wheeler returned to Hazeltine as a director and chief consulting engineer. Later, he became chairman and then chairman emeritus. He worked full-time until he was eighty years old and then worked three days a week until his eighty-fourth birthday. He filed for his 182nd patent at age eighty-four and published his last paper, the hundredth, at age eighty-two.

Wheeler always argued for understanding design principles and practices and objected to carrying out computations by the use of canned programs or tables. He sought instead a perspicuous symbolic or graphical presentation of the quantitative relationships, expressed as simply as possible.

In 1984 the IEEE celebrated its 100th anniversary by reprinting the classic papers it had published during the past century. These included papers by Alexanderson on alternators, Armstrong on FM, Steinmetz on hysteresis, Barrow on waveguides, and Wheeler on wide-band amplifiers for television.

Professor J.S. Brittain, who edited the collection, noted that Wheeler's paper was the first classic paper by an author who was still living and still publishing. He wrote several important papers on the analysis of strip line (microstrip), with emphasis on their use by the design engineer. The Microwave Theory and Techniques Society of the IEEE published a widely used paper on this subject, written when Wheeler was seventy-four years old. He wrote two historical books, *Hazeltine the Professor* in 1978 and *The Early Days of Wheeler and Hazeltine Corporation-Profiles in Radio and Electronics* in 1982. He published two books of monographs that included nineteen articles he had written in the years 1948 to 1954. In 1964 Wheeler received the most prestigious award of the IEEE, the Medal of Honor, “For his analysis of the fundamental limitations on the resolution of television systems and on wide-band amplifiers and for his basic contributions to the theory and development of antennas, microwave elements, circuits, and receivers.” Wheeler received the Microwave Career Award of the Microwave Theory and Techniques Society of the IEEE. In all, he received over fifty awards. He was an adviser to the Department of Defense and served on the Guided Missile Committee from 1950 to 1953 and on the Defense Science Board from 1961 to 1964. He served on several committees of the IRE and was the chairman of the Radio Receiver Committee, which issued a *Standard Guide for Testing Radio Receivers,* used in many countries. Wheeler was a member of the National Academy of Engineering, a fellow of the IRE, American Institute of Electrical Engineers, the IEEE, and a director of the IRE from 1940 to 1945. In 1985 the Antenna and Propagation Society of the IEEE established the Harold A. Wheeler Applications Paper Award.

Dr. George Brown of RCA, former vice-president of engineering and a distinguished antenna designer who received a hundred patents and knew Harold Wheeler and his work for nearly fifty years, said, “Wheeler's publications and patents are profuse and cover such a broad field as to be overwhelming. He is one of the giants of the industry.”

I would like to express my gratitude to Dr. Frederik Nebeker, senior research historian of the IEEE History Center of Rutgers University, who interviewed Wheeler for several days as part of the IEEE's Oral History Program. Nebeker published the material in a paper, "Harold Alden Wheeler: a Lifetime of Applied Electronics" in the Proceedings of the IEEE, August 1992.

Additional material was kindly provided by Henry L. Bachmann, vice-president (retired), now with BAE Systems, formerly Hazeltine Corporation and a colleague of Harold Wheeler for more than forty years.


Basil W. Wilson

BASIL WRIGHT WILSON

1909-1996

BY THORNDIKE SAVILLE, JR.

PREPARED WITH THE ASSISTANCE OF OTHERS, PARTICULARLY, ELIZABETH WILSON AND ROBERT O. REID

BASIL WRIGLEY WILSON, consulting oceanographic engineer and noted researcher in the fields of coastal and oceanographic engineering, who made pioneering contributions to ship motion and mooring technology, died February 9, 1996, in Pasadena, California, at the age of eighty-six. He is survived by his wife, Betty, and four children (Mary, Richard, Gerald, and Derek).

Elected to the National Academy of Engineering in 1984, Basil was a dedicated professional known for his thoroughness and his problem-solving capabilities, often involving innovative concepts—breaking new ground and charting new waters. His 1967 work on harbor-ship oscillations is as valid today as when he first pioneered the development, and continues to influence design practice throughout the world. Basil's interests were wide-ranging; he was a gifted artist and photographer; he was a poet, writing and illustrating two children's books; he was a nature lover and wildlife enthusiast. He was a perfectionist who knew only one way to do things—to do them as well as they could be done, and to do them right. This principle he applied equally in his engineering contributions and in his avocations of art, poetry, and nature.

