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Memorial Tributes

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FOREWORD

THIS IS THE FIFTEENTH VOLUME in the series *Memorial Tributes* compiled by the National Academy of Engineering as a personal remembrance of the lives and outstanding achievements of its members and foreign associates. These volumes are intended to 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.

Through its members and foreign associates, the Academy carries out the responsibilities for which it was established in 1964. Under the charter of the National Academy of Sciences, the National Academy of Engineering was formed as a parallel organization of outstanding engineers. Members are elected on the basis of significant contributions to engineering theory and practice and to the literature of engineering or on the basis of demonstrated unusual accomplishments in the pioneering of new and developing fields of technology.

The National Academies share a responsibility to advise the federal government on matters of science and technology. The expertise and credibility that the National Academy of Engineering brings to that task stem directly from the abilities, interests, and achievements of our members and foreign associates, our colleagues and friends, whose special gifts we remember in these pages.

Thomas F. Budinger
Home Secretary

Memorial Tributes

NATIONAL ACADEMY OF ENGINEERING

WILLIAM D. ALEXANDER

1911–2003

Elected in 1978

"For leadership in organizing complex multidisciplinary engineering projects."

BY JAMES L. LAMMIE

WILLIAM D. ALEXANDER died on December 9, 2003, at Waccamaw Community Hospital at Murrells Inlet, North Carolina. Bill was elected to the National Academy of Engineering in 1978 in recognition of his contributions to design and construction management for major infrastructure projects in the United States.

Bill was born on June 20, 1911, in Charlotte, North Carolina. He graduated from Central High School in Charlotte. He then attended Virginia Military Institute, earning a bachelor of science degree in chemistry in 1934. He later obtained a civil engineering degree from North Carolina State University in 1953. He was a registered professional engineer in 11 states.

After graduation in 1934, Bill worked as a consulting engineer in High Point, North Carolina, and Boise, Idaho, until being commissioned as an officer in the U.S. Army Corps of Engineers in 1940. Bill worked on projects, mostly heavy air fields, in the United States and in the Philippines and Japan. He transferred to the Air Force in 1953 and became chief of engineering for Far East Operations and then moved to the Air Force Directorate of Civil Engineering, with responsibilities for global Air Force installations, including early warning projects such as SAGE (Semi-Automatic Ground Environment system and the DEWLINE (Distant Early Warning Line).

In 1958 he became chief of facilities design for the USAF Ballistic Missile Division and was in charge of facility design for the Atlas, Titan, and Minuteman missile facilities. This multibillion-dollar complex project, known collectively as the Intercontinental Ballistic Missile System, received the Outstanding Civil Engineering Achievement Award from the American Society of Civil Engineers in 1962. Bill retired from the Air Force in 1962 with the rank of colonel.

In 1962, Bill became the project manager of a joint venture—URSAM—composed of the firms Urbahn, Roberts, SSV&K, and Mueser Rutledge, to design Launch Complex 39 and NASA's (National Aeronautics and Space Administration's) Vehicle Assembly Building on Merritt Island at Cape Canaveral, Florida. The success of the Apollo program and the record size of the vehicle assembly building resulted in the project being designated as the Outstanding Civil Engineering Achievement for 1966 by the American Society of Civil Engineers.

In 1964, Bill became a partner in and president of the design firm SSVK (Seelye-Stevenson-Value and Knecht) of New York City. In 1966 he became project director of the DUSAF Joint Venture (DMJM, Urbahn, SSV&K, G. A. Fuller), responsible for the design and construction of the Fermi National Accelerator Laboratory in Batavia, Illinois. This 200-BEV national accelerator won the American Society of Civil Engineers Award of Merit as one of the top U.S. projects in 1972.

In 1975, Bill moved to Atlanta and joined the staff of the Metropolitan Atlanta Rapid Transit System, as MARTA's assistant general manager, directly responsible for the design and construction of the multibillion-dollar Atlanta transit system. MARTA General Manager Allen Kiepper said, "I need a man who has built big projects and managed large organizations but more importantly one who has successfully built world-class projects on time and on budget." His leading candidate was Bill Alexander. Bill took immediate charge; restructured his organization; renegotiated the contract with the general engineering consultant; improved relations with the city, railroads, and public utilities; and put the project back on track. Bill also developed an excellent relationship and a high degree of credibility with MARTA's public Board of Directors. MARTA, a billion-dollar-plus project, was recognized as a model of an on-time, on-budget system with a reputation for fair dealings with contractors and an ability to find a way to move ahead despite many obstacles. MARTA was recognized in 1983 with an Award of Merit as one of the outstanding civil engineering projects of the year by the American Society of Civil Engineers.

After MARTA, Bill moved on to Houston to start up the Houston Transit System, which he did with several major design contracts that were awarded very quickly. Unfortunately, political issues developed, and Bill then had to terminate contracts that were already in progress, which he did in a fair and an equitable fashion. He then served as an individual consultant for Denver, Hawaii, and other transit systems and mega projects before fully retiring to Pawley's Island, North Carolina.

Bill was very active in the civil engineering profession. His numerous articles appeared in *Civil Engineering Magazine* in 1962, 1965, and 1972; in *Transactions of ASCE* in 1966 and 1973; and in *Consulting Engineer* in 1960. He testified on airstrip paving materials before the House Armed Services Committee in 1957. Bill was a recognized authority on organization and procedures for civil design and on the engineer's role in managing major projects, including construction. He lectured extensively before professional societies and at the engineering schools of many universities. His many organizational affiliations permitted him to interact with other professionals, who were able to learn from his experiences. He was a fellow of the American Society of Civil Engineers, chairman of its AeroSpace Transportation Division, and chair of its Research Committee from 1966 to 1971. He was also a fellow of the American Consulting Engineers Council, a member of the Society of American Military Engineers, and a member of the Board of the Civil Engineering Foundation. He was a member of the Moles, Phi Kappa Phi, Tau Beta Pi, and North Carolina State University's Engineering Advisory Council.

Bill received the Air Force Commendation Medal early in his Air Force career and the Legion of Merit in 1962. *Engineering News Record* named him among "Men Who Made Marks" in 1962, and he received the Outstanding Engineering Alumnus Award from North Carolina State University in 1976. He was designated Civil Engineer Member of the Year by the American Society of Civil Engineers New York Chapter in 1967. Bill's greatest recognition, though, was having his major projects—the Air Force ICBM System, the Apollo Space Launching Facility, the Fermi Accelerator, and the MARTA Transit System—all receive awards as outstanding projects for their respective years.

For his many awards, Bill was described as a "creative engineer, team organizer and leader, a manager of huge, sophisticated, complex multidisciplinary engineering projects." He was a man with "an unusual ability to understand and manage complex engineering systems and to provide leadership and motivation for his management team."

Mr. Alexander was survived by his wife, Alice; a son, William D. Alexander IV; and a grandson, Adrian Alexander.

LEW ALLEN, JR.

1925–2010

Elected in 1978

"For pioneering work in combining technologies of space and information processing to strengthen the nation."

BY JOHN R. CASANI

LEW ALLEN, JR.—a towering figure in all respects—died on January 4, 2010, at his home in Potomac Falls, Virginia. He devoted 36 years of service to the nation in the U.S. Air Force, becoming a four-star general and the tenth U.S. Air Force chief of staff. When he retired from the Air Force in 1982, he agreed to become director of the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL). In 1990 he left JPL and served as chairman of the board of the Charles Stark Draper Laboratory in Boston. Throughout his long and productive life, Lew Allen, Jr., was recognized and honored not only for his technical knowledge but also for his wide-ranging intelligence, great integrity, and profound vision. He possessed strong, engaging leadership qualities—a "steady steel hand in a velvet glove," as one colleague put it.

Lew Allen was born in Miami, Florida, on September 30, 1925, and grew up in Gainesville, Texas. He entered the U.S. Military Academy at West Point in 1943, graduating in 1946 with a bachelor of science degree, a commission as a second lieutenant, and pilot wings. After completing multiengine flight training, he was assigned to Strategic Air Command's 7th Bombardment Group at Fort Worth Army Airfield (later renamed Carswell Air Force Base), where he flew B-29s and B-36s and served in positions related to nuclear weaponry. In

1950 he entered the University of Illinois for graduate training in nuclear physics and was awarded a master of science degree in 1952 and a Ph.D. in physics in 1954. His thesis was on high-energy photonuclear reactions.

Allen's Air Force career was characterized by a focus on technology, science, and steadily higher levels of assignments. At Los Alamos National Laboratory, he measured the cross section of neutrons coming out of nuclear explosions. At Kirtland Air Force Base, New Mexico, he was science advisor to the Physics Division of the Air Force Special Weapons Center from 1957 to 1961. The Van Allen belts had been discovered by the nation's first satellite, *Explorer 1*, and there was concern that nuclear weapons exploded in space might blank out civilian and military communications. Lew Allen defined a program to measure this effect, directing an experiment that flew a series of high-altitude rockets to measure electrons trapped in the geomagnetic field after an exoatmospheric nuclear blast. In December 1961 he moved to the Office of the Secretary of Defense, Space Technology Office, in the Directorate of Research and Engineering, in Washington, D.C. He spent 1965 to 1973 in service to the Office of the Secretary of the Air Force, first in Los Angeles and then at the Pentagon as deputy director of space systems, becoming director in June 1969. In 1970–1971 he was back in Los Angeles as assistant to the director of special projects and then director. He then served as chief of staff for the Air Force Systems Command at Andrews Air Force Base in Maryland.

No doubt in recognition of his leadership abilities and reputation of integrity, Lt. Gen. Allen was appointed deputy to the director of central intelligence for the intelligence community in Washington, D.C., in 1973. During a memorial tribute at JPL on April 7, 2010, Albert Wheelon, retired chief executive officer of Hughes Aircraft Corporation and a life trustee on Caltech's Board of Trustees, remarked that Allen was "a straight shooter. Many thought of him as the straightest of the straight shooters. . . . [He] made an enormous contribution to reconnaissance and general intelligence." In August 1973, Allen was named director of the National Security Agency

(NSA) and chief of the Central Security Service at Fort George G. Meade, in Maryland, by President Richard M. Nixon. According to Albert Wheelon, "his job was to bring that organization to heel and to calm the concern that Congress had about it. He was remarkably successful in this difficult assignment." Lew Allen was to become the first NSA director to testify before a U.S. House of Representatives, and then a U.S. Senate, committee, in open session, in 1975. When he departed the NSA in 1977, he was named commander of the Air Force Systems Command. He received his fourth star on August 1, 1977.

Starting in April 1978, Allen served as vice chief of staff of the Air Force, becoming chief of staff in July of the same year. He was then responsible for the entire U.S. Air Force. According to a statement on Allen's passing by the Secretary of Air Force Public Affairs, General Allen "left an indelible mark on the Air Force." Honoring tradition, Allen made *The U.S. Air Force* (popularly known as "Off We Go into the Wild Blue Yonder") the service's official song (courtesy of the copyright holder). Encouraging education, Allen created Project Warrior, a professional development program for airmen, calling for "the continuing study of military history, combat leadership, the principles of war, and the applications of air power."

General Lew Allen retired from the Air Force in July 1982. That year JPL was searching for its eighth director. A division of Caltech and a principal center for robotic planetary exploration for NASA, JPL had had a string of brilliant deep-space mission successes under William Pickering (director, 1954–1976); but NASA's planetary budget was cut in 1981, and JPL faced considerably reduced funding. NASA Administrator James M. Beggs even proposed terminating the nation's planetary exploration program altogether, making JPL "surplus to our needs."

Caltech began seeking other sources of funds, considering the addition of defense work to JPL's tasks. Nominated as JPL director, with a concurrent position as vice president of Caltech, Allen brought to JPL his extensive experience with military space missions and technology. This was seen as a great boon for developing JPL's defense work, and so it was. But Dr. Allen, as he was known at JPL and Caltech, brought much more than this to his new position. As Larry Dumas, JPL's deputy director from 1992 to 2001, remembers him, Lew Allen was "an unassuming and soft-spoken gentleman with the knack of asking deceptively simple questions that could absolutely confound the brightest scientist or engineer. It takes a deep understanding of the subject to be able to do that."

Dr. Allen was a new-technology enthusiast. Terry Cole, appointed JPL's chief technologist in 1980, was also a research associate in chemistry at Caltech. Cole and Allen collaborated on initiating, nourishing, and finally instantiating JPL's Microdevices Laboratory (MDL), which grew into a research, development, and fabrication facility for highly capable, miniaturized devices for space missions. Cole described the beginnings of MDL in a 1996 interview for the Oral History Project of the Caltech Archives. At a meeting of the Caltech Trustees JPL committee with Burton I. Edelson, NASA associate administrator for space sciences, Edelson discussed a letter he had received from Caltech Trustee Mary Scranton in which she asked if there was any new role that JPL could play in addition to its work in solar system exploration. Edelson proposed that JPL become a microelectronics center of excellence for all of NASA.

Dr. Allen asked Cole to investigate the possibility and report on what kind of hiring and investment would be needed and to come up with a plan. The approach was to define an area or areas where JPL would be unique. "It was clear," Cole said, "that we couldn't compete with industry in producing computer chips or memory chips. . . . It was senseless to do that because we were forbidden, since we're a government-sponsored lab, to compete with industry. And the Defense Department was investing billions of dollars in improving conventional electronics."

Cole and the colleagues he consulted identified four areas of interest. First, they discerned that there were areas of the electromagnetic spectrum where detectors that would be useful in remote sensing were inadequate or nonexistent. They discussed the idea of fabricating custom microchips (very large-scale integrated circuits) that would move technology from academic research into reality in a "silicon foundry." A third area was photonics: using lasers for remote sensing and eventually interplanetary communication. The fourth area was collective computational behavior: neural nets and parallel computing. Allen pointed out that the NASA Office of Space Science did not have a charter within NASA to develop technology, so while Edelson might support the idea, JPL would have to sell the rest of NASA on it. According to Cole, when he and Allen finally did make their presentation at NASA headquarters, the deputy administrator (Dale D. Myers) "turned to Lew Allen and said, 'Lew, do we really need this?' And Lew said, 'Yes, we really need this. It's important for NASA.' And he said 'Done.' . . . Lew Allen carried a tremendous reputation with him when he became director of the laboratory. And he was so well known in Washington that his word was really solid platinum."

In 1984, Terry Cole recruited Carl Kukkonen from the Ford Research Laboratory in Dearborn, Michigan, to be director of an advanced microelectronics program. Work in parallel computer architecture was growing at Caltech and, said Kukkonen, "Dr. Allen wanted JPL to work closely with [the Caltech] campus on this new computing technology." The Strategic Defense Initiative, begun around this time, was to use advanced technology to track and intercept Soviet missiles. Tracking objects simultaneously was a perfect task for parallel computing. JPL scientists and engineers also wanted access to a supercomputer. Allen agreed to find funding for a used Cray XMP, and eventually supercomputing became a widely used tool at JPL. As Kukkonen said, "As the technology advanced, parallel computing and supercomputing merged into a single organization—all started by Dr. Allen." NASA saw the value and became a prime sponsor of advanced computing and eventually also provided research and development (R&D) funding for advanced infrared, submillimeter, ultraviolet, and visible sensors for imaging; advanced lasers for sensing; and technology to miniaturize spacecraft. The Strategic Defense

Initiative's Innovative Science and Technology Office sponsored unclassified, high-risk, high-payoff R&D at both JPL and Caltech. NASA supported the Center of Excellence at JPL by providing funds for a building to provide a state-of-the-art R&D facility. Groundbreaking for what became the MDL at JPL was on January 21, 1987, and the facility became fully operational in 1990. At the memorial tribute at JPL in April 2010, Charles Elachi, director of JPL, called the MDL a major contribution by Lew Allen: "He really had the vision, 20, 25 years ago, that this was going to be a very important field for JPL." Elachi went on to cite a new European mission—Herschel/Planck—looking at the origin of the universe using MDL-developed focal plane submillimeter detectors, "which would have been unthinkable 10 years ago."

Elachi described another major contribution by Allen: his support for new research and the technology to enable it. In 1984 two astronomers, following up on data from the Infrared Astronomical Satellite that revealed unusual amounts of infrared radiation from Beta Pictoris (implying the existence of orbiting solid material), obtained an image of a circumstellar disc using a ground-based telescope. Though it was not clear if there actually were planets around the star, the disc was the first ever clearly seen in astronomical photographs. Recalled Elachi, "Dr. Allen said, 'This is going to be a great field in the future and I want JPL to be the leader. I'm going to invest our internal money into making that happen.'" Allen directed a substantial portion of discretionary funds toward further study of extrasolar planets.

During Lew Allen's tenure as JPL director, he oversaw the launch of the *Galileo* mission to Jupiter, which provided the first observations of an asteroid with a moon and imaged a comet colliding with Jupiter; *Magellan* to Venus, which used synthetic aperture radar to map the planet and its gravity field; the *Voyager 2* flybys of Uranus and Neptune; and the Infrared Astronomy Satellite, the first space-based telescope to survey the universe in infrared. He gracefully handled the concerns at JPL and at the campus about a retired general running a civilian space laboratory and quickly won over both populations. He helped JPL obtain defense-related work that bolstered both technical work and morale at a time when NASA's planetary exploration program was declining. When the program started to rebound, he helped JPL respond with vigor and new levels of expertise. Eventually JPL even ended up turning away more defense work as the laboratory bumped up against infrastructure limitations.

Mention should be made of Lew Allen's interest in and support of students. The Summer Undergraduate Research Fellowship (SURF) program at Caltech was created in 1979. SURF is modeled on the grant-seeking process: Undergraduates collaborate with mentors to define a project prior to writing a research proposal; a faculty committee reviews the proposals and recommends awards. Students then work on their projects over 10 weeks in the summer, submit technical papers, and give oral presentations. Allen thought it was a great idea for JPL, too, and with participation of JPL Chief Technologist Terry Cole, a companion SURF program was initiated at the laboratory. After Allen retired from JPL, he continued as a member of the SURF board for three years and chaired it for a year. He and his wife Barbara provided money each year to fund a SURF student summer stipend and continued this after moving to the East Coast. Such direct encouragement of graduate students would not have been a surprise to his children. In the eulogy given by James (Jimmy) Allen, the youngest of five offspring, at Arlington National Cemetery, emphasis was placed on how the children were imbued by their father with "an endless thirst for knowledge. . . . One of [Dad's] proudest accomplishments was to be named outstanding graduate of every academic institution he attended: It was recognition for a life of learning."

Throughout his life, Lew Allen undertook concurrent assignments and tasks. In 1987 he chaired the Committee on Science, Engineering, and Public Policy, a joint unit of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The committee's report, *Balancing the National Interest: U.S. National Security Export Controls and Global Economic Competition*, caused a stir with its conclusion: that export control laws had impeded U.S. trade in high-technology products while making an unclear and variable contribution to national security. The report was later seen as a major contribution to a dialogue that led to removal of some export restrictions and to improvement of the U.S. position in export control collaboration with NATO allies and other friendly nations.

From 1989 to 1995, Allen was a member of the President's Foreign Intelligence Advisory Board and the Intelligence Oversight Board, and as former U.S. Air Force chief of staff, he continued to be active in the military intelligence community, serving as a member of the National Security Agency Advisory Board. He was a member of the National Academy of Sciences Committee on International Security and Arms Control. He served on the Keck Foundation's board at the request of Howard Keck and on the California Association for Research in Astronomy board that oversaw construction of (and now operates) the Keck Observatory on Mauna Kea in Hawaii. He participated in meetings in 1986–1987 on possible U.S.–Soviet cooperation in space missions. Allen served on the Council on Foreign Relations. In 1988 he became chairman of the Board of Directors for the Charles Stark Draper Laboratory and was a member of the Board of Trustees for Aerospace Corporation. In 1989 he joined the Scientific Advisory Committee of General Motors. Also in 1989 he was elected to the National Academy of Engineering and served on a number of its committees. In 1990 he became a member of the Secretary of Energy's Advisory Board. Allen also served as regional chairman of United Way for several years. He held the position of senior faculty associate at Caltech until 1997.

Before retiring from JPL at the end of 1990, Allen made another major contribution to the nation's space program. As is well known now, the Hubble Space Telescope was launched with a flaw in its primary mirror that prevented proper focusing. Lew Allen was asked by NASA to lead the Optical Systems Failure Review Board. James Breckinridge, technical advisor to Dr. Allen, recalled that "Dr. Allen's technical knowledge of optical engineering was far greater than any one of us imagined. He . . . fully understood both the engineering implications and the impact to the astronomical sciences community. . . . During our meetings, Dr. Allen took no notes but relied on his excellent memory to recall in-depth details during discussions. He identified all ambiguities in the presentations by the contractor, listened intently to the board members, and resolved issues in real time." The report was issued in November 1990, the board having identified precisely the errors that led to the flawed optics. The finding enabled fabrication of corrective optics in JPL's Wide-Field and Planetary Camera 2, which was installed during an astronaut-servicing mission in 1993. Finally, Hubble was able to perform as wonderfully as space scientists had hoped it would.

Dr. Allen was the recipient of numerous awards, decorations, and medals. He wore the Command Pilot Badge (more than 4,000 flying hours) and the Master Missile Badge. He was awarded the Air Force Legion of Merit in 1957, 1968, and 1971; the U.S. Department of Defense (DoD) Joint Service Commendation Medal in 1965; the U.S. Air Force Distinguished Service Medal in 1973 and 1982; and the DoD Distinguished Service Medal in 1977, 1979, and 1982. He was awarded the National Intelligence Distinguished Service Medal for service on the President's Foreign Intelligence Advisory Board, 1993–1995. In 1990, Dr. Allen was honored with the George W. Goddard Award from the Society of Photo-Optical Instrumentation Engineers/International Society for Optical Engineering; the Rotary National Space Trophy; the Robert H. Goddard Memorial Trophy from the National Space Club; and the William Oliver Baker Award from the Security Affairs Support Association (now the Intelligence and National Security Association). In 1999 he received the Distinguished Graduate Award from the West Point Association of Graduates.

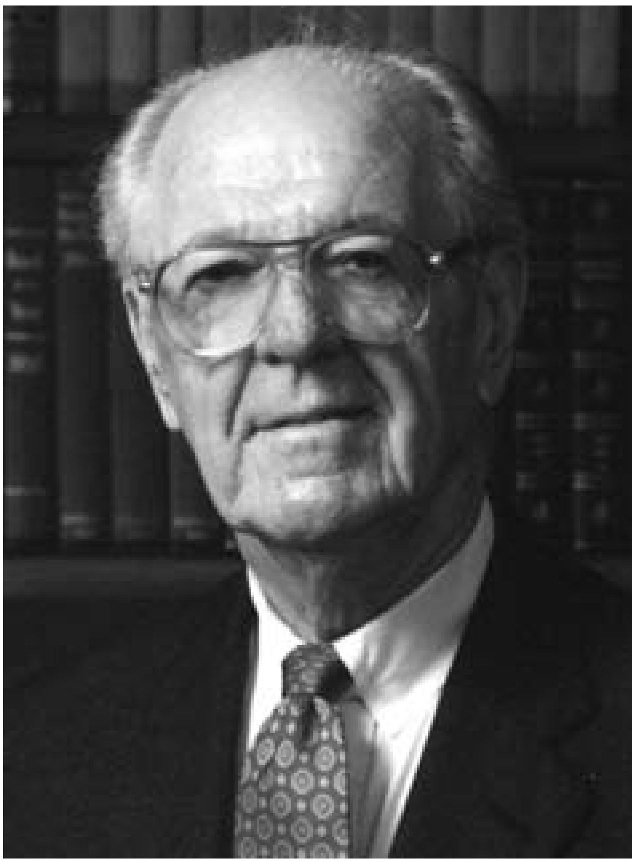
Dr. Allen was inducted into the Air Force Space and Missile Pioneers Hall of Fame on August 8, 2007, at Peterson Air Force Base in Colorado. Additional honors included the University of Illinois Alumni Achievement Award, the National Geographic Society/General Thomas D. White Trophy, the American Institute of Aeronautics and Astronautics von

Kármán Lectureship in Astronautics in 1987 and the Goddard Astronautics Award in 1995, the American Astronautical Society Military Astronautics Award, the Distinguished Graduate Award of the Air Force Institute of Technology/Association of Graduates of the U.S. Air Force Academy, and the NASA Distinguished Service Medal.

Two awards are named in his honor. The U.S. Air Force's General Lew Allen, Jr., Trophy is awarded annually to recognize sustained job performance, job knowledge, direct sortie involvement, and military qualities. The annual Lew Allen Award for Excellence presented by JPL recognizes significant accomplishments and leadership in scientific research or technological innovation.

To his colleagues and friends, Lew Allen was an unfailing source of encouragement, support, wisdom, and knowledge. Stories abound of his personal warmth, humility, commanding presence, expectations of excellence, and creative vision. Of the many remembrances, there is one that may especially capture his qualities: "He was quiet, considerate, and extremely intelligent. He listened a lot and asked a lot of questions. He did not say much, but what he did say was very important."

Dr. Allen was laid to rest at Arlington National Cemetery on March 22, 2010. He is survived by his wife of 60 years, the former Barbara Frink Hatch; two sons, Lew III and James; three daughters, Barbara, Marjorie, and Christie; 13 grandchildren; and 11 great-grandchildren.



NEAL R. AMUNDSON

1916–2011

Elected in 1970

"For pioneering contributions to the fundamental analysis of chemical processes and leadership in chemical engineering education."

BY DAN LUSS AND ARVIND VARMA

NEAL R. AMUNDSON, Cullen Professor Emeritus of Chemical and Biomolecular Engineering and professor of mathematics at the University of Houston, passed away peacefully on February 16, 2011, at the age of 95. He was a transformational figure, considered by many to be the most prominent and influential chemical engineering educator in the United States.

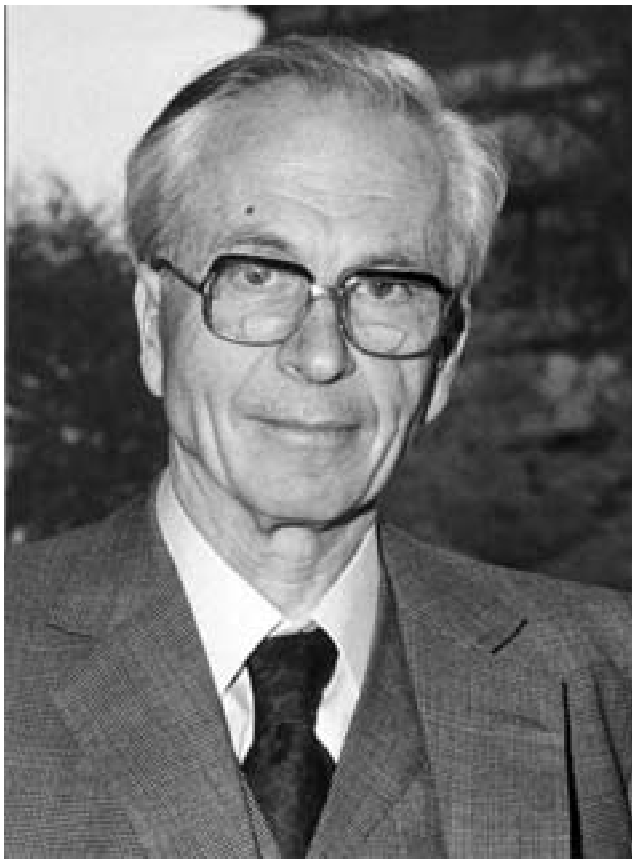
His contributions to the chemical engineering profession were both revolutionary and multifaceted. They included introducing science into a field that before his time was dominated by an empirical and qualitative approach. Amundson charted an innovative course that transformed the profession and led to the development of a science-based methodology guided by quantitative analysis. Starting in the 1950s, he repeatedly demonstrated the advantages of applying mathematical modeling and advanced solution techniques to predicting the behavior of complex chemical processes and systems. He pioneered the application of advanced mathematical techniques to understand the behavior of chemical processes, including chemical reactors, separation systems, polymerization, coal combustion, and atmospheric science. His research led to a deeper understanding of such systems and contributed to their better and safer design and operation. This approach is now widely followed all over the world in education, research, and practice.

Amundson made major contributions in research, education, and academic and professional leadership. He authored more than 200 articles in journals and five books. This research led to many advances in the design and operation of chemical processes. He guided the research of nearly 70 Ph.D. students. He was a most influential mentor, and many of his students achieved prominent positions in universities and industry, such as department chairs, deans, chief executive officer of Exxon Mobil, and members of the National Academies. He served as the U.S. editor of the journal *Chemical Engineering Science* during 1957–1972 and led its establishment as the foremost journal of the profession then. He also served as editor of the Prentice-Hall International Series in the Physical and Chemical Engineering Sciences, from its inception in 1961 until the year 2000.

Amundson had a major impact on changing the techniques and methodology used to tackle chemical engineering problems. His professional leadership roles included chairing the National Research Council committee that prepared the report titled *Frontiers in Chemical Engineering: Research Needs and Opportunities* (1988), which charted new directions and expansions for the profession, such as materials science and bioengineering. Amundson was also a most successful academic leader. He was appointed head of the Department of Chemical Engineering at the University of Minnesota in 1949, at the relatively young age of 33, and remained in that position for the next 25 years, until 1974. With his own brilliant research and the hiring of outstanding faculty members, he transformed the department from relative obscurity to the top-ranked program in the country. He had the vision to foresee that infusion of talent from other disciplines can enrich education and research in chemical engineering. Thus, among his early faculty hires were individuals with a background in microbiology, mathematics, and chemistry, who themselves made enormous contributions to the field. Thus, Amundson was the earliest proponent of interdisciplinary research, so common in universities today. The magnitude of his contributions was recognized by the University of Minnesota when it named the building housing the chemical engineering department as Amundson Hall in 1979. Amundson joined the Department of Chemical Engineering at the University of Houston in 1977 and led to its prominence as well.

During his career, Amundson received a large number of prestigious awards from professional societies, such as the American Institute of Chemical Engineers, the American Society of Engineering Education, and the American Chemical Society. He was elected as a member of many prestigious societies, including the National Academy of Engineering (1970), the National Academy of Sciences (1992), and the American Academy of Arts and Sciences (1992). The International Symposia of Chemical Reaction Engineering named an award in his honor to recognize a pioneer in the field and made him the first recipient in 1996. He also received the NAE Founders Award (1990) and honorary doctorate degrees from the University of Minnesota, the University of Notre Dame, the University of Pennsylvania, the University of Guadalajara, and Northwestern University.

Neal Amundson was born on January 10, 1916, in St. Paul, Minnesota. He earned both a B.S. and an M.S. in chemical engineering from the University of Minnesota in 1937 and 1941, respectively, and a Ph.D. in mathematics from Minnesota in 1945. He married Shirley Dimond on September 25, 1941, who survives him along with their children, Gregg, Beth, and Erik as well as six grandchildren and four great-grandchildren. Among his hobbies was that of raising orchids, and at one time he held one of the largest private collections in the country.



JOHN H. ARGYRIS

1913-2004

Elected in 1986

"For outstanding pioneering and continuing contributions in computer mechanics over a period of more than 30 years."

BY THOMAS J. R. HUGHES, J. TINSELY ODEN,
AND MANOLIS PAPADRAKAKIS
SUBMITTED BY THE NAE HOME SECRETARY

JOHN H. ARGYRIS was a person with great vision, class, and persuasion, who dramatically influenced computational engineering and Science and who will be long remembered as one of the great pioneers of the discipline in its formative years. He passed away quietly on April 2, 2004 after respiratory complications. John rests in peace in Sankt Jorgens Cemetery in the city of Varberg, 60 km south of Goteborg, Sweden, near Argyris's summer house.

John was born on August 19, 1913, in the city of Volos, 300 km north of Athens, Greece, into a Greek Orthodox family. His father was a direct descendant of a Greek Independence War hero, while his mother came from an old Byzantine family of politicians, poets, and scientists, which included the famous mathematician Constantine Karatheodori, professor at the University of Munich.

Volos, as it was during his childhood, remained very much alive in his memory, especially the house he grew up in. He vividly remembered, until the end, details of the room where, at the age 2, he almost died from typhoid fever.

(Note: This article was first published in 2004 in *Computer Methods in Applied Mechanics and Engineering*, Vol. 193, pp. 3763–3766. With the permission of the authors and CMAME, we share it with you here.)

In 1919 his family moved to Athens, where he received his initial education at a classical gymnasium in Athens. After studying civil engineering for four years at the National Technical University of Athens, he continued his studies at the Technical University of Munich, where he obtained his engineering diploma in 1936. Just after graduation he was employed by a private consulting organization working on the leading-edge technical design of highly complex structures. One of these early engineering accomplishments was that of designing a 320m high radio transmitter mast with a heavy mass concentrated at the top.

With the outbreak of World War II, John was in Berlin continuing his studies at the Technical University. Just after the German invasion of Greece, John was arrested and led to a concentration camp, on the accusation of transferring research secrets to the Allies. His savior turned out to be the eminent German Admiral Kanaris, of Greek descent, who arranged his escape by informing the guards that the prisoner would be executed outside the camp. In 1944, Kanaris himself was tragically executed as one of the leaders of the assassination attempt against Hitler. Following his escape from prison, John managed to leave Germany soon thereafter in a very dramatic manner. He swam across the Rhine River during a midnight air raid, holding his passport in his teeth. He managed to reach Switzerland, where he completed his doctoral degree at ETH Zurich in 1942 in aeronautics. In 1943 he moved to England and worked as a technical officer at the Engineering Department of the Royal Aeronautical Society of London.

John could never derive any pleasure in ordinary day-to-day work and was only attracted to problems that seemed unsolvable. Even when working in industry, his directors soon realized that the best policy toward John Argyris was to entrust him with intractable problems. At the same time he was fascinated by the properties of triangular and tetrahedral components that appeared to him as ideal elements to build up an engineering system. He could never sympathize with Cartesian analytical geometry that he found most inelegant. During the war, he wrote three classic papers in *Reports and*

Memoranda of the then Aeronautical Research Council. These were concerned with the diffusion of loads into stringer-reinforced stressed skin structures of wings and fuselages. He developed a theory using his intuition that combined differential equations and finite difference calculus that was immediately successful and later confirmed by experiments and applied with great success to British fighter and bomber aircraft during the war. However, the real breakthrough in his way of thinking and approach to technical problems of solid mechanics was achieved when the first electromechanical computing devices emerged in 1944 in Britain at the National Physical Laboratory and in the United States at Harvard University.

In those days aeronautical engineers were trying to build the first combat jet aircraft whose speed required swept-back wings. One such example was the flawed German fighter ME262, proof of its designers' failure to develop a reliable method of analyzing the nonorthogonal geometry of wings. In August of 1943 John spent three whole days and nights in a bold attempt to solve that particular problem. His only help was a rudimentary computing device capable of solving a system of up to 64 unknowns. It took one sudden moment of clarity, on the third evening of his brainstorming session for him to realize that the answer could be the application of triangular elements. Here his dislike of orthogonal Cartesian geometry found an ideal field. Astonishingly enough the deviation from preceding experimental test results proved less than 8 percent. This was the birth of the matrix force and displacement methods, the finite element method, as later named. Immediately, all publications on this method were declared secret. Within the triangular element philosophy, John did not use Cartesian direct and shear stresses and strains, but a novel definition of stresses, expressed in terms of these direct stresses and strains, measured parallel to the three sides of each triangle. This new definition of stresses and strains led to the formulation of the Natural Approach, which possessed great computational advantages and allowed a simple and elegant generalization to large displacements.

In 1949 John joined the Imperial College of the University of London as a senior lecturer and in 1955 became a full professor and director of the Sub-department of Aeronautical Studies until 1975. After becoming an emeritus professor he continued his collaboration with Imperial College as a visiting professor until 1980. In 1959 he accepted an offer from the University of Stuttgart and became director of the Institute for Statics and Dynamics of Aerospace Structures. He created the Aeronautical and Astronautical Campus of the University of Stuttgart, a focal point for applications of digital computers and electronics. After becoming an emeritus professor at the University of Stuttgart, he continued to work until the age of 88 with the same vigor, writing books and scientific papers with a compelling vitality and creative thinking.

In 1956 John addressed the problem of stress analysis of aircraft fuselages with many cut-outs, openings, and severe irregularities. Computers then were not capable of enabling a global application of the finite element method. John, again following his intuition, realized that the problem could be solved by a new physical device involving the application of initial stresses and strains and an extension of matrix methods to a higher level. This was presented at the International Union of Theoretical and Applied Mechanics (IUTAM) Congress in Brussels in 1956 and created a great upheaval, because the whole derivation involved only 20 lines of physical argument and four lines of advanced matrix algebra. Most experts in the United States and Europe said that the theory must be wrong on the grounds of its simple derivation, and they did not even accept the evidence of the computational results obtained by John that proved the correctness of this derivation. Somewhat later, however, a Ph.D. thesis from Sydney, Australia, was sent to John in which the candidate proved in 124 pages of close mathematical argument that the formula of John Argyris was indeed correct. This approach was also extensively applied to the design of the Boeing 747 as early as 1960. In the 1960s and 1970s John had applied the finite element method with great success in aerodynamics, optimization, combustion problems, nonlinear mechanics and other fields of research and industrial interest, among them the suspension roof of the Munich Olympic Stadium in the late 1960s. Around that period the National Aeronautics and Space Administration (NASA) sought his knowledge on the thermal shielding of the Apollo spacecraft. He suggested covering the fuselage with specially formulated substances that, upon reentry into the atmosphere, would evaporate and cool its surface. In 1976 John was concerned with the theory of chaos and introduced these theories in studying the turbulence flow around the European space vehicle *Hermis*.

It is difficult to summarize the impressive accomplishments of John Argyris. Among his writings were over 10 books, including three important textbooks: *Introduction to the Finite Element Method,* Vols. I, II and III, (1986–88); *Dynamics of Structures* (1991), *An Explanation of Chaos* (1994). The latter was printed in English and German and in Germany alone was published three times in one year, a rare achievement for a scientific publication of this kind. In addition to these writings, he published over 500 extended scientific articles in major international journals and lectured extensively both within Europe and abroad. His textbooks and extensive journal publications are essential reading material for students, practicing engineers, and researchers around the world and have become benchmarks for later treatises on computational mechanics.

One of his most important contributions in the engineering community was the founding and editorship of the journal *Computer Methods in Applied Mechanics and Engineering,* a publication that has provided much of the lifeblood of computational methods in applied mechanics and engineering for more than three decades. John Argyris took great interest and pride in this venture and insisted on running the journal meticulously and diligently, thus succeeding in making it one of the leading journals in computational mechanics available today.

John received many honors including 18 doctorate degrees, "Honoris Causa," three honorary professorships and six academy memberships from universities and academies all over the world, and more than 25 other awards and distinctions, among them the Gauss–Newton Award from the International Association for Computational Mechanics (IACM), the von Karman Medal from the American Society of Civil Engineers (ASCE), the Timoshenko Medal from ASME, the Laskowitz Gold Medal from the Academy of Science of New York for "the invention of the Finite Element Method," the Prince Philip Gold Medal of the Royal Academy of Engineering, the Grand Cross of Merit of the Federal Republic of Germany, and the Einstein Award from the Einstein Foundation for his "momentous work on the Finite Element Method and Chaos Theory." He was also a fellow of the Royal Society of London, honorary member of the Executive Council of IACM, and honorary president of GACM.

John was blessed with many talents, making him a true modern Renaissance man; he was a scholar, a thinker, a teacher, a visionary, an orator, an elegant writer, a linguist. Deeply cultivated, a man with rare principles and a passionate patriot, he was also unique in blending his Mediterranean temperament with Western European rationalism.

In the paper that coined the name "Finite Element Method," published in 1960, the world-renowned author Ray Clough refers to the finite element method as "the Argyris Method." Von Karman's prophetic statement that Argyris's invention of the finite element method entailed one of the greatest discoveries in engineering mechanics and revolutionized our thinking processes more than 50 years ago was proven to be absolutely true. Indeed, the finite element method, based on John Argyris's fundamental and far-reaching contribution, has truly revolutionized today's engineering and scientific environments. He had the vision and intellectual capacity to develop the basic steps of the finite element method and to make numerous contributions in the development of the method. His early work "Energy Theorems of Structural Analysis," published in 1954, is considered to be the most important series of papers ever published in the field of structural mechanics.

During the early years at Imperial College he met his wife Inga-Lisa, who provided him with unshakable support throughout all the difficult moments of his life. John was also fortunate to see his son Holger follow a successful career in engineering and bring into the world, with his wife Carina, two adorable grandchildren who brightened his final years.

John, in accordance with Herakleitos's aphorism of "everything flows," has joined the pantheon of those enlightening personalities who, with their revolutionary ideas and contributions, changed the scientific world in the 20th century. His geometrical spirit, the elegance of his writings, his deep appreciation and understanding of classical ideas, his creativity, and his epochal vision of the future initiated and defined the modern era of engineering analysis and set us all on life's path of discovery. Our computational mechanics community has lost the most eminent member and for many of us a devoted friend. He will be deeply missed, but his legacy will empower generations.

HOLT ASHLEY

1923–2006

Elected in 1970

"For contributions to the field of aeroelastic structures and unsteady aerodynamics, aiding in the solution of problems in vibration and gust loading."

BY BRIAN J. CANTWELL AND GEORGE S. SPRINGER

HOLT ASHLEY, professor emeritus of aeronautics and astronautics and of mechanical engineering at Stanford University, whose methods changed the design of structures from wings to wind turbines, died on May 9, 2006, at the age of 83.

His contributions were diverse and multidisciplinary. While he is known for his pioneering research and books in the field of aeroelasticity—the combination of aerodynamics and structures—he wrote classic textbooks in aerodynamics and aircraft engineering as well.

Professor Ashley served on committees and advisory boards of NACA, the National Advisory Committee for Aeronautics, the predecessor of the National Aeronautics and Space Administration; NASA itself; the Air Force; the Navy; and the National Research Council as well as of the aerospace industry. From his work on the NACA subcommittee on vibration and flutter to a review of space-shuttle tile safety, Holt Ashley applied fundamental approaches to a wide area of practical engineering problems.

Professor Ashley was elected to the National Academy of Engineering in 1970.

Holt Ashley was born January 10, 1923, in San Francisco. His father Harold had served in World War I and was a prominent businessman by the time World War II broke out. Nonetheless, he reenlisted. The younger Ashley felt intense guilt that it was his father and not he who was serving and took leave from the California Institute of Technology, where he had been a sophomore, to join the Army Air Corps. After training at the University of Chicago where he earned his undergraduate degree in meteorology, he served in the war as a weather forecaster and reconnaissance officer flying with squadrons over the North Atlantic and Europe. The experience spawned his first paper "Icing in North West Europe" and earned him six military medals. Professor Ashley was 6 feet 8 inches tall, a height that prevented his acceptance as a pilot during World War II. Shortly after joining Stanford in 1967, he achieved his dream by obtaining his pilot's license.

After earning his master's degree (1948) and doctoral degree (1951) in aeronautical engineering from the Massachusetts Institute of Technology, Holt Ashley rose through the faculty ranks at MIT to become associate professor in 1954 and full professor in 1960.

In 1964 he helped establish the Department of Aeronautical Engineering at the Indian Institute of Technology in Kanpur, India, and served as the first head of the department. He taught there during the very first year of the institute, wrote a classic book, and inspired a generation of young Indian engineers. He maintained good relations with his former students and colleagues in the decades after leaving the department. One of the young Indian engineers whom he inspired was his colleague in the Department of Aeronautics and Astronautics, Professor Sanjiva Lele, who was a graduate of ITT Kanpur and the department that Holt Ashley helped to found.

Ashley returned to his native California in 1967 to join Stanford University as a professor in the Department of Aeronautics and Astronautics. His students remember him as a patient mentor whose door was always open and whose meticulous lectures were models of clarity. He was extremely supportive of minority students, including African Americans, and vigorously encouraged them in their studies. He also was passionately committed to fairness in the promotion of the careers of women in academe. He wrote an angry letter to one of the national committees on which he served in protest against the repression of the career of a woman scholar and threatened to boycott any further meetings until there was a change of heart. He wrote a letter in protest against the treatment of the Chinese American scientist Wen Ho Lee, who was falsely accused of stealing nuclear secrets on behalf of the People's Republic of China while employed at Los Alamos National Laboratory providentially the day before all but one charge was dropped, so his letter was not actually sent, though it was signed by both Professor Ashley and his assistant at his request.

After the death of his wife, Frances Day Ashley, his social life centered on his affiliations with the Bohemian Club of San Francisco, of which he was a member from 1962. He enjoyed the camaraderie of his fellow Sundodgers (one of the camps at the Bohemian Grove in Northern California), and all of the social, literary, and cultural activities of the club. He also liked to invite his colleagues in the Department of Aeronautics and Astronautics to join him at events that took place in the magnificent setting of the Bohemian Club in San Francisco and at the Bohemian Grove encampment near the Russian River.

Besides his involvement with the Bohemian Club, he also served on the board of the civic association for the Town of Woodside. He was very much involved in the study of the impact that expansion of the runways at San Francisco International Airport would have through increased noise over the Bay Area and his community.

Professor Emeritus (Research) Richard Christensen recalled a visit to Holt Ashley, who had been bedridden for some time, a week before his death. Professor Ashley said to him, "Please tell your lovely wife hello," not goodbye. The spirit of thoughtfulness and grace toward others that had always characterized his professional and social life he maintained to the very end of his life.

His one vice was his fondness for cigars. When Stanford

University instituted an antismoking policy inside university buildings, he found it necessary most afternoons after teaching his classes and meeting with his students to retreat to a small company on whose board he sat near California Avenue in Palo Alto so that he could smoke his cigars to his heart's content.

He had a tremendous sense of humor. At the end of a committee's first meeting he would make a motion to terminate the committee to stimulate the discussion that would test its worth. With Bob Halfman, one of his coauthors, he formed a consulting company to work on aircraft design—they called it Half-Ash Aeronautical Consultants.

Professor Ashley became emeritus in 1989. The former Aero/Astro Chair George S. Springer, the Paul Pigott Professor of Engineering, observed that Professor Ashley took early retirement to enable the department to hire new young faculty. He then proceeded to carry a full load of teaching and research for the following years without pay until a couple of years before his passing.

Holt Ashley's honors include the 2003 Daniel Guggenheim Medal, which is jointly sponsored by the American Institute of Aeronautics and Astronautics (AIAA), the American Society of Mechanical Engineers, and the Society of Automotive Engineers, and the 2006 Reed Aeronautics Award of the AIAA, two of the highest awards in aeronautics and astronautics. It was with great sadness that his physical decline was such that he was unable to attend the annual meeting of the AIAA and ceremony, where the latter award was to have been presented to him acknowledging that he had scaled the pinnacle of achievement in his discipline.

He was a man totally without guile and ill will toward any. He relished the opportunity to nominate colleagues for recognition and awards in the several prestigious professional societies of which he was himself a member, including the National Academy of Engineering and the American Academy of Arts and Sciences. Many of his colleagues benefited from the weight his own professional recognition brought to bear in their behalf through his championing of their professional advancement. Holt Ashley will forever be remembered in every respect as a gentleman and a scholar.

His work has been published in about 100 journal articles and five books: *Aeroelasticity*, *Thickness and Boundary Layer Effects*, *Principles of Aeroelasticity*, *Aerodynamics of Wings and Bodies*, and *Engineering Analysis of Flight Vehicles.*

He is survived by his sister, Joan Ashley Ennis, and his nephews, Ashley Ennis and Holt Ennis. His sister wrote, "We shall never stop loving him."

KERMIT EARL BROWN

1923–2009

Elected in 1987

"For exceptional teaching of university and industry courses and the promotion of cooperative oil and gas drilling and production research."

BY JAMES BRILL

KERMIT EARL BROWN, professor emeritus of petroleum engineering at the University of Tulsa (TU) and one of the world's foremost experts on the production of oil and gas, passed away on December 10, 2009, at the age of 86.

He built his career around innovative ideas, applied research, and industry solutions. But Kermit's love of teaching drove everything he did. Because of his passion for knowledge and his commitment to mentorship, many of his students have become the petroleum industry's top executives and researchers and have propelled the industry to new heights.

Kermit was elected to the National Academy of Engineering in 1987 and was named a Legend of Production and Operations by the Society of Petroleum Engineers *Journal of Petroleum Technology* in 2009.

Known for his West Texas folksy demeanor, Kermit was born on a cotton farm in Haskell, Texas, on November 2, 1923. His small high school did not offer enough science and math to enroll in the local junior college, so Kermit taught himself from textbooks and passed the entrance exams on his own. Like many young men in the 1940s, he interrupted his schooling to serve his country, enlisting in the Army Air Corp where he became a World War II reconnaissance pilot flying in Europe.

When Kermit returned from the war, he accomplished two milestone achievements: he married Katherine Bunkley Brown in 1945 and enrolled at Texas A&M University, where he earned two bachelor of science degrees in mechanical engineering and petroleum engineering in 1948.

After graduation, he joined Stanolind Oil & Gas Company (changed to Amoco, and now BP America Production Company) as a petroleum engineer. He then worked for Garrett Oil Tools, Inc. (now part of U.S. Petroleum Equipment, a division of U.S. Oil Company, Inc.) and was a research engineer for the U.S. Atomic Energy Commission. But he felt a calling to expand his scholarship and enrolled at the University of Texas (UT) in 1955 as a teaching assistant and graduate student. He earned both his master's and doctoral degrees from UT and conducted groundbreaking field research that had a long-term influence on the field of artificial lift engineering.

In 1965, as an evaluator for ECPD (Engineers' Council for Professional Development), now ABET (Accreditation Board for Engineering and Technology), Kermit visited TU to evaluate its petroleum engineering program. At that time the department did not have a full-time chairman, and Dr. E. T. Guerrero served as both dean and chair. Kermit criticized TU in his report for not having appropriate leadership in its petroleum program. When Guerrero read his comments, he asked Kermit: "Why don't you provide the leadership?" Kermit took Guerrero up on the challenge and arrived at TU in early 1966 as chairman of the petroleum engineering (PE) department.

It is not an exaggeration to say that Kermit's arrival changed the PE department at the University of Tulsa forever. He was a bold visionary and a risk taker. In 1966, TU had only three full-time faculty members, fewer than 50 undergraduate students, a fledgling Ph.D. program, and no funded research. Kermit's first order of business was to initiate a research model that is now mimicked by many other universities. He developed the idea of forming a research consortium, where oil companies contribute a small amount of money every year to the university, and TU faculty and students conduct research that is of interest to the industry.

This allowed TU faculty to be grounded in what industry wanted and reduced the petroleum department's pursuit of government funding for research. At that time it was a radical concept, and not a single petroleum engineering program in the United States had a research consortium. Under his leadership, TU started its first consortium—Tulsa University Drilling Research Projects—in 1966. Kermit established the new research consortium on TU's North Campus, which housed a full-scale indoor drilling rig donated to the university by Standard Oil Company of New Jersey (now ExxonMobil).

Today, TU's North Campus has 13 different consortia and joint industry projects covering various aspects of petroleum engineering, unique experimental facilities, and a worldwide reputation of conducting applied research.

With the research program established, Kermit turned his attention to increasing the quantity and quality of the undergraduate student body. He created the Petroleum Engineering Undergraduate Honors Program, which provided scholarship funding to deserving students and was sponsored by the petroleum industry. He traveled around the region presenting engineering seminars to high schools and recruiting the best and brightest students. Many of those early TU scholarship recipients went on to become chief executive officers, presidents, and vice presidents of major oil and gas producing and service companies or created their own successful independent oil and gas companies.

Because of its reputation for applied research and quality students, the petroleum engineering program at TU has been consistently ranked among the top five petroleum programs in the nation.