Basil was born in Cape Town, (Union of) South Africa, of English parents. One grandfather was a vicar at Great Missenden, and one grandmother was a Wrigley, related to the chewing gum family, hence Basil's middle name. His father, George Hough

Wilson, went out to South Africa as a reporter on the Cape Times, where he rose to be editor. Basil's education was broadly based, and he received a B.Sc. degree with honors (civil engineering) at the University of Cape Town in 1931. From 1932 to 1952 he worked with the South African railways and harbors in the research engineering area, where at first he was concerned mainly with problems of bridge vibration, stresses in railroad track, and mechanics of motion of railway vehicles on curves. During this time he also developed the first hydraulic harbor model in South Africa, for Port Elizabeth, in 1932.

In 1938 he was selected as a Commonwealth Fund Service Fellow (at that time, only five each year were selected from the Commonwealth countries outside Great Britain) and did graduate work at the University of Illinois, receiving an M.S. degree (railway engineering) in 1939 and a C.E. degree in 1940. There he met his future wife, Elizabeth Mary Davenport, who was studying library science. They were married in Cape Town in February 1941.

In 1942 Basil was placed in charge of designing and operating a large engineering model of Table Bay and its harbor to experiment on ways to control and reduce the effects of surging in the harbor. The model itself was one of the first of its kind. The understanding developed from his model and the extensive field observations he undertook was incorporated in his 1951 D.Sc. dissertation at the University of Cape Town. Theoretical considerations for range action and motions of moored ships developed at this time underlie much of what we know and do in the field today. Continuing work in this field throughout his career, he published a number of papers, four of which have received professional awards (Arthur M. Wellington Prize, American Society of Civil Engineers (ASCE), 1952; The Institution Award, South African Institution of Civil Engineers, 1960; Overseas Premium, Institution of Civil Engineers, London, 1968; Norman Medal, ASCE, 1969). His 1967 paper in the Proceedings, ICE, *The Threshold of Surge Damage for Moored Ships,* developed a simplified expression for the difficult nonlinear dynamics of ship mooring coupled with harbor resonance. This expression is still most useful in resolving realistic engineering prob lems—applied recently to harbor-ship oscillation problems in the Port of Long Beach, California. A 1977 invited paper then virtually solved the ship motion problem for any situation.

In 1952 Basil moved to the United States, becoming a citizen in 1956, taking a teaching and research position at the Texas A&M University (TAMU). This period was at the beginning of the coastal and ocean engineering initiative at TAMU, and Basil played an important role. During this time, in addition to innovative work on mooring line dynamics, he developed an improved procedure for predicting the height and period characteristics of waves in the variable winds of moving fetches. He later adapted this procedure for high-speed computation, and it was used successfully both in this country and abroad. At this time too, he did innovative work on storm surge caused by hurricane winds, particularly in a definitive work on New York Harbor, but also for the Gulf of Mexico.

As a sidelight to his professional efforts, while at TAMU Basil started a tradition of giving to individuals leaving the department a plaque done in color with a poem in Old English script and an appropriate hand-drawn illustration, combining avocation with vocation.

From 1961 to 1968 Basil continued work in these areas with National Engineering Science Company (Pasadena, California) and Science Engineering Associates (San Marino, California). He also applied his wave dynamics insight to tsunamis and explosion waves. The large and damaging tsunami generated by the 1964 Alaskan earthquake was the subject of a major study by the National Research Council to which Basil contributed significantly, and his material formed the substance of two papers in the final 1972 report.

Going into private practice in 1968, Basil continued to contribute to these areas, advising clients on harbor surging, tsunami hazards, and mooring forces in particular. Among his many clients were Chicago Bridge and Iron (dynamic behavior of off-shore structures and mooring of supertankers); United States Naval Civil Engineering Laboratory (earthquake occurrence and effects in ocean areas); Weston Geophysical Research; Southern California Edison; Pacific Gas and Electric; the Nuclear Regula tory Commission (tsunami hazards at coastal power plants); Dames and Moore (mooring facilities); Kaiser Engineering (exposed mooring of large ships); Bechtel (port locations on the Algerian coast); and the Iron and Steel Corporation of South Africa (long wave effects and loading facilities). Though acting as a consultant, Basil was concerned with teaching throughout his life, through participation in a number of short courses and seminars at coastal institutions in this country and invited lectures abroad.

Throughout his professional career, Basil garnered many awards, the most important being the Arthur M. Wellington Prize (1952), Norman Medal (1969), and John G. Moffatt-Frank E. Nichol Harbor and Coastal Engineering Award (1983), from ASCE; the Overseas Premium (1968) from the Institution of Civil Engineers, London; the Institution Award (1959), Shape Memorial Lecture (1975), and the Award for Meritorious Research (1984) from the South African Institution of Civil Engineers; and the Distinguished Alumnus Award of the Civil Engineering Alumni Association, University of Illinois (1987). He was elected to the National Academy of Engineering in 1984 and because an honorary member of ASCE in 1988.

Basil was active in his professional societies, serving on a number of committees, particularly in the ASCE Waterways Division and Technical Councils on Ocean Engineering and Lifeline Earthquake Engineering. He was a fellow and honorary member of ASCE; a fellow of the Institution of Civil Engineers (London), the South African Institution of Civil Engineers, and the American Association for the Advancement of Science; and a member of several other professional societies. He was a registered engineer in the state of Texas. His publications numbered over one hundred among them pioneering efforts which have influenced significantly work in the coastal field. He was also a director of the Pasadena Artist Association.

Basil's work on Table Bay, Cape Town, and his later theoretical work underlies modern harbor surge work. Work beginning with observations in Table Bay on the way surges affected moored shipping and continuing with theoretical analysis resulted in 1977 in a description of methods for handling ship motion problems for virtually any situation. He developed a generalized formulation of rope influence in the basic equations of moored ship motion in waves and surges, including the strong nonlinearity of both elastic properties under cyclic loading and catenarian configuration (from which the conditions under which a ship could rupture its mooring lines or crush the fenders are determinable). Following his extensive analysis of the large and damaging tsunami from the 1964 Alaskan earthquake and study of earthquake incidence worldwide, estimates of tsunami hazards have been developed for a number of locations, particularly nuclear power plants. He has been responsible for major advances in techniques for wave prediction (particularly with moving fetches), hurricane surge and flooding prediction, submarine pipeline stability under wave loading, and wave forces. His insight into the physical background and his mathematical capability, coupled with his thoroughness and determination, have left a major engineering legacy in the coastal field, furthering materially the knowledge base for the civil engineering discipline.

These achievements came despite a progressing deafness, which at times made communication difficult, and which influenced him to go into engineering rather that follow in his father's footsteps as a journalist. But his love of writing remained throughout his life, as shown not only by his technical literature, but by his poetic children's books and his lengthy annual Christmas poems summarizing the past year.

CARLOS C. WOOD

1913-1997

BY WILLIS M. HAWKINS

THE TWENTIETH CENTURY WAS NOTABLE for many major changes in the way that people lived and related to one another. Among these changes were the modes of travel, which included not only the automobile and the railroads but also the airplane and the beginnings of man in space. The airplane was unique in the twentieth century: the time between the first faltering accomplishments of the Wright Brothers and today's global airlines with hundreds of passengers per flight was within the life span of a few creative individuals. One of the most creative of these contributors passed away in October 1997, Carlos C. Wood.

Carlos was born in Turlock, California, on June 19, 1913, early enough to become aware of all the early efforts to fly by those with almost no educational base or established technologies to support sound design concepts or rational development. The promise of innovation and the obvious excitement over a means to fly affected Carlos, and he led many who saw a future in making practical, useful aircraft. He entered the University of the Pacific to learn mechanical engineering, and on graduation in 1933 he enrolled at the California Institute of Technology, a pioneer in establishing a solid foundation of knowledge for flight. In four years at Cal Tech, he obtained a master's degree in both mechanical and aeronautical engineering and acquired the major part of the educational credit to achieve a doctorate.

During the 1920s and 1930s, the fledging aeronautical industry was beginning to form and Carlos joined other pioneers who made up the Douglas Aircraft Company in Santa Monica, California. Douglas founders had already introduced the earliest true airline transports, the DC-2 and DC-3 family, as well as their earlier round-the-world Army Cruisers and the Douglas M-2 pioneering mail planes. The company recognized Carlos for his sound efforts to achieve knowledge about designing modern aircraft, and in 1942 he was made the head of a small group to create future designs for Douglas. This group was called the Preliminary Design Department.