Kermit's reputation in research led to his appointment as TU's vice president of research in June 1968. But the pull of the classroom was too much, and after serving as VP for three years, he returned to teaching until he retired in 1987.

Even in retirement, Kermit found ways to reach out to a new category of students. He taught short courses around the world on his favorite industry topic—artificial lift. Wherever he taught, he was always selling TU, and his classes outside the United States often brought international students into the TU graduate program. TU now has a booming international student body, which can often be traced back to Kermit's relationship building overseas.

His indelible love of teaching brought him back to TU in his early 80s, when he volunteered to teach an undergraduate course, without compensation, for four semesters. The students loved his teaching and would wait outside Keplinger Hall, where the petroleum engineering classes were held, and offer to carry his briefcase and books to the classroom. He could often be seen in his office mentoring students after class and gently guiding them through the concepts.

Kermit's remarkable career also brought him a great deal of recognition. The Society of Petroleum Engineers presented him with several of its international awards, including Distinguished Lecturer, John Franklin Carll Award, and Legend of Production and Operations Award. He also received many outstanding teaching awards, including his induction into the Oklahoma Higher Education Hall of Fame. In 1987 he received the ultimate recognition for an engineer, membership in the U.S. National Academy of Engineering.

As the man who made TU a multimillion-dollar petroleum research resource and the teacher who inspired multiple generations of energy industry leaders, Kermit Brown has left TU a lasting legacy for which the university's alumni, faculty, students, and consortia members are forever grateful.

His daughter, Sandra Kay Brown Paschal, wrote: "Besides teaching and travelling, our father was an avid skier." He is survived by his wife, Katherine; his son Stephen Wesley Brown and his wife, Peggy Brown, of Skiatook, Oklahoma; his daughter Sandra Kay Brown Paschal and her husband, Wade, of Tulsa; his son Robert Michael and his wife, Lisa, of Austin, Texas; and his son David Earl Brown of Tulsa. Kermit had eight grandchildren: Stephen and Bryan Brown; Trey Paschal; Katherine Fulda and Nikola Paschal; and Jessica, Melissa, and Michelle Brown. He had four great-grandchildren.

PRAVEEN CHAUDHARI

1937–2010

Elected in 1988

"For contributions to the field of materials science and engineering and to the advancement of electronic materials."

BY MERTON C. FLEMINGS

PRAVEEN CHAUDHARI, an innovator in the field of thin films and high-temperature superconductors, died on January 13, 2010, at his home in Briarcliff Manor, New York. Dr. Chaudhari joined IBM in 1966 and became vice-president of science in 1982. After retiring from IBM in 2003, he became director of Brookhaven National Laboratory, a position he held until 2006.

Praveen was born on November 30, 1937, in Ludhiana, India, where he lived through the scarring times of the Indian partition and witnessed the bloodshed of the 1947 riots. Sent to boarding school, reputably because of his tendency to go fishing during school hours, he began his path to a professional career. In 1961 he received his bachelor's degree in metallurgy from the Indian Institute of Technology, in Kharagpur, and then in 1966 his doctoral degree in metallurgy from the Massachusetts Institute of Technology. His thesis topic, under advisor Michael Bever, was on irradiation defects in bismuth telluride.

Praveen then embarked on a 37-year career at IBM Research in Yorktown Heights, New York. He quickly became a source of inspiration to researchers there in many areas of thin-film physics. He was a crucial contributor to IBM's product development activities. During the 1970s, while working with others, he developed the amorphous gadolinium cobalt films that were integrated into IBM's magnetic bubble devices and later served as the basis for read-write media for the magneto-optic disk industry. In recognition of that development, he and his coinvestigators were awarded the National Medal of Technology in 1995.

Appointed vice president of science in 1982, Praveen shaped the evolution of IBM's science research programs in the 1980s while continuing his own productive research career. During the early years following the high-temperature superconductivity discovery, he carried out his executive duties during the day while working in his laboratory in the evenings. His team made a number of important contributions to the field, including the growing of yttrium barium copper oxide crystals with current densities two orders of magnitude greater than those previously obtained.

In 2003, Praveen retired from IBM and became director of Brookhaven National Laboratory. He put the laboratory on a firm foundation of stability and growth. His vision led to new initiatives for the laboratory, including establishment of its Center for Functional Nanomaterials. Praveen stepped down as laboratory director in 2003, joined Columbia University as adjunct professor, and returned to his old laboratory at IBM in Yorktown, where he could often be found running experiments. He remained active in his research until a few months before his death.

Praveen was deeply involved in science and technology policy. He was elected to the National Academy of Engineering in 1988. He was co-chairman of the National Research Council Committee on Materials Science and Engineering (1985–1989). This study was the basis of a presidential initiative in advanced materials and processing programs, announced by the White House in January 1992. He served on the U.S. National Critical

Technologies Panel (1992–1993) and advised the government of India on science and technology policy.

For his achievements, Praveen was honored with a number of awards. In addition to the National Medal of Technology, these included the Institute of Electrical and Electronics Engineers Morris N. Liebmann Memorial Award (1992) for "the discovery of amorphous magnetic films in magneto-optic data storage systems," now the foundation of the worldwide magnetic-optic disk industry; the American Physical Society's George E. Pake Award (1987) for personal contributions to science and science management; and the Excellence Award of the U.S. Pan Asian American Chamber of Commerce. Praveen was a fellow of the American Academy of Arts and Sciences and a member of the National Academy of Sciences.

Praveen was also a gifted leader who moved easily in the worlds of science, engineering, and policy. He was quiet but determined, demanding but understanding. His scientific and technological enthusiasm was infectious. He remained a gentleman to the end.

He is survived by his wife, Karin; his son, Ashok; his daughter, Pia; his sister, Neera Sahgal; and his two brothers, Shiv Chaudhari and Deepak Chaudhari.

AARON COHEN

1931–2010

Elected in 1989

"For technical leadership and engineering achievements in manned spaceflight systems."

BY JOHN L. JUNKINS

AARON COHEN, former director of the Johnson Space Center and pioneer of the Apollo and Space Shuttle programs, died February 25, 2010. Aaron was born to Russian immigrant parents, Charles and Ida Cohen, on January 5, 1931, in Corsicana, Texas. His family moved to San Antonio when he was 5. At 16 he met his future wife, Ruth, then 14. They married in 1953 and shared a 57-year marriage that was richly fulfilling. Aaron and Ruth lived the American Dream.

In 1949, Aaron enrolled at Texas A&M University, where he earned a bachelor of science in mechanical engineering in 1952; upon graduating and following completion of his ROTC military obligation, including a tour of duty in Korea, Aaron began his engineering career at the Radio Corporation of America in 1954. There he contributed to the development of a magnetron tube, which would be the heart of a revolutionary new kitchen appliance, which we all know and own today as the microwave oven. Along with two colleagues at RCA, Aaron was also awarded a U.S. patent for innovations in a cathode ray tube design for color television.

Three life-changing events occurred during the four years that Aaron was employed at RCA. It was during this period that he and Ruth became parents. His daughter, Nancy, was born in 1956 and his son, David, in 1958. While working full-time, Aaron completed a master of science in applied mathematics from Stevens Institute of Technology, in Hoboken, New Jersey, in 1958. In October 1957 the Russians launched *Sputnik I*, ushering in the space age. Aaron knew that this was the beginning of the space age, and he wanted to be involved.

In 1958, Aaron and his family moved to San Diego, California, where he worked for General Dynamics on the Atlas and Centaur programs. His son, Daniel, was born there in 1960. When President Kennedy and the National Aeronautics and Space Administration (NASA) announced the Apollo program to send men to the Moon, Aaron could not resist the opportunity and challenge to join the effort. Aaron and his family moved to Houston in 1962 to launch his storied career at NASA. He began contributing significantly during the early 1960s and soon was playing key leadership roles in the Apollo mission that landed men on the Moon in July 1969.

Stevens Institute of Technology awarded Aaron an honorary doctor of engineering in 1982, and in 2010 Texas A&M University conferred on Aaron an honorary doctor of letters. Aaron was elected a fellow of the American Association for the Advancement of Science and an honorary fellow of the American Institute of Aeronautics and Astronautics (AIAA). In addition to election to the National Academy of Engineering, Aaron won numerous honors over his career, including the AIAA von Karman Lectureship, the AAS Lovelace Award, and twice was named NASA Engineer of the Year, in 1982 and 1983.

Aaron had a remarkable career at the Manned Spacecraft Center, later renamed the Lyndon B. Johnson Space Center. He was manager of the Command Module for the Apollo program and later led the Shuttle Orbiter Project; he also served as director of research and engineering at JSC. In 1986, after seven astronauts died in the explosion of the Space Shuttle *Challenger*, he was named director of the Johnson Center.

During that uncertain period, his leadership was crucial in rebuilding confidence in the organization and the technology and eventually getting Americans back in space with successful Space Shuttle flights resuming in 1989. He remained director of the Johnson Space Center until his retirement in 1993. In his last year with NASA, Aaron also served as acting deputy administrator at NASA headquarters in Washington, D.C.

During his career he experienced great tragedy and also incredible success. He never forgot the lessons learned from the tragedies, and he was always quick to share successes with his colleagues. The significant pioneering roles that Aaron played in the historic *Apollo 8, Apollo 11,* and *Apollo 13* missions provided the reference frame for his technical and managerial leadership during the Space Shuttle and Space Station programs from the early 1970s until his retirement in 1993. The Space Shuttle was Cohen's "baby," his wife Ruth said. Aaron's leadership and technical competence were the keys to the Shuttle program; he took great pride in NASA's recovery from *Challenger* and in the 14 years of nearly flawless Shuttle missions interrupted by the *Columbia* tragedy in 2003.

We record here brief tributes from a few colleagues and friends well positioned to appreciate Aaron's many contributions:

NASA Administrator Charles Bolden said Cohen was one of his earliest mentors and praised him as being instrumental in the success of human spaceflight. It is clear that Aaron's blend of technical expertise, experience, judgment, and "calm leadership ability when the chips were down" were unique and vital attributes: "His engineering expertise and rigor were tremendous assets to our nation and NASA," Bolden said. "Aaron provided the critical and calm guidance needed at the Johnson Space Center to successfully recover from the *Challenger* accident and return the Space Shuttle to flight. We will miss him as a colleague, mentor and a friend."

Michael L. Coats, the Johnson Space Center's current director, wrote in a message to employees announcing Cohen's death that Aaron Cohen's efforts had been critical to the successes of all six American lunar landings. He was a leader in the space program for more than three decades, “with scientific and programmatic experience that is unparalleled,” Mr. Coats wrote.

“He would be the individual you would try to duplicate in every program manager that you have at NASA,” said Christopher Kraft, Cohen’s friend, colleague, and supervisor at NASA. “I think Aaron was one of those people who was the ideal man for the job, and I think that anybody who tries to do it in the future ought to do it like he did it.”

“He was the one person at the Johnson Space Center responsible for the design, development, tests, and the funds—the budget of the Shuttle—from the time it started to the time it flew,” Kraft said. “Everybody looked up to Aaron and everybody had the highest regard and respect for him throughout the government and the aerospace industry, and that’s what made the Shuttle project go as well as it did.”

While Aaron led a busy and frequently hectic life with the leadership roles throughout his career, he was a loving husband and father. He was extremely disciplined and focused on his work, but he always carved out time to be with his wife, Ruth, and their three children. “He had a routine of putting in 12- and 14-hour days,” Ruth said. “He worked on Saturday until maybe 1 o’clock, and then he put it away until Sunday evening. So Saturday afternoon until Sunday evening was our family time.”

Ruth wrote that he won the Texas State High School Tennis Tournament in 1948; he taught their sons to play tennis and each played on high school and college teams, as he had done. He took great pride and pleasure in accompanying his granddaughter, Ariela, to national tennis tournaments and then seeing her serve as captain of the women’s tennis team at Lehigh University. He and I enjoyed fabulous trips both at home and abroad, and one of our great pleasures was taking grandchildren on special trips, two cousins at a time.

Following his retirement from NASA in 1993, Aaron and Ruth moved to College Station, Texas, where Aaron started a new career, as a professor of mechanical engineering at his alma mater, Texas A&M University. Aaron taught design for a decade and was a favorite of the mechanical engineering students privileged to study under his direction. “He loved teaching,” Ruth Cohen said. “The young people were just so interesting for him to work with, and he just took to teaching like a duck takes to water.” One of Aaron’s proudest moments came in January 2010, when Texas A&M President Bowen Loftin and many friends and family came to his home to witness President Loftin confer on Aaron the doctor of letters degree, a rare and most meaningful honor to crown his career.

Following his death on February 25, 2010, in College Station, Aaron was buried in San Antonio. He is survived by his wife, Ruth; children Nancy, David, and Daniel; and nine grandchildren. The Aaron Cohen Engineering Scholarship has been established at Texas A&M in his honor.

CHARLES CONCORDIA

1908–2003

Elected in 1978

"For contributions in the field of analysis of rotating equipment and power systems performance, control, and reliability."

BY PAUL DE MELLO

CHARLES CONCORDIA, one of the world's best-known power systems engineers, passed away in Venice, Florida, on Christmas night 2003 at the age of 95.

In July 2003, I was the recipient of the Charles Concordia Power Systems Award, an award sponsored by the General Electric Company in honor of one of its greatest engineers, Charles Concordia. "Charlie," as he was known, presented the award himself—an act of unusual dedication since at that point in his long career he was almost completely blind. He was assisted by his nephew and namesake, who accompanied his uncle.

At that meeting in Toronto, Charlie also addressed the Institute of Electrical and Electronics Engineers (IEEE) Power Engineering Society's System Dynamic Performance Committee, and he did so with great clarity, touching on the major milestones achieved by the power industry in the past century.

Charles Concordia was born in Schenectady, New York, on June 20, 1908, the youngest of three brothers. His father was a music teacher who imbued the family with music skills and appreciation. The family lost their father when Charlie was 6, after which he and his brothers grew up in a one-parent family with all the struggles this implies. Charlie was uncommonly interested in science and mechanical gadgets as a child, particularly radio and TV in their embryonic years. He became a young radio ham at a time when rectifiers were connected to bedsprings and communication was in code. Charlie also built a crude TV set before graduating from high school.

While still in high school he earned a living doing sundry jobs, including collecting bills. He also supplemented high school work with evening courses and by tutoring mathematics to Union College students many years his senior.

In 1926, at the age of 18, convinced he knew more than many college professors, he gave up college in favor of a job with General Electric at its Schenectady laboratories. His unusual talent was quickly recognized, and his supervisors encouraged him to take additional courses of his choice at Union College.

At the GE labs he worked in instrumentation development, magnetic materials testing, and even wind measuring equipment. After four years of lab assignments, Charlie enrolled in GE's advanced engineering course, a program offered to only the most promising college graduates after they had finished the GE test engineering program. In that program advanced engineering theory was honed to the rigors of the real world. He was one of nine students selected to complete the three-year course out of an initial group of 30. This was at the beginning of the 1929 Great Depression, when many young engineers were let go.

In 1934 he joined General Electric's Central Station Engineering Department (later called Electric Utility Engineering Department) in Schenectady's Building 2. This group of engineering luminaries, first led by Dave Jones and later by Sel Crary, was at the forefront of international power systems engineering. It was full of challenges in the broadest definition of systems engineering, including its electrical, mechanical, and control dimension—challenges that extended from power generation to transmission, distribution, and utilization.

Because of his unusually keen insight into complex technical problems, Charlie was in constant demand by various GE manufacturing departments, to tackle first-of-a kind problems in protection, control, and reliability.

World War II brought special research and development demands, particularly for generators and turbines for naval vessels and superchargers for airplanes. Charlie's expertise led to innovations in the early use of electric drives for ships.

In the 1940s, Charlie Concordia undertook some of his most important work—that is, pioneering the analysis of synchronous and induction machines and their effect on system stability. These contributions took advantage of the subsequent rapid progression in analytical tools, beginning with analog system models (network analyzers) and mechanical differential analyzers, which later gave way to the exploding power of digital computation technology. These contributions fostered successful networking and interconnection of U.S. electrical power systems.

In 1951 he published his book, *Synchronous Machines: Theory and Performance* (John Wiley & Sons), which remains a basic reference on the dynamic performance of rotating machinery.

His contributions to professional societies, both U.S. and international, are too numerous to cite in their entirety. In 1940 he served as chairman of the American Institute of Electrical Engineers (AIEE; predecessor to the Institute of Electrical and Electronics Engineers, IEEE) subcommittee on large-scale computer devices. In 1947 he chaired the first committee on computing devices, which eventually evolved into the IEEE's Computer Society.

Charlie published 130 technical papers, was awarded six patents, and was granted an honorary doctorate of science degree from Union College in 1971 and another from Iowa State University in 1993. He retired from General Electric in 1973 but continued consulting to companies worldwide and continued his contribution to technical societies.

Charlie was a member of the U.S. National Committee of CIGRE, served as chairman of the CIGRE Committee on Power System Planning and Operation for nine years, and was made an honorary member of CIGRE, having attended its biennial meetings in Paris for several decades, including the 2002 session at age 94.

He received many awards, including the 1942 GE Coffin Award for contributions to the analysis of wind tunnel drives; the 1961 AIEE Lamme Medal for achievements in the development of electrical machinery; the 1973 GE Steinmetz Award for technical achievement; the 1984 IEEE Centennial Medal for contributions to the Electric Power Discipline; the 1989 U.S. CIGRE National Committee Phillip Sporn Award for career contributions to the achievement of the concept of system integration in the theory, design, and operation of large high-voltage power systems; the 1992 Power-Life Award for contributions to the harmonious development of man and environment; and the 1999 IEEE Medal of Honor for outstanding contributions in power system dynamics.

I worked with Charles Concordia for 14 years in the Analytical Engineering Section of the Electric Utility Engineering Operation at General Electric in Schenectady. As their lead consultant, he was always available to give sound advice on approaches to problems. He was a great teacher and had an amazing ability to get to a problem's essentials with his powerful "back of the envelope" approach, which quickly gave him the expected range of answers.

He was also an outstanding mathematician and delighted in the pursuit of mathematical riddles. From him I learned about such things as the Golden Ratio and Fibonacci Series. His confidence, as a consultant, came from his being a self-learner.

During the late 1950s and 1960s Charlie was famous for being the only owner of a Silver Cloud Rolls Royce in Schenectady.

Behind every great man there usually is a great woman. In 1948 Charlie married Frances Buttler, who predeceased him at age 88 in June 1988. They were married 53 years, and her passing was a major blow to Charlie. His nephew, Chuck, who lived in Boston helped him greatly after Fran's death and into the last years of his life. Chuck shared these additional tidbits with me that give another dimension to Charlie's personality:

Charlie loved to travel, he hiked all the peaks in the Adirondacks, and on his last trip to Paris he walked every street and described them vividly even though he could no longer see well. He went to Hawaii in the 1930s, visiting the islands by small boat and walking the islands a week at a time.

Charlie knew French like a native; the hotel clerk said he sounded like he came from South France. He could converse in at least six other languages and knew greetings and phrases in 10 or more languages.

He could quote from the Bible and had read it in Greek to understand it better.

He knew Shakespeare in the same detail as the Bible. He quoted poetry on any subject.

Charlie and his two brothers had a great interest in photography, both in taking pictures and developing them.

He would try eating anything from mushrooms in the woods to various kinds of worms and bugs. In his young days he varied his weight from 120 to 160 pounds to see what "felt" better. He also tried sleeping from 2 to 10 hours a night to find the ideal night's sleep.

We salute Charlie for an exceptionally gifted and giving life on earth. For those with strong beliefs in eternity of the spirit, I share a quote from Tagore, the famous Bengali poet-philosopher: "Death is not extinguishing the light but putting out the candle because the dawn has come." And another quote from Rossiter Raymond: "Life is eternal and love is immortal and death is only a horizon, and a horizon is nothing save the limit of our sight."

I thank Dick Schulz, Ed Owen, and Virginia Sulzberger for their help in supplying information on Charles Concordia's life.

ALFRED JOHN EGGERS, JR.

1922–2006

Elected in 1972

"For contributions to experimental and theoretical research in supersonic and hypersonic aerodynamics and in aerospace vehicle technology."

BY GLENN BUGOS AND WALTER VINCENTI

AL EGGERS was one of the brightest lights in the Ames group that pioneered hypersonic aerodynamics in the 1950s and enabled the technology for all reentry vehicles. A brilliant theorist, Eggers also validated his ideas by building significant experimental facilities. He led the teams that forged the theoretical and empirical basis for lifting-body reentry vehicles, presaging the Space Shuttle, and of hypersonic interference-lift aircraft. Later in his career he helped fashion research policy for the National Aeronautics and Space Administration (NASA) and led a major National Science Foundation effort in energy research.

Eggers was born in Omaha, Nebraska, on June 24, 1922, and earned his bachelor's degree in mathematics from the University of Omaha in 1944. As a naval ensign, in October 1944 he was assigned to work as a research engineer for the National Advisory Committee for Aeronautics at its Ames Aeronautical Laboratory, located adjacent to the Moffett Field Naval Air Station in California. His heart was set on service in the Pacific theater, but he soon warmed to the excitement of Ames. Later, working full time at Ames as a civilian, he continued his education at nearby Stanford University, earning a master's degree in engineering in 1949 and his Ph.D. in 1956.

At Ames he joined the legendary high-speed research division led by H. Julian Allen. At Allen's selection, his first responsible job was to design a hypersonic research facility. Using pressurized air from the nearby 12-foot pressurized tunnel, Eggers designed a 10- by 14-inch wind tunnel that operated between Mach 3 and Mach 6.3. Eggers designed a test section with variable geometry, a double throat, and boundary layer scoops for stable operation. It opened in 1950 and, though small, was a workhorse tunnel for years as Ames explored new terrain in hypersonic aerodynamics.

Eggers is perhaps best known for a revolutionary report he cowrote with Harvey Allen on the theory of blunt bodies for managing the heating challenges of reentry vehicles as they blazed into the earth's atmosphere. The heating and volumetric efficiency of blunt bodies provided the enabling nose shape for ballistic missiles and formed the basis for all human spaceflight vehicles. Eggers's early career balanced brilliant theoretical insight with the engineering of unique testing facilities. The combination of concept and proof made safe reentry possible. Eggers designed the Atmospheric Entry Simulator, opened in 1958, which ingeniously simulated the increasing density of the earth's atmosphere encountered during reentry. The 3.5-foot hypersonic wind tunnel, which he also helped design, opened in 1961 and was the site of a quarter of all Space Shuttle wind tunnel testing.

Because of the broad significance of his work, Eggers won the Arthur S. Flemming Award in 1956 for excellence in federal service and the Sylvanus Reed Award of the American Institute of Aeronautics and Astronautics in 1962 for achievements in aeronautical science and engineering. The U.S. Junior Chamber of Commerce named him one of Ten Outstanding Young Men of 1957. From 1958 to 1972 he served on the Scientific Advisory Board of the U.S. Air Force.

Together with Clarence Syvertson, Eggers advanced new vehicle configurations and hypersonic flight trajectories. They developed the theory behind waveriders, which had favorable lift interactions with their own shock waves at hypersonic speeds. In tunnel tests they demonstrated a lift-over-drag ratio of 6, and the North American XB-70 Valkyrie demonstrated the concept of interference lift at full scale.

Eggers led his Ames colleagues into work on the NASA human spaceflight program. From 1959 to 1963 he led the Ames Vehicle Environment Division, which studied all facets of the aerothermodynamic envelope of spacecraft. Eggers also led NASA's Manned Satellite Team, which helped plan the agency's human spacecraft research. As NASA's human spaceflight program expanded into the 1960s, Eggers pioneered the concept of the lifting body. This led to a decade-long flight test program which showed that wingless vehicles could reenter and land safely. It also gave NASA confidence that the Space Shuttle Orbiter could manage an unpowered landing.

Eggers was innovative, argumentative, and extremely well informed on all facets of the new field of hypersonic aerodynamics. His energy and enthusiasm were boundless. "He would enter a room of engineers dispassionately discussing a problem," remembers his colleague at Ames, Jack Boyd, "and while bringing focus to the root problem raise the decibel level in the room. He led by doing, through logic, and a seriousness of purpose that could be intimidating."

In the mid-1960s Eggers moved more forcefully into research policy. At Ames he served as assistant director for research and then as director of research and development analysis and planning from 1963 to 1964. He convinced NASA to locate its mission analysis division at Ames, which paved the way for the early Ames spacecraft projects. As an advocate for project engineering and physics, Eggers initiated a solar probe program that evolved into the very successful Pioneer series of solar probes. He moved to NASA headquarters and from 1964 to 1968 served as deputy associate administrator for advanced research and technology. From 1968 to 1971 he served as assistant administrator for policy during which time he also served as Hunsaker Professor at the Massachusetts Institute of Technology.

Eggers left NASA in 1971 and for six years served at the National Science Foundation as assistant director for research, leading a major new, and controversial, NSF program on Research Applied to National Needs, or RANN. The program funded large research projects on the scarcity of energy and environmental and material resources and was the first major NSF program to issue grants to small businesses, to emphasize engineering and applied research, and to fund social scientists to simultaneously study infrastructure problems. He earned a presidential distinguished service award in 1977. Moving back to the San Francisco Bay area, from 1977 to 1979 Eggers served as director of research laboratories at the Lockheed Palo Alto Research Laboratory.

Eggers finished his career by developing the technology base for renewable energy. From 1979 until his death, he served as president of RANN, Inc., an energy engineering consultancy doing research on solar and wind power. This company was separate from the research program he advanced at NSF, which had since been terminated, but was inspired by that agenda. He also served on the advisory board of the Solar Energy Research Institute and engineered new technologies for wind power. He devised a widely used active control system that altered the pitch of wind-turbine blades under varied winds, as well as a biplane design for twinned turbine blades.

Among his many awards, Eggers was elected a member of the National Academy of Engineering, a fellow of the American Institute of Aeronautics and Astronautics, a fellow of the American Astronautical Society, and a fellow of the American Association for the Advancement of Science.

He had a lifelong love of skiing and golf.

Al died on September 22, 2006, at the age of 84 and is survived by two sons, Philip and Alfred Eggers III; by three grandchildren, Andrew, Alexander, and Amanda; by his brother, Bob Eggers; and by his wife of 56 years, Elizabeth Ann.

LEOPOLD B. FELSEN

1924–2005

Elected in 1977

"For contribution to the theory and application of microwave propagation in complex media and for leadership in engineering education."

BY THEODOR TAMIR
SUBMITTED BY THE NAE HOME SECRETARY

LEOPOLD B. FELSEN, an internationally renowned authority on wave electrodynamics with applications to electrical engineering, optics, acoustics, and geophysics, died on September 24, 2005, at the age of 81.

Leo, as his close colleagues and friends generally knew him, was born in Munich, Germany, on May 7, 1924, to Jewish parents. Upon witnessing anti-Semitic persecutions that were initiated by the Nazis before World War II, his parents sent him in 1939 to England, after which he managed to reach New York in 1940. As a new American, he served in the Army for three years. He thereafter married his wife Sima in 1944 and they had two children, Michael and Judy.

Prompted by an early but keen mathematical insight and interest in science and engineering, Leo studied at the Polytechnic Institute of Brooklyn (now Polytechnic Institute of New York University), where he received the degrees of B.E.E., M.E.E., and D.E.E. in 1948, 1949, and 1952, respectively. He then joined the faculty of that institute, where he became professor of electrophysics in 1961, dean of engineering in 1974, university professor in 1978, and university professor emeritus in 1994. In 1975 his wife Sima died, and a few years later Leo learned that he suffered from a rare form of muscular dystrophy that slowly wasted away his muscular system. To live closer to his family, he substantially reduced his activities at the Polytechnic in 1994 and joined Boston University as a professor in the Aerospace and Mechanical Engineering Department.

Leo was granted top-rank membership as life fellow in the Institute of Electrical and Electronics Engineers (IEEE), fellow of the Optical Society of America (OSA), and fellow of the Acoustical Society of America (ASA). He received many additional honors in his lifetime, which included a Guggenheim Fellowship in 1973, IEEE/APS Distinguished Lecturer in 1974, the Van der Pol Gold Medal from the International Radio Science Union (URSI) in 1975, the Humboldt Foundation Senior Scientist Award from the Federal Republic of Germany in 1980, the IEEE Centennial Medal in 1984, the IEEE Heinrich Hertz Gold Medal in 1991, the Antennas and Propagation Society Distinguished Achievement Award in 1998, and the IEEE Electromagnetics Award in 2003. In addition, he was granted many awards for distinguished papers authored or coauthored by him; also, he was honored with special recognition awards by academic institutes and professional societies for his excellence in teaching and research.

Throughout his career, Leo held named visiting professorships and fellowships and was invited to visit and lecture at distinguished universities and research institutes in the Soviet Union, Japan, China, Brazil, Korea, Israel, Germany, Turkey, Italy, and other European countries. In that context, he received honorary doctoral degrees from the Technical University of Denmark (1979); the University of Sannio, Italy (2003); the Technical University of Munich, Germany (2004); the Polytechnic University, New York (2005); and the Dogus University of Istanbul, Turkey (2005).

Leo's most significant early achievement was the book *Radiation and Scattering of Waves* (Prentice-Hall, 1973) on which he devoted a major portion of his time for five years with Nathan Marcuvitz as coauthor. This book was reprinted in 1996 by IEEE as a classical and invaluable resource for rigorously solving a multitude of analytical problems involving fields and waves in electromagnetics, optics, acoustics, geophysics, and other areas of applied physics. A main feature of the book is the twofold view in time and frequency domains, which is treated with the systematic rigor that characterizes all his work. An important and very useful aspect is the emphasis on alternative Green's representations; these are subsequently treated in terms of spectral and asymptotic solutions that lend insight into physical interpretations of the relevant phenomena.

Leo's professional papers span a period that started in 1952, and their impact has been continued posthumously by his many collaborators. He published over 350 articles on a wide variety of topics, a short list of which includes the classification and properties of basic (surface, leaky, lateral, creeping, etc.) waves that appear in actual propagation and scattering problems; the development of augmented ray-tracing techniques that connect typical sources to scattering objects; the construction of hybrid representations involving finite numbers of rays and modes that effectively describe field representations that otherwise require an infinite number of terms; the derivation of solutions to canonic problems involving realistic beams having bounded cross-sections; the extension of modal and ray techniques to the study of transient wave propagation in complex environments; and many other related topics as well as their application to typical configurations in electromagnetics, optics, acoustics, and geophysics.

Leo's dedication to the study of wave phenomena motivated him to participate in every major national or international conference that addressed the latest progress on theoretical aspects in the above areas. His attendance was often by invitation and, during presentations by others as well as in subsequent technical discussions, his views usually provided the conclusive arguments on debates concerning the validity of a given approach to specific problems and their solutions.

While Leo's most cherished activity was his academic research, he was also sought after and highly recognized for his teaching activities. In this context, he offered primarily graduate courses on basic aspects of propagation, scattering, and guiding of waves. In these courses, his approach was to deftly combine mathematical rigor with models of actual applications while at the same time emphasizing the strengths and weaknesses of various methods. He made a point of stressing the elegance and utility of canonic problems; he clearly presented the latest state-of-the-art techniques and indicated the principal as-yet-unsolved problems. Most importantly, his course assignments were actually mini-projects whose basic aspect and treatment often served as a prelude to M.S. and Ph.D. dissertations. Needless to say, those courses turned out to be an inspirational source to many of his students, as well as to colleagues with interest in wave phenomena.

Perhaps most impressive was Leo's heroic achievement in living a full and productive life after being stricken by his unforgiving and progressive muscular illness. He did not just stoically accept a debilitating situation, but he adroitly accommodated his daily activities and scientific pursuits so as to continue taking full advantage of his brilliant intellectual capacity. It is simply amazing that he was able to continue until his death a distinguished professional career, both working on his own and in collaboration with many others. By adding to this a piquant humor and charming his friends with insightful verses that he composed for many odd occasions, Leo was an inspiration to all his professional peers as well as to his younger colleagues.

A few of Leo's additional sides: In his earlier years, he was an avid hiker, and remained a lover of nature, and especially the mountains, throughout his life. He was a true humanist; he appreciated and respected the many cultures found around the globe and knew that he was fortunate to have had the opportunity to experience so many of them firsthand, through his wide professional travels and his diverse relationships with students and colleagues. He very much enjoyed following the exploits of his three growing grandsons, just as he relished offering the obligatory sage advice from "grumpy gramps." And there were few family events at which he didn't offer a topical poem or limeric—sometimes gently gibing, but just as often wittily self-mocking—to liven up the festivities.

Indeed, even though English was not his native tongue, he became a real admirer and master of the language. His prose was elegant, but his poetry—whether on scientific themes or philosophical musings or family matters—was his pastime and his real pride and joy. For years he authored the "Poet's Corner" in the *IEEE Antennas and Propagation Magazine,* penning rhymes about waves and computers and conferences and the comradeship of colleagues. For a symposium luncheon honoring his birthday in 1990, he wrote about himself:

You've been a gadfly through critique
With questions often sharp, direct.
While this may not engender love
With those who've worked up close with you,
Heated debates have spurred the quest
To find the route that formulates
A controversial issue best.

And as you inch along that path,
Your sparring can become intense.
Yet close encounters of this kind
Have transformed colleagues into friends.

In his later years, as his body became increasingly feeble, his mind remained sharp, engaged, and intrigued by life's mysteries. He appreciated each day, but also was well aware of his mortality, and was moved to comment on it from time to time. The following poem, written a few years before his death at 81, provides a small window into how he contemplated his passing from the stage:

Evanescent Professors

Occasions like the recent one
Remind those who have come of age
That surely there will be a time
When they will move from center stage.

Just how a person leaves the stage
Is often difficult to say
Old soldiers, getting to that point,
They never die, they Fade Away.

Professors somehow do the same.
How it is done, you'll hardly guess.
For those of us who deal with Waves,
We do not fade, we Evanesce.

IAIN FINNIE

1928–2009

Elected in 1979

"For contributions in high temperature design, erosion, and brittle fracture of materials."

BY ALICE M. AGOGINO, DAVID DORNFELD, AND C. D. (DAN) MOTE, JR.

IAIN FINNIE, professor emeritus of mechanical engineering at the University of California, Berkeley, and one of the world's leading experts on the fracture of materials, died on December 19, 2009, from pneumonia and complications of Parkinson's disease. He was 81.

Finnie was a leading expert on engineering materials. The textbook he coauthored with William R. Heller, *Creep of Engineering Materials* (McGraw-Hill, 1959), is a classic.

"His pioneering work on erosion of materials has been emulated, but never equaled, by generations of subsequent researchers," said Ian Hutchings, professor of manufacturing engineering at the University of Cambridge in England. "His early papers remain very highly cited."

In the course of his 32-year career at UC Berkeley, Finnie mentored more than 40 doctoral students with whom he wrote more than 185 papers on fatigue of metals, crack propagation, and erosion of materials. He served as chair of the Department of Mechanical Engineering from 1979 to 1987. He held a strong record for recruiting some of UC Berkeley's top talent and for encouraging underrepresented minorities to pursue careers in engineering. Many of the faculty members he hired have become university presidents, deans, and distinguished faculty worldwide. He remains beloved by all of them.

Iain Finnie was born on July 18, 1928, to Scottish parents in Hong Kong, where his father worked as director of a British-owned dockyard. In 1940, Finnie, with his mother and sister, moved to British Columbia when British civilian women and children were ordered to evacuate Hong Kong during World War II.

After graduating from high school after only two years, Finnie left Canada to attend Scotland's University of Glasgow, where he graduated in 1949 with a bachelor of science degree with first-class honors. He completed his M.S. and Sc.D. degrees in mechanical engineering at the Massachusetts Institute of Technology (MIT) in 1950 and 1953. While at MIT he was trained by such luminaries as Jacob Pieter Den Hartog, a world expert on mechanical vibrations; Wallodi Weibull, author of what is widely considered the world's most popular probability model for life data; and Milton C. Shaw, a renowned materials expert.

After graduating from MIT, Finnie moved to Emeryville, California, to work for Shell Oil Development Company. In 1961, Finnie joined the faculty at UC Berkeley as an associate professor and was promoted to full professor just two years later.

In 1965, as part of a UC team led by Erich Thomsen, a recently deceased Berkeley emeritus faculty member, Finnie helped establish the engineering department at Universidad Católica in Santiago, Chile.

In 1967 he received a Guggenheim Award, a rarity for engineers, to study brittle solids—research that took him from a South African gold mine to a rock drilling site in Switzerland. In 1974 he received an honorary D.Sc. degree from the University of Glasgow.

Iain Finnie was elected to the National Academy of Engineering in 1979 and was honored with recognition by appointment to honorary membership in the American Society of Mechanical Engineers International (ASME) in 1983. He received the ASME Nadai Medal in 1982. When he retired from UC Berkeley in 1993, Finnie received the Berkeley Citation, the highest honor the campus bestows.

In 1969, Finnie married Joan Roth McCorkindale, a widow with two young daughters, Carrie and Katie. The couple had a daughter, Shauna. All three daughters pursued graduate degrees, including two in mechanical engineering, and each credits her father's influence for her academic and professional drive.

Finnie spent two sabbatical leaves, in 1976 and 1987, in Lausanne, Switzerland, where he was a visiting professor at L'École Polytechnique Fédérale de Lausanne (EPFL).

"Iain was a great scientist and engineer, highly intelligent and of great originality," said Wilfried Kurz, EPFL professor emeritus of materials science. "He gave lectures of outstanding clarity. He was a gentleman, and he had great humor. Often, I was laughing to tears with him."

Finnie remained close to his students over the years, sharing his humor, passion for skiing, and hospitality, his colleagues and family recalled. At one of many gatherings at Finnie's Berkeley home, his graduate students wore T-shirts labeled "Finnie's Flaws" in honor of their research on fracture mechanics, and gave him a "Master Flaw" T-shirt.

His wife, Joan, wrote:

> "Iain Finnie had dancing eyes, always with a twinkle and always with jokes and puns on words. It kept anyone close to him listening attentively.
>
> His passion was skiing. He managed to include trips to Alta, Utah, en route to or by return from conferences or consulting. He was asked to be a ski instructor at several ski resorts, and he was tempted. However, his passion for engineering was greater. Even when he served me tea in bed in the morning (a Scottish tradition he maintained almost to his last days), he often would explain some engineering problem or talk about his most recent paper. He could get carried away. His students laughed that he wrote equations and diagrams on napkins when they went out for coffee, also a daily tradition he enjoyed. They saved the napkins and found they were helpful when studying for exams. His exams usually included

actual occurrences. One student groaned when he saw the exam, 'Oh, no, this was Mireille's cracked Pyrex container.'

He traveled a great deal from his early age going to and from Hong Kong and Scotland. He enjoyed describing his flying boat experiences when the amphibious planes landed on water, and the few travelers stayed in exotic places and pleasant hotels. He once counted that he had visited over 70 countries. We were fortunate to be invited by the Chinese government in 1979 to visit China with nine professors and their wives from Engineering, UC Berkeley. The group remained close friends. Former students and colleagues invited us, and we had superb trips to Turkey, Greece, Egypt, Israel, Japan, Indonesia, and Europe. Many of these friends traveled to Berkeley in Sept., 2010, for the Symposium in his memory at UC Berkeley. Even a former UC B forestry student who helped Iain in the garden came from Australia.

He was totally committed and involved with our family life. He liked puttering with household projects, working in the garden, and especially loved our parties. We regularly gave a Robbie Burns party, complete with haggis and poetry readings by the guests. He was an incredible dad, tough but fair, claiming to be a 'benevolent dictator,' ready to assist with homework. He could solve problems easily, but outnumbered by females, he said topics on hair and diets were outlawed at the dinner table. When the girls were young, he told night-time stories, even going to the library to authenticate his stories. They still remember 'Nanook of the North.' One of his early papers was about put-put boats. He took his little boats and water tub to each of the girls' classrooms. The grandchildren also delighted in his demonstration and explanation. He was an avid reader of history and a great storyteller, making it come alive.

> When he no longer could ski, his passion became swimming. He swam every day and loved when we went to Maui to swim in the ocean. He loved good food and good wine. He loved life!"

Iain is survived by his wife, Joan Finnie (of Berkeley); three daughters, Carrie McCorkindale (of Fremont, California), Katie Croxdale (of Edina, Minnesota), and Shauna McIntyre (of Encinitas, California); three grandchildren (a fourth was born in February 2010); and his sister, Jean Mackie (of Hong Kong).

JOHN A. FOCHT, JR.

1923–2010

Elected in 1986

"For developing innovative, practical methods of designing piles subject to extreme loads and heavy mat foundations on deep soil formations."

BY WILLIAM F. MARCUSON III

JOHN ARNOLD FOCHT, JR., of Houston, Texas, the highly esteemed consulting geotechnical engineer and 1990 American Society of Civil Engineers (ASCE) president died October 22, 2010. He was 87.

John was born in Rockwall, Texas, on August 31, 1923, to John A. Focht, Sr., and Fay Goss Focht. He moved to Austin in 1926 when his father joined the civil engineering faculty at the University of Texas. He attended public schools, graduating from Austin High in 1940. He earned the rank of Eagle Scout while in high school. John attended the University of Texas, where he received his B.S. in civil engineering degree in 1944. John was then called to military service and served his country in the U.S. Army during the occupation in France and Germany.

After the war, John attended Harvard University under the G.I. Bill, earning a master of science in civil engineering degree in 1948. While at Harvard he studied under Karl Terzaghi, Arthur Casagrande, and other early pioneers of the emerging field of soil mechanics. John and Dr. Casagrande became lifelong friends, and it was at Casagrande's urging that John began working at the U.S. Army Engineer Waterways Experiment Station (WES) in Vicksburg, Mississippi, in 1948.

While at WES, John applied his knowledge and judgment to the design of levees, locks, and other structures being built by the U.S. Army Corps of Engineers along the Mississippi River system, including the Morganza Floodway. John met Edith Rials at a square dance in Vicksburg, and they married on August 8, 1950, just prior to John's return to active duty at the outbreak of the Korean War. John served in the 434th Engineering Battalion as a captain and company commander, where his company was responsible for the construction and maintenance of roads and bridges.

After John was honorably discharged from the Army in 1953, he moved to Houston and joined Greer and McClelland, which became McClelland Engineers. He was a member of a three- or four-man leadership team that was responsible for McClelland's growth from a small Houston group of about 20 to a multinational organization of more than 800 employees offering a wide range of geotechnical services to industry and government. He was an internationally renowned consulting engineer, having consulted and lectured around the world.

Throughout his career John contributed widely to many different aspects of pile foundation design. When development of offshore structures began to rapidly expand in the 1950s, he led development of the first satisfactory design analysis for nonlinear soil-pile interaction under storm loading and the first useful correlation of soil test data with such soil behavior. His contributions acquired special significance when design load requirements of such structures rapidly outstripped the practical applicability of pile load tests. Other aspects of pile design for which John developed techniques that continue to be used in today's practice include laterally loaded pile groups and tension-loaded piles in sand.

Focht was closely involved with the development and application of state-of-the-art techniques required in the design and construction of heavily loaded mats resting on deep soil foundations. He applied the observational approach of soil mechanics to solutions of many related design problems, such as deep excavation bracing, construction dewatering, prediction of excavation heave, permanent basement dewatering, and control of long-term settlement.

The city of Houston has benefited from Focht's work. He was responsible for the design of both Lake Livingston and Lake Conroe dams, and his innovations and judgment guided the foundation design of most of Houston's tallest buildings, including the JP Morgan Chase Tower, the tallest soil-supported building in the world. John was also involved in the design and construction of many southeastern Texas and Louisiana refineries and chemical plants as well as Port of Houston facilities and much of the original development of the Johnson Space Center. His pioneering work also led to many innovations in the support of offshore exploration and drilling structures both in the United States and around the world, particularly relating to pile foundation design and construction. Much of the research conducted in this area at the University of Texas was due to his personal ties to that institution as well as his personal relationships and strong influence within the oil and gas exploration industry. In 2001, John was honored for this innovation, creativity, and work with the Offshore Pioneer Award by the Offshore Energy Center.

He was elected to the National Academy of Engineering in 1986 for developing innovative, practical methods of designing piles subject to unprecedented loads and heavy mat foundations on deep soil formations.

John received numerous awards, including Distinguished Engineering Graduate from the University of Texas in 1964. He received national awards from ASCE for five of his more than 40 papers, mostly on embankment dams, pile foundations, and offshore structures. He was the Texas Society of Professional Engineers Region IV Engineer of the Year and state Engineer of the Year in 1987. He served as president of the ASCE from 1989 to 1990. John was the ASCE Karl Terzaghi Lecturer in 1993—the highest honor bestowed on a geotechnical engineer; a national honor member of Chi Epsilon in 2000; and an ASCE Geo-Institute "Hero" in 2002. Also in 2002 he received the Texas Section ASCE Lifetime Achievement Award. He also received an award in recognition of his dedicated service as a founding director of Civil Engineering Certification, Inc.

John was a driving force for the creation of specialty certification within the ASCE, and it is likely the program would not have come to fruition without his long-term efforts to promote advanced, post-license certification for civil engineers. He was a frequent speaker at universities in the United States and presented invited lectures in Mexico, China, Taiwan, Thailand, Singapore, and Saudi Arabia. He also was a member of Tau Beta Pi and Chi Epsilon.

In addition to professional activities, John was active in his community. When John and Edith moved to Houston Heights in 1953, they joined Grace United Methodist Church where they were both active. John served as chairman of the board of Grace Church and taught a high school Sunday school class for over 15 years. At Fair Haven United Methodist Church he served on the board and as finance chairman. He was a member of United Methodist Men at both churches.

John served as a committeeman for a Cub Scouts pack and a Boy Scout troop and as a scoutmaster. Focht believed that focus, drive, dedication, and self-discipline were important personal characteristics. He also thought the Boy Scouts taught these traits and that the attainment of the rank of Eagle demonstrated that you were on the path to learning that quitters never win. John was pleased that his son John and grandson Kyle were Eagle Scouts and that grandson Thomas was finishing his requirements for Eagle.

John also served as a director for the Northwest YMCA. During his term as president of ASCE, his theme was "The Civil Engineer Being a Good Citizen Engineer," and the Texas ASCE membership created an award in his honor named the "John A. Focht Jr. Citizen Engineer." This award is given annually to an engineer for outstanding contributions in the community.

He is survived by his devoted wife, Edith; their two children and their spouses, Cheryl and John A. Focht III and Scott and Judy Focht Rimato; and six grandchildren.

GEORGE A. FOX

1920–2001

Elected in 1988

"For contributions to the advancement of engineered heavy construction, and for services to higher education."

BY RICHARD T. ANDERSON
SUBMITTED BY THE HOME SECRETARY

GEORGE A. FOX was an outstanding leader of the New York City construction industry and was respected and renowned throughout the United States. A former chairman and chief executive officer of Grow Tunneling Corporation, he headed many professional and civic organizations in New York before his death on May 17, 2001.

George Fox's career began in 1940 upon his graduation from Cooper Union, from which he received B.C.E. and C.E. degrees. He was awarded an M.C.E. from Brooklyn Polytechnic in 1942. He also held a citation from Cooper Union for outstanding professional achievement, the equivalent of an honoree doctorate. He was a member of Tau Beta Pi, the National Honorary Engineering Society, and was a member and former trustee of the Moles, as well as a fellow and life member of the American Society of Civil Engineers (ASCE) and a former member of the British Tunneling Society.

George Fox was proud of his membership in the National Academy of Engineering, among the highest professional distinctions given an engineer, which he was awarded for contributions to the advancement of engineered heavy construction. He also received the 1979 Moles Award for outstanding achievement in construction, the most prestigious national award in the U.S. construction industry. In 1980 he received the Civil Engineer of the Year Award of the ASCE metropolitan section.

He was the first recipient of the Roebling Award of the ASCE, in recognition of outstanding contributions to construction in America.

For more than 50 years, George was active with the Grow Company in extensive tunneling work in New York, New Jersey, and elsewhere, specializing in heavy construction, shafts, and tunnels, notably those done using compressed air. He was progressively involved in the engineering, planning, design, cost estimating, and management aspects of construction of major public works projects involving billions of dollars and enormous public benefit.

Nonetheless, George was never satisfied with professional accomplishments and recognition alone. In 1980–1981 he was president of the General Contractors Association of New York City, and for many years he was chairman of the Tunnel Committee. He was deeply involved in industry-wide labor negotiations and in employer-employee relations, especially in connection with the Tunnel Workers Union, Local 147 Welfare Fund, and was chairman of the trustees of the Local 147 Retirement Fund for many years.

George became chairman of the New York Building Congress from 1982 to 1986 and was the driving force behind professionalizing the organization and hiring full-time executive staff. Most significantly, he guided efforts to expand the Building Congress's reach beyond networking into public policy advocacy and research. Furthermore, George chaired the organization's Council of Presidents for a number of years thereafter. He cared deeply about the industry as a whole and was a forceful advocate for industry-wide positions and activities. His efforts transformed the Building Congress into one of New York City's most influential membership organizations.

Earlier in his career, George was chairman of the Contract Administration Committee of the ASCE Construction Division and was a member of the Publications Committee. He served for two years on the Contracting Practices Subcommittee of the National Academy of Engineering, which produced in 1974 the widely accepted report entitled *Better Contracting for Underground Construction.*

George Fox performed tunneling consulting work for engineers and contractors, both in the United States and abroad. He served on research review panels at the Massachusetts Institute of Technology and other institutions. He appeared before various ASCE groups and wrote articles for *Engineering News Record, Construction Methods,* and the *ASCE Journal.*

George Fox was the uncommon engineer whose interests extended well beyond construction. He was a humanist who combined his love of the arts and commitment to social justice in diverse community involvements. He served as chairman of the Board of Trustees of the Cooper Union for the Advancement of Science and Art. He also served on the Board of the New York City Partnership and was former chairman of the WNYC Foundation, which supported and administered the municipally owned and operated public radio and TV station. He was a member of the Board of Directors of Symphony Space and was chairman of its finance committee. He also served on the board of the Boys Choir of Harlem.

During his more than 50-year career, George Fox played lead roles in the planning, design, and management of 70 major public works projects valued in excess of $61 billion. While millions of New York City residents have benefited from his projects, few ever saw Mr. Fox's work, which mainly consisted of elaborate underground tunneling. His crowning achievement was his engineering and construction work for New York City's third water tunnel—the largest capital construction project in the city's history and the largest tunneling project in North America. Widely hailed as a modern engineering marvel when the first stage was opened in 1998, construction of the 60-mile water tunnel some 600 feet below New York City began in 1970. Completion is expected in 2020.

In 1996, George told *The New York Times,* "The education of the public on all the needs of the City is deficient," referring to the enormous infrastructure requirements of New York. He went on to say, "We have to feel we are on the edge of the cliff before we wake up to it," reflecting on the need for a huge public works project like the third water tunnel.