To appreciate the leadership that Carlos provided in this assignment, it is pertinent to recall the “airline transport” environment at that time. Several companies had produced practical transport aircraft with modern features that made obsolete many early transports, the early Fokkers, the big but inefficient biplanes, and the first all-metal Ford Trimotors. The DC-1, DC-2, and especially the Douglas DC-3, had demonstrated to the airlines the advantage of larger passenger capacity and new aluminum structure to lower the cost of carrying each passenger. The DC-3 became the airline standard while the smaller new transports from Lockheed and the large Boeings were not selected because of their higher cost per passenger mile. Carlos recognized the importance of fitting aircraft size to the traffic needs as he took on the task of creating future new concepts of airline transports for Douglas.

To Carlos, this environment suggested the growing need for a bigger airplane, but the power plants available prevented enlargement of the two-engine concept of the DC-3. Eventually a four-engine airplane was selected and the DC-4 design, simple like the DC-3, emerged. Its passenger carrying capacity and its alternate use as a cargo carrier also suited the needs of the military as the United States prepared for World War II. Variations in fuel capacity, cargo doors, and strengthened floors, produced the C-54, used as a military supply carrier and troop transport.

One of these planes became the “Sacred Cow” with an electric elevator for President Roosevelt. The four-engine concept during the war years became an accepted standard for trans ports for the military and the airlines that supported the military.

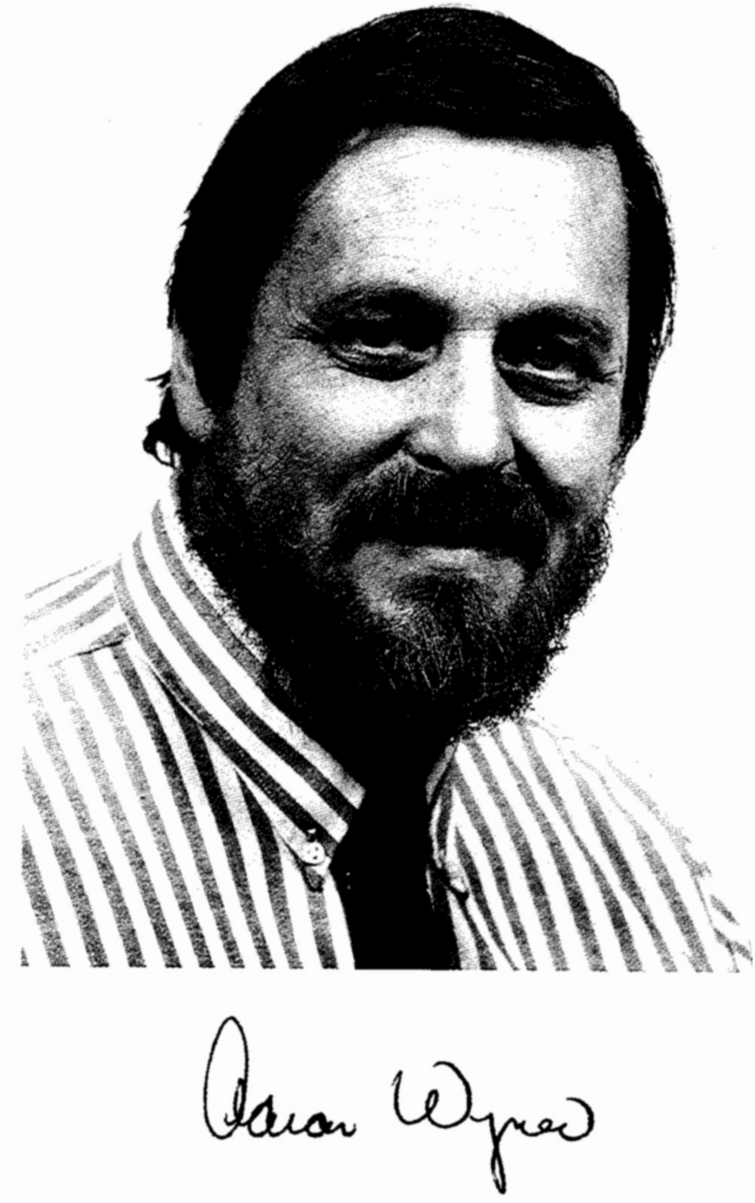
Using the C-54 (commercially the DC-4) as a base, Carlos led the design effort to add more power, lengthen the fuselage, redesign the fuselage and systems to pressurize the interior, and ultimately increase the wingspan. The resulting DC-6 became a major player in the postwar airline transport system, worldwide. Like its predecessor, the DC-4, a DC-6 became the presidential airplane “Independence” for President Truman. Although complete airplane designs were rarely the subject of patents, the DC-6 was patented listing Carlos Wood as a cocreator. Similar competitive designs such as the Boeing 337 Stratocruiser and the Lockheed Constellation also emerged using even more powerful engines. This competition led Carlos to use the same large aircraft engines in another upgrade of the DC-6, which became the DC-7, fully competitive with the other airline transports.

The emergence of useful turbine engines, both pure jet and turbo-propellers, created a further challenge to the creators of transport airlines. Carlos and his advanced design team responded with a new larger high wing military transport, the C-133 (the largest cargo aircraft at the time), with four turbine propeller engines. At the same time, an entirely new four-engine pure jet passenger transport, the DC-8, was created. It is still being used for cargo after many years as a competitive commercial passenger transport. On the strength of his performance in creating these successful aircraft, Carlos became chief engineer of Douglas in 1955 and director of advanced engineering planning in 1959, a position reflecting the growing dependence of the military and commercial customers on the creative aircraft industry to forecast future requirements that new aircraft could be expected to meet.

In 1960, responding to his own concerns that future passenger and cargo services needed to be independent of major expensive commercial airports, Carlos moved to Sikorsky Aircraft to share the expanding knowledge of how vertical takeoff and landing aircraft could be used. Within two years he rose to be vice-president of engineering, the year that the Sikorsky Skycrane first flew. It was the most powerful helicopter in the United States and its unique design, which carried all payloads externally, could carry ten tons. It is still used in many unusual ways such as fire fighting with large water loads in tanks and carrying assembled structural segments of new bridges. During his later years, the beginning analysis of attack helicopters ultimately resulted in the S-69 Black Hawk. Similar "future requirement" approaches brought on the S-65 transport helicopter. He retired from Sikorsky in late 1970.

The experience acquired by Carlos over the years was sought by many. He served the Federal Aviation Administration (1961 to 1965) on its Technical Advisory Board. He also served the Army Mobility Command Scientific Advisory Group and a similar group for the Test and Evaluation Command. This history with its accomplishments supported his election to the National Academy of Engineering in 1967 and his subsequent membership in the Aeronautics and Space Engineering Board under the chairmanships of Dr. Guyford Stever and Dr. Raymond Bisplinghoff.

It has been a true pleasure for me to remember my many early personal discussions with Carlos and my current queries with those who were his peers and bosses at Douglas. His final home was in Napa Valley, California, where he resided with his wife and daughter and enjoyed golfing at the Silverado Country Club. He was a fellow of the American Institute of Aeronautics and Astronautics and a member of the Conquistadors du Ciel, an association of high-level executives in the aerospace industrial community. In all these activities, he was respected as an important, knowledgeable contributor to his industry and the United States, both of which he served well and as a gentleman.



AARON WYNER

1939-1997

BY0DAVID SLEPIAN

AARON WYNER was born in the Bronx, New York, on March 17, 1939. His early education was in the public school system, and he graduated from the Bronx School of Science in 1955. It was apparent even at an early age that he was a talented, unusually intelligent young man. He then completed a five-year joint engineering program with Queens College of the City University of New York and Columbia University, receiving a B.S. degree in mathematics and physics from Queens and a B.S. degree in electrical engineering from Columbia, both in 1960. In 1963 he received his Ph.D. in electrical engineering from Columbia University, and after a summer job at the IBM Thomas J. Watson Research Center, he joined the Bell Telephone Laboratories at Murray Hill, New Jersey, as a member of the technical staff. He became head of the Communications Analysis Research Department there in 1974. These laboratories (now part of Lucent Technologies) remained his main technical home until his untimely death on September 29, 1997, at the age of fifty-eight. Aaron was a victim of cancer.

Aaron had been a major figure in information and communication theory research for thirty-four years. During his career he published eighty-five papers in the leading technical journals of his field. This research spans so many specialties—including channel coding theory, source coding theory, optical communications, algebraic coding, cryptography, and stochastic process theory—that I cannot hope to comment on them all here. I limit myself to a few of his most important contributions.

Aaron's doctoral thesis worked out the first mathematical theory for what are now called convolution codes, a class in wide-spread use today. He gave the first physically meaningful characterization of the band-limited Gaussian Channel and the first comprehensive study of the limitations of “bounded distance” decoding.