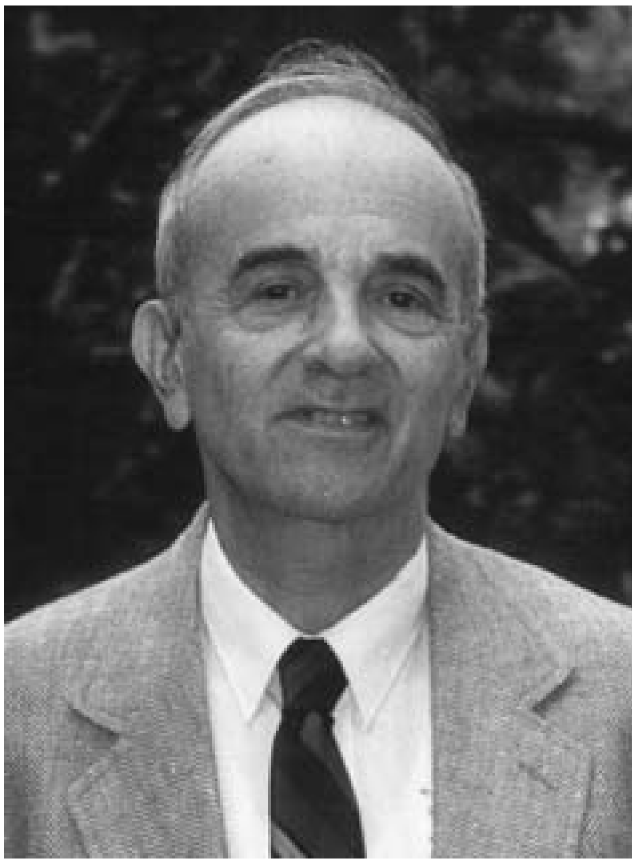
George earned considerable praise as an educator and a civic leader. In addition to chairing the board of Cooper Union, he taught a course for engineering seniors that focused on the realities of being a civil engineer. In 1996, Cooper Union honored him with its first "Builder of the City Award" for lifetime contributions to the construction of New York City's infrastructure.

For his public service, the Building Congress established, in 2005, the George A. Fox Public Service Award, which is bestowed annually on building industry professionals who perform exemplary charitable work. Recipients have included Frank J. Sciame of F. J. Sciame Construction Company; Robert E. Selsam of Boston Properties; Susan L. Hayes of Cauldwell Wingate Company, LLC; and Peter L. DiCapua of ATCO Properties.

George Fox was a man of enormous vision and integrity. He inspired all with his exceptional ability to bring together a diverse and often fragmented industry using his keen intellect and engaging persuasiveness. His personal warmth and humor played no small part in all his accomplishments. His legacy is an unsurpassed commitment to the construction field and to the City of New York.

George left his mark on New York everywhere—from the vast subterranean tunnel structure beneath the city to the education of our youth—and demonstrated the highest standards of public service. All who knew him remember a unique New Yorker who gave much more than he received.

He is survived by his wife, Cecily; two sons, Andy and Roger; two daughters, Alice and Laurie; and three grandchildren.



FERDINAND FREUDENSTEIN

1926–2006

Elected in 1979

"For leadership and research in kinematics and design of mechanisms."

BY BERNARD ROTH
SUBMITTED BY THE NAE HOME SECRETARY

FERDINAND FREUDENSTEIN, longtime Columbia University mechanical engineering professor who is considered the father of modern kinematics in America, died on March 30, 2006, at the age of 79.

Ferdinand Freudenstein was born into a Jewish family, on May 12, 1926, in Frankfurt am Main, Germany. When Ferdinand was 10 years old, he, his parents, and two sisters fled the Nazis for safety in Holland. In the spring of 1937, after six months in Amsterdam, the family moved to England, where they joined his brother, who was studying there. They lived in London during the Blitz, moved briefly to Cambridge, and then spent several years in Llandudno, North Wales. During this period his father and brother, were sent into exile in Australia, since the British government regarded all adult male German citizens, even victims of Nazi anti-Semitism, as enemy aliens.

In 1942, when he was 16 years old, Ferdinand, his mother, and one sister sailed on an old British cargo boat from England to Trinidad. They remained there for six weeks until a distant cousin arranged for their visas to the United States. They arrived in New York harbor in March 1942. Ferdinand had a high school equivalency certificate from Wales and was able to enter college at New York University. He spent two years studying there and then at age 18 joined the U.S. Army.

He was able to graduate from the Army Specialized Training Program in Engineering, at Texas A&M (1945). After the Army, he went to Harvard University and earned an M.S. degree in mechanical engineering (1948). He then worked, for approximately two years, as a development engineer in the Instrument Division of the American Optical Company in Buffalo, New York, before he left to study for his Ph.D. at Columbia University. This work experience helped solidify a strong youthful fascination with machines. His longtime interest was further stimulated by subsequent summer jobs as a development engineer at Ford Instrument and American Machine and Foundry and as a member of the technical staff at Bell Laboratories.

At Columbia University he encountered a major obstacle: No one on the faculty did research in kinematics of mechanisms. Fortunately, Professor H. Dean Baker, a specialist in combustion, agreed to be Freudenstein's thesis supervisor and to allow him to work on mechanism kinematics, even though Baker himself knew very little about the subject. For the rest of his life, Ferdinand was extremely grateful for what he considered an act of great kindness and generosity on Baker's part.

After Ferdinand received his Ph.D., he was appointed to an assistant professorship in Columbia University's mechanical engineering department. His career up the academic ladder was meteoric. In less than three years he was promoted to associate professor. Then one year later he became the chairman of the Department of Mechanical Engineering, a post he held for six years. After only two years as an associate professor, he was promoted to the rank of professor (1959).

In the same year, at the age of 33, he married Leah Schwartzchild. Their first child, David, was born on February 3, 1961, and their second child, Joan, was born on February 6, 1964. The young family took up residence in the Riverdale section of the Bronx, where they purchased a comfortable three-story brick house on a quiet residential street. Ferdinand lived in that house for the rest of his life.

As a researcher, he had made his mark early with his seminal Ph.D. dissertation in which he developed what is known as Freudenstein's equation. At the end of the 1950s and the beginning of the 1960s, Ferdinand's kinematics program at Columbia started to get worldwide recognition. It became known as the best place to study mechanism kinematics in the United States. He attracted prominent colleagues from abroad, some of whom he collaborated with on research projects. During a long career at Columbia University, he and his students produced outstanding research results in most areas of modern kinematics. At the time of his death there were over 500 academic descendents belonging to the Freudenstein family tree.

In the midst of all Ferdinand's professional success, tragedy struck when his wife Leah died in May 1970. This created a huge challenge for Ferdinand who had not had any real experience with domestic details, such as cooking and running a household. Fortunately, he was a quick learner. For the next 10 years, he ran the household and was both mother and father to his children. At the same time he remained a highly productive and world-renowned Columbia professor.

In May 1980, 10 years after the death of his first wife, Ferdinand married Lydia Gersten. Lydia was a teacher who was widowed, had grown children, and was caring for her elderly mother. Lydia and her mother moved into the house in Riverdale. Lydia took over the domestic management of the household and became a close and loving partner in Ferdinand's life. Over the next years, Ferdinand's children grew up, Lydia's mother died, and Lydia and Ferdinand became the sole occupants of the house. Their marriage flourished for nearly 26 years, until Ferdinand's death, and was the great gift in the last half of his life.

Two years after he remarried, Ferdinand was made Stevens Professor of Mechanical Engineering. He held this chair for two years and then in 1985 was made Higgins Professor, a position he held until his retirement. In addition to these honors, he was elected a member of the National Academy of Engineering, an honorary member of International Federation for the Promotion of Mechanism and Machine Science, and a fellow of the New York Academy of Sciences; he also became an honorary life fellow of the American Society of Mechanical Engineers. He accumulated a long list of other awards for his research and teaching.

Throughout his career Ferdinand was also as an industrial consultant. He very much valued these contacts and the insights they afforded into "real-world" engineering problems. His main consulting activities were with Bell Telephone Laboratories, Designatronics, IBM, The Singer Company, Foster Wheeler, Gulf and Western, and General Motors. The General Motors consulting activities went on for over 15 years.

An interesting event occurred at an American Society of Mechanical Engineers meeting in San Francisco in 1972, where Freudenstein was the scheduled luncheon speaker. At one point, as part of the introduction, the moderator asked that "all the people in the room who are either part of the Freudenstein academic family tree or feel that their work has been strongly influenced by their relation with him please rise from your seats." At that moment, almost all of the approximately 200 people in the room rose to their feet. Similar requests were made subsequently at other meetings over the years, and the results were the same. It always created a powerful emotional response to witness this physical demonstration of Freudenstein's great influence on the field.

Ferdinand Freudenstein was a kind and soft-spoken individual. He was extremely modest. He was an accessible professor and was always pleased to assist his professional colleagues at Columbia and throughout the world. His benevolent influence was felt, both directly and indirectly, by practically everyone who taught or did research in the field of kinematics or machines and mechanisms. His progeny are teachers in many different countries, and his research results have shaped the teaching and practice of mechanism and machine theory throughout the world. In addition, his descendants have taken his basic ideas into new areas of interest, such as mechatronics (particularly robotics), microelectromechanical systems, biochemistry, and bioengineering, where they have also made pioneering contributions.

The warm memories for him as well as his strong influence on the field will be with us long into the future. Ferdinand is survived by his wife, Lydia; his son, David; his daughter, Joan; three grandchildren; two sisters, Elsa and Greta; and by now almost 600 academic descendants.

His wife Lydia Freudenstein wrote:

> "It was my great good fortune to meet and marry Ferdinand Freudenstein. As he is described in his professional life, so he was in his personal life: kind, gentle, modest, and thoughtful. He had a subtle sense of humor which was evident at special family gatherings when he would write spoofs and poetry relating to the occasion. His piano playing also added to the enjoyment at these times.
>
> Ferdinand always seemed in equilibrium, never angry or anxious. His work and his thoughts protected him from the trivial problems that one encounters in daily life.
>
> Ferdinand enriched the work with his seminal contributions to the science of mechanisms; but he also enriched his many colleagues and students with friendship, and his family with love."

ROBERT A. FUHRMAN

1925–2009

Elected in 1976

"For contributions to the design and development of the Polaris and Poseidon underwater launch ballistic missile systems."

BY SHERMAN N. MULLIN
SUBMITTED BY THE NAE HOME SECRETARY

ROBERT ALEXANDER FUHRMAN, retired vice chairman, president, and chief operating officer of Lockheed Corporation, died on November 21, 2009, in Pebble Beach, California. He was 84 years old.

Bob was born on February 23, 1925, in Detroit, Michigan, and was educated in the Detroit public school system. He enlisted in the U.S. Navy in 1942, which selected him to attend the University of Michigan. He received a bachelor of science degree in aeronautical engineering in 1945. Bob never forgot what the Navy and Michigan did to enable his career. In his words, "I graduated in a sailor suit, was commissioned, and sent off to aviation officers school, where I learned how to analyze a jet engine, take it apart, and put it back together." He was then assigned to the Naval Air Test Center, Patuxent River, Maryland, as a flight test project engineer, an exciting assignment for a 21-year-old junior Navy officer. He cherished this experience for the rest of his life.

Discharged from the Navy in 1949, Bob became a civilian instructor at the Navy Test Pilots School and concurrently attended the University of Maryland, receiving a master of science degree in fluid mechanics in 1952.

Recruited by Ryan Aeronautical Company, Bob, his wife Nan, and their two children moved to San Diego. He contributed to the design of experimental vertical takeoff aircraft and other advanced aircraft designs, progressing to chief technical engineer. However, he did not see the future he desired and decided to move on.

Recruited in 1958, Bob joined the rapidly growing Missile Systems Division of Lockheed Missiles and Space Company in Sunnyvale, California, as systems engineer on the Polaris fleet ballistic missile project, at that time the highest-priority project in the U.S. Navy. This was a major turning point in his career, moving from traditional aeronautical engineering to system design of missile and space systems, initially the development of pioneering submarine-launched ballistic missiles. He promptly developed a productive relationship with the Polaris technical director, Captain Levering Smith, USN (1910–1993), later vice admiral. Captain Smith made their mutual objective clear: Make decisions, based on system design trade studies, to deliver Polaris missiles ready for installation in the first fleet ballistic missile launching submarine, the *USS George Washington*, by June 1960. The Navy–Lockheed Polaris program team achieved this. In July 1960 the Navy submarine *USS George Washington* successfully launched two Polaris A1 missiles and in November was operational at sea in the U.S. Atlantic Fleet. Bob became chief engineer in 1966 and vice president and general manager in 1969.

In 1970 Bob was abruptly appointed president of Lockheed Georgia Company in Marietta, where the C-5A Galaxy transport aircraft, being developed for the U.S. Air Force, had encountered major problems. Working with the Air Force, he restructured the program and it moved successively to completion. He was proud of taking a C-5A aircraft to the Paris Air Show in 1971 and showing it to the world.

He was then given another tough assignment, becoming president of Lockheed California Company in Burbank, where the L-1011 TriStar commercial airliner program was in deep trouble, primarily due to the sudden 1971 bankruptcy of jet engine supplier Rolls Royce. This had led to the L-1011 production line being shut down and massive layoffs. Under these conditions Bob took over leading the recovery. With the British government rehabilitating Rolls Royce, he contributed to getting L-1011 TriStar development completed and initiating production deliveries to several major airlines. He was also responsible for two major Navy aircraft programs: development of the S-3A Viking carrier antisubmarine warfare aircraft and production of the P-3C Orion maritime patrol aircraft. As an inspiring leader of a company under great pressure, he reached out continuously to recognize talent and grow the fundamental strength of the company. His humility, down-to-earth attitude, and broad knowledge gained him wide respect and restored morale in the company.

In 1973 Bob returned to Lockheed Missiles and Space Company as executive vice president, becoming president in 1976. Over the next decade he was the inspired leader of this major developer and producer of classified space systems, missile systems, and a wide range of advanced technologies. He thrived on competition for new systems development programs and was pleased when Lockheed won the National Aeronautics and Space Administration's Hubble Space Telescope program in 1977. He mentored many outstanding engineers, two of whom ultimately became chief executive officers of Lockheed and its successor in 1995, Lockheed Martin. Needless to say, both were systems engineers of the first rank.

Bob was elected to Lockheed's board of directors in 1980, serving to 1990. He became president and chief operating officer of Lockheed Corporation in 1986, moving to the new corporate offices in Calabasas, California. He oversaw four large operating groups: aeronautical systems, missiles and space systems, electronic systems, and information systems. He retired in 1990, after 38 years at Lockheed. Throughout this period he made significant contributions to the transformation of Lockheed from an aircraft company to becoming one of the major aerospace corporations in the world.

Like one of his Lockheed engineering heroes, Willis Hawkins (1913–2004), Bob Fuhrman never really retired. He was an active senior advisor to Lockheed Corporation and its successor, Lockheed Martin Corporation, to the end of his life. His extensive work from 1991 to 2009 covered a wide range, primarily in support of the U.S. Department of Defense. In Bob's view an engineer's responsibility was unbounded. He was much sought after as an advisor to the government because of his ability to look at complex issues objectively. He was viewed as a true gentleman, strategic thinker, and roll-up-your-sleeves contributor. Some of his major contributions follow.

He was on the Defense Science Board for several years, participating in numerous major studies, chairing several of them. In 1992, commissioned by the director of Central Intelligence, he chaired a classified task force to improve the functioning of the National Reconnaissance Office (NRO), particularly in the area of its direct support of operational U.S. military forces. He advocated that the existence and purpose of the NRO be made public, which it was. In the 1990s he served for six years on the Defense Science Board Task Force on Acquisition Reform, where he spoke with authority and carried much weight with his peers.

For the National Research Council, Bob organized the Air Force Studies Board and was its chairman for several years. Later he led a task force on the Air Force C-17 transport aircraft program, which made significant contributions to resolving its technical and program management problems.

He served on the board of directors of the Charles Stark Draper Laboratory (formerly the Instrumentation Laboratory of the Massachusetts Institute of Technology).

Throughout his career Bob was a dedicated member of the American Institute of Aeronautics and Astronautics (AIAA). He was elected a fellow and later an honorary fellow. In 1978 he was the AIAA von Karman Lecturer in Astronautics. He was the AIAA's president in 1992. When asked to serve, he said *yes,* that it was his duty to serve his profession. As president he traveled extensively and achieved improved coordination with the International Aeronautical Federation and with the Royal Aeronautical Society, of which he was a fellow. The

AIAA staff loved him because of his positive attitude and willingness to cooperate.

Bob Fuhrman was one of the foremost aerospace systems engineers and managers of the 20th century, with major contributions to the development of missile systems, space systems, electronic systems, military aircraft, and commercial aircraft. He pioneered systems engineering as a fundamental and pragmatic technical and management discipline, essential to achieving the technical, schedule, and cost objectives of aerospace programs of high national priority.

He was an optimistic, inspiring leader and a determined problem solver throughout his career. For over three decades he nurtured a flock of engineers and managers whose technical achievements were diverse and significant. For the two decades that followed, he was continually involved as a trusted advisor to the U.S. government on defense policy matters, particularly acquisition of new systems. He was widely respected for his disciplined contributions. He was much loved by the staff members who supported these efforts.

A longtime resident of Pebble Beach, California, Bob was devoted to his growing family. His first wife, Nan McCormick Fuhrman, died in 1988. He is survived by his second wife, Nancy Richards Fuhrman; his sister, Eloise Schmidt; three children from his first marriage—Lee Ann Kahl, Richard Fuhrman, and William Fuhrman; two stepchildren—Michelle Aliotti and Scott Richards; nine grandchildren—Alexis, Brennan, Robert, Rebecca, Ricky, Ryan, Ali, Madalynn, and Gaspare; and one great-grandchild, Ryder.

HAREN S. GANDHI

1941–2010

Elected in 1999

"For contributions to the research and development of automotive catalysts."

BY DERRICK M. KUZAK

HAREN S. GANDHI, Henry Ford Technical Fellow at the Ford Motor Company and one of the world's foremost authorities in the area of automotive emissions control, died on January 23, 2010, at the age of 68.

Dr. Gandhi was born on May 2, 1941, in Calcutta, India. He received a bachelor's degree in chemical engineering from the University of Bombay and a master's of science and doctorate degrees from the University of Detroit. He joined the Ford Motor Company as a research engineer in 1967 and went on to achieve the rank of Henry Ford Technical Fellow, the highest level that a scientist or engineer can achieve within the company, a position he held for 16 years.

Dr. Gandhi was the author of 70 technical publications and earned 53 U.S. patents, with many more patents awarded in other countries. His research involved seminal contributions in the areas of three-way automotive catalysis, including landmark papers on oxygen storage, catalyst poisoning by fuel and oil components (lead, manganese, phosphorus, zinc, sulfur), and optimized precious metal utilization. Under his direction, Ford was the first company to employ nonplatinum and nonrhodium three-way catalyst technology in the

United States. He worked closely throughout his career with catalyst supplier companies, government agencies, national laboratories, universities, and fuel and oil additive companies. To this end, his work arguably involved the greatest scope of anyone working in the broad area of automotive emissions controls.

During his long career, Dr. Gandhi received numerous technical awards, chief of which was the 2002 National Medal of Technology and Innovation for his contributions to the research, development, and commercialization of automotive exhaust catalyst technology. This marked the first time for any member within the entire automotive industry to win this prestigious award. In addition, Dr. Gandhi received five prestigious Henry Ford Technological Awards, the most bestowed on any single researcher within the Ford Motor Company. He also received the Platinum Award from the Institute of Chemical Technology–Mumbai, marking its Platinum Jubilee Year in 2009, the Pacific Basin Award in 2001, the Manufacturers of Emission Controls Association 25th Anniversary Outstanding Technical Contributions Award in 2000, the PNGV Medal (Partnership for a New Generation of Vehicles) for Technical Accomplishments Government-Industry Teamwork in 1997, the Real Advances in Materials Award for Palladium-Only Catalyst Development in 1994, the Award for Excellence in Catalysis by Exxon in 1992, the Technological Innovation Award by *Discover* magazine in 1990, the SAE (Society of Automotive Engineers) Ralph R. Teetor Industrial Lectureship Award for 1988–1989, the Crompton Lanchester Medal in 1987, and the AIChE (American Institute of Chemical Engineers) Chemical Engineer of the Year Award for 1982.

Dr. Gandhi had a long history of championing the introduction of emissions controls and supporting technology around the globe. He was a member of the advisory committee to the Ministry of Industry and Ministry of Environment to advise the government of India on automotive emissions regulations. He was also appointed to an expert panel by the United Nations and the government of India. Under this

U.N. program, Dr. Gandhi was involved in a joint project with the Automotive Research Institute of India to bring advanced automotive emissions testing capability to India and reduce emissions from Indian vehicles, thereby promoting environmental protection. He also interacted extensively with various groups in Europe, Korea, Brazil, China, and Australia throughout his career. In all of these countries, he led the implementation of emissions controls on Ford vehicles as emission standards were introduced and also worked with government agencies and fuel suppliers to ensure that fuel quality was of the level needed to ensure efficient performance and durability of exhaust catalysts.

Dr. Gandhi's impact and recognition went far beyond the Ford Motor Company and the automotive industry. He was elected to the National Academy of Engineering in 1999. He was appointed as a member of the Board of Directors to the International Precious Metals Institute in 2004 and the same year was appointed a member of the International Advisory Board for the 2006 Fifth Tokyo Conference on Advanced Catalytic Science & Technology for the University of Tokyo. He had been a member of the Leadership Advisory Group to the renowned Cleveland Clinic Foundation since 2003. He was also elected an SAE fellow in 2006. The National Science and Technology Medals Foundation appointed Dr. Gandhi as a member of its Board of Directors in 2006, followed by an appointment to the Nomination Evaluation Committee in 2008. Also in 2008 he was appointed to the Scientific Advisory Board for the proposed Engineering Frontier Research Center for Efficient and Clean Combustion of 21st Century Transportation Fuels, led by the University of Michigan in partnership with the Massachusetts Institute of Technology, Stanford University, the University of California–Berkeley, the University of Illinois at Urbana-Champaign, and Lawrence Livermore National Laboratories. In 2008, AIChE recognized Dr. Gandhi as being among "One Hundred Engineers of the Modern Era."

Clearly, this was an extraordinary list of accomplishments by an extraordinary man, a list of accomplishments that has impacted Ford vehicles sold globally and makes each of those vehicles cleaner for our planet's environment. Haren Ghandi will be remembered for a unique combination of technical innovations and as a contributor and, at the same time, for his humility and commitment to mentorship and teaching.

Dr. Gandhi was a music aficionado, enjoying a wide array of music from the Beatles to Elvis and myriad Indian musical styles and compositions. He enjoyed traveling and experiencing diverse cultures and customs. He was fond of spending time with his family, his role as the doting grandfather, and the spoils of being the youngest son of a family of 13. Beyond his family, he cherished the company of close friends and enjoyed the opportunity to be in touch with his larger network of contacts and colleagues in the Detroit area and around the world. In addition to his passion for basic research, he was an astute businessman, with an uncanny ability to avoid market downfalls and stay ahead of the curve. Above all, Dr. Gandhi was best characterized by his principles—a man of honesty, integrity, ethics, hard work, dedication, and loyalty. These are the principles that guided his professional and personal life. It is these principles in conjunction with his numerous contributions that set him apart and made his life impactful for those who had the privilege of knowing him.

Dr. Gandhi is survived by his wife of 43 years, Yellow; his daughter Sangeeta, son-in-law Sanjiv, and their daughter Sarika; and his son Anand, daughter-in-law Mili, and their son Milan.

JOSEPH G. GAVIN, JR.

1920–2010

Elected in 1974

"For leadership in the design and production of the Apollo Lunar Module."

BY NEIL ARMSTRONG

JOSEPH G. GAVIN, JR., a highly regarded aerospace engineer and former president, chief operating officer, and director of the Grumman Corporation died on October 30, 2010, at age 90.

Joe was born in Somerville, Massachusetts, on September 18, 1920. He earned bachelor's and master's degrees in aeronautical engineering from the Massachusetts Institute of Technology in 1941 and 1942. After graduation he joined the U.S. Navy and was assigned as a jet fighter project officer in the Bureau of Aeronautics.

In 1946 he joined the Grumman Aircraft Engineering Corporation as a design engineer on Grumman's first jet fighter, the XF9F "Panther." Joe was subsequently the project engineer on Grumman's first swept wing fighter, the F9F-6 "Cougar," co-project engineer on the supersonic F11F-1 "Tiger," and chief experimental project engineer.

He was named chief missile and space engineer in 1957 and oversaw development of the Orbiting Astronomical Observatory, Grumman's first spacecraft, whose success influenced the building of the Hubble Space Telescope.

The Grumman Space Group was deeply involved in the bidding for the Apollo Command Module at the time when the mission mode was still undecided. Grumman was not on the winning team for the Command Module (North American was the winner) but, as it happened, the Space Group had been working on Lunar Orbital Rendezvous. The Group continued to work on the craft that would be required for that mode.

When, in 1962, the Lunar Orbit Rendezvous mode was approved, Gavin's team had a substantial lead and won the competition for the Lunar Excursion Module (LEM; later shortened to Lunar Module, LM). Joe Gavin, now a Grumman vice president, was named the LM program director. He directed the team to begin work immediately, although the contract was not signed until March 1963. He led the team in the design and construction of a unique vehicle, a true spacecraft that could travel only in the vacuum of space. The challenge of creating a machine carrying two men from lunar orbit to the lunar surface and back up into lunar orbit with a total weight of 32,000 pounds demanded enormous ingenuity and the very best engineering skills.

Joe continued as director of the Lunar Module program throughout the remainder of the Apollo lunar missions. Every Lunar Module was successful and, on the flight of *Apollo 13,* the LM, in a mode for which it was not designed, saved the flight and the crew after an explosion in the Service Module.

Joseph Gavin went on to become president and chairman of the board of the Grumman Aircraft Engineering Corporation and in 1976 became president and chief operating officer of the parent Grumman Corporation until his retirement in 1985.

Among other awards, he received the National Aeronautics and Space Administration's Distinguished Public Service Medal for his contributions to the Apollo program. He was a fellow of the American Astronautical Association and a honorary fellow and past president of the American Institute of Aeronautics and Astronautics.

Joe Gavin chaired the National Research Council's Committee on Earth-to-Orbit Transportation Options and the Committee on Advanced Space-Based High-Power Technologies. He was a member of the Energy Research Advisory Board of the U.S. Department of Energy and a member of the Policy Advisory Committee, Advisory Panel on Fusion Energy, for the U.S. Department of Defense.

Joe Gavin maintained a strong lifetime association with his alma mater, the Massachusetts Institute of Technology. He was a life member of the MIT Corporation and served on its executive committee from 1984 to 1991.

He was a director of the Charles Stark Draper Laboratory and a member of the MIT Education Council. He served on a number of MIT visiting committees and was president of the alumni association from 1986 to 1987.

The MIT Instrumentation Laboratory (later the Draper Lab) was responsible for the Apollo Guidance and Navigation System. Dick Battin, director of mission development for the MIT Apollo program, reported that Joe Gavin was dedicated to engineering education and often lectured in Battin's seminars.

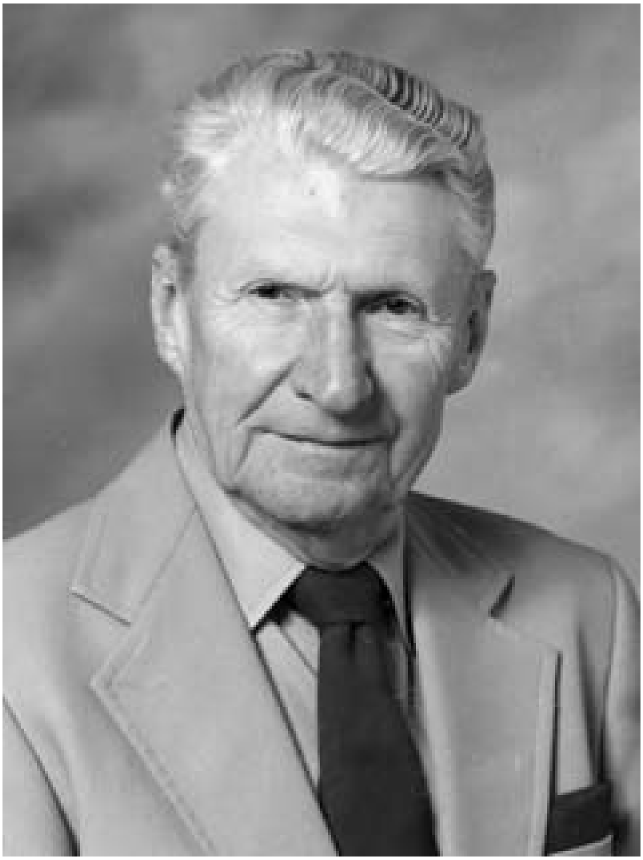
Carl Mueller, fellow member of the MIT class of 1941, called Joe "a modest gentle man whose powerful intellect and effective leadership have literally put men on the moon and returned them safely to Earth."

Joseph G. Gavin, Jr., was an engineer and engineering manager in the highest tradition of the National Academy of Engineering and will be well remembered.

His wife wrote:

> "Gavin served in many community leadership positions, including head of the school board, hospital board, and charities. He was an active supporter and fundraiser for his schools. He had a lifelong interest in learning and the advancement of science, and he was a frequent guest speaker to audiences of many levels: school children, academics and business groups. His interests included energy policy and alternative energy sources such as fusion, solar, and wind energy, and he served on some government advisory committees.
>
> He was a graduate of Boston Latin School, and was a voracious reader and a history buff. He spoke German and read Latin. One hobby was traveling with his family. As a former captain of the MIT crew, he enjoyed sports, particularly tennis and downhill skiing, until age 86."

He is survived by his wife of 67 years, Dorothy; his sons, Joseph III and Donald; and four grandchildren. A daughter, Tay Anne Gavin Erickson, died in 1998.



LESLIE A. GEDDES

1921–2009

Elected in 1985

"For his contributions in combining electrical and physiological principles with pioneering efforts in biomedical research."

BY KINAM PARK
SUBMITTED BY THE NAE HOME SECRETARY

The Geddes Way

At the northwest corner of the city of West Lafayette, the home of Purdue University, there is a street leading to a huge, Star Trek–like, pyramid-shaped building that is leaning forward as if about to tip over. It feels like one is entering the Twilight Zone when walking the street toward the building that houses MED Institute, Inc. The name of the street is Geddes Way. The street is, of course, named after Professor Leslie A. Geddes. This is a most appropriate name for the street, as Les Geddes was never afraid of crossing the Twilight Zone into a land whose boundaries are those of one's imagination. In fact, he pursued a journey into the fifth dimension of imagination throughout his entire life. To Les, imagination was the only limitation to what he did. He had a curiosity-driven, can-do-anything mindset, and such a positive attitude was the source of his endless successes until the day he died.

Les Geddes was born on May 24, 1921 in Port Gordon, Scotland. His family moved to Canada, where he studied electrical engineering and obtained his B.S. and M.S. degrees from McGill University in Montreal. Then he enrolled at Baylor University's College of Medicine, in Texas, to obtain his Ph.D. degree in physiology. Being a graduate student at Baylor brought him the opportunity to work on a part of the space program. He participated in developing impedance pneumography for measuring the respiration of astronauts who flew the Mercury and Gemini spaceships for the National Aeronautics and Space Administration. He also designed simple yet effective physiological monitoring systems that are still in use today. Most recently, he designed a simple tool for effective cardiopulmonary resuscitation that can easily provide 100 pounds of force without danger of cracking a rib or the sternum.

Les married Dr. LaNelle E. Reese in 1962. LaNelle, who led the School of Nursing at Purdue University for many years, helped Les bridge the gap between engineering and medicine. Les's research on electrodes and cardiovascular, neural, and respiratory devices and restorative tissues resulted in numerous diagnostic and therapeutic methods affecting thousands of lives. He had many patents; one of them brought the largest out-licensing deal in the history of Purdue University.

Despite his sky-high scientific achievements and adoration by his peers, Les Geddes was a remarkably down-to-earth man. He was easy to access, have a conversation with, and exchange ideas. He was *always* available to those who requested time with him, no matter who or why. He was frequently the first person arriving at a meeting place, and many times he arranged the desks and brought additional chairs to the room to make the meeting more pleasant and efficient. It all stemmed from his love and respect of people, and it was most pronounced in his teaching. He was masterful at guiding students in his classes and research group to be independent thinkers with ample curiosity, motivating them to be their best. His excellence in teaching led to his induction into the Purdue University Book of Great Teachers in 2008. Whether we knew Les through occasional acquaintance only or on a daily basis as his colleague, our impression of him was the same—what we saw is what he was. Like a good neighbor, he always tried to find something to help others and cherished and valued the wonderful people he had around him.

From his arrival at Purdue University in 1974 until his official retirement in 1991 at the age of 70, Les dedicated himself to establishing the biomedical engineering research center, which eventually became the Department of Biomedical Engineering, and then most recently the Weldon School of Biomedical Engineering. To him, retirement simply meant conducting research and teaching only with no administrative paperwork—and he loved the arrangement. For the next 18 years he served as the Showalter Distinguished Professor Emeritus of Biomedical Engineering. He came to his office before 5 a.m. and finished all his official daily business by 10 a.m. He then went back home to enjoy what he liked most—thinking. He loved thinking over a drink— a Manhattan. He mentioned that he came up with many new ideas during these quiet times.

Those who interacted with Les in any capacity knew that any of his new ideas was followed by experiment in a matter of hours. One day we were talking about condensing the exhaled breath for monitoring glucose levels, and in less than 24 hours he showed me a prototype that he had assembled. He then volunteered to be the first human subject for the experiment. I was 30 years his junior but felt like I was 30 years slower with 30 times fewer ideas. One day he left a nice bottle of liquor on my desk. It was one of the most expensive liquors one can buy. Perhaps, he wanted me to start drinking Manhattans.

Of the many awards that Geddes received during his memorable career the National Medal of Technology shines brightest. President Bush celebrated his lifelong career, and Les responded by saying, "I'm not done yet." He enjoyed his research life so much that he never thought about doing anything else. Other things simply were not as much fun as research. Following the award ceremony at the White House, adoring friends and colleagues at Purdue University gathered together to celebrate the event at a gallery in the new Martin C. Jischke Hall of Biomedical Engineering. After a remark thanking all of his associates through the years, Les finished his talk with a joke: "A man had a bottle of the best whiskey that he cherished all his life. At the time of his final days, he gave it to his brother and asked him, 'Would you please pour this whiskey on my grave?' His brother said, 'Yes, of course I will, but can it go through my kidneys first?'" If the man were Les, he could have answered, "Yes, but artificial kidneys only please."

A few years ago, over 200 friends gathered at the Weldon School of Biomedical Engineering at Purdue for a tribute to Les's lifelong achievements. Each of more than 100 of Les's former students had many stories to tell, but they were all about love and respect. Les loved his students as if they were his own children. One of his former students said that the first day he joined Les's group, Les took him to a shop to buy him a razor blade to shave his beard off to make him look cleaner and more handsome. Not only did he inspire his students, but also many scientists throughout the world. In so doing, he truly helped shape the modern medical industry. His legacy will continue to inspire future generations of scientists and entrepreneurs. To keep his legacy burning brightly, Purdue University established the Dr. Leslie A. Geddes Scholarship Fund in the Weldon School of Biomedical Engineering. The school also established the Geddes Professorship through the generosity of the Cook Group to pass the torch to a new generation of biomedical engineers.

Les was never afraid of facing his final days and continued teaching his class until five days before his death. Prior to his passing he asked for no funeral and no memorial. I believe that it was not necessary for him, as he was about to enter a new world where he would know how much we adored him and how we felt about his passing. Sometimes I wonder what new biomedical devices he is thinking of in his new place, maybe over a Manhattan. I would not know, but I can say for sure that they will be for the health and well-being of others, just as he left his body for medical research, to help improve the quality of life for us all.

In the end, it is clear that Les lived a life that was full, with no regrets, by doing what he enjoyed most until his last day. Yes, it was his way. The Geddes Way.

He is survived by his wife, LaNelle E. Geddes; a son, James; two granddaughters; and four great-grandchildren.

PAUL GERMAIN

1920–2009

Elected in 1979

"For contributions in research and education leading to the development of improved supersonic aircraft."

BY ARNOLD MIGUS

PAUL GERMAIN, a French scientist of great reputation in the field of mechanics, died on February 26, 2009, at the age of 88. A leader in the field of supersonic aerodynamics for many years, Paul Germain also wrote textbooks and taught continuum mechanics, greatly influencing engineering education in France and abroad.

Paul Germain was born in Saint-Malo, France, on August 28, 1920. His father, who was a soldier during World War I, suffered from the effects of having been gassed, and died when Paul was only 9 years old. Following this premature departure of his father, Paul Germain, the eldest of three children, developed the sense of responsibilities and commitment that characterized him all his life, in an atmosphere of big family solidarity.

Trained as a mathematician at the Ecole Normale Supérieure in Paris, he quickly became interested in fluid mechanics. In 1948 he attended the International Congress of Mechanics in London, where, thanks to Sydney Goldstein, he had the opportunity to meet a large number of talented colleagues and was invited to spend some time in the Department of Applied Mathematics of the University of Manchester, headed in 1949 by Goldstein and in 1951 by his long-lasting friend James Lighthill. His thesis on the subject of conical supersonic flows was published by ONERA (The French Aerospace Lab), where he was a group leader from 1946 until 1952, and was translated into a National Advisory Committee for Aeronautics technical memorandum. After becoming a senior lecturer at the University of Poitiers, he was invited by Professor William Prager at Brown University for the full academic year 1953–1954 to be a member of the graduate division of applied mathematics, which, as Paul Germain noted, was surprising at that time for a French scientist by its closeness to engineering.

In October 1954, coming back to France he was appointed professor in the chair of "rational mechanics" at the University of Lille. At that time, in France at least, rational mechanics was considered a branch of mathematics, dealing mostly with the application of the Newtonian theory to rigid body motions and Lagrange's analytical mechanics. Paul Germain noted in his memoirs that his progress in understanding fluid mechanics was then mostly due to his close relations with and good knowledge of the works of Paco Lagerstrom, Saul Kaplun, and Julian Cole, his colleagues during his stay at the California Institute of Technology, and later to the academic year spent by Paco in his laboratory, and also to the two visits in Paris of Milton Van Dyke for one full year each. All of them theorized on asymptotic singular expansions, which Germain came to use frequently. He also benefited much from the long stay of W. Eckhaus in his laboratory, but above all from his collaboration with his former student Jean-Pierre Guiraud.

In 1958, Germain became a professor at the University of Paris, Pierre et Marie Curie, until 1987 and from 1973 to 1985 he was also professor of mechanics at the Ecole Polytechnique. For five years (1962–1967) he left the university to be in charge of aeronautical research in France as general director of ONERA. After leaving this position he went back to research and was invited to Stanford and Berkeley. He became professor emeritus at his university in 1987 and from 1988 until 1992 was president of the International Union of Theoretical and Applied Mechanics.

Germain was elected a corresponding member of the French Academy of Sciences in 1965 and became a full member in 1970. He was elected "perpetual secretary" of the academy in 1975, with the mission to reform the institution, which he did until the end of his term in office in 1995. Among his many works should be mentioned the *Rapport sur les sciences mécaniques et l'avenir industriel de la France* (*Report on the mechanical sciences and the industrial future of France*), which had an important influence on the orientation of many people working in mechanics, on scientists in universities and research establishments, on engineers and directors of companies, and on the orientation of long-term programs. One outcome of the report was creation of the *Haut Comité de mécanique* (*High Level Committee on Mechanics)*, of which Germain was the founder and first president. After a lapse of some 15 years, in 1997 the decision was made to join together 20 small scientific and technical associations into a single society, the Association Française de Mécanique (French Association of Mechanics).

Paul Germain was in the 1950s an expert on the theory of transonic flows. He obtained many important new results in the mathematical theory of partial differential equations of mixed types, with the aim of finding a better understanding of the aerodynamical properties of transonic flows. One must also mention his significant contributions to the theory of shocks with Jean Pierre Guiraud, with whom he gave the complete theory of the shock structure—to any order—a question previously studied by Russian and American scientists but erroneously after the second order. He is also the first to have given an extensive analysis of magneto-fluid-dynamic shocks, taking into account the four main dissipative effects. In his personal contributions it may be mentioned his study of shock waves in elastoplasticity and an extension of some of these results to a two-fluid model of a plasma, showing in particular the oscillatory behavior that may exist in the structure of a shock. But his systematic application of the method of virtual power in various fields of continuum mechanics was more important. It must be emphasized that this method gives the possibility, first, to significantly reduce the classical presentation and to clarify it, for instance, for plates and shells, and second, to derive with no ambiguity the general equations of motions for sophisticated materials.

Paul Germain was elected a National Academy of Engineering foreign associate in 1979 and was recognized by many academies, including the American Academy of Arts and Sciences, the Polish Academy of Science, and the USSR (now Russian) Academy of Science.

Paul Germain's name stands extremely high in the literature of theoretical aerodynamics (with important aeronautical applications) treated by advanced mathematical methods. His work as general director of ONERA deepened the impact of his contribution to aeronautics very considerably. His leadership of an important school of theoretical fluid dynamics in the University of Paris, Pierre et Marie Curie, was outstanding. He was recognized as the strongest French research worker in his field. The development of supersonic wing shapes was particularly influenced by his contributions.

I would like to point out some other facets of his exceptional personality. Paul Germain was quietly a man of religious faith. He was a leader of his student Christian youth organization. Much later, in 1986, he became a member of the Pontifical Academy of Sciences. In 2006 he published *Memoirs of a Christian Scientist*, a work that enlightens the route and life of an outstanding figure. A final story about Paul Germain: he was quite perturbed during the academic year 1953–1954 by the statement of a young boy who filled the tank of his car at a gas station near Brown University who told him one day, "Let me be straightforward. A professor is somebody who was put to school when he was five years old and who had not enough imagination to get out." At the end of his life he could find at last the best answer to the young guy's remark by starting from the motto he was at the origin in France: "Mechanics? In the heart of a moving world!" And a professor of mechanics? One of the best spots to look at and to participate in this moving world.

Marie-Antoinette Gardent, his wife, followed him on December 19 of the same year. They had two children and eight grandchildren.

ROBERT R. GILRUTH

1913–2000

Elected in 1968

"For aircraft design and testing in subsonic, transonic, and supersonic speed ranges; development and use of satellites."

BY CHRISTOPHER C. KRAFT, JR.

ROBERT R. GILRUTH, a father of human space flight, never sought public attention, and his leadership and technical contributions were often overlooked. Of the many heroes in the early days of the U.S. space program, Gilruth was among the most respected. He led the United States in the Mercury, Gemini, and Apollo efforts and directed the greatest engineering achievement in history: the safe voyages of humans to the Moon.

I worked for Bob as director of flight operations and succeeded him as director of the Johnson Space Center. He was one of the greatest men I have ever known. He launched his career at the Langley Memorial Aeronautical Laboratory in Hampton, Virginia, concentrating on the handling qualities of airplanes. In 1945 he organized and directed free-flight experiments with rocket-powered models at Wallops Island, investigating flight dynamics at transonic and supersonic speeds. By 1952 Gilruth was assistant director of the Langley laboratory, responsible for research into hypersonic aerodynamics, high-temperature structures, and dynamic

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Adapted from the biographical memoir of Robert A. Gilruth, by Christopher C. Kraft, Jr., pp. 93-112, in *Biographical Memoirs of the National Academy of Sciences*, vol. 84 (Washington, DC: National Academies Press, 2003).

loads. In 1958 he became director of the Space Task Group and then managed the design, development, and flight operations of Project Mercury, which put Americans into space. In 1961, after President Kennedy committed the nation to land a human on the Moon, Gilruth became director of the National Aeronautics and Space Administration's Manned Spacecraft Center in Houston, Texas. He actively directed and oversaw the design and construction of spacecraft, the selection and training of astronauts, and the planning and operation of space flights. In 1973 Bob Gilruth retired from NASA. In later life he suffered from Alzheimer's disease. He died on August 17, 2000, at the age of 86.

Robert Rowe Gilruth was born October 18, 1913, in Nashwauk, Minnesota. He graduated from high school in Duluth, Minnesota, after attending public schools in several communities in that region. He studied aeronautical engineering at the University of Minnesota, where he received his bachelor's degree and then a master's degree in 1936. Bob Gilruth's first engineering experiences came from watching his grandfather carve little boats to sail on the Minnesota lakes. Gilruth's parents were both teachers. His mother had an inclination toward math, while his father was "a born teacher, but not an engineer," who loved to read the classics to Gilruth and his older sister. Gilruth did not want to follow in his parents' footsteps as an educator. "I was going to build something," he remembered later. "I wasn't sure what." Aeronautical engineering grabbed his imagination, although he would continue to invent and build boats for the rest of his life.

When Gilruth was about 11, his father lost his job, and the family moved to Duluth to find work. There the young Gilruth designed rubber-band-powered airplanes, inventing a feathering propeller to reduce drag during glide. Modestly, Gilruth later asserted that he "wasn't a very good student, and said his parents did not see much future in aviation, but the young Gilruth scoured magazines for articles about airplanes. He read *American Boy* and *Popular Mechanics*, as many boys did. When Bob learned about the National Advisory Committee for Aeronautics (NACA) from the pages of *The Saturday Evening Post,* he sent away for NACA reports on airfoils. He used the information to improve his rubber-band gliders and successfully competed in local model-airplane contests.

To save his family money, Gilruth attended junior college before entering the University of Minnesota to study aeronautical engineering. He studied structure and loading and basically "how to design an airplane," although he felt the department at that time was better at "teaching you . . . the routine things you did in an airplane company."

When Gilruth completed his undergraduate degree in 1935, the United States was so deep in the Great Depression that none of the 17 graduates received job offers in aviation. Some of Bob's classmates joined the Naval Air Corps, but Gilruth never seriously considered becoming a pilot. "I didn't think that I had time to learn to fly," he said. "And I didn't really think that it would do that much for me to be a pilot. I wanted to go to NACA. That's what I wanted to do."

The University of Minnesota gave Gilruth a graduate research fellowship. Earning $50 a month, he worked toward his master's degree on several projects. For example, he reluctantly helped on a department chief's project to build a hot-air military "barrage balloon" that depended on a ground-based generator transmitting electricity up a tether to heat the balloon's air. The project failed, and an embarrassing demonstration for the press provided Gilruth with some useful early experience.

About this time the famed French balloonist Jean Piccard joined Minnesota's faculty. Piccard, a pioneer in upper-atmosphere research, asked Gilruth to develop a valve to keep constant air pressure inside an airplane's cockpit. According to Gilruth, Piccard was very interested in helping airplanes fly high: "He said they'd be out of the thunderstorm belt, the air would be thinner, and you'd be able to go faster." And he was right. This experience primed Gilruth for his future studies of high flight.

Piccard's mentoring helped Gilruth in other ways, too. For example, Gilruth said Piccard "used blasting caps on everything. It was great for me because it wasn't too long before I was using igniters on all kinds of spacecraft," beginning with rockets at NACA's Wallops Island site. Gilruth learned much from Piccard, especially his "ways of looking at problems . . . of simplifying things." Piccard's ideas about high-altitude balloon gondolas would help Gilruth later when the Mercury capsule was being designed.

During his fellowship at Minnesota, Bob Gilruth met and married Jean Barnhill, a fellow engineering student and an aviatrix who flew in cross-country races. The new Mrs. Gilruth likewise worked with Piccard, and she helped construct an unmanned balloon that sent back telemetry on cosmic radiation. Piccard himself was married to an American, Jeannette Piccard, an engineer and a balloonist who Gilruth considered to be "at least half the brains of the family." Later, during Mercury, Gilruth would hire Mrs. Piccard to serve as a consultant.

Also at this time, for a wage of 40 cents an hour, Gilruth helped design the *Laird Watt,* a racing plane flown by the famed pilot Roscoe Turner. According to Gilruth, "I was trying to design an airplane that was going to win the Thompson Trophy Race. . . . I made good use of that experience when I went to work for NACA. . . . It was equivalent to a couple of years' experience, even though it was done while I was at school."

In his graduate project at the University of Minnesota, Gilruth investigated the possibilities of placing an airplane's propellers at the ends of its wings to take advantage of the tip vortices that are naturally produced there. However, the added effects were not large enough to follow up on his findings. In December 1936, just before he received his graduate degree, Gilruth was offered a job as a junior engineer at NACA.

Gilruth regarded NACA to be a better place to learn than graduate school and found Langley to be "an absolutely fantastic place to work." When he left Minnesota, the temperature was 20 degrees below zero with 2 feet of snow on the ground. He arrived by train in Hampton, Virginia, where it was about 45 degrees and overcast. The grass was green, and the magnolia leaves were on the trees. "I got out in that air, and . . . my goodness!" He looked around and said, "Gee, this is really neat." Jean subsequently joined Bob in Hampton, where they set up housekeeping in a small apartment. This is where they would design and build their first boat, and later design their home and await the birth of their daughter, Barbara.

When Gilruth joined NACA in early 1937, he felt the United States had not made much progress in aviation since World War I. Charles Lindbergh's 1927 solo flight across the Atlantic had been "a great shot in the arm for this country," much as Alan Shepard's *Mercury* flight would be in 1961. However, Gilruth said, "The Army flew the airmail for a while and they lost a lot of airplanes. . . . We had not made our mark in aviation." But Langley had an engine research lab, advanced wind tunnels, and a towing basin for work on seaplanes. "Best of all, they had a staff of skilled people, dedicated in how you made the airplane better."

Oddly, Gilruth was given no assignment at first. He was just assigned to a desk. As a new, young engineer he was "kind of worried, yet I hadn't done anything wrong." So Gilruth started reading. He studied all of NACA's technical reports. One day another engineer, Hartley Soulé, noticed Gilruth and said, "Here, you're not doing anything. How about working these up for me?" He handed Gilruth films that he had taken during a recent research flight. Six months later Gilruth had replaced Soulé as the engineer who flew with the test pilots. The purpose of the project was to determine quantitative criteria for the flying and handling qualities of airplanes. When Soulé was soon promoted, Gilruth became the flying quality expert at Langley.

As a result of the project, Gilruth wrote a report titled *Requirements for Satisfactory Flying Qualities of Airplanes,* which abstained from pilot jargon and put numbers to the qualities that made an airplane's characteristics good or bad. For the first time Gilruth used his concept of "stick force per g," which compares the pilot's actions to the airplane's reactions. This report helped make Gilruth's reputation. Later when World War II was raging, the British were so enamored with Gilruth's findings that they sent a team of people to consult with him in 1943.

During the war, Bob Gilruth and many other aeronautical engineers were inducted into the military, put on enlisted reserve, and then sent back to their design work. When I joined Langley in 1945, Gilruth was trying to break the sound barrier. He had invented a technique he called "wing flow." This placed small models above the wings of flying airplanes and used the accelerated flow there to study Mach conditions. "This was like making a wind tunnel along the top of a wing of an airplane," Gilruth explained. He was able to show that a thinner wing like that of a P-51 flew better around Mach speed than a thicker wing like that of a P-47. The results were so important that they were promptly classified top secret, but they helped shape the wing of the Bell X-1, which would break the sound barrier in 1947.

At about this time Gilruth and others at Langley were also dropping streamlined bodies from high altitudes. They used telemetry to measure airfoil drag as the bodies went through the sound barrier. In 1945 Gilruth was placed in charge of developing a guided missile research station on Wallops Island. His team used Doppler radar to measure missile speeds and calculate the drag of airfoils and the behavior of ailerons as they passed through the speed of sound. Gilruth's organization became known as PARD, the Pilotless Aircraft Research Division. Others joining him at Langley after the war were people like Max Faget and Caldwell Johnson; both would be major contributors in the race to the Moon.

Promoted to assistant director of Langley in 1952, Gilruth worked on several of the ballistic missiles that were being developed then. He was deeply troubled by the advent of the atomic age of warfare. He said, "I felt that things had really gotten out of hand." He was also aware of the discussion of orbiting an artificial satellite, but he wasn't much intrigued by that possibility. On the other hand, he said, "When you think about putting a man up there, that's a different thing. That's a lot more exciting. There are a lot of things you can do with men up in orbit."

Like most Americans, Robert Gilruth realized the world changed when, in 1957, the Soviet Union orbited first a *Sputnik* satellite and then a second satellite, which carried a dog named Laika. According to Gilruth, "When I saw the dog go up, I said, 'My God, we better get going because it's going to be a legitimate program to put man in space.' I didn't need somebody to hit me on the head and tell me that."