In the 1970s and 1980s he played a major role in the explosion of multiple-user information theory research. In 1975 he invented the “wire-tap channel” and also worked out virtually its complete theory. He showed the then-surprising fact that one could obtain perfect secrecy without the advance exchange of secret keys provided that the legitimate receiver enjoys a better channel from the sender than does the wire-tapping opponent. This work, which preceded the introduction of public-key cryptography, has had a steadily increasing influence on developments in cryptography. Again, in the area of secrecy, Aaron invented (and patented) a secure voice-scrambling scheme that does not expand the bandwidth of the signal. He also developed a new precise characterization of “common information” as needed in multiuser systems.

As head of the Bell Labs Department for Communication Research, he had an active involvement in the work of its members and gathered around him a strong team of young researchers. The department served as consultants to many areas in Bell Labs involved with communication systems in use or under development. Particularly strong was the involvement with underwater systems, microwave transmissions, satellite communications, and the cellular systems now so widely in use.

In 1993 at his own request, Aaron gave up the direction of this group and returned to his own research on a full-time basis. There then appeared a succession of papers mostly devoted to data-compression. Many were published jointly with Jacob Ziv, Aaron's closest technical associate for many years. They studied the Lempel-Ziv data-compression system and its applications in great detail and succeeded to show that it is asymptotically optimal.

It is difficult to find anyone who has worked as unselfishly as Aaron Wyner for the advancement of the engineering profession, in particular for the interests of the Institute of Electrical and Electronics Engineers (IEEE) Information Theory Society. He has held every possible service position (editor of the IEEE Transaction on Information Theory, associate editor, president of the society, twice cochairman of the IEEE International Symposium on Information Theory, workshop cochairman, member of the board of governors, etc.) and discharged these duties extraordinarily well. His editing (jointly with N.J.A. Sloane) of the collected papers of C.E. Shannon recently culminated in the publication of these papers as an IEEE book of about 1,000 pages, for which every serious worker in the field owes Aaron a debt of gratitude.

Aaron had concurrent teaching leaves to many universities and received various honors. Among these he served as full and part-time faculty member in the Department of Electrical Engineering at Columbia University (1963 to 1972); Guggenheim Fellow (1966 to 1967) spent as visiting scientist at the Technion in Haifa, Israel; visiting scientist in the Department of Applied Mathematics at the Weizmann Institute of Science, Rehoboth, Israel (1969 to 1970); adjunct professor of electrical engineering at the Polytechnic Institute of Brooklyn (1971 to 1975); and visiting lecturer in electrical engineering at Princeton University. He (with J. Wolf) received the IEEE Information Theory Group Prize Paper Award (1977). Other IEEE honors include the Centennial Medal Award (1984) and the Claude E. Shannon Award (1994). He was elected to the National Academy of Engineering that same year.

A word about the man. Aaron was open and affable. He was generous with his time—always available to fellow workers for his help. He took his position as department head seriously and was a natural leader. In addition to his intense interest in science, Aaron had another passion—his family. His office was adorned with pictures of his wife, his four children, and his six grandchildren. He was truly deeply devoted to them all. He was also much interested in Israel and in Judaism. In his later years, he greatly enjoyed opera.

I cannot leave this tribute to Aaron without talking about the remarkable courage he showed in the face of his final illness. With me he talked freely about it, but always in a detached scientific way. Although he was frequently in pain, there was never a word of self-pity or complaint.

With the passing of Aaron Wyner, the engineering profession has lost a great contributor. For those who have known Aaron, the loss is even deeper.

KONRAD ZUSE

1910-1995

BY MANFRED SCHROEDER

KONRAD ZUSE, German computer pioneer, died on December 18, 1995, in Hünefeld near Bad Hersfeld (Hessia). Zuse is widely credited with the creation of the first functioning, freely programmable, and fully automatic digital computer. He also created, before 1946, the programming language Plankalkül, which anticipated essential aspects of modern programming languages. His concept of Rechnender Raum (literally: computing space) foretold computation by means of cellular automata.

Zuse was twenty-eight when, in 1938, he built his first sizeable computer, the Z1, occupying a large portion of his parent's living room. The Z1 was programmed by punched tape, stored sixty-four characters, and took three seconds for a multiplication. In the late 1930s, the German inventor built a functional computer, years before inventors in the United States and Great Britain would unveil similar machines. World War II restrained Zuse from claiming patents and seeking industry backing; it also left him in virtual obscurity.