After the dog flew in space, Gilruth and his colleagues considered manned space flight. "We started scheming about what you could do." To Gilruth, "the problems of putting a man in space [and] the physical problems of the vehicle were pretty well solved before we ever really started the *Mercury* program. . . . We could do it without exceeding the gravity forces" that a man could endure. "We had experiments with couches where a man could safely stand 20 g's . . . and that's a lot more than you need for reentry."

At Wallops Island, Gilruth's teams had already studied the heat generated by high-velocity reentry. The U.S. Air Force was considering using winged reentry vehicles, but they would be too heavy. On August 1, 1958, Gilruth went before Congress to present a manned space program based on the blunt body shape, which *Mercury* would later use. Still, there were skeptics. Even Gilruth's supportive boss Hugh Dryden called the blunt body approach the same as "shooting a lady out of a cannon." Using a blunt capsule seemed a stunt to many at the time, but the new idea of using a preceding shock wave was the best way for a spacecraft to reenter the atmosphere.

Gilruth was made the leader of the Space Task Group: "I was pried out of Langley. . . . I was expected to put man in space and bring him back in good shape—and do it before the Soviets, which we didn't do." I got to work with Bob as his assistant.

Congress created NASA on October 1, 1958, and incorporated all of NACA and its 8,000 employees. Before long, NASA absorbed the space science group of the Naval Research Laboratory, the Jet Propulsion Laboratory, and the Army Ballistic Missile Agency in Huntsville, Alabama, where Werner von Braun's engineers were already designing large rockets.

At this point Gilruth's career took a turn not uncommon to first-rate engineers. He went from being leader of design and testing teams to being manager of a huge program. As his first task he hired the best engineers and managers he could find, even bringing in many from Canada. NACA's Langley largely had been an in-house operation, but NASA would work differently. In some ways, said Gilruth, "All we were was a contracting agency," letting contracts to companies large and small.

Project *Mercury* commenced. Astronauts were selected and trained, capsules were designed and constructed, rockets were tested, and the Cape Canaveral launch site was readied. But the Soviet Union beat the United States into space with the one-orbit flight of Yuri Gagarin on April 12, 1961. This event stirred the world and frightened the United States. To many the Soviets obviously led the Americans in important areas of technology. They were certainly ahead in propaganda. In Gilruth's words, "Poor President Kennedy was fit to be tied."

When Alan Shepard flew his suborbital flight on May 5, 1961, Kennedy and the American public were delighted. But now Project *Mercury* wasn't enough. By itself it was just "a dead-end program," which had already ceded space primacy to the Soviets. *Mercury* needed to be part of a bigger competition that the United States could expect to win. As Gilruth tells it, "And that's where Kennedy came along and said, 'Look, I want to be first. How do we do something?'"

Gilruth advised the President, "Well, you've got to pick a job that's difficult—that's new—that they'll have to start from scratch. They just can't take their old rocket and put another gimmick on it and do something we can't do. It's got to be something that requires a great big rocket—like going to the Moon. Going to the Moon will take new rocket technology, and if you want to do that, I think our country could probably win because we'd both have to start from scratch."

In Gilruth's later recollection, "Kennedy bought that. He was a young man. He didn't have all the wisdom he would have had. If he'd been older, he probably never would have done it." Interestingly, this decision was made in the same time frame as the failed U.S.-supported military operation at the Bay of Pigs in Cuba in April 1961.

And so on May 25, 1961, President Kennedy challenged the U.S. Congress: "[T]his nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth . . . [for] . . . one purpose which this nation will never overlook: the survival of the man who first makes this daring flight. But in a very real sense, it will not be one man going to the moon—if we make this judgment affirmatively, it will be an entire nation. For all of us must work to put him there."

Even though Gilruth was "up to his neck" in Kennedy's decision, he was still stunned when he heard the speech. He was flying on a DC-3 with NASA Administrator James Webb. They heard it on the radio. Gilruth knew well what Kennedy was going to say, "but I still was aghast that he was saying it, and that we were going to try to do it." The enormity of the challenge was overwhelming. Still, Gilruth was glad Kennedy had set a lunar landing date of "before this decade is out." Otherwise, with budgets and politics the Moon landing might never happen.

So the Apollo program was born: the most audacious engineering challenge in history. Bob Gilruth was to lead it from the new Manned Spacecraft Center to be located a few miles south of Houston, Texas. Not only did he have to manage Apollo, but he also had to build a great space center in a place that was then no more than a salt-grass cow pasture. Of Houston, Gilruth thought what many have thought: The climate is bad, the air conditioning is good, and the people are wonderful. It was also near water, where Gilruth could build his boats.

In an amazingly brief period the Manned Spacecraft Center was constructed, the Gemini flights were flown, and the Apollo spacecraft were built, all as Gilruth coordinated these activities and other efforts with the other NASA installation directors, von Braun at Marshall in Huntsville, Alabama, and Kurt Debus at Cape Canaveral, Florida. But even with the pressures of deadline and the competition with the Soviets, Gilruth demanded that things be done right. He insisted on inclusion of the Gemini flights that would develop technology and techniques for orbital rendezvous, docking, and space walks.

Then, on January 27, 1967, a fire during a ground simulation in an Apollo spacecraft test killed the *Apollo 1* prime crew: Gus Grissom, Ed White, and Roger Chaffee. Bob Gilruth was in Washington, D.C., meeting with contractors. "I got a call from [the prime contractor] North American, saying 'We just lost our crew on the Cape.' I said, 'We lost them? Nobody's flying.' They said, 'But this was on the ground.'" Gilruth couldn't believe it. None of us could. We learned it was due to a lot of bad luck and some bad work. As would happen with NASA's later space tragedies, *Apollo 1* triggered rethinking and reworking.

It also brought about a recommitment to courage. In 1968 NASA decided to fly the *Apollo 8* around-the-Moon mission much ahead of schedule. At that point, "James Webb retired because he felt that he could not face another potential tragedy after the Apollo fire of January 1967," Gilruth said. "I hated to see him leave, but I understood how deeply he felt and all he had endured since the fire."

The Apollo program was now beginning to move rather rapidly. With *Apollo 8,* for the first time in history humans had left their home planet. Everyone now realized a Moon landing was imminent. On July 20, 1969, much of the world watched as the *Apollo 11* crew set footprints on the Moon. Later flights introduced lunar rovers to the Moon's surface, and the final mission, *Apollo 17,* included a geologist, Harrison Schmidt.

But by now Apollo had lost much of its political support and the public's interest in space flight had waned. In fact, NASA had to pay the television networks to broadcast *Apollo 17.* Interestingly, this mission was the only Apollo launch that Gilruth watched in person. He preferred to be with us at Mission Control in Houston.

Ironically, Bob's interest in Apollo was waning, too. I don't mean his interest in the challenge, but his interest in risking lives to repeat what had already been done. As he put it, "We'd already flown to the Moon many times. I put up my back and said, 'We must stop. There are so many chances for us losing a crew. We just know that we're going to do that if we keep going.'" Bob Gilruth regarded the astronauts almost as his own family. The decision to halt Apollo was made with his tacit approval.

Gilruth thought the U.S. space program should look in other directions. At one time before Apollo, he was more interested in building a space station than in going to the Moon. He was also interested in opening up cooperation with the Soviets, and he made trips to Russia to prepare for what was to become the Apollo-Soyuz mission of July 1975.

Gilruth's wife, Jean, died in 1972 after the last Moon landing and during the period of his trips to Russia. He had left the Manned Spacecraft Center to work in Washington, D.C., as NASA's head of personnel development. He subsequently retired from NASA in 1973 and worked as a consultant for a short time thereafter; but soon he moved back to Houston with his new wife, Jo. Later that year they launched a 52-foot multihull sailboat, *The Outrigger,* designed and built by Gilruth in his spare time during the previous 10 years. Gilruth died in Virginia in 2000 after a long illness. In addition to his wife, Jo Gilruth, he is survived by his daughter, Barbara Jean Wyatt.

Bob Gilruth received many honors and awards throughout his career. In addition to the National Academy of Engineering, he was an elected member of the National Academy of Sciences and the International Academy of Astronautics. He was elected an honorary fellow of the American Institute of Aeronautics and Astronautics and the Royal Aeronautical Society and was a fellow of the American Astronautical Society. The Sylvanus Albert Reed Award in 1950 from the Institute of Aerospace Sciences was the first of many prestigious awards and medals he received, including the Louis Hill Space Transportation Award (1962), the Goddard Memorial Trophy of the National Rocket Society (1962), the Spirit of St. Louis Medal from the American Society of Mechanical Engineers (1965), the Daniel and Florence Guggenheim International Astronautics Award of the International Academy of Astronautics (1966), the Space

Flight Award by the American Astronautical Society (1968), the ASME Medal from the American Society of Mechanical Engineers (1970), the James Watt International Medal from the Institution of Mechanical Engineers (1971), the National Aviation Club Award for Achievement (1971), and the Robert Collier Trophy of the National Aeronautic Association and the National Aviation Club (1972). Gilruth was one of the first 10 persons installed in the National Space Hall of Fame (1969) and one of 35 space pioneers inducted into the International Space Hall of Fame (1975). He received the NASA Distinguished Service Medals in 1962 and 1969 and the President's Award for Distinguished Federal Civilian Service in 1962. Honorary doctors were awarded to Gilruth from the University of Minnesota (1962), Indiana Institute of Technology (1962), George Washington University (1962), Michigan Technological University (1963), and New Mexico State University (1970).

Robert Gilruth's achievements and life history are simple enough to trace; however, his effects on people were deep and continuing. He was such an interesting personality, a beautiful man, a true leader, and a mentor. When I succeeded Bob as director of the Johnson Space Center, I was fully ready. No one could have prepared me better.

Note: The quotes from Bob Gilruth's colleagues are from the Johnson Space Center's Oral History Project. They, along with Gilruth's own interviews conducted for the National Air and Space Museum, were the major resources in compiling this tribute.

LAWRENCE R. GLOSTEN

1918–2010

Elected in 1990

"For innovative naval architectural and marine engineering solutions to problems of ocean transport and ocean research."

BY J. R. PAULLING

LAWRENCE R. GLOSTEN, founder and president, The Glosten Associates, died February 22, 2010, in Bainbridge Island, Washington. Larry was born in New York City on August 5, 1918. His father was a retired rear admiral, having started as a merchant marine officer and later serving in the U.S. Navy in command of troop ships. Larry's interest in ships started at an early age. He was an avid reader of great sea literature as well as a builder of model ships. At an early age he had heard of the Webb Institute of Naval Architecture, which at that time was located in the Bronx, and he decided that it was where he wanted to study. After graduation from high school he took the competitive examination for Webb, was admitted, and received his B.S. degree in 1940.

Larry had joined the Naval Reserve as a student at Webb and went on active duty two months after graduation. His first assignment was to the New York Naval Shipyard, but after only a few months he was sent to the Pearl Harbor Naval Shipyard where he served as a docking officer and ship superintendent. He was at Pearl Harbor at the time of the Japanese attack on December 7, 1941, and in May 1942 was in charge of dry docking the *USS Yorktown*, which had been damaged in the Battle of the Coral Sea. In two days' time the yard completed repairs initially estimated to require 90 days.[1] This enabled *Yorktown* to play a significant role in the Battle of Midway, an action that is regarded as the turning point in the Pacific war. In 1943 he was sent to the U.S. Navy's Bureau of Ships Preliminary Design Division in Washington, D.C., and later evaluated damage to target ships as an observer to the Bikini atom bomb tests. He left active duty in 1946 but continued to serve in the U.S. Navy Reserve, retiring with the rank of captain in 1978.

Upon moving to Seattle in 1953, Glosten entered a partnership with Phillip Spaulding and Hart Livingston. His own consulting practice was established in 1958 as L. R. Glosten, Naval Architect & Marine Engineer. Much of his early work involved the design of tugs and barges for operation at sea and in river systems as widely separated as the Columbia, the Yukon, and the Nile. He designed barges to transport bulk cargo, liquid cargo, containers, and large-diameter pipes for the Alyeska pipeline. One of the barge innovations in which he was involved was the "dry tow" of very large floating structures, such as offshore drilling platforms. In these operations a barge was submerged by flooding internal compartments, the floating cargo was brought over it, and the barge was pumped dry, lifting the cargo out of the water for transport. Another unusual submersible barge design was the Hughes mining barge, part of a Central Intelligence Agency scheme intended to raise a sunken Cold War–era Russian submarine. The Glosten organization designed a number of tugs for both river and sea-going service, including small shallow draft vessels for Northern Alaska, Columbia River towboats, ocean towing vessels, harbor assist, and escort tugs.

Glosten invented the "Sea Link" articulated tow system by means of which a barge could be pushed ahead of a tug, a more efficient system than the conventional means of towing behind on a long towline. Sea Link provided a degree of motion flexibility and relief from wave-induced loads between tug and barge while still maintaining directional control of

[1] Samuel Eliot Morison, *History of United States Naval Operations in World War II,* vol. 4, p. 81 (New York: Little, Brown, 1949).

the barge. Another, totally different, articulated structure is the floating bridge, consisting of a number of interconnected floating modules, anchored in place to support a roadway crossing a body of water. Glosten performed analyses of the dynamic response to short crested waves of several of the floating bridges in the Seattle–Puget Sound area after one of them, the Hood Canal Bridge, was heavily damaged by a severe winter storm in 1979.

In the early 1960s Glosten was brought in by the Gunderson shipyard in Portland, Oregon, to consult on and prepare construction plans for a unique oceanographic research platform being constructed for the Scripps Institution of Oceanography. *FLIP* (FLoating Instrument Platform) is a slender spar structure intended to float with its axis vertical when conducting research in the ocean. It consists of two coaxial cylindrical sections, joined end to end by a conical tapered section, having the upper section of smaller diameter than the lower. The total length of *FLIP* is about 355 feet and, when floating vertically, it has a draft of about 300 feet. By evacuating ballast water from internal tanks, it can rotate (flip) to a horizontal attitude for towing. The ratio of diameters of upper and lower sections is chosen so as to minimize the motion response of *FLIP* to the ocean waves, and this results in a very stable platform from which to conduct scientific measurements even in high-sea states. *FLIP* marked the beginning of a long and mutually beneficial relationship between the Glosten organization and Scripps.

Glosten designed one other Scripps research platform named *ORB,* a research ship, *Alpha Helix,* and was also involved in the upkeep and major refits of other ships of the Scripps fleet. His work for Scripps expanded to other oceanographic research organizations, including Woods Hole, the University of Washington, the University of Alaska, and the Monterey Bay Aquarium Research Institute.

One of the Scripps scientists that Glosten worked with once observed, "The one episode that I do recall from about that time—I couldn't put an exact date on it—had to do with a discussion about the fundamental necessity for seaworthy design, and a caution not to zoom off in the direction of maximizing some other factor without due regard to possible impact on this fundamental."

An important part of Glosten's work was marine risk analysis and included such diverse considerations as dynamic loads and sea fastenings for extraordinary-sized deck cargo, the transportation by barge of radioactive materials, and the safe passage of tankers in restricted waters. An early application began in 1970 with the first Arctic Sea Lift in support of the Alaskan North Slope and the Alyeska pipeline. Barges were used to transport a variety of materials to the North Slope, ranging from thin-walled pipe to large preconstructed industrial modules, weighing up to 3,000 tons each and standing up to 150 feet high. It was necessary to determine the randomly varying loads and sea-fastening requirements to secure such cargoes during the voyage from the American West Coast through the stormy Gulf of Alaska to the North Slope. Much fundamental research on the hydrodynamics and probabilistic nature of ship motions in waves had taken place in the 1950s and 1960s, and Glosten was among the first to apply these analytical methods to such barge transportation problems.

Glosten's leadership in barge transportation technology and risk analysis led naturally into involvement in the developing field of barge transport of radioactive materials where he was involved in risk analysis, cargo engineering, operations planning, and design. The pioneering transportation of the decommissioned steam generator from the reactor in Surrey, Virginia, to Hanford, Washington, in 1980 has become a landmark referred to by all subsequent similar projects. Under Glosten's direction, the safe passage of oil tankers in restricted waters was also studied following the *Exxon Valdez* grounding and subsequent oil spill. The studies paid particular attention to the efficacy of escort tug intervention following propulsion or steering failures.

Throughout his career, Larry Glosten established a personal reputation for honesty, integrity, and adherence to the highest ethical standards that was well known in the industry.

He was a strong supporter of the education and professional development of younger engineers. Within his firm he encouraged broad-minded inquiry, technical innovation, and publication in the technical literature.

In recent years, Larry continued to participate actively in the affairs of the firm, even after completing a carefully planned transition of ownership and operation to the next generation of engineers. Other members of the firm have begun to make their own marks on the profession, but these achievements, too, can be properly credited to Larry because of the creative environment in which they flourish.

Larry was always a strong supporter of his professional society, the Society of Naval Architects and Marine Engineers, and his alma mater, the Webb Institute of Naval Architecture. For many years he was a guest lecturer and advisor to Webb, and in 1990 the Webb Alumni Association recognized his service to his profession and his alma mater with the William Selkirk Owen Award. In 1997, Webb further recognized his achievements with an honorary doctor of science degree.

Larry was a life fellow of the Society of Naval Architects and Marine Engineers, where he participated in the technical, educational, and licensing committees of the society. The society awarded him its David W. Taylor Medal, the highest award, for notable achievement in naval architecture in 1988. He was elected to the National Academy of Engineering in 1990, where he served as a resource on issues affecting the marine community.

Larry served as chairman of the board of The Glosten Associates through 2000. After retirement, he and his wife, Lois Peterson "Pete" Glosten, continued to host the firm's annual picnic at their home on Bainbridge Island to meet the newest Glosten associates.

An article that he wrote in 1995 describing the first 10 years of The Glosten Associates contained the following characteristic observation:

> "The SEA-LINK episode, with its trials, disappointments and successes, was a difficult experience that I value

> highly and would not like to have missed. It brought worldwide exposure to our organization and gave us invaluable experience in the engineering business. We earned more friends than money, but that is not an unsatisfactory outcome."

Holly farming was a much less well-known Glosten venture. It, too, generated experience and earned more friends than money but not much worldwide exposure. Approximately contemporaneous to the establishment of The Glosten Associates, Larry and Pete purchased seven acres of land on Bainbridge Island, and, with the help of son Larry Jr., Glosten planted 700 holly trees. Nominally, this venture known as Island Holly was part of a diversification strategy: The viability of one enterprise would be unlikely to affect the profitability of the other.

Most weekends found Larry and his son working on the holly farm—tending the holly trees, clearing new acreage, and planting more evergreens to generate future forests. Larry Jr. considers this experience invaluable both for the skills learned and the motivation it provided to obtain higher education. In fact, he did escape to college, leaving the holly chores to sisters Barbara and Beth. They received other benefits from the farm, as it became a place for their horses to graze. Eventually, Island Holly had a small horse barn.

The holly trees and horses flourished (as did The Glosten Associates), though it must be said that Island Holly as a business did not. This was of little concern to Larry, since the point was the experience and the joy he got from the land. After Barbara and Beth left for college, Pete and Larry built their new home among the holly trees. Larry could often be found in his wood shop, and in retirement he returned to the craft of model ship building.

Larry Glosten is survived by his son, Lawrence R. Glosten, Jr., of New York City; daughters Barbara Radovich of San Luis Obispo, California, and Beth Glosten of Redmond, Washington; and three grandchildren. Larry's wife of almost 64 years, Lois Ann "Pete" Glosten, died on June 15, 2010.

WALLACE D. HAYES

1918–2001

Elected in 1975

"For contributions to the basic understanding of transonic and supersonic flow, and the Hayes equivalence principle for hypersonic similitude."

BY RONALD F. PROBSTEIN

WALLACE DEAN HAYES, an emeritus professor at Princeton University and one of the world's leading theoretical aerodynamicists, whose numerous and fundamental contributions to the theories of supersonic and hypersonic flow and wave motion strongly influenced the design of aircraft at supersonic speeds and missiles at hypersonic speeds, died on March 2, 2001, at the age of 82.

Wally was born on September 4, 1918, in Beijing, China, where his father worked as a civil engineer. He came to the United States at the age of 10, settling in California. He received all of his higher education at the California Institute of Technology, from which he was awarded a B.S. in physics, with honor, in 1941, the professional degree Ae.E. in 1943, and a Ph.D. in aeronautics, magna cum laude, in 1947.

His early professional career began as a stress analyst in 1939 with Consolidated Aircraft and continued during World War II as an aerodynamicist with North American Aviation. He joined the Division of Applied Mathematics at Brown University in 1948, which he left in 1952 to become science liaison officer at the U.S. Office of Naval Research in London. Returning to the states in 1954, he became a professor at Princeton University in the Department of Aeronautical

Engineering, where he remained until his retirement in 1989. He also taught for periods at other universities he visited, including Delft Technical University in Holland. What was important about his teaching in Holland was that he learned Dutch and gave his lectures in Dutch. A number of Wally's friends who lectured at Delft after he did were upset with him because they were all asked why they could not give their lectures in Dutch like Wally did.

In a series of papers beginning with his Ph.D. thesis, "Linearized Supersonic Flow," submitted to the California Institute of Technology and defended on New Year's Day 1947, he developed the concepts of transonic and supersonic area rules. Although the world-famous aerodynamicist Theodore von Karman was Wally's thesis supervisor, he had never seen his work until Wally turned in his thesis, at which point he discussed the results with him. The rules define how an airplane's cross section should be designed to minimize the drag that results from shock waves that develop locally when a plane flies at speeds below but close to the speed of sound and the shock waves that develop about the airplane above the speed of sound. Credit for the transonic area rule was not accorded Wally but rather given to Richard Whitcomb, who independently but some five years after Wally's presentation of it discovered it while working at the National Advisory Committee for Aeronautics, which later became the National Aeronautics and Space Administration. This work resulted in the "Coke-bottle" aircraft design in which the airplane's fuselage was indented from the wings inward by an amount related to the area occupied by the wings from the fuselage to the wingtips.

Wally has been given full credit for the related supersonic area rule. The design concepts of his theoretical work were applied to the Convair B-58 bomber, the world's first operational supersonic jet bomber, which went into production in 1959, and to the Concorde airliner, which went into service about 10 years later along with other supersonic aircraft of the period. All supersonic aircraft incorporate the area rule considerations in their design.

The contributions of Wally to hypersonic flow theory can be traced to a series of about five basic papers, beginning with the now classic pioneering note "On Hypersonic Similitude" [1] (published in 1947) and peaking with the books (written with this author) *Hypersonic Flow Theory*[2] (published in 1959) and *Hypersonic Flow Theory, Second Edition: Volume I: Inviscid Flows*[3] (published in 1966). These works have, among other things, included the "Hayes equivalence principle," which has led to hypersonic similitudes that enable one to take the results of one series of theoretical calculations or tests and apply them to the analysis of an entire family of similar configurations. The Hayes principle now includes generalizations to a broad class of viscous and nonviscous (inviscid) flows.

Wally's development of Newtonian flow theory provides the starting point for almost all quantitative hypersonic flow theories. This theory employs the fact that at hypersonic speeds the shock wave enveloping the body lays close to the body surface, and in this thin layer the gas density is very high compared to the density in front of the shock. The shock wave has about the same inclination as the body, there is no friction between the thin shock layer and the surface, and the fluid density is essentially constant. This theory served as the starting point of almost all calculations in the hypersonic speed range, where experiment and detailed theory are often limited. Without the theoretical concepts of Hayes, the problems of design in the hypersonic speed range would have been enormous because of the difficulties involved in directly reproducing flow conditions in the laboratory.

No presentation of Wally Hayes's contributions would be complete without noting his brilliant studies on wave motion. The first of these is his book *Gasdynamic Discontinuities*[4]

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1 W. D. Hayes, 1947, "On hypersonic similitude," *Quarterly Applied Mathematics* 5:105-106.

2 W. D. Hayes and R. F. Probstein, *Hypersonic Flow Theory* (New York: Academic Press, 1959).

3 W. D. Hayes and R. F. Probstein, *Hypersonic Flow Theory, Second Edition: Volume I: Inviscid Flows* (New York: Academic Press, 1966). Reprinted as *Hypersonic Inviscid Flow* (Mineola, NY: Dover, 2004).

4 W. D. Hayes, *Gasdynamic Discontinuities* (Princeton, N.J.: Princeton University Press, 1960).

(published in 1960). In this study Wally clearly laid out the subject of the physics of shock waves in a manner that is as relevant today as when it was first published. Through visits to the Soviet Union in the early 1960s, Wally and this writer became aware of the important Russian book *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*[5] by Ya. B. Zel'dovich and Yu. P. Raizer. We thought that this work should be made available to American scientists, and our translation and editing were done from a manuscript provided by the authors of the then-forthcoming second edition. It was published in 1966 in English at about the same time as the second Russian edition, which had incorporated many of the edits and corrections of the English edition.

Somewhat after publication of the Zel'dovich-Raizer book, Wally's attention was drawn to the problem of sonic boom resulting from the motion of an aircraft at supersonic speeds through the atmosphere. His theory for the calculation of sonic boom propagation in a stratified atmosphere has become the model for all such calculations and the basis for minimizing its effect. His general theory on the conservation of wave action applies to the broad range of studies of progressive waves and can be called foundational in the subject of wave studies.

Among his honors Wally was elected to the National Academy of Engineering in 1975. He was also elected a fellow of the American Academy of Arts and Sciences, the American Physical Society, and the American Institute of Aeronautics and Astronautics, which honored him in 1965 with its Research Award. It is this writer's view that these honors alone cannot represent the depth and brilliance of Wally's contributions, which profoundly shaped our understanding of high-speed flight that is now taken for granted but for which he laid the trail.

Wally had many friends throughout the world, for he was a very easy person to have as a friend. He had a wonderful

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[5] Ya. B. Zel'dovich and Yu. P. Raizer, *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena,* edited by W. D. Hayes and R. F. Probstein (New York: Academic Press, vol. I, 1966; vol. II, 1967; corrected and reprinted by Dover Publications, Mineola, NY, 2002).

sense of humor, he almost always had a smile on his face, and he was interested in people. He was a glider pilot and small-airplane flight instructor, and he had a love for the outdoors and extreme sports, including mountaineering, ice climbing, hiking, water sports, and skiing. Unfortunately, I did not share his love for the outdoors and sports, although I did fly and ski with him. However, I fall into the cautious category when compared with Wally's daunting approaches. I recall one time when my wife Irène and I were skiing with him in Switzerland, and he suggested we ski down from the top of Piz Neir, the highest and steepest mountain in St. Moritz. When we got off at the top of the lift, not a soul was to be seen except the attendant whom Wally asked in German what the skiing was like. After he answered, Wally turned to both of us and said, "He says it's not so bad." For a moment he had forgotten that Irène understood German, and she whispered in my ear that the attendant had responded that it was "very dangerous." Our downhill speed that day exceeded anything I had ever done before or since, and as I look back on it I have never been certain just how we made it down. But that was Wally; he savored the thrills and excitement of activities that brought him to his limit, while at the same time his scientific work was the product not just of his deep insights but also of a caution that ensured every result could be justified or seen from different approaches. There was no challenge either physical or intellectual from which he would ever turn away. His curiosity was unbounded and the depth to which he would plumb an intellectual problem unlimited.

His daughter Judith wrote:

> "My sisters and I remember our dad as an unusually un-self-conscious, fun-loving person who enjoyed camping, hiking, rock-climbing, snorkeling, canoeing, both downhill and cross-country skiing, dancing, traveling, and eating really fine or interesting food. We are grateful that he shared these proclivities with us. He was very loving, capable of truly unconditional love for his kids. He was also a pretty bad procrastinator

and absent-minded professor. But when he worked, he focused like no one else we have ever met—we used to have to shake him to get his attention away from his work. Having been raised in California, he loved fruit and made his own jams and jellies. His sense of wry, dry and sometimes bawdy humor was almost always in gear. We all feel fortunate to have had this playful, adventurous, loving, and quirky man for a father."

Surviving family members are his three daughters, Carolyn G. Hayes, Judith L. Hayes, and Barbara D. Hayes; six grandchildren; and his stepbrother, retired Air Force General Peter D. Hayes. His former wife, Laura Hayes Horbatt, survived him for about a year and a half.

IRA GRANT HEDRICK

1913–2008

Elected in 1974

"For contributions to aerospace technology, particularly in the area of structures and materials."

BY RENSO L. CAPORALI

IRA GRANT HEDRICK, a guiding force in aerospace technology and former senior vice president and director of all technical operations at the Grumman Aerospace Corporation, died on January 14, 2008, at the age of 94.

Grant, as he was called by most of his peers and close acquaintances, was born in Kansas City, Missouri, on February 10, 1913. As a young man he spent one year at the University of Illinois and two years at the University of Washington. He graduated from the University of Arkansas with a bachelor's degree in civil engineering. A year of graduate work at Princeton University, with special emphasis in structural design/analysis, led to a graduate degree in 1937. From February 1942 to September 1943, Grant worked for Johnson, Drake and Piper, assigned as "contractor support" to the U.S. Army Corps of Engineers in North Africa on the design and construction of infrastructure in support of the Allied war effort in that theater of operations. He returned to the United States in September 1943 and went to work for Grumman Aircraft Engineering Corporation as a stress analyst the following month. He quickly became the project analyst for the U.S. Navy's SA-16 Albatross amphibian aircraft intended for, among other uses, open-sea rescue operations. During this assignment he developed a method for predicting hull loads that would be experienced during water landings and takeoffs that became an industry standard. This was but the beginning of a rapid rise up the technical ladder.

Grant was made chief of structures in 1946, chief technical engineer in 1957, vice president of engineering in 1963, and senior vice president and director of all Grumman technical operations in 1970—a position he held until his retirement in 1980. During that time he was directly involved both as a personal contributor and a technical overseer with every Grumman aircraft program from the Korean War–era F9F Panther through the recently retired F-14 Tomcat, as well as the Apollo Lunar Module, which successfully landed men on the Moon. During this time, Grant made contributions in the area of structural design and analysis for which he was widely recognized. His development of a simple but effective method for fatigue life prediction enabled the industry to design and guarantee the operational life of an aircraft. With proper instrumentation, this led to the ability to track the remaining life of an individual aircraft.

In the twilight of his career, Grant led Grumman's participation in the Princeton Tokamak Reactor, a federal program to study the feasibility of using fusion reactors to generate electricity. Subsequent to his retirement, Grant served as a senior Grumman management consultant until 1994.

A registered New York state professional engineer, Grant was affiliated with several professional societies. In 1974 he was elected to the National Academy of Engineering in recognition of his many contributions to aerospace technology. In 1976 he was appointed to the U.S. Air Force Scientific Advisory Board and served until 1984. He served on many advisory committees for the government, industry, and universities. Grant received the American Society of Mechanical Engineers Spirit of St. Louis Award in 1967, the American Institute of Aeronautics and Astronautics (AIAA) Sylvanus Albert Reed Award in 1971, the National Aeronautics and Space Administration's

Distinguished Public Service Medal (the agency's highest decoration) in 1984, and the Department of the Air Force's Exceptional Civilian Service Award in 1984. In 1989 he was elected an honorary fellow of the AIAA and in 2008 was elected to the Long Island Technology Hall of Fame.

Beyond his interest in technology, Grant was interested in the development of engineers of the future and in their growth on the job. He gave lectures at universities and served on several advisory boards. At Grumman he was a colleague and teacher to generations of engineers who looked up to "the technical conscience of Grumman." Some he mentored at close range. I went to work for him directly as a technical assistant from 1966 to 1968. In those two years and despite some eight years of university training, a Ph.D. in aeronautical engineering, and four years of military service as a naval aviator, it is hard to imagine a postdoctoral appointment that could have provided a better learning experience. Beyond the technical knowledge that he imparted, his demand for thoroughness and integrity taught like no textbook ever could. Without those two years of mentoring, I have no doubt that my own life's journey would have been very different.

And Grant had a life outside of Grumman. In the 1960s he decided to try the operator side of aerospace, learned to fly, and bought an aircraft that he continued to operate until advancing years and prudence suggested it was time to quit. He was also an extremely interested and accomplished tennis player—probably the equivalent of a golfer with a low single-digit handicap. At one time he and his son got to the finals of the father/son national tennis tournament on the grass at Forest Hills.

His wife Tina wrote:

> "I knew Grant Hedrick for more than twenty years as my husband's boss. When I married him in 1993, he was 80 years old and we had fifteen wonderful years together. I had been a widow for nine years and Grumman and Northrop were discussing the merger. Grant had been planning to move to California to be closer to his family, but instead he chose to stay on Long Island, where

> Grumman was located, and married me.
>
> He designed and built a guest wing and his children and grandchildren and my sons visited often. We played golf and traveled to California often and to Germany in 1997. We were both active in the development of the "Cradle of Aviation," a museum in Garden City, New York, which now houses many of the Grumman airplanes and the Lunar Module."

Grant was married to his first wife Shirley for more than 50 years. They had three children, sons Grant II (known as Bing) and Karl and a daughter Cindy.

Grant was predeceased by his first wife, Shirley, and a son. He is survived by his second wife, Tina, another son, a daughter, four grandchildren, and two great-grandchildren.

DAVID R. HEEBNER

1927–2003

Elected in 1999

"For aerospace systems engineering accomplishments that have substantially improved our national security."

BY CHARLES A. (BERT) FOWLER

One of the very few really great things I did during my Pentagon years was to lure Dave Heebner from Hughes to work in the Office of the Secretary of Defense. It was great for me; for our boss, Johnny Foster; for the U.S. Department of Defense; and for the country. It was also great for the Fowlers because the couples quickly became fast friends. And over the years we traveled, skied, golfed, and wined and dined together.

We left sitzmarks at ski slopes all over New England, the American West, and the Interlaken region of Switzerland, where in a single week we totally depleted the wine supply of the village of Meiringen—with a great deal of help, I must add, from our skiing mates, Carolyn and Dave Stanford and Robin and Bill Layson.

Those golfing ventures, which also included the Stanfords, raised the pond levels from California to Bermuda. Without fail, one of us would say to the one whose ball was up against a rock or tree, "Would you like to improve your lie?" And the other would dutifully respond, "OK. Give me a par on the last hole."

We saw many plays, art exhibits, and concerts and partook of food and refreshments at the best restaurants wherever we went.

And so it was among best friends.

Shortly before Dave's death, I said sadly to Bob Hermann, "Our old buddy Dave is not doing well." Bob said, equally sadly, that he had heard. Then he added, "But he's had a great life."

And I have thought a lot about that. Dave really did have a great life. He had a super wife, four wonderful children, and a bevy of marvelous grandchildren. His surviving loved ones are his wife of 52 years, Lynn; his son, Rick Heebner of California; his daughters, Karen Moore of Virginia, Kim Price of Maryland, and Kathy Geiger of Virginia; and his eight grandchildren, all of whom he adored.

He had a very successful career in industry. As a young engineer, his invention made the towed array practical and led to its wide use today as the principal means of detecting submarines. He was awarded the Institute of Electrical and Electronics Engineers (IEEE) Simon Ramo Medal for this extraordinary accomplishment.

He played a major role in the fantastic growth of SAIC (Science Applications International Corporation), starting an effort that changed it from a study house to a systems powerhouse. Dave rose steadily in the ranks of the company to vice chairman of the board. After retirement from SAIC, he became a consultant—an honorable profession, I must note.

In his retirement Dave also had more time to devote to his many hobbies. His winter pastime, in addition to skiing, was working on his stamp collection—a passion he developed as a child. His spring and summer hobby was gardening. He raised flowers and vegetables in abundance, to the delight of his family and friends. His major all-year-round pastime was building and flying radio-controlled model airplanes, everything from gliders to helicopters. He built them, flew them, crashed them, and then rebuilt them to fly again. They traveled with him on trips is a specially fitted travel case, so that he could fly his models in different venues.

His professional peers recognized him by election to the grade of fellow in the IEEE, the American Association for the Advancement of Science, and the American Institute of Aeronautics and Astronautics and as a member of the National Academy of Engineering. At the time it was noted that he became just the second alumnus of the New Jersey Institute of Technology to join the ranks of the Academy.

His contributions as an advisor to the U.S. Department of Defense are fabled. He led many major studies and served as chairman or vice chairman of major advisory committees.

These contributions were recognized in 2002 when he received the Eugene G. Fubini Award for giving valuable advice to the Defense Department. In presenting the award, Deputy Secretary of Defense Paul Wolfowitz noted:

> "Dave, you made the world a better place than you found it. You made our country a safer country than you found it. On behalf of Secretary Rumsfeld and Eugene Fubini, who I'm sure is here with us, it is my pleasure to present you with the Eugene Fubini Award."

Dave also possessed a marvelous perspective plus a great sense of humor. Some years ago, I started collecting one-liners. These Heebner-isms reflect those attributes:

> "Hell hath no fury like a military staff officer whose decision memo was changed by his superior."
>
> "My goal in golf is not to shoot my age but to shoot the temperature. Last week when it was 97 degrees, I shot 106; so I'm closing in on it."

Dave did indeed have a great life. And with Lynn always by his side, he did it all!

And he did it with style, grace, and humor. And, in so doing, he brought joy and warmth to all of us.

ALLAN F. HENRY

1925–2001

Elected in 1985

"For continuous outstanding achievements in the understanding of reactor kinetics and in the development of methods for reactor analysis."

BY KENT F. HANSEN

ALLAN F. HENRY was born on January 12, 1925, in Philadelphia, Pennsylvania, and spent his childhood in the greater Philadelphia area. He graduated from the Haverford School in the spring of 1942 and enrolled as a freshman at Yale University in the fall of 1942. Due to the exigencies of World War II, he accelerated his education and graduated in January 1945 with a B.S. in chemistry. Because of a high school football injury to his knee, he was ineligible for the military draft. However, he did want to serve, and he enlisted in the American Field Service. In March 1945 he was posted to the China/Burma/India theater as an ambulance driver for General William Slim's 14th British Army. He served until after the end of hostilities, returning to the United States in December 1945. From his experiences and travels in India he developed a lifelong affection for Indian spices and food.

Allan enrolled in graduate school at Yale in the fall of 1946 and changed his major from chemistry to physics. He completed his master's degree in 1947 and his Ph.D. in 1950. His dissertation, entitled "Theory of Magnetic Resonance in Nitric Oxide," was done under Professor Henry Margenau.

After graduation he took a position at the Bettis Atomic Power Laboratory in Pittsburgh. The laboratory was operated by the Westinghouse Electric Company under contract to the U.S. Atomic Energy Commission. The work was devoted to the development of nuclear power for the Naval Reactors Program. Many of the power plants for the nuclear navy were designed at Bettis, including the first nuclear submarine, Nautilus. Allan worked on reactor theory projects and rose to be the manager of the reactor theory and methods group in 1954. He declined further advancement in order to stay deeply involved in research.

Much of the work at Bettis was classified, and it was not until the late 1950s that Allan and his colleagues could publish in the open literature. It soon became evident that they had succeeded in creating a superb approach for the analysis and design of nuclear reactors.

The physics of nuclear reactors is exceedingly complex due to the nature of the fission process, the energy distribution of fission neutrons, the multiple processes by which neutrons interact with matter, and the extreme heterogeneity of reactor cores. There was no hope of analytic solutions to the governing equations, and it was necessary to find approximate techniques that were computationally feasible but also capable of providing accurate representations of the multiple phenomena. Allan and his colleagues invented, tested, and validated methods and procedures that are now the basis of almost all reactor designs for both the military and commercial industries.

Perhaps his most important contributions were in the development of methods for analyzing the kinetics of reactors. Control of reactors is vital for the safety of nuclear plants. However, the processes present in reactors span an enormous range of time constants, ranging from nanoseconds for the birth of some fission neutrons to days and weeks for the depletion of certain isotopes, such as uranium. Allan authored, or coauthored, a series of papers on representation of the multiple phenomena involved in nuclear systems, as well as techniques for quantification of the phenomena.

In 1968 he accepted a position as a visiting professor in the nuclear engineering department at the Massachusetts Institute of Technology. After a year as a visitor he agreed to remain as a full-time faculty member. He remained at MIT for 30 years before retiring in 1999 due to ill health. He led the reactor physics curriculum in the department and developed his text, *Nuclear-Reactor Analysis* (The MIT Press, 1975), which is still in wide use.

His research centered on mathematical models of reactor analysis and development of tools for the simulation of reactor behavior. He was the principal, or co-principal, investigator on numerous research projects. Over the years he supervised, or co-supervised, 66 master's theses and 72 doctoral theses. In conjunction with his students and colleagues, he authored over 100 refereed articles in the literature. As a consequence, many current methods available in the nuclear power industry for design and analysis are based on the results of Allan's contributions.

Allan was much in demand outside academia. He served as a consultant to the Oak Ridge, Los Alamos, Savannah River, and Argonne laboratories. In addition, he was a consultant to the Atomic Energy Commission, its successors the U.S. Department of Energy and the Nuclear Regulatory Commission. He also consulted for the major reactor vendors, the Electric Power Research Institute, electric utilities, and the International Atomic Energy Agency. Finally, he served as a member of the visiting committees to the nuclear engineering departments at the University of California–Berkeley and the Georgia Institute of Technology.

Professor Henry was honored by the U.S. Atomic Energy Commission in 1967 with its E. O. Lawrence Award. This award is in honor of Professor Lawrence, who was a Noble Laureate. Professor Henry was cited for his significant contributions to research and development in reactor theory. In 1980 he was awarded the Glenn L. Murphy Award by the American Society of Engineering Education for his contributions to nuclear engineering education. In 1992 he was given the Eugene P. Wigner Award by the American Nuclear Society for outstanding advances in nuclear reactor physics. While a student at Yale, he was elected to Sigma Xi. Dr. Henry was also elected a fellow of the American Nuclear Society in 1960. In 1985 he was elected to the National Academy of Engineering.

For those of us privileged to know and work with him, there were aspects of his person more precious than his scientific accomplishments. He was a person of great personal charm, compassion, and humor. He was a wonderful companion who possessed a wide range of interests and talents that made him a delight to be with. For example, he was an accomplished classical pianist who won several awards in his youth for his artistry. Although he chose science for his career, he retained a love of music throughout his life. He also enjoyed good food, good wine, and good company. A particular pleasure in his life was the theater, and for many years he took semiannual vacations to London for the theater there. He also attended the Shakespeare Festival in Canada each summer.

He grew up in a close-knit family with two older brothers, and they remained very close throughout his life. Together they owned a home on the Jersey shore, and he always spent August there with his brothers, nephews, nieces, and friends. In fact, one reason for his joining academia was for the added freedom in the summers to pursue both theatrical and family interests.

For all of his achievements, Allan remained a modest person who was always respectful of others and their opinions. He retained an almost Victorian politeness and deference to others irrespective of their station in life. He was particularly appreciated by students for his openness, kindness, and interest in their progress. He retained close contact with all of his graduates throughout their careers.

Through a long final illness he retained his sense of humor and his sense of dignity. He faced his mortality with strength and greater courage than his friends, who continue to mourn his passing.

GEORGE HERRMANN

1921–2007

Elected in 1981

"For major contributions to administration, publication, research, and teaching of applied and structural mechanics; has particularly stimulated students and younger colleagues."

BY PETER PINSKY, DAVID BARNETT, AND CHARLES STEELE

GEORGE HERRMANN, professor emeritus of mechanical engineering, passed away quietly as he sat with a friend in Zurich's main train station on his way to Lucerne to celebrate Russian Christmas, on January 7, 2007. He was 85 years old.

Herrmann played a major role in the mechanics community in the latter half of the 20th century, and his influence persists to the present day. Born in Moscow on April 19, 1921, he moved to Basel, Switzerland, with his Swiss mother (leaving behind his Russian father) in 1933 and was educated at the Gymnasium of Mathematics and Sciences, where he received his *Maturität* in 1941. He attended the Swiss Federal Institute of Technology, where he received a diploma in 1945 and a doctor of science in 1949, both in civil engineering. After a year as a postdoctoral exchange fellow and an assistant professor at the *École Polytechnique* in Montreal, Canada, he joined the Department of Civil Engineering at Columbia University in 1951. He became associate professor in 1955. From 1962 to 1970 he was a professor of civil engineering at Northwestern University, including two years as Walter P. Murphy Distinguished Professor. In 1970 he moved to Stanford

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Adapted from the *Memorial Resolution: George Herrmann* written by Peter Pinsky, David Barnett, and Charles Steele and published in the *Stanford Report,* March 11, 2009. The National Academy of Engineering wishes to thank Stanford University for permission to use the Memorial Resolution.

University. At Stanford he served as chair of the Department of Applied Mechanics and, when the department merged with the Department of Mechanical Engineering in 1975, as chair of the Division of Applied Mechanics. He held this post until his retirement from Stanford in 1984.

His research interests were broad and touched on many of the major themes in mechanics over the past 60 years: plate and shell theory, stability theory, vibrations of elastic bodies, wave propagation, and fracture mechanics. He remained active in research following his retirement from Stanford, and in later years he developed an interest in the mechanics of solids as viewed from an Eshelbean standpoint. He pursued this vigorously with longtime collaborator Reinhold Kienzler until his death in 2007. His work brought him wide recognition and a number of awards from various professional societies. These included election to the National Academy of Engineering, the Centennial Medal of the American Society of Mechanical Engineers, the von Karman Medal of the American Society of Civil Engineers, the Eringen Medal of the Society of Engineering Science, and the American Academy of Mechanics Outstanding Service Award.

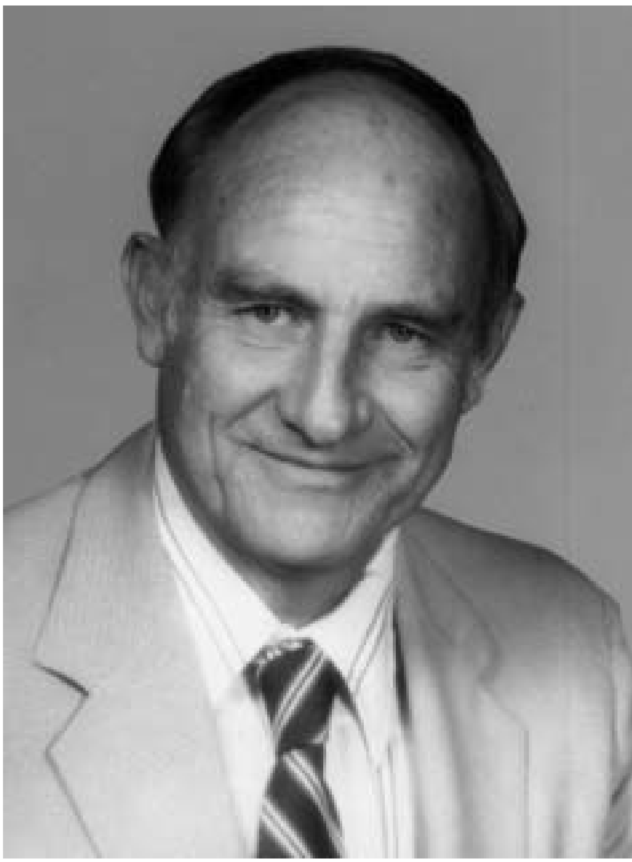
George Herrmann's service to the mechanics community was equally important. He served on innumerable boards and committees and was quite influential in the Applied Mechanics Division of the American Society of Mechanical Engineers. During an era in which important Soviet work in mechanics was largely unknown in the West, he began the English translation edition of *PMM*, the premier Russian-language mechanics journal and served for many years as its translation editor. Perhaps most significantly, he founded the *International Journal of Solids and Structures* in 1965 and served as its editor until his retirement from Stanford, building it into one of the most reputable journals in the field.

On a personal level, George Herrmann was a man of great warmth and charm. His former students recall his kindness and consideration. Particularly impressive was his uncanny ability to find the best line of attack on a given research problem, where he was often able to obtain significant results with only a minimum of tools. His lectures were clear, focused, and well organized, and his courses were always popular with students. He was an accomplished linguist and constantly amazed those around him by his ability to converse with the seminar speaker of the day in the speaker's native language. While at Stanford, he organized frequent outings, excursions, and dinners for students and faculty that did much to build a strong sense of camaraderie within the Department of Applied Mechanics and later the Division of Applied Mechanics.

At the time of his death, Herrmann's primary residence was in Davos, Switzerland, although he continued to travel extensively, including visits to Stanford several times a year. Following his retirement, he maintained much the same life he had lived as a professor. He continued to publish papers, give talks, attend and organize conferences, and collaborate on books, including *Mechanics in Material Space with Applications to Defect and Fracture Mechanics* (2000), which he co-wrote with Reinhold Kienzler. Toward the end of his life he was learning Spanish, even though he was already fluent in English, German, French, Russian, and Italian. Herrmann was an extraordinary individual with an enthusiastic, creative spirit that was never diminished.

His final journey exemplified several characteristics of his life: his Russian origins, his love of travel, and his curiosity about religion as both a scientist and a close friend, toward the end of his life, of Kirill, the current patriarch of the Russian Orthodox Church. He was married three times. The first marriage ended with the death of his wife, Elizabeth Rütschi-Herrmann, the mother of his two children, in 1978; the second marriage ended in 1983 with the death of his wife Alicia Golebiewska Herrmann. His third marriage, to Louise Ostroff, ended in divorce. His second and third marriages also brought attachments to stepdaughters Joanna Lasota and Debbie Kahn-Wand. He was a skier until late in life, and in his middle years he was also a mountaineer, which involved climbing both the Matterhorn and Piz Palü. He was an avid reader, a devotee of classical music, and a frequent visitor to art museums. He was also a gifted excursionist whose destinations often included a visit to one of many obscure baroque churches near Davos and a meal at a Michelin-starred restaurant. One of his oldest friends and colleagues, Tom Kane, put it this way: "Art, science, music—with anything [George] was interested in, he didn't waste time on anything less than the best." He saw himself as a "citizen of the world," who was interested in those he had not yet met, made friends easily with the prominent, and although certain about where he was going, was not always clear about what it was he wanted to leave behind.

Herrmann is survived by his daughter, Anne Herrmann of Dexter, Michigan; his son, Peter Herrmann of Küsnacht, Switzerland; and two grandchildren, Celine and Henrik.



WALTER HERRMANN

1930–2000

Elected in 1993

"For technical and managerial leadership in material models and tools for numerical simulation of nonlinear dynamic phenomena."

BY ORVAL E. JONES
SUBMITTED BY THE NAE HOME SECRETARY

WALTER HERRMANN was born on May 2, 1930, in Johannesburg, South Africa. He was the only child born to Gottlob Fredrich Herrmann, a hotel proprietor, and Gertrud Louise Herrmann (nee Ratzlaff). Herrmann received both his undergraduate (1953) and Ph.D. (1955) degrees in mechanical engineering from Witwatersrand University in South Africa. Dr. Hermann then taught mechanical engineering at the University of Cape Town for two years until 1957, when he was invited by the Massachusetts Institute of Technology (MIT) to work as a researcher in the Cold War effort.

He married Betty Lorraine Allard in 1955. They raised two children, a daughter, Inga, and a son, Peter, before divorcing in 1983. In 1988, Dr. Herrmann married Ednarae Bligh Gross, who preceded him in death in 1996. Dr. Herrmann was an accomplished skier, a mountaineer (he volunteered for many years for mountain rescues in New Mexico), and a cyclist. He also enjoyed river rafting and scuba diving. After retiring from Sandia National Laboratories, he was a volunteer for the New Mexico Museum of Natural History and served as a docent at archeological sites in southern Colorado. Throughout his life Dr. Herrmann was an avid traveler, and in his later years he developed a passion for tall ships, sailing, and archeology.

Walter Herrmann came to Sandia National Laboratories via the MIT Division of Sponsored Research, where he was developing his WAVE 1 finite-difference computer program for numerically calculating high-amplitude, nonlinear wave propagation in one-dimensional structures. Sandians C. Donald Lundergan and Charles F. Bild, then the director of materials and process development, along with others, recognized that computers were becoming powerful enough to realistically simulate shock-wave deformation of structures. Such deformation results from the detonation of explosives or high-velocity impact. Indeed, they were proven right; Herrmann was successful in building this capability at Sandia. During the Cold War between the United States and former Soviet Union, such capability was urgently needed for the development of new nuclear weapons.

Herrmann joined Sandia in early 1964 as supervisor of the Deformation of Structures Division. Initially, he had no staff, but he had management support to build a computer-code development team. WAVE 1 became the basis for the Sandia WONDY finite-difference computer program, which was soon used in nuclear weapons component development. Next, the Sandia TOODY computer program was developed, which enabled two-dimensional simulation and analyses of structures. Some of the important code developers included Herrmann (a formidable mathematician and computer scientist), Larry D. Bertholf, Darrell L. Hicks, R. Jeffry Lawrence, Samuel L. Thompson, Billy J. Thorne, and Robert J. Walsh. Thompson went on to develop a powerful three-dimensional code that included radiation transport.

These computer programs all required knowledge of nonlinear constitutive behavior of materials at the extreme stresses and strain rates induced by shock-wave loading. Building on Lundergan's program of projectile plate impacts, along with data from other Sandia organizations and other laboratories, the experimental data for developing constitutive models of many types of materials—metals, ceramics, polymers, composites, foams, for example—were obtained. Names of some of the key staff members engaged in this activity during the next 25 years included James R. Asay, Lynn M. Barker (inventor of the VISAR), Barry M. Butcher, Lalit C. Chhabildas, Robert A. Graham, Charles H. Karnes, Darrell E. Munson, and Karl W. Schuler. The experimental data then had to be incorporated into theoretical constitutive models in order to be used in the computer programs that were under development. Some of the key researchers in this activity included Albert J. Chabai, Peter J. Chen, Lee W. Davison, Douglas S. Drumheller, Dennis B. Hayes, Herrmann, James N. Johnson, Orval E. Jones, and Jace W. Nunziato. Many of these individuals and others were also involved in code simulations applied to pressing national problems. A particularly notable example is the work of Paul Yarrington on missile impact and cratering and warhead contact fusing. Other such contributors included Marlin E. Kipp and Timothy J. Trucano.

Over a period of more than 25 years Herrmann recruited, managed, directed, and led by example an extremely productive and internationally known organization of some 45 to 50 scientists and technicians. In 1982 he was appointed director of engineering sciences—an organization of some 140 technical staff—that, in addition to the aforementioned solid dynamics activities, included general engineering structural analysis and fluid and thermal sciences. In 1992, prior to his retirement in 1993, he was named a Sandia Senior Fellow.

Herrmann died on June 4, 2000, at the age of 71.

Survivors include his children, Inga and Peter, and stepsons, Allan and Jeffrey Gross, all of Albuquerque; a stepdaughter, Janis Gross of Longmont, Colorado; grandchildren Rishar, Mariah, and Joshua; and his former wife, Betty Lorraine Allard Herrmann, of Albuquerque.

WALTER R. HIBBARD, JR.

1918–2010

Elected in 1966

"For metallurgy."

BY PAUL TORGERSEN

WALTER R. HIBBARD, JR., of St. Augustine, Florida, and formerly of Blacksburg, Virginia, died on February 24, 2010, at his home at the age of 92. He was born on January 20, 1918, in Bridgeport, Connecticut. Retired from Virginia Polytechnic Institute and State University as a university distinguished professor of engineering in 1988, he was world renowned for his scholarship in metallurgy.

When Dr. Hibbard received the American Institute of Mining, Metallurgical, and Petroleum Engineers Mineral Economics Award in 1983, he was cited for understanding and effectively communicating "the importance of mineral economics to the nation" throughout "his outstanding career in industrial research and management."

Walter received his bachelor's degree in chemistry from Wesleyan University in 1939. Three years later he was awarded his doctorate in metallurgy from Yale University. During World War II, he served as a lieutenant in the metallurgical section of the Bureau of Ships, Navy Department, Washington, D.C.

During his last year with the Navy, he also became an assistant professor of metallurgy at Yale University. Within five years he was elevated to associate professor. Simultaneously, Walter served as director of the engineering division of the New Haven YMCA Junior College.

In 1951 Walter left Yale to become a research associate in materials processes with the General Electric Research Laboratory in Schenectady, New York. He decided he still wanted to keep a relationship with academia and joined the Rensselaer Polytechnic Institute as an adjunct professor of metallurgical engineering, a position he held from 1952 until 1965. At General Electric, Walter was promoted within two years to manager of alloy studies, a position he retained for seven years. In 1960 he became the manager of GE's metallurgy and ceramic research.

In 1965, President Lyndon B. Johnson asked Walter to head the U.S. Bureau of Mines, and he remained in Washington, D.C., for three years. Prior to leaving this post in 1968, Walter provided testimony about the threats of the adequacy of the nation's mineral supplies. His forecast at that time was that the United States would find it increasingly difficult to compete with foreign ores unless technology improved, access to the world's supply of minerals was continually sought through mutually advantageous agreements with friendly nations, and the United States developed effective techniques for recognizing events that foretell significant changes in demand patterns. Walter was quoted as saying, "The successful application of technology to meet the mineral demands of the future is the most recurring theme in the appraisals of the projected supply-demand relationship." He concluded by asking for a minerals policy for the United States.

When Walter left that post in 1968, he joined Owens-Corning Fiberglass Corporation as its vice president for research and development. After a year he became the company's vice president for technical service, based in Toledo, Ohio.

He moved back to Washington, D.C., in 1974 to become the deputy director and specialist on fossil fuels with the Energy Research and Development Office of the Federal Energy Office/Administration. His stint with the federal government was short lived, though, as he accepted an invitation within the year from Paul E. Torgersen to join the faculty at Virginia Tech.

Walter spent the last 14 years of his working career at

Virginia Tech, appointed as a university distinguished professor of engineering in 1974. In 1977 he was named the first director of Virginia Coal and Energy Research, created by the Virginia General Assembly on March 30, 1977. The interdisciplinary study and research facility for the state was, and remains, housed at Virginia Tech. In April 1990, "Virginia Coal—An Abridged History," written and compiled by Walter was released.

Governor Gerald L. Baliles of Virginia cited Walter's importance to the state's energy policy, noting his "research and analysis of Virginia's energy situation," his "numerous in-depth studies of the Virginia coal industry," and his promotion of the "expanded use of Virginia coal" as major contributions to the economic vitality of the coal industry and the state.

Walter was a registered professional engineer in three states: Connecticut, Ohio, and Virginia. He held the distinction of being named a fellow by five different societies: American Ceramic Society, American Academy of Arts and Sciences, American Association for the Advancement of Science, American Society of Metals, and Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers. He was also a member of the American Society for Engineering Education, the National Society of Professional Engineers, Cosmos Club, Virginia Academy of Science, and the National Institute of Ceramic Engineers.

He received a host of honors throughout his career, including the Rossiter W. Raymond Award of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) in 1950; the James Douglas Gold Medal of AIME in 1967; and the Henry Krumb Lecturer of AIME in 1971. He was awarded an honorary doctor of law from Michigan Tech in 1966 and an honorary doctorate of engineering from the Montana School of Mineral Science and Technology in 1968.

In 1967, Walter served as president of the AIME, one of the first national engineering societies established in the United States, known as an Engineering Founder Society. During his presidency, AIME appointed a Ten-Year Outlook Committee.

In 1966 he was elected to the National Academy of

Engineering, and his primary section was materials, with a secondary interest in earth resources engineering. Walter served as co-chairman of the National Academy of Sciences "Forum on Coal as an Energy Resource: Conflicts and Consensus" in 1977. He served on the AIME Council of Economics Meetings in the 1970s. He was a participant at the Oak Ridge meeting of Future Strategies for Energy Development in 1976. He served on the Engineering Manpower Commission (EMC) of the Engineers Joint Council, and he chaired the EMC's Conference on Measuring and Forecasting Engineering Personnel Requirements in 1978. He was also part of the organizing committee for the 1978 Conference on National Materials Policy.

For the National Academy of Engineering, he served on its council from 1968 until 1971, was a member of its Panel on Community Systems from 1979 until 1983, and was a member of its Committee on Industrial Energy Conservation from 1980 until 1986. He chaired both the Materials Advisory Board and the Building Research Advisory Board of the National Research Council and served on the National Academy of Sciences Committee on the Survey of Materials Science and Engineering.

Walter authored more than 125 technical and economic policy reports related to materials, minerals, energy, and the environment.

His son, Doug, remembers that when he and his siblings were young, "My Dad would sit at the top of the stairs and play a ukulele and sing us songs to help us go to sleep." Doug noted that this father was very proud of his football letter from Wesleyan, especially because he was a chemistry major and due to the lab work he needed to complete, he could not practice as much as nonscience majors. He worked his way through college and sent money home. He was also proud of the key blocks he made in 1938 against the University of Rochester and the U.S. Coast Guard Academy.

Walter was active as a vestry member in an Episcopal Church in Schenectady and an Anglican Church in Blacksburg and taught Sunday School in Schenectady and New Haven.

He was also a coach and leader in the Little League and Babe Ruth League.

His son also shared that his father was a good tennis player in Waterbury, Connecticut, and played against Rosalind Russell before she was famous.

Walter was preceded in death in 1970 by his first wife, Charlotte. He is survived by his second wife, Louise; his daughter, Diana H. Bitz, of Gainesville, Florida; sons Douglas T. Hibbard of St. Augustine and Lawrence R. Hibbard of Toledo, Ohio; and two grandchildren, Anthony H. Bitz of Brooklyn, New York, and Elizabeth J. Hibbard of Gainesville, Florida.

JOHN HILL

1921–2008

Elected in 1976

"For leadership in all phases of the British nuclear energy program and the promotion of international cooperation in nuclear energy undertakings."

BY CON ALLDAY
SUBMITTED BY THE NAE HOME SECRETARY

SIR JOHN MCGREGOR HILL died on January 14, 2008, at the age of 86, after two successful careers as both a physicist and a businessman. The first was in the Royal Air Force working on the perfection of radar. He left the RAF in 1946 as a flight lieutenant. His second and major career was in atomic energy, where he made a major contribution to the development of nuclear power as a commercial source of electricity in the United Kingdom. He became chairman of the United Kingdom Atomic Energy Authority (UKAEA) at the age of 46 and of its industrial offshoots British Nuclear Fuels plc and Amersham International Ltd., a radio isotope pharmaceutical company, a few years later.

Sir John was born in Chester, England, on February 21, 1921; was educated in Richmond, Surrey; and was awarded a first-class degree in physics at Kings College, London University, and later a Ph.D. at the Cavendish Laboratory, in Cambridge.

After five years in the RAF working on the development of radar and a short spell as a lecturer in physics at London University, Sir John joined the Department of Atomic Energy in the Ministry of Supply and was posted to Windscale, Cumbria, England, where he was involved in the construction and operation of two air-cooled reactors (piles) for the production of plutonium. He enjoyed telling the tale that, when he went north to Risley in Lancashire for his recruitment interview, he spent the previous night in a hotel in Warrington and enjoyed a convivial evening with other guests only to discover the following morning that he was facing them as his interview panel!

In 1954 the Department of Atomic Energy became the UKAEA, comprising three groups—The Weapons Group based at Aldermaston, Buckinghamshire; the Research Group based at Harwell, Oxfordshire; and the Industrial Group based at Risley, Lancashire. Sir John quickly made his mark and when the manufacturing activities were split off to form the Production Group he progressed up the hierarchy to become managing director. Then on appointment to the Main Board of the UKAEA as member for production, he became chairman of the group with all the fuel-cycle facilities under his wing—that is, uranium purification from yellow cake and manufacture of fuel elements, both uranium metal and uranium oxide at Springfields, Lancashire; enrichment of uranium hexafluoride for both defense and civilian use at Capenhurst, Cheshire; reprocessing of spent fuel and production of plutonium at Windscale (subsequently renamed Sellafield), Cumbria, and the Magnox reactors at Calder Hall, Cumbria, and Chapel Cross, Dumfriesshire. The latter, although built primarily for production of plutonium, produced the first commercially sold electricity from nuclear power in the world.

The cutback in defense requirements in the United Kingdom for both enriched uranium and plutonium in the early 1960s created difficulties for the Production Group. Highly enriched uranium production in the diffusion plant at Capenhurst and short-term irradiation of fuel in the Calder Hall and Chapel Cross reactors for production of plutonium were curtailed. The group recognized the need to become more commercial in its civilian activities, and Sir John and colleagues set about the task of changing the culture of the group and getting away from its civil service past and enforced secrecy. They created a cadre of sales personnel from within the company who were both technically competent and flexible. Sir John had earlier already launched himself into commercial and sales activities through negotiation of the supply of fuel for the British-built Magnox reactors in Latina, Italy, and Tokai Mura, Japan. In both instances he established himself as an honest and capable negotiator who could be trusted, and he consequently won the admiration and friendship of both customers. Similarly, when contractual relationships with the U.K. Central Electricity Generating Board and South Scotland Electricity Board for supply of fuel services were negotiated, Sir John followed the same pattern.

In 1961 the group became British Nuclear Fuels Ltd. (BNFL) with 100 percent government ownership but with provision for the introduction of up to 49 percent of private equity capital. Sir John, who by that time had become Chairman of the UKAEA, played a major part in the negotiations with government and succeeded, remarkably, in achieving a high degree of financial independence for the new company by having it excluded from the public-sector borrowing requirement, which meant the new company was not dependent on an annual parliamentary vote for its financing and was free to raise capital on the London financial market and from the European Union. This made it independent of government financing and, therefore, from day-to-day treasury control.

BNFL became extremely successful and returned substantial dividends to the government and additions to its capital value. However, the company faced increasing public hostility stemming from activities of environmental and antinuclear organizations. Anthony Wedgwood Benn, who in Harold Wilson's cabinet was secretary of state for technology, had been politically enthusiastically pronuclear, but later as secretary of state for energy was responsible for both the UKAEA and BNFL and became positively antinuclear. This was probably an act of political opportunism aimed at wooing the green antinuclear left wing of the Labour Party. Despite all the evidence and statistics to the contrary, he continued to maintain publicly that nuclear power was "too expensive, too dangerous and too environmentally unfriendly." Opponents also continually alleged that the company was shrouded in secrecy. While secrecy had stemmed from the defense era, Sir

John changed the practice early on. In a press statement on the formation of BNFL, he said, "We are no longer a secret business. Of course, we have to have commercial confidentiality as does any other enterprise dealing in new technology, but we will be open as to what we are doing, what precautions and standards we work to protect our workers and the public and we will not hide any faults which occur in our operations." He commented that "the gulf between us and the public is extraordinary. They're concerned about dangers that don't worry us while we are concerned about dangers which don't worry them." The allegations of secrecy persisted long after Sir John's period in office.

Sir John retired as chairman of BNFL in 1983, and his successor carried on his policy of business expansion and creation of a realistic competitive culture throughout the company. His ambition of achieving private participation up to the 49 percent permitted in the company's constitution was, however, never realized.

In the 1990s there was a major change in government policy. The company was deprived of its assets, many of which were sold to overseas companies, and the company was progressively run down to become a mere shell. BNFL, which had grown from its initial capitalization of £33 million to a company worth several billion, became a nonentity.

When in 1967 Sir John, at the age of 46, a top-level physicist, and an acute businessman, was appointed to follow Lord Penny, father of the British atomic bombs, as chairman of the UKAEA, it represented recognition that the role of the authority had changed from being essentially a defense organization to being at the forefront of establishing commercial nuclear electricity production in the United Kingdom. When the U.K.-designed Advanced Gas Cooled Reactor (AGR) program faltered, he strongly advocated adoption of the Steam Generating Heavy Water Reactor (SGHWR) and continued development of fast breeder reactors. Bedeviled by intense disloyalty of successive deputy chairmen, the divided opinions of industry regarding reactor choice, persistent antinuclear propaganda, and frequent changes in secretaries of state and their top civil servants responsible for energy policy, Sir John remained calm and determined.

Ultimately, however, recognizing that native reactor types would not survive in the world market, he took the brave decision to tell Wedgwood Benn that development work on both the fast reactor and SGHWR should be halted. Benn was not pleased.

A pressurized water reactor designed by Westinghouse was chosen as the United Kingdom's next reactor installation. Because of world reaction to Chernobyl and lack of government support, no further reactor stations have been built in the United Kingdom. Sir John commented: "It does not matter how well you build nuclear power stations if the public won't let you build them." However, the tide is turning now, and it is recognized in the United Kingdom that more nuclear stations must be built to secure future energy supplies.

At the same time as BNFL was formed out of the UKAEA's Production Group, the Amersham Radio Chemical Centre, operated by Research Group Harwell, became Amersham International Ltd., with Sir John continuing as chairman until 1988. Like BNFL, this proved to be a very successful enterprise.

Sir John retired as chairman of UKAEA in 1981 and subsequently, in semiretirement was chairman of Rea Brothers Group and Aurora Holdings.

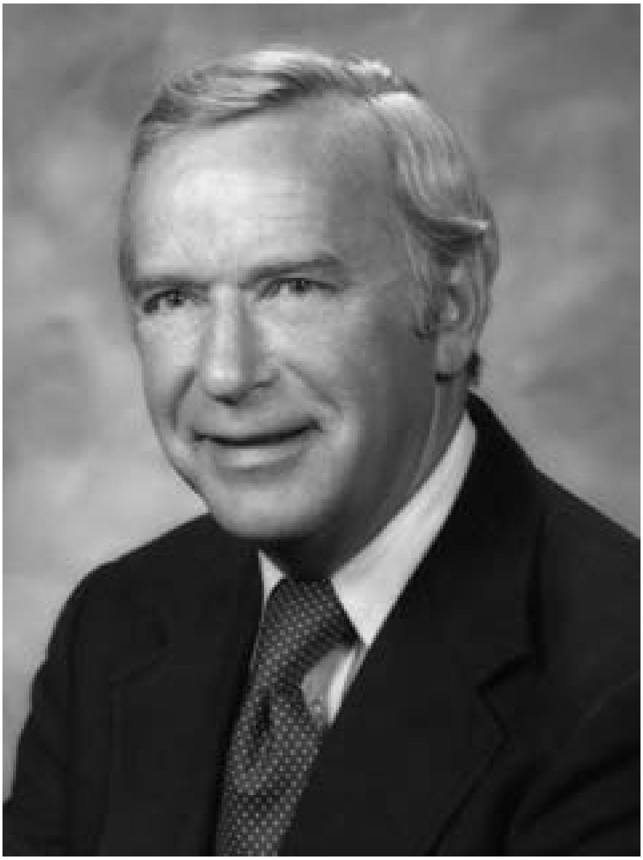
Sir John received many accolades recognizing his achievements and remarkable career: Knight Bachelor; *Chevalier La Legion d'Honneur;* fellow, Royal Society; fellow, Royal Society of Arts; fellow, Royal Academy of Engineering; fellow, Institute of Physics; fellow, Institute of Energy; fellow, Institute of Chemical Engineers; fellow, Institute of Electrical Engineers; Melchett Medal, Institute of Energy; Sylvanus Thomson Medal, Institute of Radiology; president, British Nuclear Forum; honorary member, American Nuclear Society; honorary doctor, Bradford University; and foreign associate, National Academy of Engineering.

Sir John was a keen golfer and was captain and president of the prestigious Royal Mid-Surrey Golf Club. He was a keen gardener and enjoyed family life with his wife, Nora, and their two sons and daughter, all of whom survive him.

Sir John Hill was a pioneer who made a major contribution to the development of nuclear power and established the United Kingdom as one of the world's leading countries in this field, particularly in the key fuel-cycle services of enrichment and reprocessing. It is a great pity that he had to witness the demolition of this industry by the government during a period when it became increasingly clear that the future supply of secure and affordable electricity will depend on it.

Sir John was a remarkably sociable, kind, and extremely competent scientist and businessman who reached the top posts in his profession.

We pay him tribute.



DAVID CLARENCE HOGG

1921–2009

Elected in 1978

"For contributions to the understanding of electromagnetic propagation at microwave frequencies through the atmosphere."

BY ED R. WESTWATER
SUBMITTED BY THE NAE HOME SECRETARY

DAVID C. HOGG, outstanding researcher and technical manager in the fields of antennas, radio propagation, and remote sensing, died on August 9, 2009, at the age of 87.

Dave was born in Vanguard, Saskatchewan, Canada, on September 5, 1921, and served in the Canadian Army from 1940 to 1945. It was during his five years of service overseas that he learned about radar systems, and that knowledge influenced his education and career. This career included distinguished research at two well-known organizations—Bell Telephone Laboratories in Holmdel, New Jersey, and the National Oceanic and Atmospheric Administration (NOAA) Wave Propagation Laboratory in Boulder, Colorado.

After his war service, Dave attended the University of Western Ontario (Ontario, Canada) and received his BSc. (radio physics) in 1949. He received his MSc. (physics) in 1951 and Ph.D. (physics) in 1953 from McGill University (Quebec, Canada). During his undergraduate studies, he also met his future wife, Jean MacMillan, and they married in 1947. In 1953, Bell Telephone Laboratories recruited him to Holmdel, New Jersey, and he stayed with the company until 1977.

During his career at Bell Laboratories, Dave was a member of the technical staff in the Radio Research Department from 1966 to 1977. From 1966 to 1973 he was head of atmospheric research and from 1973 to 1977 was head of antennas and propagation research. The scope of his research activities was exceedingly broad and included basic diffraction studies, microwave antenna design, tropospheric beyond-the-horizon propagation, and a plethora of studies that were fundamental in the development of satellite communication using Echo and Telstar satellites. He also performed some of the first experiments in visible and infrared propagation using lasers and was instrumental in the design of millimeter wave beacons on the COMSTAR satellites. During his distinguished career at Bell Laboratories, he was also closely associated with Nobel Prize–winning physicists Arno Penzias and Robert Wilson and was a contributing author to *Finding the Big Bang* (Peebles, Page, and Partridge, 2009). In this historical account of the discovery of the Big Bang, both Penzias and Wilson acknowledge Dave's important work.

He was elected to the National Academy of Engineering in 1978 for his activities at Bell Laboratories. In addition, he was a life fellow of the Institute of Electrical and Electronics Engineers (IEEE), a member of the American Association for the Advancement of Science, and a U.S. chairman of URSI (International Union of Radio Science) Commission F. He authored or coauthored some 80 publications in scientific journals, wrote chapters in four scientific books, and held eight patents.

In 1977, Dave moved to Boulder, Colorado, where he joined the NOAA Wave Propagation Laboratory and was chief of the Environmental Radiometry and Radio Meteorology Program Areas (1977–1986). During his tenure at NOAA, he was instrumental in developing wind profilers, radiometric profilers, and dual- and three-channel water vapor and cloud radiometers. His thrust was to develop unattended remote sensing instruments that would operate in near all-weather conditions. Many varieties of these instruments are now available commercially and are used routinely by scientists and meteorologists throughout the world for remote sensing of the atmosphere. In a series of papers in the 1980s, he also demonstrated many of the applications of the instruments to aircraft icing detection, weather modification, meteorological forecasting, spectroscopy, and observing integrated water vapor and cloud liquid on subminute temporal scales. He was awarded the IEEE Geoscience and Remote Sensing Society's Distinguished Achievement Award in 1984 and received a U.S. Department of Commerce Silver Medal in 1983. He also contributed to two NATO institutes and several committees of the U.S. Army services. In 1985 he presented a series of lectures on remote sensing at institutes in Japan and the People's Republic of China. From 1983 to 1994, Dave was also an adjunct professor in the electrical and computer engineering department of the University of Colorado, Boulder.

How was Dave able to accomplish all of this? Of course, he had the technical knowledge and skills to lead a diverse group. But he had another remarkable talent: He made everyone in his group feel their mission was very important and that each one was important in its accomplishment. The NOAA group was composed of physicists, electrical engineers, mathematicians, meteorologists, electronic technicians, data clerks, and even an ex-truck driver. For each of them he provided clearly understood tasks, integrated the tasks into a coherent program, and made each person feel their contributions were important to the mission. Like a good coach, he made everyone a little better than they really were. In addition, group pride was clearly evident.

Dave also had a special interest in developing young students and minorities. He encouraged his senior staff to bring on students using a NOAA-university cooperative program, and he, himself, took the time to develop young scientists. Again, as with his professional staff, he made the students feel that they were contributing something important to group goals, and they responded. He was also instrumental in developing the careers of several of the midcareer scientists in the group. Perhaps, he just liked to develop things, whether they were instruments, concepts, or people. And for young (and not-so-young) scientists, Dave served as an excellent role model.

After retirement from NOAA and the University of Colorado, Dave turned to another of his lifelong passions: music. He had many pieces of his classical music published by the Voice of the Rockies. He was a vocal (solo and choral) composer and a composer for strings and piano. He participated in many public performances as a vocalist, pianist, and composer. He sang at Canadian Regina exhibitions, where he composed both music and lyrics. In 1992, Dave received a composer award from the Colorado Music Educators Association, and more recently he completed a large musical composition to the *Canterbury Tales.*

Dave is remembered by his colleagues as a highly articulate spokesman for science and technology, an innovative scientist and a compassionate manager, a role model for many to emulate, and, in the best sense of the word, a true gentleman.

He is survived by his wife, Jean; son, Randy; daughter, Rebecca; son-in-law, Richard; grandchildren, Stevie, Caitlin, and Ryan; and his sister, Margaret.

His daughter Rebecca wrote:

> "Dad was a great influence on his grandchildren's lives and always took a very active role as Papa, friend and teacher.
>
> His family remembers the fun side of him. My parents enjoyed hosting many dinners and parties through the years. At Christmas parties, it was traditional for him to entertain everyone by playing the piano with the expectation that, at some point, 'Oh Canada' would be heard. Dad also loved to tell stories and always enjoyed a good chuckle when sharing the tale about fireworks and cherry bombs in the fireplace!
>
> He also loved the outdoors and stayed active throughout his life. His dog, Brandy, loved taking Dad along for their morning and evening walks. In his younger days, he joined friends in golf leagues and, in later years, golfed with his grandchildren. He was an avid skier who enjoyed family outings and spent many

years in Colorado skiing with friends in the 'Over the Hill Gang.' He was still skiing with his grandchildren into his seventies! My parents spent many summers in British Columbia visiting lifelong friends where they stayed in 'Hogg Hollow.' One of his favorite pastimes was fishing with the Loons before sun up at Lake Tyax."

GEORGE W. HOUSNER

1910–2008

Elected in 1965

As an "eminent authority on earthquake engineering."

BY PAUL C. JENNINGS

GEORGE W. HOUSNER, Braun Professor of Engineering Emeritus at the California Institute of Technology, died on November 10, 2008, a few weeks before his 98th birthday.

George was born in Michigan on December 9, 1910. He had an older brother who died very young and a sister who had polio as a child and died as a young adult. He earned his B.S. degree from the University of Michigan in 1933. Moving to California, he received his master's degree from the California Institute of Technology in 1934. After working several years as a practicing engineer, he returned to Caltech and earned his Ph.D. in 1941, doing a thesis with R. R. Martel on the response of an oscillator to arbitrary earthquake ground motion. All his degrees were in civil engineering.

He served in the Army Air Force during World War II, where he did operations analysis in Africa and Italy. During this time he showed that bombers confronted by barrage balloons could safely fly through the balloons' tethering cables because the cables would break from plastic yielding before they could damage the airplane severely. He also showed the counterintuitive result that it was more effective for a bomber trying to strike a bridge to approach the bridge perpendicular to its centerline rather than to take a path along the bridge, even though when approaching perpendicular one can only hope to take out at most one span.

George returned to Caltech as an assistant professor in 1945, where he remained the rest of his career. Although the retirement rules in place then required that he become professor emeritus in 1981, he remained technically active in the field of earthquake engineering for two more decades.

Professor Housner had an extraordinary range of accomplishments in research. Perhaps most notable was development of the response spectrum as a fundamental tool in earthquake-resistant analysis and design. He was the first to use statistical methods and techniques of random processes to characterize strong-motion accelerograms and to assess the probabilities of experiencing damaging shaking at a specific site in a given number of years. He was a leader in the development of instrumentation to measure strong ground shaking and building response and in the programs to deploy these instruments and analyze the resultant data. He also saw the need for research on the dynamic characteristics of structures, and with colleagues at Caltech led the effort to develop "shaking machines" with sufficient force and frequency control to excite large buildings, dams, and other structures to amplitudes large enough to determine accurately their natural frequencies and mode shapes. To help understand how large liquid storage tanks respond to earthquake motion, he produced now-classic papers on the dynamics of rocking and sloshing of these structures.

In other classic papers he elucidated the mechanics of the dynamic behavior of inverted pendulum structures and the bending vibrations of pipelines carrying flowing fluid. He also did some of the first studies of the nonlinear yielding response of structures to strong earthquake motion and the role of soil flexibility—the soil-structure interaction phenomenon—in the earthquake response of buildings. In the area of soils engineering, he authored a seminal study of the mechanism of sand blows, the minigeysers that often accompany major earthquakes when areas of saturated soils are shaken strongly.

George was a "real engineer" as well as a researcher, and his advice was sought on many important engineering projects in the United States and around the world. Among his consulting activities was work on the earthquake engineering challenges of the Bay Area Rapid Transit tunnel across San Francisco Bay, the California Water Project, the Tagus River suspension bridge in Portugal, the first skyscrapers in Los Angeles, industrial refineries, and offshore drilling platforms in various parts of the world. For many years he headed the consultant Board of California's Division of Dam Safety and the Seismic Advisory Board of the California Department of Transportation.

In addition to his broad range of fundamental technical accomplishments, he was an intellectual leader in a broader sense. He helped found the Earthquake Engineering Research Institute and served as its president for 12 of the first 13 years of its existence. During this time he guided the early development of the institute and laid the groundwork for the transition of the institute into the strong and active technical society that it is today. He also played a key role in the founding of the International Association for Earthquake Engineering and served as its president for four years. This organization holds world conferences on earthquake engineering every four years and promotes cooperation among the many national societies active in this very international field. George continued to influence both of these organizations long after he was out of office, participating in many of their activities and serving the role of elder statesman.

One of the first technical delegations to the People's Republic of China after President Nixon's visit opened up relations was a National Academy of Sciences–sponsored delegation in earthquake engineering in 1978. This team, led by George Housner, reported back on the status of earthquake engineering research and practice in China and on some of the effects of the disastrous Tangshan earthquake of 1978, which killed an estimated 650,000 people. This visit also led to the subsequent publication, in both Chinese and English, of a detailed, multivolume report on this most destructive earthquake, which George meticulously edited.

George was elected to the National Academy of Engineering

(NAE) in 1965, in the first election after that of the founding members, and to the National Academy of Sciences (NAS) in 1972. He participated widely in the work of both NAS and NAE committees dealing with earthquake engineering, seismology, and natural disasters. He chaired the Engineering Section of the NAS from 1978 to 1981 and committees of the NAE and the National Research Council (NRC). He chaired the Engineering Panel of the National Academy of Sciences Committee on the Great Alaska Earthquake of 1964, editing and overseeing publication of arguably the most extensive report ever produced on earthquake effects on engineered structures and facilities. He also chaired the NRC Committee on Earthquake Engineering Research, producing a report in 1969 that greatly influenced earthquake engineering research in the following decades. Later, in 1982, he chaired the NRC Earthquake Engineering Research Committee reprise of this effort, producing the report *Earthquake Engineering—1982,* which was also very influential in determining the path of subsequent earthquake engineering research.

He was also chair of the NAE's Committee on Natural Disasters, which dealt with tornados, hurricanes, and floods, in addition to earthquakes. After the Loma Prieta earthquake in 1989, which caused severe damage to freeways and bridges in the San Francisco Bay area, George was appointed by California Governor Deukmejian to chair the Governor's Board of Inquiry on the earthquake and to prepare responses to key questions that arose from the earthquake's damage and to make recommendations for future practice. The resulting report, *Competing Against Time* (Earthquake Spectra, 1990), is a landmark in the field.

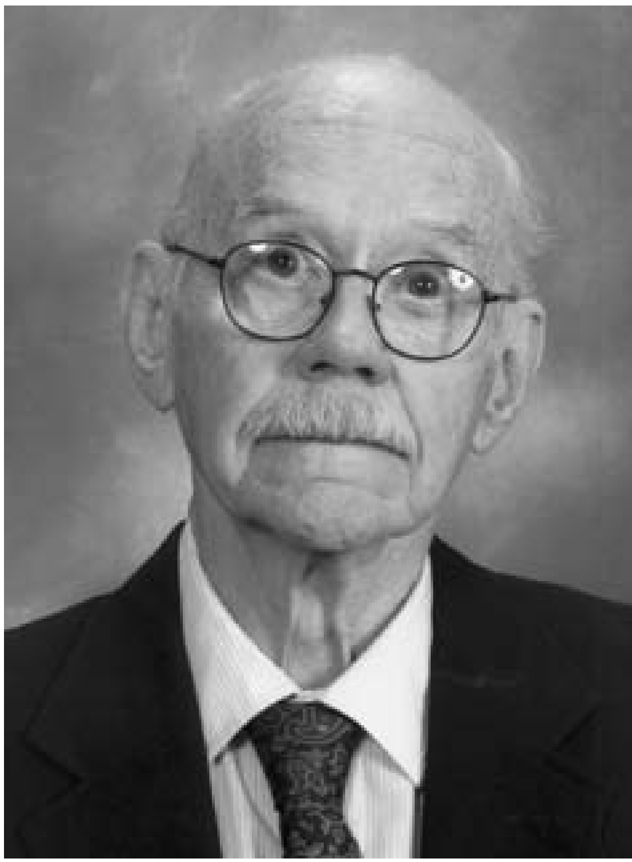
George's strategic leadership and excellent research contributions were widely recognized. The NAE honored him with its Founders Award in 1991, and in 1988 President Reagan awarded him the National Medal of Science. He earned the Von Karman, Newmark, and Norman medals from the American Society of Civil Engineers, in addition to being made an honorary member. The society also published a collection of his technical papers in its Civil Engineering Classics series.

The volume, entitled *Selected Earthquake Engineering Papers of George W. Housner*, contains 54 of his many papers in the field.

He was elected to honorary membership in several national and international engineering societies and received honorary doctorates from the University of Michigan and the University of Southern California. As noted above, he was one of the founding members of the Earthquake Engineering Research Institute, and that technical society established the George W. Housner medal in 1989. Appropriately, he was the first recipient. Another organization he helped establish, the Consortium of Universities for Research in Earthquake Engineering, honored him with a symposium in his name on the occasion of his 85th birthday.

For his unique role in the field of earthquake engineering, George was often called the "Father of Earthquake Engineering."

George never married. He lived modestly and he invested well. He left the bulk of his substantial estate as an endowment to the California Institute of Technology, where the funds are used to provide scholarships for graduate students, research support for earthquake engineering projects, and support for undergraduate research and other scholarly activities. Another part of his estate—his large collection of historic scientific books—was left to the Caltech Archives.



W. J. JACK HOWARD

1922–2010

Elected in 1979

"For contributions to nuclear ordnance engineering, particularly in systems concepts, command, control, intelligence, and safety."

BY JULIA M. PHILLIPS

W. J. "JACK" HOWARD, a former executive vice president at Sandia National Laboratories who was a valued national advisor on U.S. nuclear policy, passed away September 13, 2010, at the age of 88.

Born in Kimball, Nebraska, on August 25, 1922, Howard came to New Mexico with his family when he was a junior in high school. He graduated from what is now New Mexico State University with a bachelor's degree in mechanical engineering and served in World War II. While serving at Clark Air Force Base in the Philippines, after a mountain airplane crash that killed the pilot, he hiked for six days along a stream with a shattered kneecap, until he found help. During his military service he earned the rank of captain and the Combat Infantry Badge, Bronze Star, and Purple Heart.

In 1946, Howard joined the Z Division of Los Alamos National Laboratory, which became Sandia National Laboratories in 1949.

During his career at Sandia National Laboratories, Howard racked up a notable list of achievements in weapons work. He directed the ordnance engineering design and development of the first Polaris missile warhead, which led to Sandia receiving a Certificate of Merit from the U.S. Navy. In addition, he was the motivating force behind the concept of the nuclear warhead and delivery system, which led to what is known as the "Davy Crockett" infantry weapon system. The system was designed for use by the U.S. infantry in Europe against Soviet troops during the Cold War.

Safety and control of nuclear weapons were priorities of Howard. "He was a forward-looking person in a very pragmatic sense," according to Orval Jones, a former executive vice president at Sandia who first worked with Jack in 1973. "Jack saw the need to really aggressively pursue nuclear weapons safety." To prevent unauthorized detonation of nuclear weapons, he recognized early the need for built-in control of the arming sequence of U.S. nuclear weapons. He participated in the preliminary design of the Permissive Action Link (PAL) system, a coded switch inside a nuclear weapon that blocks the arming signal and requires an order from the President of the United States to pass through the proper channels for activation.

In 1969, Howard was instrumental in establishing an independent nuclear safety assessment group at Sandia. The group oversaw an ongoing safety review of existing nuclear weapons, developed new safety technologies, and developed techniques for evaluating evolving safety concepts.

Perhaps Howard's most publicly visible achievement was his leadership of the California site of Sandia National Laboratories in Livermore. In 1956, Howard was assigned to inaugurate the new laboratory to provide ordnance engineering support to what is now known as Lawrence Livermore National Laboratory. Retired Sandia Laboratory Director Tom Hunter recalled, "I would describe Jack as one who laid the foundations not just for our nuclear weapons program but also for [Sandia's] values of national service and excellence."

Concurrently with his tenure at Sandia, Howard became a valued advisor in formulating and guiding the implementation of national nuclear policy and served the nation in various capacities. From 1963 to 1966 he served as assistant to the secretary of defense for atomic energy at the U.S. Department of Defense (DOD) and was the chairman of the Atomic Energy

Commission's Military Liaison Committee. During this time he assisted with ballistics support to locate a missing nuclear weapon near Palomares, Spain, after the collision of a B-52 and tanker aircraft during a refueling operation. Defense Secretary Robert McNamara awarded Jack the DOD Medal for Distinguished Public Service for his work. In 1976 he was appointed to serve as a delegate to the Strategic Arms Limitation Talks in Geneva, Switzerland.

Howard retired in 1982 after 35 years at Sandia, nine of them as executive vice president. He was inducted into Sandia's Hall of Fame in 2010, only the third Sandian to be so honored. This honor recognizes former employees who made pivotal contributions that have significantly enhanced Sandia. As Labs Director Paul Hommert said: "Jack Howard's contributions to Sandia and [to] national security were immeasurable, from his nuclear weapons work to his advocacy of nuclear weapons safety to his leadership establishing Sandia's California site. His actions over a 36-year career shaped the Laboratory into what it is today, and for that we are grateful."

In his retirement, Howard enjoyed flyfishing, golf, and his home and family. He received an honorary doctorate from New Mexico State University and was elected to the National Academy of Engineering in 1979, "for contributions to nuclear ordnance engineering, particularly in systems concepts, command, control, intelligence, and safety."

Howard was preceded in death by his wife of 61 years, Georgia. He is survived by his daughter Melissa Howard, of Cedar Crest; his son Andrew and wife Sandra Howard, of Chicago; his granddaughter Rebecca Howard and husband Oliver Soell; grandson Gabriel Howard; and his dog Cruces.

FREDERICK JELINEK

1932–2010

Elected in 2006

"For contributions to statistical language processing with applications to automatic speech recognition."

BY BIING-HWANG (FRED) JUANG AND LAWRENCE RABINER

FREDERICK JELINEK, an information-theoretic linguist, died September 14, 2010, of a heart attack, at the age of 77. Jelinek was a Czech American researcher in information theory and natural language processing. Born just before the war, on November 18, 1932, in Czechoslovakia to a Jewish father (who was a dentist and died of disease in the Theresienstadt concentration camp in 1945) and a Catholic mother (who converted to Judaism), Fred Jelinek and his family managed to escape being sent to the concentration camps, due to his mother's background, and to eventually emigrate to the United States in the early years of the communist regime.

Jelinek studied the newly developing field of information theory at the Massachusetts Institute of Technology under Professor Robert Fano. Jelinek had begun to develop an interest in linguistics after the immigration of his wife, who initially enrolled in the linguistics program at MIT; he often accompanied her to linguistics classes. After his graduate degree, he joined Cornell University in anticipation of the opportunity to work with Charles F. Hockett, a prominent linguist there. Although the intended research program in linguistics fell through, Jelinek went on to teach and develop information theory at Cornell in the subsequent years before joining IBM Research in 1972. Jelinek's affiliation with Cornell was not a long one, but he deserved credit for the creation and recognized prominence of Cornell's program in information theory.

Interestingly, at IBM, Jelinek got the opportunity to pursue research in the two fields of most interest to him—linguistics and information theory—through the challenge of designing an automatic typewriter that would respond to the human voice. He saw speech recognition as an information theory problem, rather than the traditional view that speech recognition could (or to some, should) be solved using fundamental principles in acoustics and/or linguistics (or more likely a combination of the two technologies). As an admirer of Claude Shannon, the "Father of Information Theory," Jelinek's approach followed the fundamental teaching of the "Shannon game," in which a person competes with a computer, which keeps an array of conditional probabilities that define the odds of a given word following a specified sequence of words, in completing a partial sentence.

Information theorists believe that a machine that chooses the most probable word to succeed the three (or more) preceding (already seen) words would be more statistically likely than the guess made by a human, thereby winning the game. The machine need not actually understand or guess the meaning the sentence really intends to express. The computer-selected word is thus based on the so-called *n*-gram statistical grammar commonly used in speech recognition systems today. With such types of grammar as the discrete source models, Jelinek treated the speech recognition problem, or rather the natural language processing problem, as a noisy-channel discrete decoding problem and advocated the method of maximum likelihood decoding. This statistical approach to linguistics, built on the framework of information theory, stayed in the course of the axiomatic probability theory, avoided the mathematically intractable problem of human intelligence, but clashed with the conventional discipline of linguistics.

Jelinek was well known for his wry humor, most especially this oft-quoted quip: "Every time I fire a linguist, my payroll goes down and the performance of my speech recognizer goes up." Jelinek's engineering results, as manifested in systems such as IBM's Tangora, eventually won the respect of many practically minded linguists or linguistic engineers and earned him many distinctions, including induction into the National Academy of Engineering. Jelinek can be considered a pioneering figure in the field of information-theoretic linguistics and its most prominent advocate.

In 1993 Jelinek retired from IBM and joined John Hopkins University as director of the Center for Language and Speech Processing and Julian Sinclair Smith Professor of Electrical and Computer Engineering. Soon after joining Johns Hopkins, Jelinek started to organize the annual summer workshop on spoken-language research, which has benefitted many young-generation research engineers and students, even to this date.

Jelinek won numerous distinctions. He received the Signal Processing Society Award of the Institute of Electrical and Electronics Engineers in 1997, the ESCA Medal for Scientific Achievement in 1999, the European Language Resource Association's first Antonio Zampolli Prize in 2004, the James L. Flanagan Speech and Audio Processing Award in 2005, and the 2009 Lifetime Achievement Award from the Association for Computational Linguistics. He received a *honoris causa* Ph.D. from Charles University in 2001 and was inducted into the National Academy of Engineering in 2006.

Fred Jelinek is survived by his wife, Czech screenwriter Milena Jelinek; a daughter and son; a sister and stepsister; and three grandchildren.

AMOS E. JOEL, JR.

1918–2008

Elected in 1981

"For inventions and contributions to switching system developments for the nationwide public telecommunications network."

BY W. O. FLECKENSTEIN
SUBMITTED BY THE NAE HOME SECRETARY

AMOS E. JOEL, JR., a world authority in the field of switching, died October 25, 2008. He was 90 years old. Amos was born in Philadelphia on March 12, 1918. He was fascinated with electronics in his childhood and graduated from DeWitt Clinton High School in the Bronx. He earned his bachelor's (1940) and master's (1942) degrees in electrical engineering from the Massachusetts Institute of Technology (MIT). After graduation he was hired by Bell Laboratories, where he worked for 43 years. During World War II, he designed circuits for general-purpose digital computers and was instrumental in the development of coding and decoding machines for military and diplomatic uses.

Amos Joel was totally engaged in switching technology for his entire adult life. In his career at Bell Laboratories he was involved in many projects, was a prolific inventor, wrote a great deal about switching technology, and participated in many education and training programs. One could make a very long list of his contributions. For this tribute I have decided to focus on three contributions that I believe are major:

First, the Automatic Message Accounting (AMA) system, which was a necessary ingredient in the move from operator-handled toll calls to Direct Distance Dialing (DDD) by the customer.

Second, the system design of the first Electronic Switching System (ESS).

Third, the design of the Traffic Service Position System (TSPS) to provide much more efficiency for operator handling of special calls.

Automatic Message Accounting

The evolution of the telecommunications network in the United States is a rich technical story. It has been a continuous process from the very beginning. One of the biggest steps in that evolution was the move from operator handling of toll calls to direct distance dialing by the customer. The planning for that move, carried out by Bell Laboratories, was one of the finest pieces of systems engineering I have ever seen. The main ingredients of the plan were as follows: a standard 10-digit numbering plan for North America that gave a unique destination code for every telephone line on the network, a network hierarchy and routing plan so the common control switching systems of that time could route calls through the network efficiently, and an automatic system for billing the customer.

The billing system involved a system in the local central office to record the details of all long-distance calls for that office. The storage medium at the time was embossed paper tape. The tapes were shipped to a central AMA center, where the call records were automatically assembled and calculations were made for billing the customer. I was a relatively new employee at Bell Labs when this work was done and was not directly aware of individual contributions. However, I have been told that Amos Joel was a major contributor to the design of the AMA system.

Electronic Switching

With the invention of the transistor in 1948 and the rapid advances in semiconductor electronics, it quickly became clear that the speed of these technologies would be a major advantage in common control switching systems. At that time Amos worked in a small systems engineering group and did the first system design of a local electronic switching system. In 1976, I nominated A. E. Joel, R. W. Ketchledge, and W. Keister for the IEEE Bell Medal, which they won—Joel for the early system design, Ketchledge for the hardware implementation, and Keister for stored program control.

Traffic Service Position System

Even though customer dialing of long-distance calls reduced substantially the need for operators in the Bell System, many operators were still needed to handle special types of calls, such as collect calls, person-to-person calls, and charge-to-third-number calls. Amos Joel was a major contributor in the development of the Traffic Service Position System, which was a console for the operator with as much automation as possible to provide as much efficiency as possible in handling these special calls.

In the 1970s when I was made vice president of switching systems in Bell Labs, one of the major goals that I set for my organization was to reduce the operator force in the Bell System by 50 percent. The TSPS system was one of the major tools that allowed us to meet that goal.

The three major contributions discussed above and a myriad of other contributions mark the stellar technical career of Amos Joel. In 1981 he received the Franklin Institute's Stuart Ballentine Medal and was elected a member of the National Academy of Engineering. He received the Kyoto Prize in Advanced Technology in 1989.

He is survived by his daughters, Stephanie Joel of New York City and Andrea Joel of Burbank, California. His wife, Rhoda Fenton, died in 2000, and his son, Jeffrey, died in 2003.

Additional contributions from Andrea and Stephanie Joel:

"Yes, my career has been one-of-a-kind, and interaction with many friends at Bell Laboratories, in the Bell System, and from around the world, who made it possible."—Amos E. Joel, Jr., April 18, 1983 (upon his retirement)

From a very young age, we knew that we had an extraordinary father.

For “Show & Tell” in grade school, we brought a copy of our father’s patent for the “Automatic Message Accounting System, “ which, at the time, as profiled on the front page of the “Business Section” of *The New York Times*, was the largest patent granted by the United States Patent Office (USPO). So we knew that our father was some sort of a creative/scientific genius—if not a bona fide, local celebrity.

However, in our home, he was a dad who worked hard, had a fabulous and mischievous sense of humor, loved Italian food and chocolate, was fascinated by trains—especially the GG1, and appreciated all kinds of music, which he played nightly on his Yamaha or Hammond organ. Family time was spent mostly at dinners, holidays, and summer family vacations, many of which took place on Cape Cod. Although his work was very intense, he was always a very gentle, quiet man with a twinkle in his eye. His great joy was in making us laugh.

His love of inventing and patents became stuff of legends in our house. We always loved to hear the story of how he met our mother on a blind date. He invited her up to his room at MIT to see his patents—which, in fact, he really did! Although Mom thought he was crazy, they were married for a fantastic 58 years!

Dad’s “love affair” with inventing did come at an early age. At 14 he developed a personal telephone system for himself and his friends. To us these were his “juvenile delinquency years,” whereby he connected all of his friends on West 86th Street in New York City, using phone lines in abandoned apartments that were vacated because of the Depression. We were always amused at this story and how a telephone repairman discovered the rigging and threatened to send him to “juvey hall” if he didn’t disconnect it pronto. How easily his brilliance could have been channeled for “evil” rather than for the greater good of humanity!

NOTE: This system was the forerunner of his future “Joel All-Relay Dial System,” which was the basis of his graduation thesis from MIT.

Throughout his formative years, Dad’s fascination with inventing and technology grew increasingly stronger.

There was no question that he wanted to work for only one company—Bell Telephone Laboratories (Bell Labs), the scientific/research/development arm of AT&T. Although that almost didn't happen, Bell Labs hired him in 1941, after he graduated from MIT.

When the United States entered World War II, Bell Labs was instrumental in the development of electronics and communications technologies. Our father's contributions to these efforts were immeasurable. He was part of the team that developed and created designs for early digital computers and cryptanalysis machines, code named "Project X." British computer pioneer Alan Turing used some of Dad's ideas in the development of the "Colossus" machine, which helped crack the German "Enigma" code.

Dad's group also designed a scrambler code named "Sigsaly." This allowed for private encrypted communication between Winston Churchill and Franklin D. Roosevelt. For this extraordinary accomplishment, along with his colleagues, Dad's name appears on the wall of Buckinghamshire, the wartime code-breaking center at the Bletchley Park Museum. Dad was always proud of his wartime achievements and the impact that they had on the outcome of the war. Fast forward to 1994. His daughter, Andrea, already an Emmy Award–winning set decorator for CBS, was able to put the art director of the television miniseries, "World War II: When Lions Roared," in touch with Dad. CBS needed help in re-creating the room from which Churchill conversed with FDR—a room, of course, with which Dad was very familiar—and had actual pictures of the room that he could now share.

It was interesting attending the theater with Dad in 1987 to see "Breaking the Code," a play about Alan Turing and the breaking of the "Enigma" code. It was the first time we met any of Dad's colleagues who worked with him during the war. Clearly, the audience was filled with as many wartime "celebrities" as there were on stage!

In 1946, after World War II, Bell Labs realized the importance for engineers to learn about electronic switching. Dad was instrumental in providing an electronic switching curriculum to the newly formed "school," which enabled him to go from one facility to another to train Bell's engineering staff. So Dad became a "traveling professor," a responsibility that he embraced until he retired in 1983.

Our brother Jeffrey, who was a mathematician, had a greater understanding regarding what our father did for a living, but nowhere was his celebrity more apparent than during the 1964 World's Fair. Dad was instrumental in the development of the AT&T Pavilion, which at the time was showcasing the "Picture Phone." Although our father would have been content to wait in a lengthy line for all of us to view the exhibit, on which he had labored day and night, our mother soon showed him the error of his thinking.

Throughout the development of this pavilion, family dinners were constantly interrupted by calls from Robert Moses, requiring Dad to drop what he was doing and travel to the site in Flushing Meadows, Queens. From Mom's perspective, at the very least, we should be given preferential treatment rather than wait in line. Sheepishly, Dad went to the head of the line and spoke with the manager, gaining our immediate entrance. We were treated to a private tour of the exhibit with Dad's running commentary. Within no time he had amassed a large audience, which crowded around him to hear what he had to say.