“Zuse suffered from being in the wrong country at the wrong time,” says Maurice Wilkes, the British inventor whose work led to the first business computer, the LEO. “If he had been in the U.K. or the U.S., he may have had a much more prominent impact,” adds Gene Amdahl, chief architect of IBM's 360 mainframe.

During the war, Zuse tried to get support from the German government for a two-year project to develop a large new computer to help improve antiaircraft defenses. “And just how long do you think it will take us to win the war?” he was asked when the project was rejected.

Only weeks before the Third Reich fell, he moved his only remaining computer, the Z4 to Göttingen in central Germany to protect it from advancing Soviet troops. His first three computers were demolished in bombing raids, but he rebuilt the Z1 from memory (no pun) more than forty years later.

“Fifty years ago, as a student of civil engineering, I was struck by the immense calculations that had to be performed in the construction of buildings,” Zuse said.

> “I became convinced that machines should be doing these calculations, but at the time I understood nothing about computers. I was not even aware of Babbage's work and of diverse parallel developments in other countries such as the United States.
>
> “Deciding to try new ways, I built my own computer with the following features: calculation of long programs controlled by a sequence of orders punched on tape (I started by using punched strips of film); use of the binary number system; introduction of floating point arithmetic.
>
> “I began with a strong preference for mechanical systems, but I did not succeed and was forced to switch to electromechanical technology. Finally in 1941, in my parent's Berlin apartment, I completed the Z3—the first computer of its kind. My work was based mostly on private initiative, with assistance from some friends. Only after 1940 had I received sponsorship from the DVL [Deutsche Versuchsanstalt für Luftfahrt] so that numerical problems, especially for aerodynamic applications, could be solved.
>
> “During these developments, further aspects of computing became apparent. My friend Helmut Schreyer proposed the use of tubes in place of relays. The development of the switching algebra led to a connection with mathematical logic. These new ideas extended the concept of calculation beyond numbers and gave rise to the concept of artificial intelligence.”

Zuse says his life has been marked by what he terms the curse of being ahead of his time. Indeed, while later iterations of Zuse's computer attracted the attention of IBM's Thomas Watson in 1947, Big Blue rejected Zuse's work. Other instances of the curse are detailed in his autobiography, *My Life—The Computer*. The English-language version was published in 1993 by Springer-Verlag in New York. But instead of frustration and bitterness, what emerges in the book is a remarkable story of a young pioneer who, against all odds, succeeded in realizing his dream.

Born on June 22, 1910, in Berlin, the son of a postmaster, Zuse grew up in Braunsberg in East Prussia not far from the shores of the Baltic Sea and the Masurian lake country. In his youth he was drawn to painting and building. He later studied engineering at Berlin's Technical University. Upon graduation, he was employed by the Henschel Aircraft Company in Berlin as a structural engineer. The mathematics of the job, Zuse recalls, was “torture.” He decided only a “computing machine” could rid him of the tedium. A few months later, Zuse quit his position at Henschel and announced, to his parents' horror, that he would construct a computer in their living room. It was 1935—seven years before John Mauchly and John Eckert got approval to build the Eniac.

The Z4, the final versions of Zuse's original machine, contained features found in today's microprocessors, such as the retrieval of computer instructions before use and a cache memory.

Zuse received many, if belated, honors. Between 1956 and 1992 he was awarded honorary doctorates, from Reykjavik (Iceland), Zürich (Switzerland), Siena (Italy) as well as four German universities. In 1966 Göttingen University appointed him an “Honorarprofessor.” Among his many medals are the Wernervon-Siemens Ring (1964), the Diesel Medal (1969), the newly created Konrad Zuse Medal (1981), Bavaria's Order of Maximilian (1984), the Golden Honor Ring of the German Museum (1984), and the Philip Morris Prize (1987). In 1972 Zuse was decorated by Federal President Richard von Weizsäcker with Germany's highest civilian order, the Grosses Verdienstkreuz mit Stern.

Zuse was honorary member of the Leopoldina, the oldest German Scientific Academy. A number of streets and buildings were named for him, as well as a research center in Berlin and a scholarship program of the German government to support foreign guest professors. In 1981 Zuse was elected a foreign associate of the National Academy of Engineering.