Over the years Dad received many awards and acknowledgments for his significant contributions:

1976: He was awarded IEEE's Alexander Graham Bell Award. He accepted this award with William Keister and Ray Ketchledge, "for conception and development of Electronic Switching Systems and their effective introduction into a nation-wide telephone system."

1981: He was awarded the Franklin Institute's Stuart Ballantine Medal for "his achievement in bringing into being the electronic switching system (ESS) and for his contributions towards the many functions it makes possible for modern telecommunications."

1987: He was instrumental in the development of the IEEE (Institute for Electrical and Electronics Engineers)

Communications Society, which honored him in 1987 as the "Father of the ISS International Switching Conference." From that time on, he was known to his colleagues as "Mr. Switching."

NOTE: The forerunner of the IEEE was the AIEE (American Institute of Electrical Engineers). Encouraged by Bell Labs, Dad helped promote the need for and oversaw the development of a "Switching Committee." This committee eventually became the International Switching Symposia (ISS).

1989: He was awarded the Kyoto Prize in "recognition of eminent achievements in the field of telecommunications."

1992: He was awarded IEEE's highest honor, its Medal of Honor. This marked the first time that our entire family attended an awards ceremony—including his father. How proud was he!

1993: He was honored by the United States with the National Medal of Technology for "his vision, inventiveness and perseverance in introducing technological advances in telecommunications, particularly switching, that have had a major impact on the evolution of the telecommunications industry in the U.S. and worldwide."

2008: Perhaps the most treasured recognition was bestowed upon him within his last year. At the age of 90 he was inducted into the National Inventors Hall of Fame for "his U.S. Patent #3,663,762 on the Mobile Communication System." "This basic patent on cellular switching pioneered the most rapidly growing segment of the telecommunications industry. His invention allows for the convenient use of cell phones." His patent also became a focal point in a lawsuit between AT&T and Motorola as to which company was entitled to bragging rights to the development of the cell phone. Because of Dad's initial patent, awarded in 1972, that right was granted to AT&T.

In 2008 we (Andrea and Stephanie) were able to bring Dad to Akron, Ohio, to accept this honor in person, accompanied by Dad's godson, David Quinto. This memorable trip was made all the more remarkable by David's story that Dad had related to David's father, Dad's oldest and dearest friend. In 1972, Bell

Labs was apparently quite shortsighted on the marketability of Dad's invention. Bell Labs viewed it as important, but a patent of little or no consequence—seeing an application for maybe about 100,000 users worldwide—slightly less than the 4.6 billion current users worldwide!

On regarding this invention of cell phone technology, Dad was most gratified that his invention enabled 9-11 victims to speak with their loved ones until they ultimately perished. Ironically, Dad did not have a "modern cell phone" for his own personal use. Although he kept up with and was continually fascinated by the current design/technological trends, he was content to carry his original cell phone prototype, which was something analogous to a brick. He kept the phone in his car so that he could order pizza on the way home from the office.

Before he passed away in 2008, and in conjunction with his induction into the National Inventors Hall of Fame, a front-page article ran in *The Newark Star Ledger* about his achievements. Dad always loved kids and for many years served as a judge for the New Jersey Science Fair Competition. He also used to go to schools and discuss technology with kids in the local grade schools, but after the article appeared, Dad actually achieved "rock star" status.

Having heard about the article on our father, and being offered the opportunity to be addressed by anyone of importance, local campers resoundingly wanted to meet the inventor of the cell phone. With eager anticipation, they waited for his arrival, and as he was walking down the hallway to the classroom, the whispers grew louder as they announced that he had arrived.

2009: His final recognition, to date, was awarded to him posthumously. He was given the Marconi Society's Lifetime Achievement Award.

Dad was passionate about documenting and sharing his love of and the importance of electronic switching from which other engineers could learn. He published numerous articles on the subject, and in conjunction with the 100th anniversary of the invention of the telephone, AT&T commissioned a series of books on the history of Bell Labs. Dad edited the volume on switching.

Other publications of note are:

Electronic Switching: Central Office Systems of the World (IEEE Press, 1976)

Electronic Switching: Digital Central Office Systems of the World (IEEE Press, 1982)

100 Years of Telephone Switching (1878–1978): Part 1: Manual and Electromechanical Switching (Elsevier, 1982); *Part 2: Electronics, Computers and Telephone Switching* (Elsevier, 1990) (Both edited with Robert J. Chapuis)

A History of Engineering and Science in the Bell System: The Early Years, 1878–1925 (Bell Labs, 1982)

A History of Engineering and Science in the Bell System: Switching Technology, 1925–1975 (Bell Labs, 1982)

Asynchronous Transfer Mode (IEEE Press, 1993)

> "He was the ultimate Switchman,
> living to four-score and ten.
> His patents all were legendary;
> He improved the lives of men."
> —*Stephanie Joel (October 24, 2008)*

ROY G. JOHNSTON

1914–2008

Elected in 1981

"For distinguished contributions and service in the field of structural engineering and earthquake-resistant design of buildings."

BY GREGG E. BRANDOW
SUBMITTED BY THE NAE HOME SECRETARY

ROY G. JOHNSTON, cofounder of the structural engineering firm Brandow & Johnston and one of the nation's most prominent structural engineering leaders, died on March 13, 2008, at the age of 94. He had practiced the profession he loved for 67 years, retiring in 2002 at the age of 88.

Roy Johnston enjoyed the practice of structural engineering, and those who were clients, employees, students, and fellow professionals were treated with technical insight, passion, and professionalism. When an engineering conversation mentioned "Roy," there was never a question who that was. Roy's legacy in buildings is well over 10,000, and the skyline of Los Angeles is a tribute to his ingenuity and technical skills. Roy influenced the profession of structural engineering and the advancement of seismic design through his involvement from California to Washington, D.C. Roy was one of the most widely admired structural engineers of the 20th century.

Roy G. Johnston was born on January 7, 1914, in Chicago and moved with his Swedish immigrant parents to California's central valley when he was 7. His father was a cabinetmaker in Sweden and became a carpenter and later a small contractor. After the 1929 stock market crash, the Johnston family moved to the Los Angeles area, where Roy and his brother Paul attended Alhambra High School. His father encouraged the boys to get a good education, and they both excelled. Roy was active on the track team and debating team, and he was encouraged to pursue a track scholarship at the University of Southern California. In the end he did get a debating scholarship, which made it possible for him to attend USC.

Having worked for his father at a young age in construction, Johnston gained an early-on insight into construction and a desire to be an engineer. He found that USC had a program in civil engineering geared toward the design professional, and with Professors Fox and David M. Wilson as mentors and friends, Roy gained the skills that launched his career.

Roy graduated cum laude with a B.S. in civil engineering in 1935. After a brief time with the Los Angeles County Building Department, he worked for seven years with Clyde Deuel, a Los Angeles engineering consultant, and designed his first buildings, such as the I. Magnin store on Wilshire Boulevard, and seismically strengthened schools in the aftermath of the 1933 Long Beach earthquake. When World War II started, he moved to the Lummus Company and worked for George Brandow, a colleague from USC, in refinery design. The military needed 100-octane gasoline for the bombers, and Roy started the design of the 27 “cat crackers” refining systems. When George moved over to Union Oil Company in charge of the fieldwork at the refinery, Roy became chief engineer for Lummus. Despite their efforts to enlist in the military, Roy and George were kept in their critical war-related activities.

At the close of World War II and at the encouragement and backing of a leading Los Angeles architect, John C. Austin, Johnston joined forces with George Brandow and started their consulting firm with their first project, the Business Administration Building at the University of California at Los Angeles. The partnership flourished because of the postwar boom in buildings in Los Angeles and because Roy and George were natural partners, complementing each other’s talents and skills. This was the beginning of a pattern of long relationships with the prominent architects of Southern California, such as William Pereira, Welton Becket, Edward Durell Stone, Claud Beelman, Adrian Wilson, I. M. Pie, Langdon & Wilson, Gensler, and others. For the next 50 years, Roy and his partners tackled over 400 projects per year. The list of projects is a true legacy and includes the original university campuses at the University of California, Irvine, and Pepperdine, the Lockheed L1011 Assembly Complex in Palmdale, the Fluor Irvine Corporate Headquarters, five medical centers for Kaiser, the Palm Springs Regional Airport, and high-rise buildings that define the skyline of Southern California and San Diego.

The 1933 Long Beach earthquake occurred while Roy was in college. The aftermath influenced the structural design he learned in his classes and started the evolution of building code requirements that continues today. Roy was more than a leading practitioner in seismic design. He was an active leader in the development of the code requirements. In 1956 he was instrumental in lifting the 150-foot height limit on buildings in Los Angeles and soon after designed the building that exceeded the 12-story height limit. He participated in the Structural Engineers Association of California's development of the first "Blue Book," Recommended Lateral Force Requirements and Commentary, in 1959, which later was adopted by the Uniform Building Code. He became president of the Structural Engineers Association of Southern California in 1961 and president of the Structural Engineers Association of California in 1962.

Shortly after the 1971 San Fernando earthquake, Roy was asked to testify before a congressional committee that was investigating the earthquake and, in particular, the collapse of the Veterans Administration (VA) Hospital in Sylmar. Within a few days the investigation was complete and the need for an ongoing committee to assess the risk to other VA hospitals was apparent. In 1973 the Advisory Committee on Structural Safety of Veterans Administration Facilities was appointed with five members, Roy filling the structural engineer position. This committee developed a program for the VA that undertook investigations and research to implement requirements for earthquake-resistant design for VA hospital facilities throughout the country. The program addressed risk and priorities, developed standards for structural evaluations and nonstructural protection, and implemented a review program. The program spent about $2 billion per year for the retrofitting and remodeling of old hospitals and the construction of new facilities. Roy's 18 years on the committee were a primary reason for its success.

Roy was appointed as a member of the Building Seismic Safety Council (BSSC) and was its chairman from 1982 to 1985. In 1988 he chaired the Program on Abatement of Seismic Hazards to Lifelines. Roy was instrumental in the early success of BSSC and the development of seismic design guidelines for the National Earthquake Hazard Reduction Program (NEHRP) of a national program on seismic design.

Roy joined the Earthquake Engineering Research Institute (EERI) in 1962 and was an active member of the organization for many years. He was twice a director, was vice president, and was on the conference committee for the World Conference on Earthquake Engineering in San Francisco in 1984. His leadership in charge of finances helped make the conference both a technical and a financial success. Roy was one of an EERI team of 10 engineers invited by the Chinese government to tour China in 1980 and discuss seismic design problems with Chinese engineers. Their team consisted of the first Americans to witness the devastation of the Tangshan earthquake, which killed a reported 240,000 people three years earlier.

Roy participated in the U.S.-Japan Committee in the early 1980s, which was a program of the National Science Foundation to test some full-scale buildings. Using the Japanese testing facility, a six-story building was constructed and subjected to earthquake motions utilizing jacks and a reaction wall. That was the first project composed of university researchers and practitioners from both countries.

Roy was appointed to California's Board of Registration for Professional Engineers by Governor Ronald Reagan in 1970, served for two 4-year terms, and was chair for two years. He guided the board through political distrust of licensing boards with his professionalism and "debating skills."

Governor George Deukmejian appointed Roy to California's State Building Standards Commission in 1986, where he served two 4-year terms. Roy found that the commission, which reviewed, approved, and published state building standards, had to address many complex areas of energy conservation, handicap accessibility, fire and life safety, and seismic safety. His wise judgment helped move the state's building code development forward.

Roy Johnston's career spanned almost 70 years, from hand calculations and slide rules to computers. He always stressed that engineering judgment was critical in developing engineering approaches to complex problems. In an interview he said:

> I remember they used to tell us, "You may not know the exact answer, but if you can establish the limits, and there is a band within which it will fall: B cannot be more than or less than B, then you can use your judgment." In those days we used to say that engineering was 25 percent calculations and 75 percent judgment and experience. The proportions have changed now, but judgment is still a very critical factor. In those days, of course, you could not depend on computers.

Roy was recognized with the Los Angeles Chamber of Commerce Construction Industries Award in 1981 with his partner George, the USC Engineering Alumnus Award for Outstanding Achievement in 1982, the Institute for the Advancement of Engineers Southern California Engineer of the Year Award in 1985, and the Structural Engineering Association of Southern California's Engineer of the Year Award in 1990. In 2000 the Institute for the Advancement of Engineering presented Roy with the Lifetime Achievement Award. Roy was elected to the National Academy of Engineering in 1981.

Besides a passion for golf, Roy's interests were family, church, and an appreciation for higher education. In reverse order, Roy served for 25 years on the Board of Trustees at Westmont College in Santa Barbara, being chairman from 1972 to 1988. During this time he also served as a director of the Independent Colleges of Southern California.

Roy was a generous man of great integrity whose Christian faith led him to serve in positions of leadership at the Pasadena Covenant Church for over 50 years. He was adept at consensus building and understood the importance of giving everyone who would be affected an early voice in decision making.

Roy used to say that if he had not been an engineer, he would have been a teacher. His natural affinity for educational tasks was clear in his approach to work assignments in his firm, trying always to assign tasks that fit the person's knowledge and skills while also providing opportunities for learning. Roy occasionally taught university courses, was a valued panelist in university-sponsored professional education seminars, and at age 71 traveled to Indonesia to teach a short course in seismic design. His primary contributions to education, however, were made at Westmont College in Santa Barbara, where he served for 32 years as a member of the Board of Trustees, including 18 years as chair. In this role he developed considerable expertise in the issues inherent in higher education, from personnel support to public relations, and served as a director of the Independent Colleges of Southern California.

Roy's leisure time was filled with family, travel, and golf. Of all his accomplishments, he was particularly proud of the two occasions on which his golf score bested his age. His relationships with his family brought him continuing joy and were characterized by unfailing trust and support.

Predeceased by his first wife Naomi (*nee* Harmon), Roy is survived by his wife Lucille (*nee* Peterson); daughter Judith Johnston, professor emerita in the School of Audiology and Speech Sciences, University of British Columbia; son Robert Johnston, professor of theology and culture, Fuller Theological Seminary, Pasadena, and his wife Catherine Barsotti; granddaughters Elizabeth Johnston, attorney, and Margaret Browne, Montessori teacher; and his brother Paul Johnston, retired pediatric surgeon, and his wife Lillian (*nee* Rogstad) and their children.

JAMES C. KECK

1924–2010

Elected in 2002

"For developing innovative, widely used new concepts for modeling coupled chemical and physical phenomena in engine combustion and high-temperature flows."

BY RONALD F. PROBSTEIN

JAMES C. KECK, known for his landmark developments in the understanding of automotive engine combustion for the purpose of minimizing noxious emissions, died on August 9, 2010, at the age of 86.

Jim was born in New York City on June 11, 1924, the son of famed sculptor Charles Keck. He spent his early years in Greenwich Village, where his father's studio was located, but financial losses resulting from the Great Depression forced the family to leave Manhattan and move to their country home in Carmel, New York.

He graduated from Carmel High School in 1942 and then went to Cornell University where he majored in physics and minored in mathematics. An outstanding student in physics, in 1944 he was drafted into the Special Engineering Detachment of the U.S. Army, given the rank of technical sergeant, and sent to Los Alamos to work on the atomic bomb project as part of the Manhattan Project. Years later Jim told me, "I can't understand how they picked me because I was just a kid and hadn't been at Cornell that long to know enough physics to be useful." I never had any doubt that was a usual understatement by Jim who was an outstanding student. This was confirmed to me some years afterwards by his supervisors at Cornell, Hans Bethe, who in 1943 became director of the Theoretical Division of the Manhattan project at Los Alamos and later won the Nobel Prize for his contributions to the theory of nuclear reactions, and mathematics professor Mark Kac, who was the developer of modern mathematical probability theory and its applications to statistical physics.

Jim left Los Alamos in 1946 and returned to Cornell to complete his studies in nuclear physics, receiving his B.S. in 1947 and his Ph.D. in 1951. Among his many life-changing events at Los Alamos was his meeting another physicist, Margaret Ramsey, one of the few women scientists employed on the Manhattan Project, which she joined in 1945. She also left the project in 1946 and went to Indiana University to pursue a master's degree, which she completed while working in physics at Cornell. She and Jim were married in 1947. They both were employed in the physics department at Cornell through 1952, where Jim conducted pioneering experimental investigations of photo-nuclear reactions on a 300-Mev synchrotron he assisted in developing. He then went to the California Institute of Technology for three years as a senior research fellow, where he continued his studies of photo-nuclear reactions on the 500-Mev Caltech synchrotron.

In 1955, at the height of the Cold War, Arthur Kantrowitz, a professor at Cornell, had become convinced that the most important problem facing America was the need to develop intercontinental ballistic missiles (ICBMs). He foresaw Russia's threatening missile development, which was confirmed dramatically two years later with the launching of the Sputnik satellite. To counteract the Russian program, he decided to set up a research laboratory in Everett, Massachusetts, under the umbrella of the Avco Corporation for the purpose of providing the research needed to develop ICBMs that could reenter the atmosphere without burning up. He had not known Jim from Cornell but had heard from Victor Emanuel the head of Avco that Jim was brilliant, a fact passed on to him by his son who did know Jim. Kantrowitz very much wanted Jim and in 1955, at a time when Jim was prepared to go to Princeton, convinced him, along with a number of other Cornell alumni, to join the new Avco-Everett Research Laboratory to help protect America from Russian domination in ICBM development.

Jim started at the Avco-Everett Laboratory as a principal scientist, where he carried out both experimental and theoretical studies of the chemical kinetics, radiation, and ionization of gases heated by high-intensity shock waves. Such shock waves are associated with the very high Mach number speeds of reentry of ICBMs. He also had general responsibility for the laboratory's associated programs in atomic physics. His experimental and theoretical contributions in the areas of nonequilibrium rate processes and the radiation of neutral gases and plasmas obtained wide recognition. His pioneering work on the variational theory of reaction rates laid a foundation for the theoretical description of thermally induced gas-phase reactions, which received wide acclaim in the field of physical chemistry.

In 1960, Jim was appointed deputy director of the laboratory but resigned that position in 1963. He had told me "the responsibilities of running the Lab aren't compatible with my doing my own creative research and that's what I want to do." I was a consultant to the laboratory at the time, and it was clear that his brilliance, coupled with his devotion to try to understand scientific and engineering problems at their basic level, made him far more suited to a university environment than to an industrial laboratory. With little effort I convinced my colleagues at the Massachusetts Institute of Technology that we should invite him to join us, and in 1965 Jim accepted the position of Ford Professor of Engineering in the Department of Mechanical Engineering at MIT.

Shortly after joining the MIT faculty Jim assumed primary responsibility for the direction and teaching of thermodynamics in the mechanical engineering department. He emphasized the important, but less well understood, nonequilibrium aspects of the subject, processes in the gas-phase, gas-surface interactions, thermionic energy conversion, and air pollution problems associated with combustion.

As a consequence of his experimental and theoretical research into the combustion processes occurring in spark ignition engines, he obtained a much clearer understanding of automotive pollution problems insofar as the production of nitric oxide, carbon monoxide, and unburned hydrocarbons are concerned. He also showed the nature of turbulent flame propagation and "knock" in these engines. Taken together his work identified methods by which these pollutants could be alleviated. These studies are regarded as a pioneering contribution to the design of all present-day efficient and clean automobile internal combustion engines.

Until his death Jim worked to develop basic theoretical models to describe elementary atomic and molecular excitation, thermally induced chemical reaction rates, rate-controlled constrained equilibrium, and flame theory, in addition to continuing to understand the nature of engine combustion. He produced outstanding research right up to his last days.

As for his personal happiness, there never was a question for he was a happy fellow who found joy in both his work and his friends at the institute and who was loved by them all. In my many years as a friend of Jim, I never heard anyone say anything about him less than "What a nice fellow. " He devoted himself to his students and was never patronizing to them or his colleagues but rather was always ready to jump into their technical problems because it was fun. He loved science and was forever curious, and it was difficult for him not to start talking to his colleagues without getting involved in their problems or raising issues with his own work because it was fun.

As involved as he was with engineering and science he had a lifelong attachment to his extracurricular activities, among which was his vegetable garden at his home in Harold Parker State Forest in Andover, Massachusetts. This was a serious matter and not on a small scale. Indeed, it required the use of a backhoe, which Jim acquired and used in a way admired by professionals. But no matter what the task, always at the forefront of Jim's behavior were fun and games. As he once expressed to me, "I would rather be loved than famous." He didn't quite get his wish, for not only was he loved by all but was also recognized and honored internationally for his pioneering scientific and engineering studies.

While gardening was a major hobby, Jim also enjoyed individual sports. In the winter it was ice skating and skiing; in the warmer months it was swimming or hiking or bicycling. When his children were growing up, he spent much of his free time with them, encouraging them to pursue their interests, and he was always willing to help them, whether it was building a dark room for his son's photography or putting up fences for his daughter's horse. In later years Jim enjoyed working with his daughter Pat, a sculptor, on the mechanical design of her movable sculptures, teaching her basic mechanics in the process and emphasizing that the simplest design was usually the best. He liked to say, "If you can't explain something simply, you probably don't understand it very well." That was a concept he used in approaching any problem.

Jim enjoyed parties and celebrations and threw himself into the preparations with great enthusiasm. He hosted many parties for graduate students and faculty, with the entertainment as varied as ice skating and sledding to badminton and swimming. He was popular with visiting children because he was always willing to stop whatever he was doing to play games with them or have a croquet match, set up an archery range, or teach them new skills. Adults, meanwhile, enjoyed his talents in mixing martinis. Jim was an optimist and was invariably cheerful and upbeat. He was a joy to live with, and he brought joy to all who knew him.

When he retired from MIT in 1989, he took on some new ventures. First, he designed and built, with the help of his daughter, a two-car garage to replace the one that she had taken over for use as her studio. This was top priority for his wife, who was tired of scraping ice off the cars during the long New England winters. Second, he designed and, again with Pat as helper, built a barn to house two horses and a storage area for garden machinery. From then on, one of his main occupations was improving and maintaining his house and property. He loved the hard physical outdoor work that this entailed, but he also claimed that he got some of his best scientific ideas while mowing the fields with his garden tractor.

In the 1990s, as a result of a chance conversation with a friend, he invented and worked on the development of a device to monitor septic systems that led to the formation of a company now known as Sepsensor, Inc. He never lost his interest in thermodynamics and continued to work until the end of his life on nonequilibrium thermodynamics and rate-controlled constrained equilibrium, meeting weekly with Northeastern University doctoral students who were interested in pursuing his ideas.

In addition to the honor of his election to the National Academy of Engineering, he was honored by election to the American Academy of Arts and Sciences and was a fellow of the American Physical Society.

Jim is survived by his wife of 63 years, Margaret Ramsey Keck; his son, Robert Keck, of Rochester, New York; his daughter, Patricia Keck, of Andover, Massachusetts; and his brother, Charles Keck, of Andover, Vermont.

EDWIN E. KINTNER

1920–2010

Elected in 1990

"For significant contributions to the development of nuclear submarine propulsion, nuclear power operation, and management of magnetic fusion programs."

BY PHILIP CLARK

EDWIN E. KINTNER, former executive vice president, GPU Nuclear, Inc., passed away on May 7, 2010, in Exeter, New Hampshire, at the age of 90.

He was born May 1, 1920, in Paris, Ohio, and he graduated from the United States Naval Academy in Annapolis, Maryland, in December 1941, a member of the class of 1942 that was accelerated due to the attack on Pearl Harbor. After serving aboard a cruiser in the Pacific for 18 months, he earned a master's degree in naval construction and engineering at the Massachusetts Institute of Technology (MIT). During that period, he also married Alice Shoemaker of Louisville, Ohio, on July 29, 1944, at Fort Benning, Georgia, where her father, a lawyer and colonel in the U.S. Army Reserve, was on duty as inspector general of the infantry school.

He then served for two years at the naval shipyard in Portsmouth, New Hampshire, working on modernizing and upgrading snorkel-equipped, diesel-powered submarines. From there he was recruited by Captain Hyman G. Rickover to the new naval reactors program, which became an agency of both the U.S. Navy and the Atomic Energy Commission (AEC) and its successors—the Energy Research and Development

Agency and finally the U.S. Department of Energy. Before assuming his duties in the naval reactors program, Captain Rickover sent him to MIT for a new program in nuclear engineering started at Rickover's suggestion. This program earned Kintner a second master's degree, this one in nuclear engineering.

Arriving at naval reactors headquarters in Washington, D.C., Kintner initially headed an engineering group but was then made project manager for the first nuclear-powered submarine, *Nautilus,* and its full-scale, land-based prototype built on an AEC site in Arco, Idaho.

The *Nautilus* project involved designing and building the first nuclear plant to produce a large amount of usable power and the associated steam plant to convert that power into the useful mechanical power and electricity needed to propel and operate a submarine without external support. That all had to be done so as to fit into the confined space of a submarine hull. It required breakthroughs in several areas, including physics, metallurgy, electronics, and environmental medicine.

A major decision in the program was to reject advice to pursue an extensive research and development program and instead to proceed directly to the design and construction of the full-scale submarine and its prototype. This decision was described by Kintner in a featured cover article in the *Atlantic Monthly* for January 1959 titled "Admiral Rickover's Gamble." The decision also influenced Ed's subsequent career.

Kintner managed and coordinated the diverse activities that resulted in successful completion and operation of the prototype and then the *Nautilus* power plant. *Nautilus* was completed and launched on January 21, 1954—a little less than three and a half years after the ship was authorized by President Truman in August 1950.

Following the successful initial operation of the *Nautilus,* a number of additional nuclear submarines were to be built. Kintner was appointed nuclear power superintendent at the Mare Island Naval Shipyard in California, to develop in that yard the capability to build them and to oversee construction of the *USS Sargo*, the fifth nuclear-powered submarine and the first built on the West Coast, and others.

In 1959 he was designated as the naval reactors' representative at the Bettis Laboratory near Pittsburgh, Pennsylvania, which was run by Westinghouse Corporation, as a contractor for naval reactors. It had developed nuclear propulsion plants for *Nautilus, Sargo,* and other naval vessels and for the first civilian nuclear power plant built in Shippingport, Pennsylvania, which began operation in 1957. In 1959 he received the Secretary of the Navy's Commendation Medal.

In 1963 he retired from the U.S. Navy as a captain and went to work for John J. McMullen, a businessman and Naval Academy graduate, as manager of a small shipyard in Portland, Maine. In 1965 he returned to naval reactors at Rickover's request (one, if not the only, senior person to leave and return to naval reactors). Soon after that he accepted a request to join the AEC's Civilian Nuclear Power Program, with a major focus on the Liquid Metal Fast Breeder Reactor (LMFBR). In that position he brought greater technical and management discipline to the work and directed the successful effort to design and build the Fast Flux Test Reactor, a liquid metal–cooled reactor of sufficient size to test materials and components in liquid metal and at temperatures and radiation levels of interest for the LMFBR. This test reactor was in use for almost 40 years.

In 1973 Ed was hired as a deputy by Bob Hirsch, who was running the AEC's Fusion Energy Program, to provide added leadership and discipline. Then in 1976 when the AEC's development work was transferred to the new Energy Research and Development Agency (ERDA), Hirsch was made assistant administrator and Kintner became the director of the Fusion Energy Program. He proceeded to aggressively pursue the 1976 Fusion Development Program, which called for building a series of large-scale test facilities. The Tokamak Fusion Test Reactor at Princeton University and the Alcator II Test Facility at MIT were completed and began operation. He participated actively in international efforts to develop fusion power, including a trip to the Soviet Union with AEC Chairman Glenn Seaborg.

In 1978, ERDA became part of the new U.S. Department of Energy, and Kintner continued to head the Fusion Energy Program. He was a leader in efforts to provide additional focus on engineering in addition to physics in the fusion program and testified before Congress in support of the Magnetic Fusion Energy Engineering Act of 1980, signed into law in October 1980 by President Carter. In 1981 he received a Leadership Award from Fusion Power Associates.

After the election of President Reagan the next month, Kintner continued his efforts to implement the plan, but the Reagan administration opposed having government build large facilities or demonstration plants, preferring to allow the private sector to do it. After a year Kintner resigned in 1982, calling the revised policy "a national error . . . There is little I can do except to make clear by my leaving that I am not party to that decision."

After a brief stay at an engineering consulting firm near Washington, D.C., Kintner was asked in mid-1982 to join GPU Nuclear, Inc., a subsidiary of General Public Utilities in Parsippany, New Jersey. GPU Nuclear was responsible for cleaning up the Three Mile Island Unit 2 nuclear plant near Harrisburg, Pennsylvania (which had been damaged in the 1979 accident), for restarting and operating the adjacent undamaged Three Mile Island Unit 1, for operating the Oyster Creek nuclear plant in southern New Jersey, and for decommissioning the Saxton experimental nuclear power plant in western Pennsylvania.

Initially, he was the director of administration, where he successfully professionalized and upgraded the security force to meet increasing security needs for nuclear plants and focused the finance and human resources groups on supporting the basic mission of the company. In the fall of 1983 he became executive vice president of GPU Nuclear. While involved in leadership and direction of the whole company, his focus was on cleanup of the damaged TMI 2 plant. There he reoriented the entire program to determine the extent of the damage to the reactor, develop a plan to remove the reactor fuel and ship it to the U.S. Department of Energy site in Idaho, and create and implement a strategy to place the plant in a stable condition to allow for long-term monitored storage. The program was successful. The total cost was under budget, and the total radiation dose to workers was less than half of the forecast. Many consider this successful effort to have been an essential element in ensuring a continuing commercial nuclear power industry in the United States.

Kintner also was a leader in a utility industry effort to prepare for future improved nuclear power plants. This multiyear effort was based on having the utilities that would own the plants working with the Electric Power Research Institute and potential suppliers to develop advanced designs based on major simplification of the design, reliance on passive mechanisms for protection, and improved operability. Three such designs were developed and ultimately certified by the U.S. Nuclear Regulatory Commission. In addition, comprehensive guidelines were developed and published on ensuring the standardization of plant designs throughout the life of the plant. This work has been and is being used (as of this writing, in 2010) as one basis for current U.S. plans for new nuclear power plants.

Kintner retired from GPU Nuclear in 1992 to Norwich, Vermont, and then moved in 2005 to Exeter, New Hampshire, where he died. Throughout his long career, Ed was influenced by four major things:

First was his deep religious conviction that there was a God and that his duty was to use his talents and energy to the fullest to benefit mankind.

Second was his belief in the value of education and in recognizing and facing the scientific and engineering facts separate from any other considerations. He served for many years on the Visiting Committee for MIT's nuclear engineering department and was recognized as a distinguished alumnus in 1982. After retiring and moving to Vermont he was involved in the Institute for Lifelong Education at Dartmouth both as a student and for several years as teacher of a popular course on science and religion.

Third was his wife of 65 years. Alice accepted and supported his commitment to his professional activities and provided a strong, intelligent force for ensuring his equally strong commitment to her and their family.

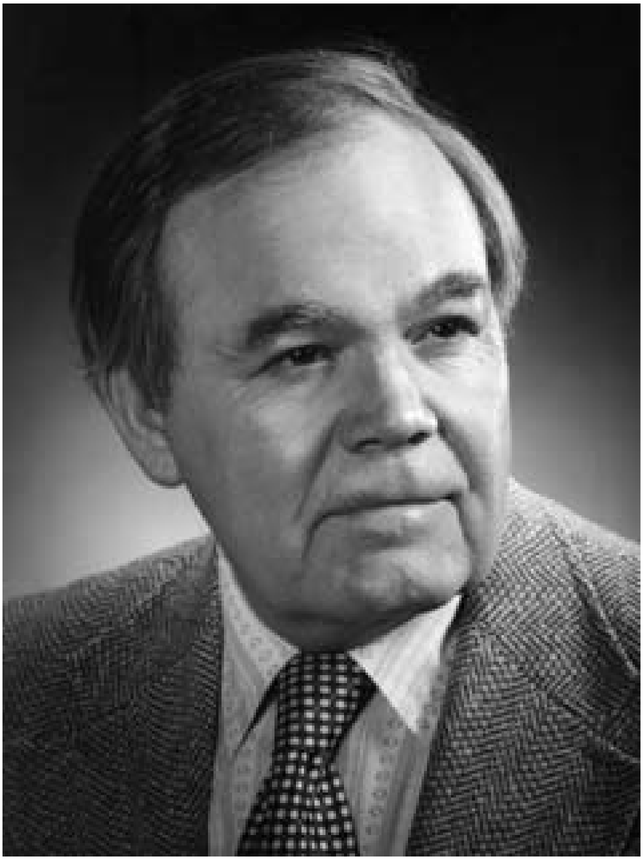
Fourth was his longtime commitment as an environmentalist, starting before it was common. He viewed nuclear power as a major environmental benefit, but also championed conservation and solar heating.

In all his activities, Ed showed great intelligence, vision, energy, and initiative. He had a great ability to recognize when there was a problem, determine what it was, and effectively address it. He was also devoted to helping people develop to their full potential, and he influenced hundreds of people of all ages.

His accomplishments were recognized by election to the National Academy of Engineering in 1990. The citation read: "For significant contributions to the development of nuclear submarine propulsion, nuclear power operation, and management of magnetic fusion programs." He was an active member of the academy and served as a member of four study committees, as chair of committees on environmental technology and on transmutation, and as vice chair of the peer committee for selection of new members for the electric power/energy systems section of the Academy.

Ed brought his energy and desire to excel to his personal life. He was an avid outdoorsman. He took camping, hiking, and skiing trips with the family. He blew up tied sheets to use as surfing floats at a vacation home in Delaware. He was an excellent sailor, serving as captain of 50-foot chartered sailboats crewed by family and friends in the Caribbean and Aegean, and he was a lifelong and excellent tennis player. He was also a voracious reader and enjoyed good conversation.

He is survived by his wife, Alice, and their four children: Eric C. Kintner of Westford, Massachusetts; John J. Kintner of Fort Lauderdale, Florida; Mary H. Kintner of Underhill, Vermont; and Peter F. Kintner of Park City, Utah; and four grandchildren.



HERBERT J. C. KOUTS

1919–2008

Elected in 1978

"For contributions in nuclear engineering, especially physical principles and safety of nuclear power reactors and nuclear materials safeguards."

COURTESY OF BROOKHAVEN NATIONAL LABORATORY
SUBMITTED BY THE NAE HOME SECRETARY

HERBERT J. C. KOUTS, who joined Brookhaven National Laboratory (BNL) on July 1, 1950, and retired as a senior physicist on October 24, 1989, died at age 88 on January 7, 2008.

The long-term value of Kouts's achievements was recognized in 2005 with the American Nuclear Society's (ANS) George C. Laurence Award for "his pioneering contributions to advancing nuclear safety and his remarkable career of leadership in initiating, guiding and executing national and international programs of great and lasting importance."

Kouts received a B.S. in mathematics in 1941 from Louisiana State University and, after service in the U.S. Air Force from 1942 to 1945, an M.S. from Louisiana State in physics in 1946. He earned his Ph.D. in physics from Princeton University in 1952.

At BNL, Kouts's first position was as an associate physicist heading the Reactor Shielding Group at the Brookhaven Graphite Research Reactor, which operated until 1968. In 1952 he became head of the Experimental Reactor Physics Group, then headed the Reactor Physics Division in 1956. He received tenure in 1957.

In 1963, Kouts won the E. O. Lawrence Award from the Atomic Energy Commission (AEC), an agency that evolved into U.S. Department of Energy (DOE). He was cited "for the development of new experimental techniques in reactor physics and their applications to a better understanding of theoretical models of chain reacting systems."

Kouts was one of the five coinventors of the High Flux Beam Reactor (HFBR), in operation from 1965 to 1999. In 1988 the ANS cited experiments at the HFBR in which "the data obtained have played a central role in the development and understanding of solutions to many problems in solid state physics, chemistry, and structural biology."

In 1968, Kouts became the first head of the new Technical Support Organization at BNL, which was established to advise and assist the AEC on nuclear safeguards. Five years later, in 1973, he became the AEC director of the Division of Reactor Safety Research. Then in 1975 he became director of the Office of Nuclear Regulatory Research for the newly formed Nuclear Regulatory Commission (NRC). He was honored with the Distinguished Service Award from the AEC in 1975 and from the NRC in 1976.

Kouts returned to BNL in 1976 as head of the International Safeguards Project Office, being named chair of the Department of Nuclear Energy in 1977. He became a member of the International Nuclear Safety Advisory Group of the International Atomic Energy Agency (IAEA) in 1985, and, following the Chernobyl nuclear reactor accident in April 1986, he coauthored the IAEA's report on Chernobyl.

In 1988, Kouts stepped down as department chair, continuing at BNL as a senior physicist. Retiring a year later, he was named presidential appointee to the Defense Nuclear Facility Safety (DNFS) Board, an agency that oversees nuclear safety at DOE defense facilities. He remained there until 1997, then became a consultant until 2000. As *Newsday* quoted DNFS Chair A. J. Eggenberger, "Kouts had a tremendous influence in nuclear safety matters, essentially through the life of the industry until now."

His wife wrote:

"Herbert Kouts was an avid reader and he loved to travel to places all over this country and the world. He loved to sail and kept various sailboats in the Bay near our house. He also was a music lover and he enjoyed attending symphonies, chamber music concerts, ballet, and the opera. He liked to work on our house in Bellport, painting and fixing things. He enjoyed being with his children and grandchildren. And he also loved to fix delicious meals for all of us!"

A resident of Bellport, Herbert Kouts is survived by his wife Barbara; daughters Catherine Sigmon and Anne Golden; stepsons Francis Spitzer, Michael Spitzer, and Daniel Spitzer; and nine grandchildren.

THOMAS R. KUESEL

1926–2010

Elected in 1977

"For innovations in the design of long-span bridges, immersed tunnel-tubes, and other special transit structures, and contributions to seismic design of underground structures."

BY JAMES L. LAMMIE

THOMAS ROBERT KUESEL, an internationally recognized authority on tunnel and bridge engineering and a former partner and director at Parsons Brinckerhoff (PB), died on February 17, 2010, at the age of 83 after a lengthy illness.

During a 43-year career with PB, Tom contributed to the design of more than 130 bridges and more than 140 tunnels in 36 states and on six continents. As one of the great PB engineers of the last half-century, he was often recognized for his unique and innovative solutions to structural and underground challenges.

Tom was born on July 30, 1926. He graduated from Yale University in 1946 with highest honors in civil engineering at the age of 19 and received a master of civil engineering from Yale in 1947 at age 20. He was a member of Tau Beta Pi, the national engineering honor society.

In 1947 he joined Parsons Brinckerhoff Quade & Douglas as a junior engineer and worked his way up to chairman of the board in 1984. He retired in 1990 but continued on as chairman emeritus and consulting engineer.

Tom was very active in his profession and fulfilled his personal obligation to communicate his ideas, experiences, and concerns through more than 60 widely circulated papers and presentations. While listing the detailed citations is not appropriate here, the breadth of topics is illustrated by a few titles: "Whatever Happened to Long-Term Bridge Design?," "Improving Contracting Methods," "A Tale of Three Tunnels," "Alternative Concepts for Undersea Tunnels," "Earthquake Design for Subways," and "Underground Structures—Designing for Constructability." Tom was also coeditor of *Tunnel Engineering Handbook,* first published in 1982 (Van Nostrand Reinhold Co.), the only comprehensive textbook covering the design and construction of virtually every type of tunnel.

In addition to many publications, his actions to improve the profession of engineering led to his active participation in many professional organizations, including the National Academy of Engineering, American Society of Civil Engineers, American Consulting Engineers Council, International Association for Bridge and Structural Engineers, The Moles (fraternal organization of the U.S. heavy underground construction industry), British Tunneling Society, Structural Engineers Association of California, and the American Railway Engineering Association. He was also a registered professional engineer in 21 states.

Tom's broad background was recognized by his selection to participate in many special committees such as:

- Steering Committee and Charter Member, U.S. National Committee on Tunneling Technology, for the report *Better Contracting for Underground Construction,* 1974
- Steering Committee, American Society of Civil Engineers (ASCE) Conference on Construction Risks and Liability Sharing, Scottsdale, Arizona, 1979
- Senior advisor to the Underground Technology Research Council for its "Guidelines for Tunnel Lining Design"
- International Advisory Committee for the International Conference on Cable-Stayed Bridges, Bangkok

- American Association of State Highway and Transportation Officials Advisory Committee for Development of "Guidelines for Vessel Collision Design of Highway Bridges," 1987–1990
- Geotechnical Board of the National Research Council, Chairman, 1988–1989
- Chairman of the National Research Council Marine Board Committee on Ship-Bridge Collisions, 1982–1983

In addition to his many committee appointments, Tom was recognized with awards from professional engineering societies. He considered his election to the National Academy of Engineering in 1977 to be the greatest recognition. He was also designated an honorary member of the American Underground Construction Association and received the Golden Beaver Award in 1989 from the Beavers, the West Coast heavy construction honorary association. In 1988 he received the Ernest E. Howard Award for Structural Engineering from the ASCE.

Tom was often referred to as an "engineer's engineer" because of his vast knowledge and experience and his willingness to mentor others. He was a real believer in the "observational method of design," which recognized the importance of the continuing interaction of the structural engineer with the construction of underground projects, observing that the most valuable design tool is the project itself. This approach, combined with Tom's practical knowledge of construction, led to the introduction of many innovations in the industry. He is given credit by his peers for innovations such as:

- Design of 100-foot-diameter structural reinforcement for underground chambers to resist nuclear effects (North American Air Defense Command Center, 1962)
- First use of flexible ring design concept for transit tunnel linings (Bay Area RapidTransit, 1964)

- First design criteria for earthquake-resistant design of subways (Bay Area Rapid Transit, 1965)
- First use of rock reinforcement for permanent support of U.S. transit stations (Metropolitan Atlanta Rapid Transit Authority, Peachtree Center, 1976)
- First precast concrete segmental liners for U.S. transportation tunnels (Baltimore Lexington Market Tunnels, 1977)
- First use of permanent structural slurry walls for transit construction (Bay Area Rapid Transit, 1965)
- Permanent shot crete lining for tunnel support in weak sandstone (Stanford Linear Accelerator Center/ Positron Electron Project, California, 1977)
- Use of rock reinforcement to reduce the size and cost of tunnel lining (Glenwood Canyon Tunnels, Colorado, 1981; Rogers Pass Tunnel, British Columbia)
- First use of New Austrian Tunneling Method design in U.S. transit tunnel (Mount Lebanon Tunnel, Pittsburgh, 1981)
- Extension of state of the art in earthquake-resistant design; special design to exclude natural gas infiltration (Los Angeles Metro, 1966)

The greatest tribute to a civil engineer is the memorial of his structures that survive him, recognizing that a complex project is never the work of one person. They are all team efforts. But one name usually stands out as the driving force behind the project or the contributor of a critical design or decision that enabled the project to move forward. The list of such projects for Tom is lengthy, but a few deserve special mention.

NORAD (North American Air Defense Command Center)

When NORAD was being mined in Cheyenne Mountain, Colorado, an unforeseen and potentially unsafe shear zone was found at the intersection of two rock chambers, creating a construction crisis. Sitting in a café, Tom sketched an alternative design, which he described as a “grapefruit with four tin cans attached,” to support the rock loads. Tom detailed the design to resist nuclear blast effects and construction proceeded.

BART
(Bay Area Rapid Transit, the first modern U.S. transit system)

From 1963 to 1968, on behalf of BART’s general engineering consultant joint venture, Tom directed the design of 20 miles of subways, 25 miles of aerial structures, two rock tunnels, and the 3.6-mile immersed tunnel between San Francisco and Oakland, California. In the course of his work, he developed the design basis for the resistance of underground structures to earthquakes.

Mount Macdonald/Rogers Pass Tunnel

The 9-mile Mount Macdonald / Rogers Pass Tunnel in British Columbia, Canada, the longest rail tunnel in North America, was driven under 5,500 feet of rock in a national park, which greatly constrained geotechnical exploration. Tom developed a series of generic designs that applied to different sections of the tunnel as conditions changed. This allowed work to proceed and eliminated disputes on differing site conditions.

Fort McHenry Tunnel, Maryland

Traffic volume in Baltimore demanded the widest immersed tube tunnel and the largest underwater highway tunnel in the world (at that time). With Tom as principal-in-charge, the project was successfully completed with many value engineering cost savings. The Fort McHenry Tunnel won major awards from the largest U.S. civil engineering societies.

Tom’s many other projects and contributions are too numerous to mention. But as a summary statement, those who worked closely with him described Tom as a leader, a teacher, a mentor, an advisor, a consultant, a problem solver, and, above all, a constant gentleman and a very nice human being.

Tom left behind his beloved wife of 51 years, Lucia Elodia, and two sons, Robert Livingston Kuesel and William Baldwin Kuesel, and five grandchildren.

JOSEPH TALBOT KUMMER

1919–1997

Elected in 1986

"For pioneering the field of ionic conductors, discovering the sodium-sulfur battery, and for seminal work in catalysis and in combustion in fuel cells."

BY MORDECAI SHELEF

JOSEPH TALBOT KUMMER was born on October 21, 1919, in Catonsville, Maryland, the youngest child of Frederic Arnold Kummer and his wife Marion (*nee* MacLean). His father came from an established Baltimore family. The father earned a civil engineering degree from Rensselaer Polytechnic Institute and was chief engineer of American Wood Company and later general manager of Eastern Paving Block Company. The elder Kummer then switched to a full-time literary career and became a well-published author of novels, short stories, screenplays, musical librettos, and so forth. In addition, he was an exhibited painter of marine scapes. As will be noted below, Joe Kummer inherited both the engineering genes and the inventiveness.

All of Joe's education was in Baltimore: His high school was the Baltimore Polytechnic (1932–1936), followed by a B.E. in chemical engineering from Johns Hopkins University in 1941 and a Ph.D. from the same institution in 1945. The historical pedigree of his teachers deserves mention. His Ph.D. advisor was the eminent surface scientist and catalytic chemist Paul Emmett (a member of the National Academy of Engineering [NAE]). Emmett himself studied under Sir Hugh Taylor at Princeton, while Taylor's scientific progenitor was the kineticist

Max Bodenstein in Hanover, Germany. Joe, however, did not choose an academic career path, opting for industry instead.

From his casual remarks I gathered that during World War II, Joe served for a time in the Merchant Marine in the Atlantic convoys. Being by nature taciturn and self-effacing, Joe never elaborated on his service, though it seemed to be quite dangerous.

Concomitant to his Ph.D. work at Johns Hopkins he was a junior project member at the National Defense Research Council from 1941 to 1943. He did not elaborate on the nature of his work there, either.

His first scientific work was quite naturally influenced by the interests of his mentor, Paul Emmett, the mechanisms of the most important catalytic processes: ammonia synthesis and Fischer-Tropsch synfuels synthesis. This work was carried out in Pittsburgh at the Mellon Institute, one of the forerunners of Carnegie Mellon University. It was distinguished by the then-novel application of hydrogen and carbon isotopes, both stable and radioactive, for the study of heterogeneous catalysis.

Moving to Dow Chemical in Midland, Michigan, Joe was involved in the improvement of several chemical manufacturing operations, with the results of these efforts being mainly proprietary in nature. His publications from this period relate to the important oxidation of ethylene to ethylene oxide on a silver catalyst and surface segregation. During this period Joe published a short paper on the latter subject, which was referred to by his NAE colleague M. Boudart as "a study that may well be the most elegant catalytic investigation of the sixties if elegance implies economy of means to convey an important message."

The last and main part of his scientific career was at the Scientific Research Laboratories of the Ford Motor Company from 1960 to 1984. There his accomplishments were nothing short of prodigious. The studies can be grouped into the following broad fields:

Automotive emissions—studies of the surface reaction of nitric oxide by isotope labeling, selective reduction of nitric oxide, three-way automotive catalysts, and studies of atmospheric aerosols.

Solid-state materials—ionic conductivity, beta-alumina solid electrolyte (BASE), Na-S battery, and alkali-metal thermoelectric energy converter.

Internal combustion—NO_x formation in internal combustion engines and effects of emission controls on fuel economy.

Electrochemistry—biofuel-powered fuel cells and rechargeable batteries.

In all these fields Joe's contributions were invariably original, one might even say seminal, and patentable. His work on automotive emissions contributed mightily to the practical implementation of automotive emissions controls. His solid-state materials work spurred the whole field of ionic conductivity and countless investigations worldwide.

Whenever a scientific consultation or an opinion was sought by anyone at the Ford Laboratories or by an engineer in other parts of the vast enterprise, the path invariably led to Joe's modest office, where the advice was generously and unselfishly offered. Being an inveterate engineer's engineer, Joe performed a large part of the experimental work himself at the bench. He was able to conjure clever experimental apparatus out of on-shelf spare parts. Soon after the appearance of the first personal computers, Joe Kummer rigged one up. He avoided the limelight and corporate-ladder climbing and resisted promotion to managerial positions. Very rarely did he travel to meetings, whether at home or abroad, or take part in large gatherings. Nevertheless, his name was very well recognized in the engineering community.

Five outstanding chemical engineers sponsored his nomination to the NAE. Joe Kummer was the first recipient of the American Chemical Society's award for the "Chemistry of Contemporary Technological Problems." He received several awards from the Michigan Section of the ACS.

His wife, Ruth, noted that:

> "Joe was an avid reader who enjoyed historical and cultural writings but Chemical Abstract and Chemical Engineering Journals enriched his professional and creative mind. In retirement the challenge was to decode computer programs and tinker with discontinued components. Often he spent time in the university libraries doing literature searches that his peers appreciated."

As stated earlier, Joe could conjure clever experimental apparatus that would not pass the requirements of the AIA in home design but was functional. His application on one occasion was a piece of a broomstick with two pieces of wood to hold rabbit ears to receive TV signals from the north, south, east, and west, a sight to be seen, and which was displayed in the living room with four switches to pick signals.

Truly a person who could focus on the heart of a topic! His philosophy was "give me the facts and spare me the details." In spite of his efficient manner, he was sensitive and attentive to others, even the youngest child.

Joe dressed modestly, and his material demands were minimal. It was quite a sight to see him shoehorning his 6′8″ frame into a Ford Escort. He raised a family of three sons, two of them engineers, and the third in medical records. His daughter is a physician. Early engineering activities often entertained five grandchildren with fond memories. Two great-grandchildren did not have the time to know him. His wives Elizabeth and Phyllis preceded him in death. Joe Kummer died in retirement in Ypsilanti, Michigan, on June 27, 1997.

(MICHAEL) JAMES LIGHTHILL

1924–1998

Elected in 1977

"For contributions to aerodynamics, and in recognition of an outstanding career in teaching and research management."

BY SHON FFOWCS WILLIAMS
SUBMITTED BY THE NAE HOME SECRETARY

JAMES LIGHTHILL, as Professor Sir M. J. Lighthill was known to his friends, died on July 17, 1998, at the age of 74. He suffered a heart attack while swimming around Sark, a swim he had been the first person to do and one that he had previously completed five times. He was considered the dominant mathematical aerodynamicist of his day.

James was the youngest son of doting parents who educated him at the best private schools and saw that he lacked for little. His father, a retired mining engineer who had changed the family name from Lichtenberg during the First World War, moved the family from Paris to London in 1927. James read a great deal and, at an early age, demonstrated impressive feats of memory and high musical talents. James always knew he was clever and found most challenge in mathematics, a subject he was allowed to develop at his own pace, a pace much faster than that of his contemporaries. He won a scholarship to Winchester at the age of 12.