Zuse loved hiking in his native country along the shores of the Baltic. He was an accomplished amateur painter and excelled at linoleum carving. Several of his works of art are reproduced in his autobiography. All his life he combined engineering insight with artistic vision.

APPENDIX

Members	Elected	Born	Deceased
Giovanni Astarita	1994	October 7, 1933	April 28, 1997
J. Leland Atwood	1974	October 26, 1904	March 05, 1999
Philip Barkan	1980	March 29, 1925	June 21, 1996
Marcel Louis J. Barrére	1984	August 19, 1920	August 25, 1996
Robert Bromberg	1969	August 6, 1921	January 25, 1999
G. Edwin Burks	1978	April 10, 1901	March 16, 1994
Paul F. Chenea	1969	May 17, 1918	March 24, 1996
Jerome B. Cohen	1993	July 16, 1932	November 7, 1999
Neville G. W. Cook	1988	January 29, 1938	March 3, 1998
Wallace Henry Coulter	1998	February 17, 1913	August 13, 1998
Sidney Darlington	1975	July 18, 1906	October 31, 1997
Rolf Eliassen	1971	February 22, 1911	March 14, 1997
Richard S. Engelbrecht	1976	March 11, 1926	September 1, 1996
Michael Ference, Jr.	1971	November 6, 1911	July 24, 1996
Donald Glen Fink	1969	November 8, 1911	May 3, 1996
John C. Geyer	1970	August 11, 1906	May 2, 1995
Martin Goland	1967	July 12, 1919	October 29, 1997
James P. Gould	1988	October 9, 1923	December 25, 1998
Meredith C. Gourdine	1991	September 26, 1929	November 20, 1998
Robert Herman	1978	August 29, 1914	February 13, 1997
Eivind Hognestad	1973	July 17, 1921	February 16, 2000
Joe Estes House	1995	September 28, 1923	May 1, 1998
George J. Huebner	1975	September 8, 1910	September 4, 1995
Lawrence E. Jenkins	1984	March 12, 1933	April 5, 1996
Reynold B. Johnson	1981	July 16, 1906	September 15, 1998
Robert T. Jones	1973	May 28, 1910	August 11, 1999
Jerry R. Junkins	1988	December 9, 1937	May 9, 1966
Robert M. Kenedi	1976	March 19, 1921	November 15, 1998
John R. Kiely	1967	November 8, 1906	January 10, 1996
Koji Kobayashi	1977	February 17, 1907	November 30, 1996
Walter F. Kosonocky	1992	December 15, 1931	November 2, 1996
Jai Krishna	1979	February 14, 1912	July 27, 1999
Rolf Landauer	1978	February 4, 1927	April 27, 1999
Clarence Edward Larson	1973	September 20, 1909	February 14, 1999
Gerald A. Leonards	1988	April 29, 1921	February 1, 1997
Fritz Leonhardt	1983	July 11, 1909	December 20, 1999
Arthur Lubinski	1986	March 30, 1910	May 3, 1996
Robert E. McIntosh	1997	January 19, 1940	July 10, 1998
David Packard	1971	September 7, 1912	March 26, 1996
Earl Randall Parker	1969	November 22, 1912	May 9, 1999
Donald William Pritchard	1993	October 20, 1922	April 23, 1999

Members	Elected	Born	Deceased
Wilbur L. Pritchard	1995	May 31, 1923	March 18, 1999
Eberhard F.M. Rees	1973	April 28, 1909	April 2, 1998
Eric Reissner	1976	January 5, 1913	November 1, 1996
Rudolf Schulten	1978	August 16, 1923	April 27, 1996
Henry E. Singleton	1979	November 27, 1916	August 31, 1999
Richard Skalak	1988	February 5, 1923	August 17, 1997
Gregory Eugene Stillman	1985	February 15, 1936	July 30, 1999
James R. Wait	1977	January 23, 1924	October 1, 1998
Robert H. Wentorf, Jr.	1979	May 28, 1926	April 03, 1997
Harold Alden Wheeler	1986	May 10, 1903	April 25, 1996
Basil Wright Wilson	1984	June 16, 1909	February 9, 1996
Carlos C. Wood	1967	June 19, 1913	May 14, 1997
Aaron D. Wyner	1994	March 17, 1939	September 29, 1997
Konrad Zuse	1967	June 22, 1910	December 18, 1995

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