At Winchester he quickly made friends with a boy of remarkably similar age and ability. His friendship with Freeman Dyson had a terrific effect on the mathematical development of both of them. The school knew that they were smarter than most and allowed them to choose the rate and direction of their studies. Both won arts scholarships to Cambridge but, being only 15, were too young to go. They read the same books, mostly about mathematics, and by the time they were 17, they started to study mathematics on scholarships to Trinity in 1941. Both had already covered most of the undergraduate material. The two of them attended Part III lectures only and graduated with distinction in 1943.

Mathematics graduates were required in wartime Britain to support the war effort, and James was sent to work under Sydney Goldstein in the Aerodynamics Division of the National Physical Laboratory (NPL). James was initially fed up with that, for his girlfriend Nancy, also a Cambridge mathematician, had been sent to Farnborough on aerodynamics research work, and James would have liked a similar posting. Goldstein, whom James quickly learned to like and admire, used mathematics to illuminate details of aerodynamic flow. He took a great interest in James and inspired him, advising him to learn what he could about supersonic and viscous flow.

Before the war most supersonic flow and boundary layer work had been done and written up by German aerodynamicists. James quickly understood and extended their work and clearly liked it. The reports on that work, written by James at the NPL and later submitted to Trinity, gained him a Prize fellowship, allowing him to return to Cambridge and resume his research into pure mathematics. But he was beginning to appreciate applied mathematics almost as much, and many people whom James admired showed such interest and curiosity about his wartime work and what he might do for aerodynamics that he hardly had the inclination or time to resume his old life. He married Nancy before the end of the war and moved to Cambridge but would not stay there long, nor, finally, would he emerge as a pure mathematician.

Sydney Goldstein left the NPL to become professor at Manchester in 1946 and invited James to go there with him as a senior lecturer in mathematics. In accepting that post he implicitly accepted also the challenge of developing the mathematics most useful in aerodynamics. James did most things that Goldstein advised and usually took note of what Goldstein said. He shared with friends Goldstein's speculation that there then existed, somewhere, several people as clever as Isaac Newton and that such clever people might well appear somewhat strange. He warned that, if ever Cambridge were lucky enough to meet but fail to recognize that modern genius, Cambridge would become an academic laughing stock but would raise no eyebrows by tolerating strange behavior or by failing to understand difficult concepts. Very bright and occasionally strange himself, James understood that view very well.

At Manchester James threw himself into teaching mathematics by applying it to aerodynamics and by ensuring that his colleagues had more interest and time for research than was normal. He was the most active and by far the brightest member of the Fluid Motion Committee of the Aeronautical Research Council, Britain's body most involved in aeronautical problems and new developments. James bristled with new ideas for solving those problems and for involving his colleagues and students.

Sydney Goldstein went to Israel in 1950 and, young as he was, James Lighthill was the obvious choice for his successor. He became the Beyer professor and head of the mathematics department at Manchester when only 26 years old.

Lighthill was a big man who towered above his contemporaries and had little patience with those who failed to recognize their relative standing. He had a vicious tongue for some, but generally they kept their distance relating their experience privately to others and creating for James an aura of respect and terror. But to those who tried hard to understand and cope with real problems, James seemed always available, helpful, and encouraging. His students were devoted to him, as were his close colleagues.

This phase has been described by Tim Pedley, Lighthill's Royal Society biographer and former Imperial student, as the Golden Years. One can easily see why by noting the large increase in the department's activity, the unusually high output of published papers, and by seeing a large number of Manchester mathematicians later became famous. Lighthill naturally developed his wartime interests at Manchester. He extended work on supersonic flow and was the first to explain how free-stream disturbances affected heat transfer and skin friction in boundary layers. He demonstrated that some flows could be better understood by specifying them in terms of vorticity. The Manchester school led the world of fluid mechanics at that time, due largely to Lighthill's extraordinary energy and ability. He had accepted an invitation to address the 1948 Congress for Applied Mechanics at the age of 24, and he accepted also an invitation to contribute a 147-page article entitled "Higher Approximation" to the Princeton series on High-Speed Aerodynamics and Jet Propulsion. It was largely James Lighthill's own effort that led to the founding of the British Theoretical Mechanics Colloquium, a popular annual meeting first held in Manchester in 1958, and it was definitely James's drive that brought the Institute of Mathematics and its application into being.

Whether James was particularly attracted by high-speed aircraft or swayed by the importance of containing jet noise, the most significant output of the Manchester school, and what was most probably James's masterpiece, was his completely original theory explaining how and why sound was created aerodynamically. That work appeared in the *Proceedings of the Royal Society* in a remarkable 1952 paper that neither had nor needed any reference. This premier British society would elect him a fellow the following year and would later invite him to summarize the subject of aerodynamic noise in the Bakerian Lecture of 1961, a prize lecture of the society. Lighthill's first paper on the subject continues to be the dominant reference, not only because it is so relevant to an important practical subject but mainly because it is clear and precise. No approximation is made in unraveling the details of aerodynamic sound generation. In fact, it is easily argued that the best modern studies of waves in compressible fluids are actually extensions of work that Lighthill might well have done himself.

No applied mathematician could fail to value Lighthill's book *An Introduction to Fourier Analysis and Generalized Functions* (Cambridge University Press, 1958) or admire the 100-page chapter "Viscosity Effects in Sound Waves of Finite

Amplitude," which he contributed to the book *Surveys in Mechanics*, honoring G. I. Taylor on his 70th birthday. The first book was inspired by Paul Dirac, but he drew on the work of his team at Manchester for the long chapter, which probably initiated the vigorous new discipline of nonlinear acoustics. Many papers and lectures followed, on large-amplitude waves and viscous water waves in particular.

James's lecturing style attracted many comments, most of them complimentary. He would invariably prepare his lectures thoroughly and took enormous pains over elaborately handdrawn blackboards and over his carefully rehearsed flamboyant style of delivery, with which no doubt Nancy helped him. His widespread scientific appeal was enormous at the end of the 1950s and probably encouraged him to become ever more striking in public lectures, but at that time James was beginning to look for a new challenge.

The change came when he was appointed director of the Royal Aircraft Establishment (RAE), headquartered at Farnborough but having several outlying sites. Friends worried that a magnificent mind was about to become cluttered with the administrative duties of supervising about 8,000 staff members. But James was determined to spend most of his energy at the RAE in raising the establishment's scientific output. He wrote many scientific papers and created there a new "director's" series of reports. He appeared to enjoy administration and even enjoyed bringing new technology into government departments, but applied mathematics was his first love and that received most of his attention. His appointment was enormously popular with Farnborough's scientific staff, each of whom seemed to benefit from the director's attention, their visibility and morale rising spectacularly. Of course, James was involved with the establishment's main activity in new aircraft, but it was science that benefited most, and it was science that after five years drew him back to academic life on his appointment as the Royal Society research professor at Imperial College.

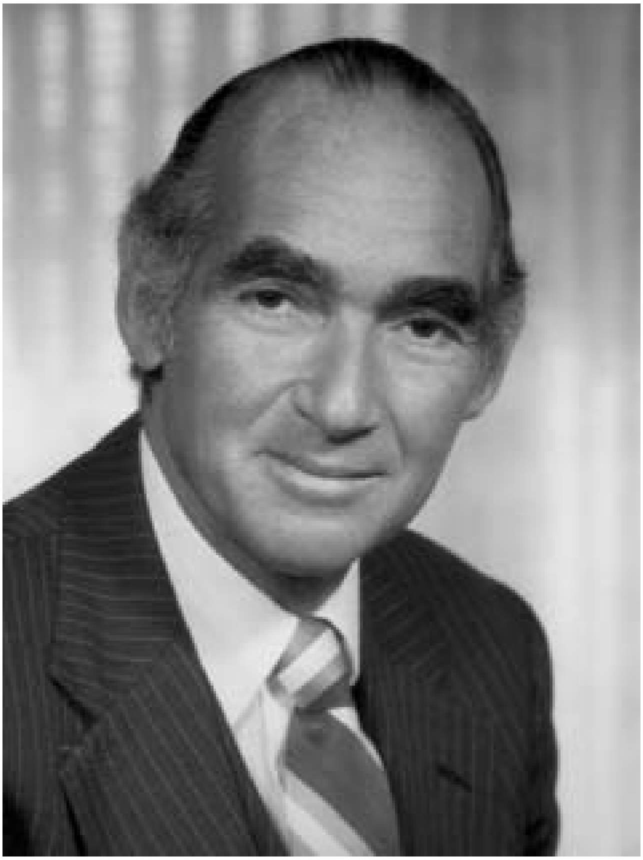
Lighthill took new offices at the top of Imperial College's new building opposite the mathematics department. He took on new research students, new disciplines, and the new practice of giving a series of lectures on what research he was then interested in. Those lectures were a spectacular success, and he enjoyed giving them. They were mainly presented in the math department and attracted several staff members and the most aspiring research students from across the college, who could see and learn from the *master* about *Fluids, The Swimming of Fish, Group Velocity, Geophysical Flows,* and *Biological Fluid Mechanics.* James also took great pride and interest in the Physiological Flow Studies Unit he had helped Colin Caro establish at Imperial College. Though very busy at that time, James seemed always to be in evidence, a familiar figure at the college and at scientific meetings in London, England, and around the world. Few who met him and certainly none who knew him well were surprised when James's next position was announced. He had been elected to the Lucasian chair of mathematics at Cambridge.

He was thrilled to bits by the thought that in that chair he would succeed Isaac Newton and that Gabriel Stokes and Paul Dirac had been there also. When it was pointed out to James around that time that a shot he was about to make in croquet was mechanically impossible, he quickly quipped that the Lucasian professor is immune to mechanical laws because he makes them; he promptly demolished the hoop!

Initially, James liked being back in Cambridge, but following the death of a close colleague, he became bored with it. His big book, *Waves in Fluids* (Cambridge University Press, 1978), was the main product of his 10-year stay. He had lost none of his mischievous qualities at this time nor his love of mystery and the use of very long words. Few knew at the time what he meant by reference to his pulchritudinous hostess. And when he was an editor of *JFM,* a journal that prides itself on having two independent referees for every paper, he was notorious to some for being both. He formed definite views very quickly. On the occasion of his 60th birthday, he was presented before dinner with a 380-page volume of the *IMA Journal of Applied Mathematics,* comprising 18 new research papers written by friends and colleagues in his honor. During dinner he read them, and in an after-dinner speech made only a couple of hours after first seeing the material, he gave a critical review of each paper. The fact that diners cheered loudly spoke volumes about his popularity.

He left Cambridge to become provost of University College, London, where he was both popular and successful. Under James the college grew in size and stature. He got to know professors personally and brought many new scholars into their ranks. He eventually retired at the end of a brilliant career and became a research assistant at University College, Nancy sharing an office with him.

James was much honored throughout the world. He had some 24 honorary degrees, and his many publications were collected and published by Oxford University Press. He was knighted by the Queen and appointed to the best British and foreign academies. James was survived by his widow, Nancy, and their five children, but Nancy died in 2010.



HENRY R. LINDEN

1922–2009

Elected in 1974

"For contributions to methods of fuels conversion and energy utilization."

BY ROBERT S. LINDEN AND MARGARET M. MURPHY
SUBMITTED BY THE NAE HOME SECRETARY

HENRY ROBERT LINDEN, world-renowned authority in energy research and policy, passed away on September 13, 2009, at the age of 87.

Born on February 21, 1922, and raised in Vienna, Austria, Henry was the only child of parents Fred and Edith (Lermer) Linden. Both of Henry's grandfathers were medical doctors, and Fred had been required to earn a law degree before being allowed to pursue his chosen career as an artist, which led to a series of commissioned portraits of the Habsburg monarchy. Edith worked as a society editor for a Viennese newspaper. Henry was expected to pursue his studies diligently, but enjoyed spending his free time outdoors in the Boy Scouts and on his own. He learned to ski the Alps when a day's ski outing consisted of eight hours of strenuous climbing and one hour of exhilaration on the way down. In a manner that came to characterize his professional career, he took satisfaction in the long climb up—all the better to appreciate the reward of the short trip down.

In 1939 the family immigrated to New York City, where Henry's parents remained for the rest of their lives. Henry applied for admission to several American colleges but could gain entrance only to West Georgia College, where he majored in textile engineering. After proving himself academically, Henry transferred to Georgia Institute of Technology, where he changed his major to chemical engineering and graduated at the top of his class in 1944. That same year he married Dorothy Jenks and returned to New York to work for Socony Vacuum (later Mobil Oil) on high-performance aviation fuels while completing a master's degree in chemical engineering at Polytechnic Institute of Brooklyn (now Polytechnic Institute of New York University).

In 1947 Henry moved to the Midwest to begin what would be a 30-year affiliation with the Institute of Gas Technology (IGT), joining as supervisor of oil gasification processes. Simultaneously, Henry continued his graduate program in chemical engineering at the neighboring Illinois Institute of Technology (IIT), conducting his doctoral research under the direction of Ralph Peck in high-temperature, vapor-phase cracking of hydrocarbons. The 1950s were highly productive years for Henry; he completed his Ph.D. degree (1952) and greeted the arrival of son, Robert Seth, and daughter, Debra Jeanne, all the while assuming greater and broader managerial responsibility at IGT. By 1961, Henry was appointed as institute director, a post he held for 17 years, executing major programs in energy supply and conversion and pioneering the concept of a hydrogen economy along the way. An accomplished technologist with a global view on energy, Henry had an illustrious career at IGT, which reached its pinnacle in 1974 with his appointment as president and trustee.

Amid growing concerns about the adequacy of U.S. natural gas supplies, Henry provided the pivotal impetus in the launching of the Gas Research Institute (GRI), the U.S. natural gas industry's cooperative research and development arm, and served as its first president and as a member of the board of directors from 1977 until his retirement in 1987. It is widely accepted that Henry's foresight and visionary leadership of

GRI are largely responsible for the widespread availability of natural gas supplies today, particularly with respect to the key contribution of technologically and economically feasible "unconventional" resources, which today comprise 65% of U.S. natural gas production.

Throughout the course of his professional life, Henry maintained a close relationship with IIT, his beloved alma mater. After retiring from GRI, he turned his energy and attention to establishing a comprehensive research and education program in sustainable global energy development at IIT. Although the preponderance of Henry's career was spent in the administration of large-scale research and development programs, he maintained a lifelong commitment to critical thinking, conducting his own research in sustainable global energy systems, industrial ecology, the energy/environment/economics paradigm, and global climate change. Beginning in the mid-1980s, long before global warming had surfaced as a topic of raging debate, Henry assumed what he called a "contrarian" perspective, encouraging researchers and policymakers alike to maintain a fact-based, long-term perspective of the issues.

In the course of pursuing these diverse interests, Henry served as an esteemed member of the faculty of the IIT Department of Chemical Engineering for more than 50 years. Most recently, he was appointed the Max McGraw Distinguished Professor of Chemical Engineering, director of the IIT Energy + Power Center, and member of the advisory boards for the IIT Department of Chemical and Biological Engineering and the Wanger Institute for Sustainable Energy Research (WISER). The culmination of Henry's lifelong effort to secure international prominence for IIT in energy research and education, WISER was established in 2008 under the directorship of Hamid Arastoopour, Henry's protégé, colleague, and recently named IIT Henry R. Linden Professor of Energy. Relentlessly dedicated to his research, Henry continued to come to work until a few short months before his death, when his failing health prevented him from doing so.

A prolific researcher, Henry was author or coauthor of more than 240 publications and 27 patents related to energy supply, energy use, and petrochemical production. He wrote and lectured extensively on U.S. and world energy issues throughout his lifetime and was revered for his uncanny ability to bridge the communication gap between key stakeholders in productive energy policy development. For this reason he was tapped to serve on several federal advisory bodies dealing with energy policy, technology, and regulation, beginning with the Kennedy administration, and held a presidential appointment during the Ford administration.

Among Henry's most noteworthy and proudest professional achievements was his election in 1974 to the National Academy of Engineering (NAE) in recognition of his "contributions to methods of fuels conversion and energy utilization." He was also fellow of the American Association for the Advancement of Science, the American Institute of Chemical Engineers (AIChE), and the Institute of Energy. Henry was a member of the Hydrogen Technical Advisory Panel of the U.S. Department of Energy (1992–2003), the NAE Advisory Committee on Technology and Society (1987–1992) and the Steering Committee on Industrial Ecology and Design for the Environment (1992–1994), the Advisory Council of the Electric Power Research Institute (1987–1993), and the Energy Engineering Board of the National Research Council (1986–1993). He served as a director of five major corporations—Sonat, Inc., and its subsidiary Southern Natural Gas Company, Reynolds Metals Company, UGI Corporation, and the AES Corporation—and as an advisory board member of five venture capital funds.

Henry received numerous awards for his technical and analytical work in the fossil fuels area, including the Homer H. Lowry Award for Excellence in Fossil Energy Research from the U.S. Department of Energy in 1991, the 1993 United States Energy Award from the United States Energy Association, the 1996 Lifetime Achievement Award of *The Energy Daily*, and the American Chemical Society Division of Fuel Chemistry Award in 1967. In 2000, AIChE recognized Henry with the Ernest W. Thiele Award, and in 2008 the AIChE's Centennial Committee selected him as one of the “100 Chemical Engineers of the Modern Era” for his guidance of the profession into the new century in the area of global climate change, industrial ecology, energy resource assessment, and clean coal technologies. An icon at IIT and a lifelong university benefactor, the IIT Alumni Association awarded him its Professional Achievement Award in 1975, the Alumni Medal in 1995, and the Lifetime Achievement Award (posthumously in 2010). Henry was inducted into the IIT Hall of Fame in 1982. Today, a chemical engineering graduate fellowship bears his name, as does the Henry R. Linden Endowed Professorship.

Although his professional commitments occupied the lion’s share of his time, Henry never lost his inherent love of nature and the desire to be alone among its elements. In the late 1980s, Henry and Natalie, his beloved wife of 42 years, bought a farm in western Wisconsin and drove nearly seven hours to get there on weekends, as time permitted. It was there that Henry enjoyed a respite from his daunting professional commitments. Respite did not mean escape from the values and goals that sustained him through his 87 years, however. Setting aside his more intellectual pursuits, he enjoyed picking up a spade on summer weekends to work the soil and plant a tree, secure in his knowledge of the long-term benefits that can grow from a little extra effort today. But in the cold Wisconsin winter, strapping on his cross country skis for yet another foray up the hills that surrounded the farmhouse, Henry truly came full circle, his boyhood passion for hard work still driving him to mark new trails—in a long life defined by self-set challenges well met.

A. L. LONDON

1913–2008

Elected in 1979

"For contributions to the theory and applications of compact heat exchangers, especially in the gas turbine field."

BY SALOMON LEVY

ALEX LOUIS ("LOU") LONDON was one of the world's best-known experts in heat transfer equipment design, performance, and analysis. He died on March 19, 2008, following a short illness after a stroke.

He was born on August 31, 1913, in Nairobi, British East Africa (now Kenya). In 1921 his parents moved to the United States, which allowed Lou London to attend school in Oakland, California, and to get a bachelor of science (B.S.) in 1935 and a master of science (M.S.) in 1938 in mechanical engineering from the University of California at Berkeley. During the period 1935 to 1938, he was employed by Standard Oil of California, he was an instructor at the University of Santa Clara, and he met and married his wife Charlotte. They had three children, and they were together for 61 years until her death in 1999. Since 2000 he lived in San Rafael with his son Allan.

Lou London began his career at Stanford University in 1938, where he was a professor of mechanical engineering until 1971. He continued to supervise graduate students until 1988, and he wrote 52 published technical papers with them. During World War II, he was in the U.S. Navy on active duty for three years doing research for the Bureau of Ships. He retired with the rank of commander from the Naval Reserve in 1978. In 1964 he worked for General Motors on gas turbines, and in 1979 he helped formulate Stanford's geothermal program.

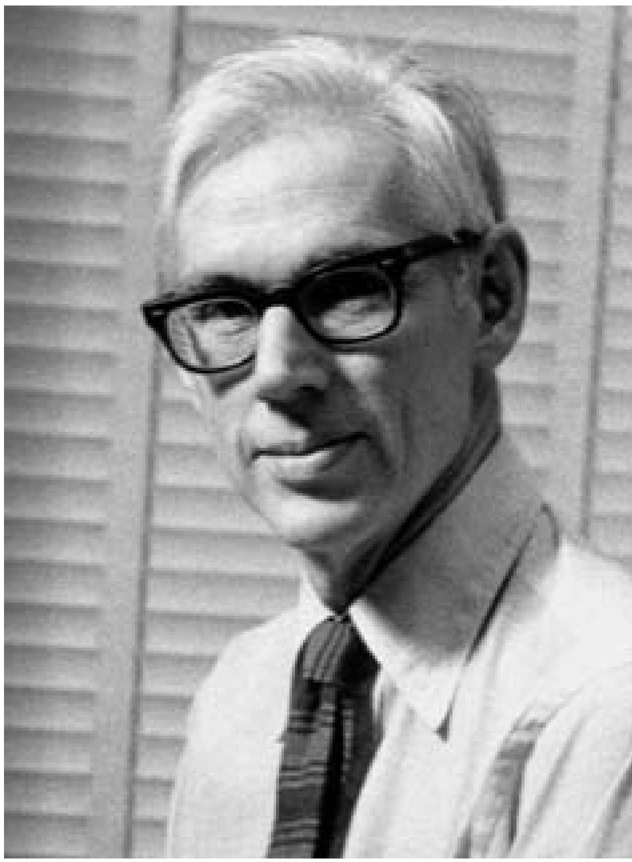
Professor London was an authority on compact heat exchangers. Typically, they are devices that remove unwanted heat from engines and disperse it into the air. The most common compact heat exchangers are the radiators in automobiles, but they are also used in airplane engines, refrigerators, computers, and gas turbines to produce electricity.

Professor London was the first to organize the field of compact heat exchangers. He was helped by Bill Kays, a former student who eventually became dean of engineering at Stanford University. Together, they wrote the book *Compact Heat Exchangers* (Academic Press, 1978), which became a prominent reference used all around the world. It utilizes the concept of Number of Transfer Units (NTUs) to simplify the determination of heat exchanger effectiveness and covers a multitude of configurations and extended surfaces. Professor London wrote another book with R. K. Shak, *Laminar Flow Forced Convection in Ducts.*

Professor London was a member of the American Society of Mechanical Engineers (ASME), a member of Sigma Xi, a life member of the American Society for Engineering Education, a member of the American Society of Naval Engineers, and a member of the American Association of University Professors. That large number of memberships speaks for his diversity of interests.

Professor London was a real, practical teacher. He took his students on field trips to power plants, electrical switching stations, oil platforms, and such applications as aircraft engines. He was tough, and he did not hesitate to mark student papers with NONSENSE in red ink. At technical meetings he would get up and tell the speaker that he was violating the fundamental laws of thermodynamics: The "secret" he transmitted to his students was that they needed to take the system they were studying and "put it in a box," better known as control volume. Then they should apply the basic principles of physics to that control volume and learn whatever they needed to know about the system. Professor London was a craftsman as he demonstrated his analysis methods on energy transfer devices, showing that believing and applying such principles as the second law of thermodynamics can spare an engineer much frustration.

Professor London was awarded the ASME Heat Transfer Memorial Award in 1952, the ASME Gas Turbine Division Best Paper Award in 1964, its R. Tom Sawyer Award in 1977, and its James Harry Potter Award Gold Medal in 1980. He received the Max Jakob Memorial Award in 1984. He was inducted into the National Academy of Engineering in 1979 and into the Silicon Valley Engineering Hall of Fame in 1990. His outstanding contributions to education, research, and professional services have not gone unnoticed.



JOHN (JACK) P. LONGWELL

1918–2004

Elected in 1976

"For contributions to the basic knowledge of combustion, particularly the design basis for gas turbines, rockets, and ramjets."

BY WALTER MAY AND ADEL SAROFIM

JACK LONGWELL died on October 6, 2004, at the age of 86 after a distinguished career at Exxon and the Massachusetts Institute of Technology (MIT). He was born April 27, 1918, in a medical facility in Denver, Colorado, the nearest to his parents' home in Wyoming. His father was a civil engineer who helped build dams for the U.S. Reclamation Service. Jack spent his first 11 years in Wyoming, where he developed his lifelong interests in the outdoors—fishing, hunting, skiing, and hiking. Then in 1929 he moved with his family to Oakland, California. He attended the University of California, Berkeley, where he obtained an S.B. in mechanical engineering before continuing his studies at MIT as a doctoral student with Professor H. C. Hottel (deceased, NAE, 1974) as his advisor. His doctoral thesis research on pressure-atomized nozzles provided the detailed size distribution of droplets in the resulting sprays. He developed the first size characterization of the drop size distribution by capturing the sprays in a dry ice/acetone bath and then sieving the frozen droplets. His method for characterizing sprays had a major impact on the development of both commercial burners and gas turbines. Will Hawthorne (NAE, 1976), while working with Whittle to develop the combustor for the first British jet aircraft, told Hottel that his team had copied Jack's atomization method and classified their report on the work!

On graduation in 1943, Longwell joined Exxon, then Standard Oil of New Jersey or Esso, in the Process Research Division in Bayway, New Jersey. In 1945 he was assigned to work on government-supported research on high-output combustion. The mission was to design a propulsion system, on the Bumblebee project directed by John Hopkins, which ultimately led to the development of the long-range Talos naval surface-to-air missile. He would later take satisfaction in the successful use of the Talos missile in the Vietnam War. His research on high-output combustion—in application to gas turbines, rockets, and ramjets—led to the invention, with Malcolm Weiss, of the well-stirred reactor, which is now widely used by the combustion community for studying high-temperature kinetics. The well-stirred reactor uses sonic feed-jets to induce recirculation in the reactor to minimize mass transfer limitations. It is of great value in determining the maximum throughput achievable by a combustor without flame blowout.

"Jack showed an unusual ability and delight in taking a piece of science and showing where it could be applied, along with a singular ability to analyze all dimensions of a problem." These attributes led to his being assigned a series of management positions of increasing responsibilities, including setting up the predecessor of the Government Research Laboratory, serving as the first head of the Exploratory Division of the Process Research Division, heading up the Chemical Research Division in 1960, serving as director of the Central Basic Research Laboratory in 1965, and becoming manager of corporate research in 1968. His breadth of experience and his penetrating technical insight were recognized in his appointment as senior scientific advisor, the company's highest technical rank. Jack's responsibilities went beyond combustion to include development of a wide range of technologies for fuel conversion and utilization, as well as helping younger researchers convert their ideas into products and processes.

Jack retired from Exxon to join the MIT faculty in 1976, where he pursued his interests in combustion, pollution abatement, and the health effects of combustion-generated pollutants.

He was named the first Edwin R. Gilliland Professor and served as associate director of the Center for Environmental Health Sciences. He supervised over 50 students, providing them with the stimulation of his wisdom and powers of penetrating analysis. Additionally, he catalyzed and refined their ideas, allowing them to blossom into independent researchers. The students enjoyed the frequent parties that he and his wife, Marion, hosted at their elegant home in the proximity of Harvard Square. His research contributions included the development of a new version of the jet-stirred reactor, which consists of a torus stirred with a series of tangential sonic jets discharging into a plug flow reactor. This system approximates the Bragg model of a combustor, which is comprised of two zones. The first is a well-stirred reactor representing the recirculation zone near the fuel and air injectors necessary to stabilize a flame zone; the second is a plug-flow region required to achieve high combustion efficiency. His research on pollution abatement at MIT was directed at control of the emissions of the nitrogen oxides, sulfur oxides, soot, and polycyclic aromatic hydrocarbons with special emphasis on their potential mutagenicity.

Jack was active on national committees in the combustion, environmental, and fuels areas. He served as chairman of the National Aeronautics and Space Administration's Advisory Committee on Combustion and Aeronautical Propulsion and served on the National Research Council's (NRC) Energy Engineering Board and on committees on the disposal of the U.S. Army's chemical stockpile. He headed up critical assessments of technologies for the conversion of domestic resources to liquid fuels and of the U.S. Department of Energy's coal program. As part of these efforts, he chaired NRC committees that led to the publication of "Fuels to Drive Our Future" in 1990, "Alternative Technologies for the Destruction of Chemical Agents and Munitions" in 1993, and "Coal: Energy for the Future" in 1995. His contributions on the NRC stockpile committee are particularly noteworthy. While he believed in incineration for destruction of the chemical stockpile, he also recognized the need for alternatives to incineration in the event that growing public opposition was successful.

As a result of his early efforts, several of the nine chemical depots at which chemical weapons were stored adopted alternative disposal technologies. For example, neutralization of an agent by sodium hydroxide has been successfully used to destroy the nerve agent VX at the Newport, Indiana, chemical depot and is planned to be used to destroy mustard blister agent at the chemical depots in Pueblo, Colorado, and Blue Grass, Kentucky.

Jack contributed his time freely to professional societies. He received the 1979 Award in Chemical Engineering Practice from the American Institute of Chemical Engineers in recognition of lifetime contributions. He was involved on the governing committees of the Combustion Institute since it was founded in 1954, serving on its board of directors and a term as its president, contributing to the growth of the institute into the preeminent international organization in combustion. He was the recipient of the 1974 Alfred C. Egerton Gold Medal, awarded by the institute for distinguished, continuing, and encouraging contributions in the field of combustion. He was elected to the National Academy of Engineering in 1976.

Jack brought to his hobbies of fishing, hunting, jewelry making, and woodcarving the same intensity that he applied to his professional activities. He was an enthusiastic woodcarver who produced furniture and figurines that graced his home; he often used wood from the trunks of trees downed in his neighborhood during storms. To make hunting more competitive, he used bows that he had designed and built. He was an avid fisherman; one of his favorite spots to fish was in the Henry's fork of the Snake River in Idaho, where his cabin was situated in the Yellowstone Caldera, with a distant view of the Grand Tetons. The cabin was designed by the architect husband of his daughter Ann and was built as a joint effort by Ann and his son John, along with John's college-age friends. Jack was responsible for carving the dovetail joints for the close to 400 logs used to build the three-bedroom home, joints that locked together so perfectly that the house was impermeable and beautifully insulated. The cabin continues to be a family gathering place and continues to be enjoyed by Ann and her family.

Jack shared his wife Marion's passion for classical music. Jack took up the cello at the age of 40, and as his expertise grew, he organized and played in an amateur music group in which his daughter, Martha, participated alternately as a pianist or violist. (He playfully referred to the group as the Mauvais Arts Trio, a whimsical variant of the Beaux Arts Trio.) His children remember Jack's creativity in playing with them—for example, casting their arms in plaster to pretend that they were broken and then removing the casts with a hacksaw. He joined John in his pastime of riding motorcycles and, ever a competitor, broke his collarbone in a wipeout when trying to beat John's best time. Discouraged by the family from riding motorcycles, he switched to riding mountain bikes and then broke the opposite collarbone attempting to jump a log. He instilled in his children and grandchildren his love of nature and the outdoors. In the early years his children joined him hiking, skiing, kayaking, digging for clams, and catching crabs, and in later years in Idaho he and his grandchildren canoed, rode mountain bikes, and explored for arrowheads. His importance in the lives of his children and grandchildren is reflected in their choice of careers. John is a mechanical engineer, Martha a biomedical researcher, and Ann a structural engineer. Out of eight grandchildren, six have chosen to go into some form of science or engineering. His legacy lives on with his familial and academic progeny.

This account was prepared from personal recollections by a former colleague at Exxon (W.M.), an MIT colleague (A.S.), description of his family life contributed by Jack's daughter Martha Blair, information including an excerpt (in quotation marks) from Ben Harte's "Portrait of a Pioneer" in the *Lamp* (an ExxonMobil publication), and the *Oral History of Hoyt C. Hottel* published by the Heritage Foundation.

FRED E. LUBORSKY

1923–2010

Elected in 1985

"For the understanding and development of fine particle magnets and plated wire memories, and for important contributions to the study of the metallurgy and magnetic properties of amorphous alloys applicable to a wide range of magnetic devices, particularly power transformers."

BY HARVEY W. SCHADLER

FRED E. LUBORSKY, an internationally known authority on permanent magnets and amorphous metals, died February 3, 2010. Fred was born on May 14, 1923. Fred was 86 and he died peacefully.

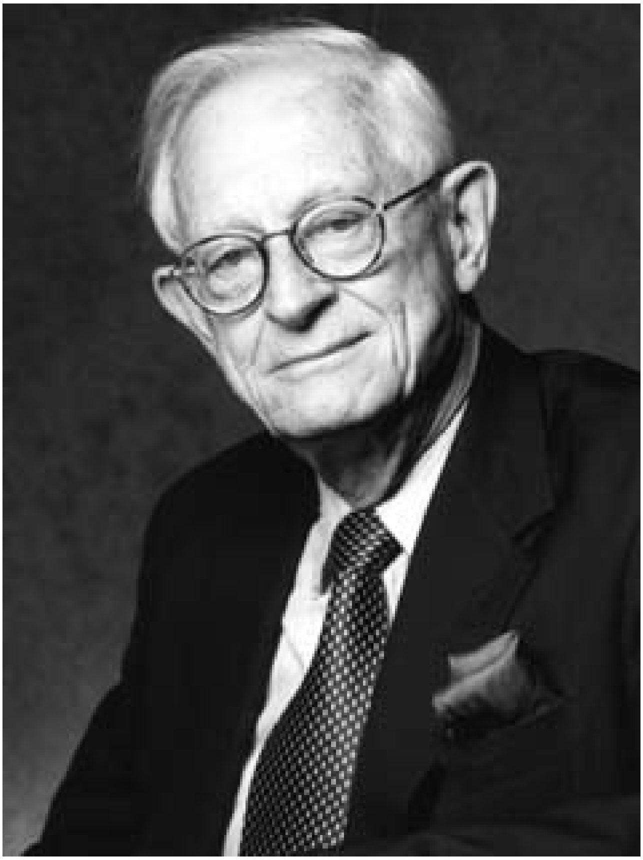
Fred was a highly educated and technically competent scientist who was open with his scientific information, his insights, and his enthusiasm. He was granted a four-year merit scholarship from the city of Philadelphia, and he completed a bachelor's degree in chemistry at the University of Pennsylvania in 1947. After serving two years in the U.S. Navy, he completed his doctorate in physical chemistry at the Illinois Institute of Technology in 1951.

Fred joined the General Electric Corporate Research and Development Laboratory (CRD) in 1951. Following one year at CRD, he spent seven years working for GE in Lynn, Massachusetts. In 1958 Fred returned to GE's CRD, where he specialized in the physics of magnets and the metallurgy of magnetic materials and devices. His career began, grew, and ended with studies in these areas. Fred's contributions to the scientific community included more than 160 technical papers and 21 patents. These documents demonstrate Fred's efforts (and those of many others in the magnet materials sphere) to thoroughly establish the knowledge base for magnetic materials. In addition to these scientific contributions, he was the key technology leader in developing GE's Lodex permanent magnets, thin-film electroplated magnetic disks, plated wire memory, amorphous alloys for transformers, and amorphous films for magneto-optic recording.

Fred's career was special not only because of these achievements but because of his enthusiasm and his openness to new information and insights. His contributions to his colleagues were immense and greatly appreciated. Some of this appreciation is reflected in his many awards, including:

- The Centennial Medal for outstanding service and achievements awarded by the Institute of Electrical and Electronics Engineers (IEEE)
- IEEE: Magnetic Society, president, 1971–1977, and editor in chief, 1972–1975
- Member of the National Academy of Engineering
- Coolidge Fellow, General Electric Corporate Research and Development
- Fellow of the IEEE, American Institute of Chemists, American Physical Society, and New York Academy of Sciences

Fred was an avid tennis player and woodworking craftsman. He and his wife Florence were married for 63 years. They raised three children: Professor Judith L. Luborsky, biologist at Rush Medical Center, Chicago; Professor Mark R. Luborsky, anthropologist (husband of Professor Andrea Sankar) at Wayne State University, Michigan; and Rhoda S. Luborsky, owner of Schenectady VanCurler Music, Schenectady, New York. He has one granddaughter, Rebecca C. Luborsky, of Philadelphia.



ALAN G. MACDIARMID

1927–2007

Elected in 2002

"For the co-discovery and development of conductive polymers."

BY RAY H. BAUGHMAN

ALAN GRAHAM MACDIARMID, who shared the 2000 Nobel Prize in Chemistry with Alan Heeger and Hideki Shirakawa, died on February 7, 2007, at age 79.

His fundamental and applied discoveries ushered in the second age of polymers, in which organic polymers became fully functional electronic materials. His mentorship and encouragement inspired generations of students. He taught them that "theories come and go, but the facts go on forever, so you have to get the facts correct."

Alan was born in New Zealand on April 14, 1927, to loving parents and a supportive family impoverished by the Great Depression. Though getting food on the table was difficult, they shared what little they had with friends and neighbors. This tradition of giving even when it was very difficult was in Alan's makeup, and he believed that winning the Nobel Prize gave him a special obligation to advance humankind. While suffering from frequent skin cancer, a broken hip, and a blood disease that was expected to soon end his life, he nonetheless struggled ahead on the day of his death to begin a 10-day trip to New Zealand for keynote lectures, governmental meetings, a television interview, and a likely last farewell to family.

Alan never forgot his origins; he went barefoot to primary school in a two-room schoolhouse, where he reported, "Most of my school chums were Maori boys and girls from whom I learned so much."* In their honor and in the celebration of life, Alan danced the spirited Maori *haka* at the all-night student celebration ending the Nobel Prize ceremonies and at many other celebrations until he died.

Alan's love of chemistry began because of his thirst for knowledge and understanding, which lasted a lifetime and enabled him to do pioneering research in diverse fields of chemistry, physics, biology, materials science, and engineering. At the age of 10, he began reading his father's chemistry textbook from the late 1800s and performing experiments from *The Boy Chemist,* which he discovered in a library.

When he had to leave high school at 16 to help support his family, he found a part-time job as a lab assistant and janitor in the chemistry department of Victoria University College in New Zealand. Alan began his academic career there, earning a bachelor's degree and a master's degree. He earned doctorates from the University of Wisconsin and Cambridge University and subsequently became a professor at the University of Pennsylvania. His initial pioneering breakthroughs in Cambridge and Philadelphia were in silicon chemistry, which earned him the 1971 Frederic Stanley Kipping Award of the American Chemical Society. He became professor of chemistry and James Von Ehr Distinguished Chair in Science and Technology at the University of Texas at Dallas in 2002. The same year he became a member of the National Academy of Engineering and the National Academy of Sciences and was inducted into the Order of New Zealand, the highest honor bestowed by his country of birth.

The voyage that led to the Nobel Prize for the discovery of conducting organic polymers began long ago. While at Victoria University College and just starting his career, Alan MacDiarmid published his first paper in 1949, which was on the cyclic monomer S_4N_4. Much later, in 1973, Mort Labes's team at Temple University showed that an inorganic polymer derived from S_4N_4, called $(SN)_x$, is metallic down to 4 K. Alan MacDiarmid and Alan Heeger subsequently reported in 1977 that bromine doping increased the room temperature electrical conductivity of $(SN)_x$ 10-fold.

* From *nobelprize.org/nobel_prizes/chemistry/laureates/2000/macdiarmid autobio.html.*

Then came the famous meeting in Japan, over cups of green tea, between Alan MacDiarmid and Hideki Shirakawa. Both had metallic-looking polymers; Alan's was an inorganic polymeric metal—$(SN)_x$—that looked like gold, and Hideki's was a poor conductor that looked like aluminum foil but was the organic polymer polyacetylene— $(CH)_x$. They developed a joint goal of understanding why $(CH)_x$ is such a poor conductor and of using this understanding to transform this beautiful organic polymer into a metallic conductor.

Money was needed to bring Shirakawa together with MacDiarmid and Heeger at the University of Pennsylvania. Alan MacDiarmid has remarked, "Vision without funding is hallucination." Fortunately, program manager Ken Wynne from the Office of Naval Research happened to have $21,650 left in his program account, which he gave to support Hideki Shirakawa's visit. Once together, Heeger's deep insights into the physics of molecular charge-transfer complexes could be combined with MacDiarmid's and Shirakawa's seminal chemical insights to make, characterize, understand, and exploit the first highly conducting organic polymer.

In the early days of the conducting polymer field, Alan MacDiarmid was frequently asked, "What use are these metallic organic polymers?"—to which he would respond, "Of what use is a beautiful poem?" or "Of what use is a newborn baby?" Yet Alan was already translating the pure poetry of science into the demonstratively useful language that enabled companies around the world to begin developing new products. Realized or proposed products resulting from his work with colleagues include, for example, antistatic and corrosion protection materials, electromagnetic shields, light-emitting devices, solar cells, sensors, artificial muscles, transistors, supercapacitors, batteries, electrochromic displays, and fuel cells. Alan often brought demonstrations of his newest invention to lectures, such as a fan powered by the first conducting polymer battery.

Rising up and down like a wild stallion, Alan carried my three-year-old son, Alex, on his back a decade ago. In much the same way, Alan carried his students through early learning experiences, bringing them to the point where they could ride the wild bronco of discovery on their own. His former students are leaders in science and technology around the world, and in his honor Alan G. MacDiarmid institutes have been started in China, India, New Zealand, South Korea, Taiwan, and Brazil. After his death, we renamed our NanoTech Institute at the University of Texas at Dallas in his memory. Because of Alan, we now have more Nobel Prize "holders" in Texas than anywhere else in the world—Alan always passed his Nobel Prize medallion among the many high school students that he lectured.

Alan was a hero in so many ways. He often said that "Science is people," and he lived his conviction by inspiring generations of scientists and technologists. Students at poster sessions always found him ready to listen. After asking them penetrating questions he would usually say, "Ah, this is so interesting!" This response from a Nobel Prize winner deeply inspired young scientists and engineers.

When there was the possibility of a catastrophic explosion, Alan was the one ready to risk his life to save others. An excited student once ran into Alan's office saying that he might have condensed acetylene into the liquid state, thereby possibly creating a powerful bomb. The fire department cleared the building, and Alan volunteered to go into harm's way to eliminate the risk. With others safely distant, Alan donned bomb disposal clothing and used a fishing rod to open a valve to avert a potential catastrophe.

Despite the many arrows in his body, no one could stop Alan from always climbing back into the saddle, from which he finally fell only as he was dying. Alan was a man for all seasons, so very exuberant, loving, sensitive, and active in responding to individual human needs and those of humankind. The institutes he founded and nourished with his scientific insights and support span the world, and there would have been others and many more breakthroughs if he had lived just a little longer.

He is survived by his loving wife, sister, four children, nine grandchildren, and friends too numerous to count.

JOHN H. MCELROY

1936–2007

Elected in 1998

"For the development and applications of laser technology to space-based geodesy, atmospheric science, and communications."

BY BILL D. CARROLL, FRANK L. LEWIS, AND JOHN J. MILLS
SUBMITTED BY THE NAE HOME SECRETARY

JOHN H. McELROY—engineer, educator, and scientist—died of a heart attack at his home in Las Vegas, Nevada, on September 14, 2007, at the age of 71.

John was born on June 27, 1936, in Marion, Ohio. He attended elementary school and junior high in Marion and was well known in the local library from an early age. His hobbies were reading and football. John's high school education was obtained at Culver Military Academy where he graduated in 1954 and entered the U.S. Army as a lieutenant. At Culver, John showed interests in English, history, science, art, and sports. He lettered in varsity baseball. His interest and preparation in these areas were certainly evident in his life and his work.

John served in the 11th airborne infantry unit in the United States and overseas until 1957. While serving in Germany, John met his future wife, Ellie, and they were married on March 18, 1957. From 1957 to 1963, he was senior instructor and technical writer at the U.S. Army Air Defense School, in Fort Bliss, Texas, and was twice named instructor of the year. In addition to teaching, John wrote several student texts that were translated into seven languages for use in the United States and abroad.

Following his military service, John enrolled in the University of Texas at Austin and earned a bachelor of science degree in electrical engineering in 1966. While pursuing his baccalaureate degree, John worked in the Quantum Electronics

Research Laboratory, where he did research on laser-induced ionization of high-pressure gases. Later he pursued graduate studies part time at Catholic University of America and earned a master's of electrical engineering degree in 1973 and a Ph.D. in 1978.

John began a career with the National Aeronautics and Space Administration (NASA) in 1966 at the Goddard Space Flight Center. Over the years he served in various capacities at Goddard, including senior physicist and electronics engineer, head of the Laser Heterodyne Systems Section, and head of the Electro-Optics and Laser Technology branches. He directed research on laser communications systems, tracking and radiometry, and advanced satellite communications technology. From 1979 to 1980, John served as director of the Communications Division, Office of Space and Terrestrial Applications, at NASA Headquarters, where he directed the revitalization of NASA's communications R&D program. John returned to Goddard in 1980 as deputy director and served in that capacity until 1982.

John served as the assistant administrator for satellites for the National Oceanic and Atmospheric Administration (NOAA) from 1982 to 1985. At NOAA he directed the national program in civil operational earth observation satellites, including responsibilities for Landsats-4 and -5, the Tiros series of polar-orbiting satellites, and the GOES series of geostationary satellites.

John joined Hughes Aircraft in 1985 as director of special projects for the Space and Communications Group. He served as vice president for technology of Hughes Communications from 1986 to 1987. While vice president, John led a corporate venture on mobile satellite communications that later became the American Mobile Satellite Corporation. During this time period, he was also senior editor of *Space Science and Applications,* a publication of the Institute of Electrical and Electronics Engineers' Aerospace and Electronic Systems Society.

From 1987 to 1996, John served as dean of the College of Engineering at the University of Texas at Arlington, overseeing a sustained period of growth in both student enrollment and research programs. He then served as UT Arlington's vice provost for research and as dean of graduate studies from 1996 to 1997. He returned to the classroom, teaching electrical and industrial engineering courses until his retirement in May 2000.

A noted authority on space sciences, John was frequently called on to serve as an advisor on investigatory committees and commissions. He was a member of the Space Studies Board of the National Academies and the Advisory Committee on the Future of U.S. Space Programs and coauthored the Center for Strategic and International Studies report *A More Effective Civil Space Program* with co-chair Brent Scowcroft.

John was recognized by several professional organizations for his technical knowledge and service. He was a fellow of the Institute of Electrical and Electronics Engineers, the American Institute of Aeronautics and Astronautics (AIAA), and the Washington Academy of Sciences and a member of the National Academy of Engineering. In addition, he was presented with a NASA First Space Shuttle Flight Achievement Award and Medallion, a NASA Apollo Achievement Award and Medallion, a Silver Medallion from the Brazilian Institute for Space Research, a Bronze Medallion from the Soviet Merchant Marine, and the German Space Agency Medallion (for founding and chairing the International Committee on Earth Observation Satellites). In 1997, AIAA awarded John the International Cooperation Award "for creative leadership in the planning, negotiation, and execution of international participation in major U.S. Space Applications Programs."

John was deeply respected and highly regarded for his personal values and the sense of warmth and friendship that he shared with all who knew him. He was above all a person of integrity and high standards.

John is survived by his wife, Eleonore (Ellie) McElroy. They were a devoted and inseparable couple over the 50 years of their marriage.

John is buried at the Veterans Memorial Cemetery in Boulder City, Nevada.

HENRY L. MICHEL

1924–2001

Elected in 1995

"For leadership in applied research technology transfer professional activities and for promoting alternative forms of project execution."

BY JAMES L. LAMMIE

HENRY L. MICHEL passed away on May 23, 2001, and the engineering and construction industry lost a leader, a teacher, and an ambassador. But we did not lose a role model, for the way in which Henry conducted himself throughout his life will continue to set an example for those who come after him.

Henry's interest in engineering started at an early age. It was the 1930s, and the Flushing High School in Queens, New York, was so crowded that students attended classes only in the morning or afternoon. So for a half-day, Henry watched the construction of Whitestone Bridge from an excellent vantage point on Long Island Sound as the bridge was rushed to completion for the 1939 World's Fair. After watching the bridge through completion, Henry decided that he wanted to be an engineer to be able to build such structures.

However, on his 18th birthday, he received two birthday cards and a letter from his draft board, which changed his plans.

The next two plus years were spent in the Army Signal Corps, which started with several electrical engineering courses at Manhattan College, followed by two and a half years in New Guinea and the Philippines. After his military service Henry entered Columbia University to study civil engineering. While there he found a mentor in Mario Salvadori, a world-renowned structural engineer. During his summers at Columbia, Henry worked on the Penn Central Railroad, where he found supervisors too old-fashioned to provide a career workplace. After graduation, Henry joined United Engineers and Constructors and studied evenings in order to pass his professional engineering exam.

Henry, now married, moved on to Toledo and Edmonton, Canada, as a resident engineer on oil refinery construction projects. Edmonton was a desolate family outpost, but Henry and his wife, Liz, were able to turn the local cow palace into a temporary concert hall with periodic performances by the Vienna Boys Choir, Arthur Rubinstein, and others.

In 1954, Henry and his family moved to England. Henry often told younger staff members that his relocation package on this move consisted of one *one-way* airline ticket. Henry started as a resident engineer on upgrading Royal Air Force stations to NATO standards, and seven years later he was named project director for the total RAF program. Henry was then asked by his mentor, Mario Salvadori, if he would take over an office and a major project in Rome. Henry agreed. When he arrived in Rome, he found that the office he was to manage was in bankruptcy. But since his wife and two daughters and their station wagon were already en route to Rome, Henry decided to start his own company, which he did and which became quite successful, particularly in the Middle East, where Henry's engineering management and marketing skills and his ability to develop relationships at senior governmental levels led to work in Libya, Saudi Arabia, Kenya, Iran, and Lagos as well as Italy and Switzerland. However, by 1965, Henry decided that he did not want to be a permanent expatriate, so he sold the company to his partners and returned to New York.

Back in New York, Henry was unemployed, but at a luncheon he met a senior engineer from Parsons Brinckerhoff (PB), who encouraged him to meet with Walter S. Douglas, then PB's managing partner. Henry did not mention that he had applied to PB's personnel department twice and had been turned down both times. He was hired by Mr. Douglas and was at work at PB in three days. He was initially manager of transportation projects and then was also assigned defense installations and commercial and marine facilities projects. Four years later he became a full partner and a senior vice president. As the junior partner, Henry had all the jobs that the other partners were not interested in. So he took over the water resources group and, with the help of Paul Gilbert, grew it from six to 35 staff members and won several high-profile water projects in Colorado.

But one of Henry's greatest accomplishments for PB came in 1975 when Walter Douglas retired after unsuccessfully trying to sell the company. As Henry had led the effort to block the sale of the company to a large conglomerate, he was asked to find out how to make the company profitable in order to be able to buy Mr. Douglas's shares. Henry then led the reorganization of the 80-year-old partnership into a modern corporate structure. For his efforts he was elected chairman and chief executive officer of Parsons Brinckerhoff.

Henry then led the effort to set up an employee stock ownership program that dramatically expanded ownership of the company among senior managers and technical personnel. He then set up a three-track professional development plan for managers, technical, and project management personnel with formal training and defined levels of achievement at each level. He also established and funded research programs for professional and technical staff members throughout the organization.

Another major contribution by Henry to PB and to the industry was his strong endorsement of growth into international markets. PB had a limited history of international marketing, including its railroad work in China in 1899 and work in South America during the Great Depression of the 1930s. Henry planned a much more strategic approach to overseas work. Starting in the early 1970s, Henry supported an effort and hired key staff to pursue major projects in geographies that had growth potential but lacked strong local engineering capability. The marketing approach stressed teaming with local firms whenever possible. Once the project was won, it then became a base to establish a local company, staffed predominantly by local nationals and with local leadership in place as quickly as possible. Technical excellence and knowledge transfer were provided by U.S. expatriates who were periodically rotated back to the United States. A 20-year partnership in Cairo, PB-Sabbour, was built on Henry's personal relationships. A project win in Hong Kong flagged a gap in the capability of the large British firms that dominated the civil engineering sector there. So PB developed a mechanical/electrical capability in the Far East that led to it having the largest M&E firms in Hong Kong and Singapore, both with Chinese PB shareholders as leaders. During Henry's period of international leadership, PB operations grew to 100 offices on six continents and PB staff grew from 500 to more than 4,000.

During his tenure as chief executive officer and later as chairman, Henry continued a very active role on projects as chairman of joint venture boards or as the primary PB contact at the senior client level. His Joint Venture (Parsons Brinckerhoff/Tudor Board Chairman role as the consultant on the Metropolitan Atlanta Rapid Transit Authority—planned and built over 20 plus years—was a case in point. Henry chaired the JV board for this multibillion-dollar project for more than half of that time, negotiating each year's contract and providing hands-on technical and political oversight and supervising the JV project director. From 1978 to 1982 he was the managing principal of the American Transit Consultants (ATC) Joint Venture, which included Parsons Brinckerhoff, Bechtel and Kaiser Engineers and which was responsible for design and construction of the $16 billion Taipei rapid transit system in Taiwan on behalf of the Taipei Department of Rapid Transit Systems (DORTS). He had key roles in many other major infrastructure projects from Egypt to Morocco to Venezuela to Hong Kong as well as in the United States in all areas of civil engineering.

Henry was a strong advocate for the profession of civil engineering and made major contributions to education and research. In the American Society of Civil Engineering (ASCE), he was an early member of the Building Futures Council. He was a founding member of the Civil Engineering Research Foundation, recruited its first president, and served on its board of directors from 1989 to 1996. The ASCE Henry L. Michel Award for Industry Advancement of Research was established to recognize these and other contributions. At PB he set up an advanced technology group and fostered employee research. After his death the Henry L. Michel Fellowship was established to support research by PB employees.

Other organizations in which Henry was active included the American Council of Engineering Companies (fellow and chairman), the Design Professionals Coalition (chairman), the ASCE (fellow and honorary member), the Society of American Military Engineers (fellow), the Institution of Civil Engineers, the International Road Federation (chairman), and the U.S. Chamber of Commerce. Henry was also a prolific writer, speaker, teacher, and advisor. His articles appeared in such publications as *Construction Business Review, World Highways, Automotive News, Public Works, Water and Wastewater Engineering, Modern Construction, National Development, Worldwide Projects,* and the *Commonwealth Ministers Reference Book,* to mention a few. He also coauthored *Environmental Design for Public Projects.* He guest lectured at the Massachusetts Institute of Technology, Columbia, Cornell, Colorado State, and New York University. He also presented short courses at MIT and Polytechnic University.

Henry's many contributions were well recognized during his lifetime. His greatest recognition was election to the National Academy of Engineering in 1995. Columbia University recognized him with the Egleston Medal in 1982, the Alumni Federation Medal—the highest honor given to an alumnus—in 1991, and the Pupin Medal for service to the nation in engineering in 2000. *Engineering News-Record* selected him in 1999 as one of 125 outstanding contributors to the construction industry in the past 125 years. The ASCE awarded him the Sverdrup Medal for Management in 1982, the CERF Award for Research in 1996, and the President's Award for Service in 1997 and selected him as an honorary member in 1998. In 1996 he received the Golden Beaver Award from the West Coast Beavers construction organization for his role in building America.

A recitation of Henry's accomplishments, while impressive, does not capture the essence of the man. Henry was an urbane, learned citizen of the world. He was a true sophisticate and a Renaissance man. He left a record and an image to be proud of.

Henry is survived by his wife, Mary Elizabeth (Liz); two daughters, Eve Michel and Ann Michel; and a granddaughter, Ava Elizabeth Milanese.

In 2005, Henry's widow, Mary Elizabeth Michel, established the Henry L. Michel Scholarship at the Columbia University School of Engineering for the study of civil engineering. This endowment enables two selected civil engineering students each year to continue their civil engineering studies at Columbia without incurring student loans.

His daughter Ann wrote:

> "My father was an avid tennis player, and also enjoyed deep-sea fishing and sailing. Each winter he would take his son-in-law along on a father-son all men, mostly civil engineers, sailing trip. They would rent four or five 50′ sailboats and in this armada, sail the Caribbean for a week.
>
> He enjoyed theater and classical music. His musical tastes ranged from the classical 3 "B's," Beethoven, Brahms, and Bach, to American jazz and Louis Armstrong.
>
> When not traveling the world, Hank was a devoted husband and father. He took his wife, his mother, and both daughters with him on many of his world travels. After his business was completed, Hank was always ready for exploring and really getting to know the countries we

were visiting. He once took me with him to Asia, and when he was done in Jakarta, he assigned me the job of arranging a trip to Borobodur. I found us a "local" hotel, and after a day there discovered why each of the small huts that served as our rooms was surrounded by an 8" high curb. The rains opened up just at dinnertime, but Dad was ready to eat, so he rolled up his pant legs and we waded to the dining building, propped our feet up on chairs in the flooded room, and were able to dine.

At home on Sundays, he would often cook a fabulous stew, carefully adding neat piles of meat, potatoes and vegetables, one after the other, culminating with seasoning the whole pot with a bottle of beer. And the Christmas roast was his affair.

My father was a lot of fun. He loved people and could remember names and stories for decades. He worked hard, leaving home at 7 AM, and rarely returning before 7 PM, but would still have time to help me with my math homework—extravagantly using a whole sheet of paper to help me see and write out all the steps in even the simplest calculation—a process which gave me a love of math, a subject I majored in at college at Cornell. My sister became an architect, I a science film maker."

WALTER SHEPARD OWEN

1920–2007

Elected in 1977

"For leadership in research on structure/property relationships in metals and in the extension of such concepts to the educational basis of materials science and engineering."

BY ALI S. ARGON

WALTER SHEPARD OWEN was born on March 13, 1920, in the West Derby district of Liverpool and died on October 13, 2007, in Cambridge, Massachusetts.

His distinguished career as a metallurgist, an academic, and a university administrator was shaped in nearly equal parts in the United Kingdom in Liverpool and in the United States at Cornell University, at Northwestern University, but most fully at the Massachusetts Institute of Technology (MIT).

His father, a shipping clerk, gave him his Welsh name and early bearing while his mother, a teacher, gave him his intellectual skills and his deep socialist convictions. In later years he remarked, "If you are not a socialist by the time you are 19, you are stupid, and if you are still one at 39 even more so."

Owen joined the metallurgy department at the University of Liverpool and graduated in 1940 with a first-class honors degree (B. Eng.). He spent much of the World War II years as a metallurgist at the research laboratories of the English Electric Company. During that tenure he continued to broaden his experience as a practicing metallurgist and even earned an M. Eng. degree from the University of Liverpool in 1942. After the war he returned to the University of Liverpool as an assistant lecturer in the metallurgy department and in the process obtained his Ph.D. degree in 1950 with a thesis entitled

"The Carbide Constituent in Iron-Carbon-Silicon and Related Alloys." This work provided the enduring stimulus for his lifelong interest in the thermodynamic and kinetic aspects of ferrous metallurgy and particularly in the study of martensite, its formation, and the source of its extraordinary hardness.

After his Ph.D. award and a faculty appointment as lecturer at Liverpool, Owen made his first of many moves to the United States in 1950 as a postdoctoral visitor at the metallurgy department at MIT for one year with a Commonwealth Fund Fellowship. There he joined Professor Morris Cohen, his professional hero, to work on diffusion-controlled bainite transformations and diffusionless massive martensitic transformations in steel. This was followed in 1953 with a longer stay at MIT as a research staff member, where he led a study of the brittle fracture of steels.

In 1957 Owen was lured back to Liverpool with an offer to become the head of the metallurgy department as the Henry Bell Wortley Professor of Metallurgy. At that time the department was small and housed in an old work house. During his nine-year tenure as head, the department was transformed into a large and vigorous research-oriented department relocated in the fully refurbished George Holt laboratories, previously the home of the physics department. Owen's new office was previously that of Nobel laureate James Chadwick, discoverer of the neutron. This was an exciting period in the department's history as many gifted teachers, researchers, and students were attracted to Liverpool, with Owen making much use of his links with industry in the United Kingdom and the United States to obtain funding for large and ambitious research programs. Another of his major transformative achievements was the introduction of new undergraduate courses to attract students from the physics and chemistry departments to study metallurgy in their final year.

Although in those days materials science as a branch of study was only a dream in the minds of a few physical metallurgists, Owen persuaded the university in 1964 to establish a new chair of physical metallurgy, which soon after changed to one of materials science.

Owen's professional interests developed in many directions. He had a real gift as a communicator and an administrator and took leading roles within the university, particularly later as dean of engineering. He also developed many consulting activities and joined Robert Maxwell of Pergamon Press to stimulate broader-based publishing in the fields of metallurgy and materials science.

After nine years in departmental and university administration at Liverpool, Owen, with his new American wife, moved back to the United States to become head of the Department of Materials Science and Engineering at Cornell University as the Thomas R. Briggs Professor of Engineering. This was followed by a move to Northwestern University, where he became first dean of the Technological Institute and later vice president for science and research.

In 1973 Owen joined MIT as the head of what was soon to transform from a metallurgy department into the Department of Materials Science and Engineering. During his tenure as head until his retirement in 1982, he led a major effort to broaden and diversify the research of the department into areas such as ceramics and polymers while retaining the historical strength of the department in metallurgy. His stewardship of this department was critical to maintaining its top-ranked position in metallurgy in succeeding decades.

After his retirement he continued to be active in consulting and other academic and scientific policy activities both nationally and internationally but divided his time nearly equally between residing in Cambridge, Massachusetts, and in Porthmadog, Wales, where he purchased a house overlooking the sea and the Welsh mountains.

Owen's professional career was centered on a long-term study of martensitic transformations, which while being of central importance in the use of steel remained ill understood until the latter part of the 20th century. In his relentless pursuit starting at Liverpool and continuing at Cornell and finally at MIT, Owen considered the complex aspects of the sources of the remarkable hardness of martensite. This pursuit combined structural studies in the purely thermal aspects of the transformation from austenite to different forms of martensite in iron-nickel alloys, ranging from the "virgin" tetragonal, internally twinned variety of Fe-Ni-C martensite with Ms transformation (start) temperatures of around 250K, first studied by Morris Cohen and co-workers at MIT, to those with Ms temperatures of 300K of partly aged cubic structure. His research also encompassed the stress-directed transformations in which the key role is played by nucleation of the martensite lamellae and the mechanistic details of their broadening by interface translations where interstitial carbon in solid solution strongly affects both the rate of such interface translation and the subsequent dislocation glide inside the twinned lamellae.

With his many gifted students and through his collaboration with Morris Cohen's group at MIT, Owen's research using a variety of theoretical, experimental, and even some computational modeling approaches made key contributions to the understanding of mechanisms governing martensite. Owen's technical journal publications numbered in the nineties.

In 1977, when Owen was elected to membership in the National Academy of Engineering, his citation read: "For leadership in research on structure/property relationships in metals and in the extension of such concepts to the educational basis of materials science and engineering."

Walter Owen's unique talents as a researcher but also as an educator and a mentor of students are well represented by the following tribute by Frederick Schoen, one of his graduate students at Cornell University:

> "I was one of the first doctoral students doing graduate study under Professor Walter Owen's tutelage at Cornell University, beginning in September 1966, shortly after he arrived from Liverpool. It was clear that Professor Owen derived immense satisfaction from his teaching, mentoring, and association with young people, as well as his research in physical metallurgy. It was also apparent that he had a high commitment to excellence in a model

of learning that shared responsibility between students and teachers, where he was always eminently respectful and caring of the professional and personal needs of both students and faculty colleagues. I remember best his friendly, encouraging, and optimistic manner that gently pushed me and my colleagues to do our best work, as much of it as possible, and as rigorously as possible.

He was extremely generous with his time and energy, making a key contribution to my career and I'm sure the careers of my fellow students, accrued from the relaxed but focused technical sessions he held for his entire group of graduate students and postdoctoral fellows at his home in Ithaca, one evening per month. At these work-in-progress sessions we learned how to thoughtfully prepare a technical talk, communicate ideas to a scholarly group of peers, and vigorously defend our thinking on our feet, skills I continue to benefit from today. As we had learned the art of preparation for a scientific presentation through these sessions, I was appalled one day when I saw him depart for a major out-of-town talk and grab his box of slides (in those days a several-pound mass of glass), not yet organized for the talk, and proceeded to the airport. Little did I realize that that was often the modus operandi of a seasoned professional (and a style that I and many colleagues regrettably adapted later as our careers matured).

Walter was a truly good mentor, and he taught me how to think critically about science in general. I shall always be grateful that he supported and followed (and I believe even relished) the evolution of my career from martensite metallurgy (the area he loved) as a Ph.D. student, into my present occupation in biomaterials, biomedical engineering, and medicine, areas he knew much less about. Only in preparation for these remarks did I uncover an article in the Cornell Engineering Quarterly in 1970 in which he predicted that the field of biomaterials would be a 'growth area' to which materials science would contribute immensely (and how correct he was).

> When he came to Cornell in 1966, Owen took over a young department, which became a separate materials science and engineering department only the previous year. Within a year there were approximately 40 students doing graduate materials study at Cornell. Through his leadership, Professor Owen established materials science and engineering at Cornell as one of the few leading departments of its kind, composed of a distinguished group of materials specialists and strong academic programs. He developed excellent and synergistic collaborations with groups doing physics, chemistry, and mechanics, thereby creating a highly interdisciplinary and intellectually stimulating environment. Through his leadership of the department at Cornell, Walter contributed greatly to the development of materials science as a systematized science and academic discipline. Owing to his contributions then and subsequently, materials science has flourished, increasing in sophistication and contributing to many important scientific and engineering advances. It was a privilege and an honor to be his colleague and friend for over 40 years."

Owen's memberships, honors, and awards included the following: member of the National Academy of Engineering, fellow of the American Society for Metals, Harold Moore Lecturer of the Metals Society, member of the New York Academy of Sciences, trustee of the American Society of Metals, and member of the National Materials Advisory Board.

Acknowledgments

In preparing this tribute to Walter Owen, I received much help from many colleagues, including Samuel Allen of MIT, Gregory Olson of Northwestern University, Derek Hull of the University of Liverpool, Mica Grujicic of Clemson University, and Frederick Schoen of the Brigham and Women's Hospital in Boston.

WILLIAM H. PHILLIPS

1918–2009

Elected in 1991

"For theoretical and practical contributions that have advanced understanding of aircraft stability, control, guidance, flying qualities, and simulation technology."

BY WILMER H. REED III
SUBMITTED BY THE NAE HOME SECRETARY

WILLIAM HEWITT PHILLIPS, a member of the National Aeronautics and Space Administration (NASA) engineering team responsible for the success of the Apollo program died at home on June 27, 2009, at the age of 91.

He was born in Port Sunlight, England, on May 31, 1918 and came to the United States with his parents when he was 2. He earned a B.S. in 1939 and an M.S. in 1940 in aeronautical engineering, both from the Massachusetts Institute of Technology (MIT).

William Hewitt Phillips was truly one of a kind. A stranger meeting this humble, unassuming man would hardly suspect that before him stood an internationally known, highly respected technical giant in his field. His entire professional career was spent with the National Advisory Committee for Aeronautics and NASA at Langley Research Center. His technical contributions in the field of aeronautics and space span from flight research on World War II aircraft in the early 1940s to the present-day Space Shuttle. His research and innovations related to such topics as aircraft stability, control and handling qualities, gust alleviation and aeroelastic effects, space rendezvous and navigation, and lunar landing studies, in which he conceived and developed the 200-foot-tall Lunar Landing Facility used to train astronauts and which forms part of Hampton's skyline.

Among Hewitt's special talents was the ability to explain incredibly complex subjects in simple understandable English. That talent is well borne out in NASA's publication of two of his books: *Journey in Aeronautical Research* and *Journey Into Space Research—continuation of a career at NASA Langley Research Center*. These well-illustrated books make for good reading for anyone interested in aerospace. Fortunately, Hewitt's research papers and files have been preserved and cataloged at Virginia Tech's Virginia Heritage Special Archival Collection, which can be accessed over the Internet.

I became friends with Hewitt through our mutual interest in a lifelong hobby of building and flying model airplanes. We were both longtime members of the "Brainbusters Free-Flight Model Club." Hewitt and I also participated in volunteer projects sponsored by the local chapter of the AIAA (American Institute of Aeronautics and Astronautics). One such project was to design and build a prototype of a wind tunnel exhibit planned for use at the Virginia Air and Space Museum. Hewitt was ideally suited for this mission, recalling that in the late 1930s, while at MIT, he and a fellow student built a wind tunnel for testing model airplanes. This prototype wind tunnel was later used by the AIAA and others in classrooms and on special occasions such as career days.

Another project in which Hewitt and I participated involved AIAA's bid to break the Guinness record for the world's largest paper airplane. Teachers from four Hampton high schools selected 18 outstanding senior students to participate. Hewitt, along with Dr. Richard Witcomb, Jim Penland, and I served as advisors. At the beginning of the one-year program, named the "White Pelican" project, the students listened to lectures by Hewitt, Dr. Whitcomb, and the other advisor on such topics as airplane design, aerodynamics, stability and control, structures, and materials. At the end of a year of intensive labor by all involved, the White Pelican was born. She weighed in at

9½ pounds and had a wing span of 30 feet and 6 inches. The recordbreaking flight took place in the NASA hangar, where she gracefully glided 114 feet, earning her place in the 1993 edition of the *Guiness Book of Records*.

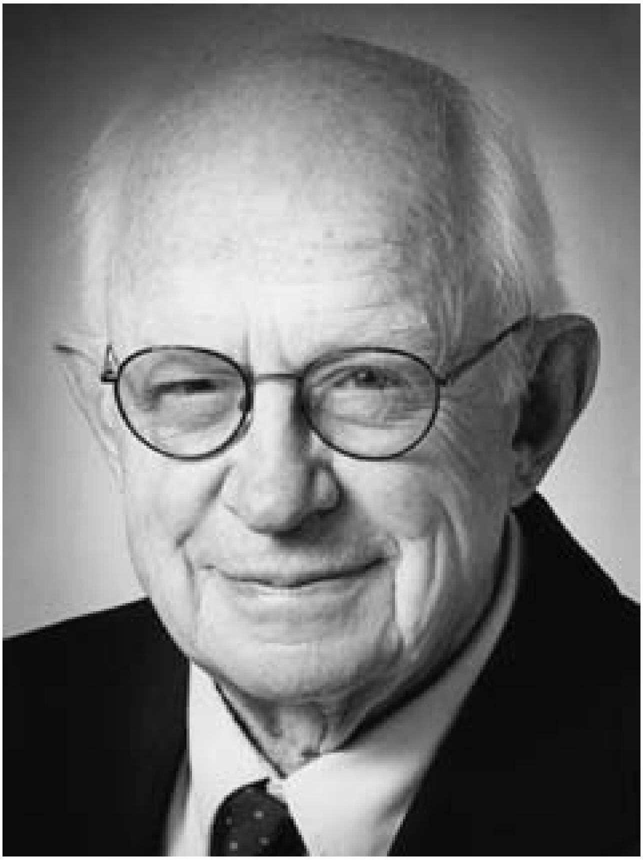
After retiring from government service in February 1979, he remained a distinguished research associate, researching solar-powered aircraft, propellers, airfoil design, and wind tunnel studies of the use of canard surfaces for the Space Shuttle. He served as a consultant on studies of flight dynamics and control. He was awarded the America Institute for Aeronautics and Astronautics' Lawrence Sperry Award for aeronautics in 1944, the NASA Distinguished Service Medal in 1979, and the President's Award for Distinguished Federal Civilian Service in 1979; he was elected into the National Academy of Engineering in 1991 and he was elected a fellow of the American Institute of Aeronautics and Astronautics.

Hewitt enjoyed a variety of outside activities. In addition to his addiction to model airplanes, he was an accomplished artist, played the piano, enjoyed opera, and looked forward to summer vacations at his time-share on the Outer Banks of North Carolina. I remember being with him there a few years back. While he was unpacking the car at the start of his vacation, curious onlookers watched as he pulled out his 6-foot radio-controlled glider, unusual kites configured with rotors and rotating cylinders, painting art supplies, and stacks of sheet music for piano practice at the recreation center. And then it was really fascinating to see this 80+ -year-old trudging up the Jockey Ridge sand dunes with said glider and kites in hand.

Another love of Hewitt's was attending, each year, the December 17 celebration of the anniversary of man's first flight by the Wright brothers. We often went together and would also attend, on the night before, a dinner sponsored by the "Man Will Never Fly (MWNF) Memorial Society." Its motto: "Birds Fly, Men Drink"; its objective, to prove that the first flight was a big hoax and that the Wright brothers came there just to party. Well, Hewitt didn't drink, but he always enjoyed the event, especially when he wore his MWNF party hat.

Phillips married Viola Ohler in 1947. They were married for 49 years and had three children—Frederick H. (of Middleton, Massachusetts), Robert O. (of Belmont, Massachusetts), and Alice B. Phillips (of Beaverton, Oregon)—and six grandchildren. He was preceded in death by his sister, Hilda Stuntz, of Lexington, Massachusetts, and is survived by Hilda's husband David and longtime caregiver Janice Singleton.

William Hewitt Phillips has left this earth a better place, and his legendary contributions will long endure.



THOMAS H. PIGFORD

1922–2010

Elected in 1976

"For contributions in nuclear power utilization and in nuclear engineering education."

BY DONALD R. OLANDER

THOMAS H. PIGFORD, professor emeritus and founding chair of the Department of Nuclear Engineering at the University of California, Berkeley, and an influential voice in nuclear policy, died at the age of 87 on February 28, 2010. Pigford's five-decade career in nuclear engineering spanned reactor design, nuclear safety, fuel cycles, and radioactive waste management.

At UC Berkeley, Pigford led a research program to develop the theoretical means for predicting the long-term behavior of radioactive and chemical waste in underground disposal sites. Results of this research have been used in the design of geologic repositories in the United States and abroad. He championed nuclear power but not at the expense of appropriate safeguards for health and the environment. He was respected among scientists and environmentalists alike for his technical expertise and objectivity.

He was appointed to numerous advisory commissions on nuclear reactor safety, including the Expert Consultant Group to Evaluate the Chernobyl Accident and the President's Commission on the Accident at Three Mile Island (TMI). "It was Tom's wisdom, judgment and practical experience that, in my opinion, led to the TMI Commission's recommendations being so well thought-out," said Vice Admiral Eugene Wilkinson, commander of the first nuclear submarine and first president of the Institute of Nuclear Power Operations. These recommendations have stood the test of time and have served as a catalyst for significant change. Even representatives of strongly antinuclear organizations admired and respected Pigford's straightforward, honest approach: "He was very strongly pro-nuclear and, because of that, he wanted it to be done right," said Daniel Hirsch, a lecturer of nuclear policy at UC Santa Cruz and president of the Committee to Bridge the Gap, a nonprofit organization critical of nuclear development. "He knew a nuclear program couldn't be viable if safety problems were ignored. I admired him beyond measure."

Pigford was one of the first to develop nuclear chemical engineering as an important subdiscipline of nuclear technology at a time when President Eisenhower was pushing strongly for nuclear power. The book that Pigford coauthored with Manson Benedict, called *Nuclear Chemical Engineering* (McGraw-Hill, 1957), is considered the seminal text in this field. The entire fuel cycle, from extraction of uranium ore, isotope separation, fabrication of fuel rods, reprocessing of spent fuel, to storage of radioactive waste is addressed in this book.

Pigford was born on April 21, 1922, in Meridian, Mississippi. He received his bachelor's degree (magna cum laude) in chemical engineering from the Georgia Institute of Technology in 1943. He continued his graduate studies in chemical engineering at the Massachusetts Institute of Technology (MIT), where he earned his Sc.D. degree in 1952.

After an interlude in the U.S. Navy and while still completing his doctorate, Pigford became associate professor of nuclear and chemical engineering in 1955. In addition to teaching and research, his career at MIT included a two-year stint as director of the MIT Graduate School of Engineering Practice in Oak Ridge, Tennessee. In 1952 he and Manson Benedict inaugurated MIT's graduate program in nuclear engineering. From 1957 to1959 he was a founding staff member at General Atomics, a nuclear technology research and development firm based in La Jolla, California.

In 1959, Pigford joined the UC Berkeley faculty as a full professor and the first permanent chair of the newly established nuclear engineering department. He served three nonconsecutive terms as department chair between 1959 and 1988. In 1966, Pigford spearheaded the construction of a 1-megawatt research reactor in Etcheverry Hall. Two decades later the reactor's role in research began to wane and the decision was made to shut it down, a process Pigford oversaw. The reactor was finally decommissioned in 1991, the same year Pigford retired and became professor of the graduate school.

Among the numerous honors Pigford received throughout his career were the Robert E. Wilson Award, given by the American Institute of Chemical Engineers for outstanding chemical-engineering contributions and achievements in the nuclear industry; election to the Georgia Institute of Technology Engineering Hall of Fame; and the Berkeley Citation. He was cofounder and charter member of the American Nuclear Society, to which he was elected a fellow in 1971. Pigford was elected to the National Academy of Engineering in 1976.

He was an avid tennis player and an enthusiastic and competitive sailor. As skilled with his hands as he was with his mind, he also was an accomplished woodworker, a dedicated gardener, and an amateur musician who played French horn, recorder, and oboe at various points in his life.

Pigford's first wife, Catherine Kennedy Pigford, died in 1992. He is survived by his second wife, the former Elizabeth Hood Weekes (of Oakland, California); his daughters from his first marriage, Cynthia Pigford Naylor (of Durham, California) and Julie Pigford Earnest (of Portland, Oregon); and his stepdaughters from his second marriage, Janvrin Demler (of Dedham, Massachusetts) and Laura Weekes (of

Los Angeles). Also surviving him are five grandchildren and a great-grandson. Tom's brother Robert, who predeceased him, also was an NAE member.

Elizabeth Pigford wrote:

> "He had a brilliant mind, a compassionate heart, an exuberant curiosity about absolutely everything, a puckish and playful wit, a strong and spirited will, an irrepressible sense of humor, a rock solid sense of honor, a unique creative energy, a keen insight into others, a delight in nature, sports, books and music, a quiet inexhaustible courage. He was a loving spouse and a loyal friend."

BRIAN H. ROWE

1931–2007

Elected in 1983

"For extraordinary contributions to the conception, design, development, and application of advanced high performance aircraft gas turbines."

BY M. J. BENZAKEIN

BRIAN H. ROWE, a successful engineer, business leader, and former chief executive officer of General Electric Aviation, died on February 22, 2007, at the age of 75. Brian was an innovator who developed technology decades before his time. He was a man who helped define aviation in the 20th century.

Brian Rowe's legacy began as a young man in an apprenticeship at deHavilland Engine Company, where he designed a jet engine component for the deHavilland Comet, one of the world's first commercial jet aircraft. After graduating from college and returning to work at deHavilland, Brian soon left Britain to pursue a career in the Flight Propulsion Lab at General Electric in Evendale, Ohio.

After a few years, Brian began his ascension through the ranks, eventually moving to Lynn, Massachusetts, to lead GE's efforts on lift fan technology. Brian's team in Lynn demonstrated the astounding amount of air that could be pulled through lift fans. He discovered that when turned at 90 degrees these lift machines could become efficient cruise fans. This newly revealed technology would greatly contribute to a jet propulsion revolution that led to the introduction of high-bypass turbofan engines. Brian soon became manager of the

J85 advanced component engineering group with primary responsibility for compressor design on the GE1 demonstrator engine. The hot section of the GE1 would later be used on GE's TF39—the world's first high-bypass turbofan engine. Gerhard Neumann, chief operating officer of GE's aircraft engine business, established the Commercial Engines Project Operation in Cincinnati, and made Brian Rowe CF6's project manager. The CF6 would transform commercial engines, offering better reliability and more power to American and European airlines.

The late 1960s saw demand rise for wide-bodied, two-engine aircraft intended for short- and medium-range destinations. This demand was met with the A300, an application developed by the newly formed Airbus Industrie, a European consortium created to develop and produce exportable airliners. In an exciting engine decision, Airbus selected GE's CF6-50 as the sole power for the A300. With this deal intact, Brian forged deep relationships with Airbus and the French engine maker, Snecma. These relationships dramatically changed the course of GE's aviation business. Brian also oversaw the development of the F101 military engine. Later, the core of the F101 engine would be combined with a front fan developed by Snecma to create a new engine—the CFM56. Brian was key in supporting his longtime friend, Gerhard Neumann, in creating CFM International, a joint company of GE and Snecma.

As the 1980s began, GE Aviation had a new business model and a new goal—to become the industry leader. Under Brian Rowe's leadership, GE's portfolio of engine developments and technological breakthroughs continued to grow. Brian, now chief executive officer of GE Aviation, helped convince Boeing to choose the CFM56 engine for the new 737 Classic Series, and two years later the CFM56 was selected for the Airbus A320. With these two aircraft, the CFM56 was on its way to becoming the most successful commercial jet engine in history. For his work with CFM, Brian was awarded in 1985 the *Chevalier of the Légion d'honneur*, France's highest civilian honor. And good news kept coming. The U.S. Air Force selected GE's new F110, derived from Brian's original

F101 core design, to power the F-16. Brian introduced the CF6-80C2, the most popular jet engine for a wide body in its day, powering Boeing, Airbus, and McDonnell Douglas aircraft. And in 1987 he helped secure CFM56 and CF6 positions on Airbus's A340 and A330 aircraft.

As a new millennium was approaching, Brian oversaw development of the GE90—the world's largest and most powerful jet engine and the first to use composite fan blades. The success of the GE90 family helped solidify Brian's reputation as a pillar of aviation technology. In the 21st century, the GE90 architecture is the basis for the new GEnx engine for the Boeing 787—the fastest-selling large commercial engine in GE's history. The legacy of Mr. Rowe lives on.

After retiring from GE in 1993, Brian Rowe continued to stay on as a leader, maintaining an office in Evendale and working as a consultant. Later, Brian published his memoirs, *The Power to Fly: An Engineer's Life* (AIAA, 2004). Brain Rowe was a fellow of the Royal Aeronautical Society and the American Institute of Aeronautics and Astronautics and a member of the National Academy of Engineering. He was awarded an honorary degree of doctor in science and technology from the University of Cincinnati and from the University of Dayton. In 1995 he was inducted into the GE Aviation Propulsion Hall of Fame and in 1996 into the Cincinnati Business Hall of Fame.

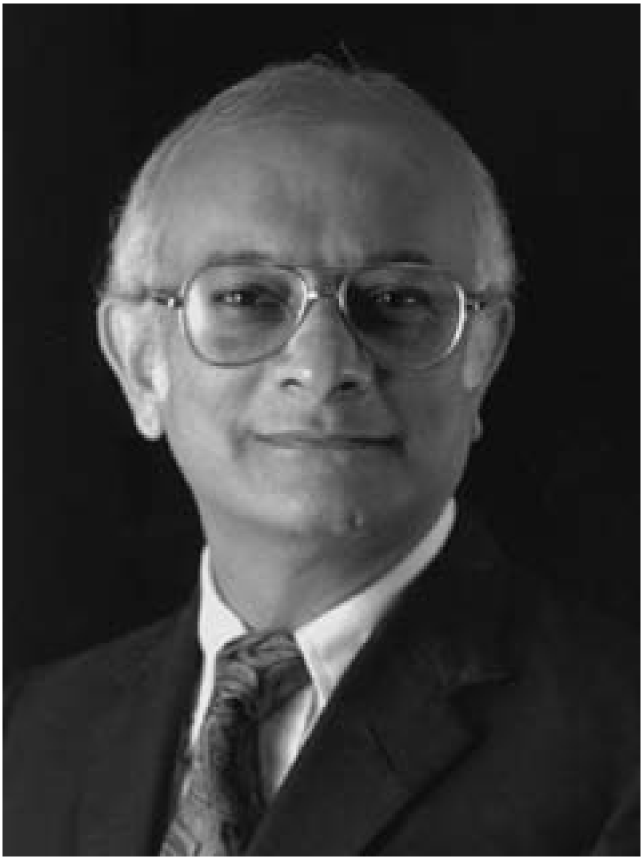
Brian was a 25-year Cincinnati resident and civic leader. He served as a board trustee for the Cincinnati Museum Center, the Institute of Fine Arts, the Cincinnati Symphony Orchestra, and the University of Cincinnati Foundation, including co-chair of the University of Cincinnati Campaign Committee. He chaired the World Affairs Council of Greater Cincinnati, served on the Ohio State President's Advisory Council, and served as president of the American Institute of Aeronautics and Astronautics. He also served on several Federal Aviation Administration advisory boards. He was a member of several corporate boards, including 5th/3rd Bank and Convergys Corporation, both in Cincinnati; Stewart & Stevenson Services, Inc., Houston, Texas; Atlas Air, Inc., Golden, Colorado; and Acterna Corporation, Burlington, Massachusetts.

Brian's principal residence in recent years was Key Largo, Florida. His wife, the former Jill Trapp, survives him. They have three grown children: daughters Linda Hernandez (Miami, Florida) and Penny Dinsmore (Cincinnati, Ohio) and son David Rowe (Savannah, GA) as well as six grandchildren, including Nicholas Dinsmore, an engineer at GE Aviation in Evendale.

His daughter wrote:

> "My Dad was a wonderful, generous dad. He always had time for his children and his grandchildren. I will never forget the look of joy he had on his face when his grandkids were all gathered around him. He was a gentle man and loved children from infancy to young adults, maybe because he was such a kid at heart.
>
> The family spent many wonderful summers together on Cape Cod. He was an avid sailor and passed on that love to his family. Sports were a big part of my dad's life, tennis and golf were his favorites, and he loved to play with the family. He had yearly golf trips with the men of the family, and a special father/son trip he went on each year with other men. The winters were spent in Ocean Reef, Florida, where he had more opportunities to go boating and play golf.
>
> My mom and my dad were a team that enjoyed many years of traveling and relaxing. My father always thought he had a great job and enjoyed all the people he worked with. He always said to go for the job you love and try to do the best job you can. We miss him terribly and are grateful for the love and guidance he shared during his lifetime."

Brian Rowe was an influential person in aviation technology. His business intelligence, exceptional creativity, and keen technical insight will leave a lasting mark on the lives of countless people, companies, and organizations around the world.



RUSTUM ROY

1924–2010

Elected in 1973

"For contributions to the development of the modern science and technology of non-metallic materials."

BY L. ERIC CROSS

RUSTUM ROY was one of the world's leading materials scientists but also a major moving force in the fields of national and international science policy and of constructive interaction between science, technology, and religion. A very strong advocate of interdisciplinary and integrative learning, he was a brilliant teacher, immensely popular with students and younger faculty, but often regarded with suspicion and even some hostility by senior administrators as a strong force for change that might endanger some of their local bases of power. He was an inspiration to many seeking change to benefit humanity and his passing is a great loss to both science and society.

Rustum was born in Ranchi Bihar province in India on July 3, 1924. The family was very well connected, and an early meeting with the great Mahatma Gandhi left a very deep and lasting influence on Roy, which helped embed his lifelong dedication to molding scientific endeavor to benefit the needs of society. Rustum took a Cambridge School Certificate from Saint Paul's School Darjeeling, then a B.Sc. (Honors) and an M.Sc. in chemistry at Patna University in 1944, followed by a Ph.D. in ceramic science from the Pennsylvania State University in 1948. He joined the Penn State faculty as a research associate in 1950 and then as an assistant professor in 1951, rising rapidly to full professor of geochemistry in 1957. In 1962 he founded the Materials Research Laboratory (MRL) at Penn State, the first in the country without block grant support. In 1981 he was named an Evan Pugh Professor, the highest academic title the university can bestow.

The MRL under Professor Roy's leadership was a lively happy place to work, as he led by example and not by edict. He worked an incredibly long day, and before the advent of the Internet his phone was ringing off the hook during normal hours, so the best time to meet for discussion was 10 p.m. to midnight. Obviously, there was no bickering over the distribution of central funds as there was no central budget. Proposals, as in all U.S. research groups, were an absolute necessity but exciting topics for targeted basic studies were constantly nucleated, targeted in areas that Rustum knew were of vital importance to specific federal and state agencies, and the success rate was truly heartening.

It is interesting to note that in 2004 Thomas Register, who kept the statistics, commented in surprise that Penn State had 12 highly cited faculty in materials studies compared to 6 at the next highest academic institution, the very prestigious materials program at Cornell University. MRL faculty, however, was not surprised as, in fact, Rustum had been heavily involved in recruiting 9 of the highly cited 12.

In his own group Roy was a major innovator in the whole area of new materials synthesis techniques. Starting in 1948 he devised what is now called the solution sol-gel process for making pure nanoscale reactive powders for many important ceramic compositions. Originally devised for making ultrahomogeneous materials, the group was later able to show that the process could be adapted to making maximally heterogeneous nanocomposites with most exciting properties.

A second major area developed with his colleague O. F. Tuttle was hydrothermal processing for materials synthesis and crystal growth. Tuttle focused on geological applications and Roy on materials applications. A third area of immense practical importance were the far-reaching studies of microwave electromagnetic processing—starting with pure SiO_2 and Al_2O_3, which were thought to be completely microwave transparent and moving to semiinsulators like tungsten carbide, and even powder metals in 2.45-H microwave fields. For the first time, using single-mode cavities the group clearly demonstrated the amazing differences generated by pure E and H microwave fields with major consequences for proper theoretical understanding.

Although a practicing scientist for 65 years, his life work defied any professional label: he was dedicated to breaking artificial boundaries in order to integrate science, religion, education, health, art, and social action for human benefit.

Roy probably holds the unofficial record for the synthesis of more new ceramic materials than anyone else in history. He trained and exported worldwide several generations of students with outstanding crystal chemical backgrounds, and his class notes, never published, have been reproduced and used worldwide. We are much saddened by our great loss but vastly heartened by the thought of his joyous new surroundings and the excitement he will have on learning full details of the organization of our amazing materials universe.

Rustum helped create a small "Christian base community," the Sycamore Community in State College, Pennsylvania, a local focus for many years of church activity. Somehow he found time for voluminous correspondence, dozens of phone calls a day, and a vital family life with his wife, children, and the extended Roy clan. Rustum worked tirelessly, often returning to the office after a family dinner, or a game of frisbee, to burn the midnight oil. He never missed a chance to combine work and pleasure, often finding time during his trips to gather friends for a simple meal and stimulating conversation.

He was responsible for bringing siblings to Penn State for advanced study, two brothers (Prodipto and Shunil) who together with Rustum, Della, and, later, son Ronnen, brought to five the number of Roy Ph.D.s from Penn State. He also assisted on bringing three sisters, Sita, Asoka (Koko), and Dipti for advanced study in the United States in their medical professions. Other siblings—Ayesha, Ronobir, Protap, and

Roma—visited the United States from time to time. The next generation of nieces and nephews helped nucleate an extended Roy clan in this country and abroad.

Rustum was born the seventh child (of 11) to Narendra Kumar and Rajkumari Roy. He is survived by his wife Della Martin Roy and sister Dipti Ioni Sisodia; sisters-in-law Krishna Roy, Joyce Roy, Sheila Roy, and Joya Chowdhury Roy; sons Neill R. Roy, Ronnen A. Roy, and Jeremy R. Roy; daughters-in-law Evelina Francis, Sinaly Munoz, and Lydia Bufanda; and granddaughter Simone D. Roy and grandson Naren S. Roy.

GEORGE S. SCHAIRER

1913–2004

Elected in 1967

"For aircraft design and development."

BY JOHN D. WARNER

GEORGE SWIFT SCHAIRER was born in Wilkinsburg, Pennsylvania, on May 19, 1913. He attended Swarthmore College and graduated in 1934 with a B.S. with highest honors in general engineering. He studied aeronautical engineering at the Massachusetts Institute of Technology (MIT) and received an M.S. in 1935. He studied airplane performance calculation methods and invented "Schairer's Airplane Performance Slide Rule." He learned to fly light airplanes during his college years. He had a solid foundation and interest in rotary wing and fixed wing aircraft by the time he completed his formal education.

Schairer was best known for his advocacy of swept wing aircraft and development of the B-47 and 707 that ensued. In 1945 he was part of a group of scientists who went to Germany as the war was winding down, to learn what they could about Germany's technology. He was reviewing some wind tunnel data when he came on the swept wing innovation. At the time he was on loan from Boeing to the U.S. Army Air Corps. He wrote a letter to Boeing colleague Bob Withington about his discovery, and the rest is history. Bill Cook later said that without George the postwar history of Boeing would not have happened.

Schairer came to Boeing in 1939 after short stints at Bendix in Indiana and Consolidated Aircraft Corporation in California. Initially, he was in charge of aerodynamics and played major roles on the design teams for the B-17, B-29, Stratocruiser, B-50, C-97, 707, KC-135, B-47, B-52, and 727. He rose to vice president of research and development at Boeing and retired in 1978. After that he continued to consult for Boeing.

In 1944 and 1955 he was a full-time member of the U.S. Army Air Force Scientific Advisory Group, when he went to Germany. He was active on many committees of the National Advisory Committee for Aeronautics. He served on the Steering Panel of the U.S. Department of Defense from 1955 to 1960 and the U.S. Air Force Scientific Advisory Board from 1954 to 1958. He was a member of the President's Science Advisory Committee Panel on Scientific and Technical Manpower from 1962 to 1964 and the Scientific Advisory Committee of the Defense Intelligence Agency from 1965 to 1970. He served on visiting committees for the University of Washington, MIT, Princeton University, and the California Institute of Technology.

Schairer was elected a fellow of the Institute of the Aeronautical Sciences in 1951 and was elected to the National Academy of Engineering in 1967, and the National Academy of Sciences in 1968.

An honorary doctor of engineering degree was awarded to Schairer from Swarthmore College in 1958. He received the Sylvanus Albert Reed Award of the Institute of Aeronautical Sciences in 1949, the Spirit of St. Louis Medal of the American Society of Mechanical Engineers in 1959, and the Daniel Guggenheim Medal of the American Institute of Aeronautics and Astronautics (AIAA)/Society of Automotive Engineers/American Society of Mechanical Engineers in 1967. He delivered the Wright Brothers Lecture of the AIAA in 1964 and the Wilbur and Orville Wright Memorial Lecture of the Royal Aeronautical Society in 1968.

George was widely known to be "an irascible son of a gun" who "was not out to make friends. He was out to get things done." He was committed to get the best out of himself and of the people he worked with and counseled over the years.

Some of those who worked with and for him described him as a brilliant engineer, a demanding boss, a doer, and a sometimes mystifying communicator. "In meetings, we'd all listen to George and we'd have to go back to the office afterwards to figure out what the heck he said," recalled Bob Withington. "His communication skills weren't as good as his aeronautical thinking, but we could usually figure it out."

Like many aerodynamicists, his recreational passion was sailing. He loved watching the wind in the sails and analyzing the behavior of the waves in the water. Having a constant fascination with all things mechanical, he enjoyed building or fixing things, including making his own replacement parts when some household object broke down and building models of his sailboat with improved keels. He also had a lifelong interest in classical music and was a great supporter of the arts, including being on the boards of the Seattle Opera, ACT Theater, and Cornish College of the Arts.

When he passed away on October 24, 2004, he was survived by his wife, four children, eight grandchildren, and 10 great-grandchildren. Joe Sutter remembered George with this statement: "He was a real technical powerhouse. His name should be on the wall at the Smithsonian. He's really an aviation pioneer."

MANFRED ROBERT SCHROEDER

1926–2009

Elected in 1979

"For founding the statistical theory of wave propagation in multi-mode media and contributions to speech coding and acoustics."

BY JAMES L. FLANAGAN

MANFRED ROBERT SCHROEDER, an internationally known acoustician, telecommunications research leader, and professor of physics, died on December 28, 2009, at his home in Goettingen, Germany. He was 83 years of age. His professional work is renowned for its diversity, embracing the fields of speech processing, room acoustics, computer art, and number theory.

In his youth his father, a mining engineer, and his mother encouraged an early interest in the beauty and utility of mathematics. He was a leading student in his secondary schooling, but still not above enjoying practical jokes on colleagues and friends. Like many science-oriented young people of the time, he was attracted to radio technology. He built short-wave receivers and transmitters and, despite government restrictions, surreptitiously listened to broadcasts from the BBC (British Broadcasting Corporation). He never considered himself a legitimate "radio amateur" ("ham") because of the difficulty of obtaining a government license and the (not unusual) additional obstacle of Morse code. But, in all other respects, he was a "ham."

Also, like many other youth of his time, Manfred's continued education was interrupted by the hostilities of World War II. At age 16 he was drafted into the German Air Force and assigned to an antiaircraft unit, serving first in Poland and later in Holland. Because of his talent for electronics, he was trained in the early uses of radar for detecting range and direction. He therefore became part of an intensive technology race, an experience that no doubt contributed to his later remarkable zeal in telephony research.

After conclusion of hostilities, he returned to his home, rejoicing that it and his family were intact and unharmed during this turbulent time. He continued his education and entered the University of Goettingen. In due course, as his university studies advanced, he fell under the tutelage of Professor Erwin Meyer, director of the third physics institute and an internationally recognized authority in acoustics. Working toward a doctoral degree, Manfred conducted fundamental research on the distribution of acoustic normal modes in enclosures, relations that characterize the spatial spread of sound energy in structures such as rooms and auditoria. In 1954 he was awarded the Dr. rer. nat. (doctor of science) degree in mathematics and physics by the University of Goettingen.

His original work, and the laudation of his professors, drew the interest of the recruiting management of Bell Telephone Laboratories in the United States. Manfred was speedily offered, and accepted, employment in the research division of Bell Labs in Murray Hill, New Jersey. There, his research shifted toward telecommunications, and he devised unique designs for voice coders and for bandwidth conservation in speech transmission. Acoustics, of course, especially transducers, continued to play an important role in telecommunications. His technical successes were rapidly recognized, and he advanced into management responsibilities. In 1958, Manfred was appointed head of the acoustics research department, and later, in 1963, he advanced to director of the acoustics and speech research laboratory. Shortly, ultrasonics and mechanics research were topics added to his responsibilities. In the course of these technical activities in the United States, Manfred achieved two important personal conditions: In

New York he met and married his lovely wife, Anny, and he obtained American citizenship.

After compiling an impressive technical record at Bell Laboratories, replete with many internal and external publications, patents, and professional recognitions, Manfred received in 1969, and accepted, a prestigious offer from the University of Goettingen—namely, appointment as professor of physics and director of the Third Physics Institute. He then moved his home to Goettingen, but retained an affiliation with Bell Laboratories, and his home in Berkeley Heights, New Jersey. He consequently became a frequent flyer between Germany and the United States. In Goettingen he managed the institute, scheduled lectures, and supervised doctoral students working on theses in acoustics, many of whom found significant careers and recognition in industry and academia. In the United States he continued collaboration on speech coding for limited bandwidths and, in partnership with Bishnu Atal, expanded an extremely successful coding method based on linear prediction that is used for cell phone communications today.

Manfred retired from his Bell Labs affiliation in 1987, and from his professorship in Goettingen in 1991 and continued as institute director until 1994. He remained active as emeritus professor until his death and maintained an office at the university. His interests in communications, acoustics, and number theory never waned. For example, he added to his publication record a third book entitled *Computer Speech: Recognition, Compression, Synthesis* (Springer, 1999).

The array of major topics to which Manfred made fundamental contributions reflects his remarkable diversity in engineering and science. With colleagues Bishnu Atal and Suzanne Hanauer, he established a new technique for adaptive differential coding of speech by linear prediction, as aforementioned. The method is amenable to bandwidth compression over a range of about 1/2 to 1/16th of the traditional 64 kilobits/second digital telephone channel. In particular, the choice of 1/8 for derivative versions of linear predictive coding is now a design commonly used in high-quality cell phone communications. An International Telecommunications Union standard has been formulated for the regimen of 8 kilobits/second voice coding.

Sound behavior in enclosures, an issue dear to Manfred's heart from his doctoral thesis days, led him to invent an advantageous practical method for measuring reverberation time by integrating the acoustic response of a room to a tone burst. His close familiarity with relationships between natural modes and frequency response, and his skill with computation, produced new methods for simulating the acoustic characteristics of enclosures, using rapidly emerging digital computers. These capabilities served him well when Manfred was asked to assist in diagnosing acoustic deficiencies in New York's Philharmonic Hall, a component of the city's Lincoln Center. With colleagues Bishnu Atal, Gerhard Sessler, and James West, he measured and characterized the problems and aided in formulating plans for improving the hall's acoustics. His use of frequency shifting to combat acoustic feedback in public address systems and his number-theoretic designs for sound diffusers (now known as Schroeder diffusers) represent other dimensions of his practical originality, contributing to the habitability of both concert halls and auditoria.

Constantly captivated by the beauty of mathematics, he stimulated early interest in abstract computer art, whereby versatile digital computers with sophisticated graphical output could reveal unique images of central relationships in equations. In fact, Manfred received awards from the arts community for his incomparable computer images.

As he progressed in his professorship, Manfred undertook prolific writing, producing scientific books on chaos, fractals, number theory, and computer processing of speech. His personal research produced more than 150 papers in archival journals, three books, and 45 U.S. patents.

Honors recognizing his ingenuity came to Manfred in a steady stream. Selected instances include election to seven different professional organizations: the Acoustical Society of America, the Audio Engineering Society, the American Academy of Arts and Sciences, the Institute of Electrical and

Electronics Engineers, the New York Academy of Science, the National Academy of Engineering, and the Goettingen Academy of Science. More concrete forms of honor included the gold medals of both the Acoustical Society of America and the Audio Engineering Society, the Helmholtz Medal of the German Acoustical Society, the Rayleigh Medal of the British Institute of Acoustics, the Medal of the International Speech Communication Association, and the Technology Prize of the Eduard Rhein Foundation.

Manfred's demeanor inevitably led to enjoyable engagement, whether on the knottiest technical problems, current events, or funny stories. His intellect, his devotion to mathematics and science, and his wit always made for a beneficial encounter. Communications research, his many colleagues, and his numerous students whose career paths he influenced will all share the deep sense of loss.

Manfred is survived by his wife Anny, in Germany and the United States; his daughter Marion in Bremen, Germany; his two sons, Julian in La Jolla, California, and Alexander in San Francisco; and his four grandchildren.

GLENN A. SCHURMAN

1922–2010

Elected in 1980

"For leadership in a major offshore engineering achievement which has advanced deepwater oil production technology."

BY R. LYNDON ARSCOTT

GLENN AUGUST SCHURMAN died peacefully at home in Tiburon on December 30, 2010, after a two-year battle with cancer.

He was born on September 6, 1922 and raised on a small dairy farm in Woodland, Washington. Glenn graduated from Washington State University in 1944 with a degree in mechanical engineering. He joined the Air Corps Enlisted Reserve and was assigned to the National Advisory Committee for Aeronautics Research (later to become the National Aeronautics and Space Administration) Laboratory in Cleveland, Ohio, working on development of the jet engine. At the end of World War II, he attended the California Institute of Technology in Pasadena, earning a Ph.D. in mechanical engineering.

In 1950 Glenn joined Chevron Corporation at its new research facility in La Habra, California, working on early developments in geophysical instrumentation and helping pioneer the field of offshore drilling and development. He was awarded 18 patents for technical inventions in various aspects of oil and gas exploration and production. After 12 years at the La Habra Research Center, having attained the position of manager of production operations, he moved to New Orleans to supervise production operations in the Mississippi Delta. Glenn spent six years in New Orleans before relocating to Midland, Texas, in 1969 as manager of production operations for Texas, New Mexico, and Arizona.

During this three-year assignment, he supervised installation of the first commercial CO_2 flood in the Snyder field, Texas. This was a period in the oil industry when enhanced recovery was just starting to bloom, and this project was watched closely by the industry. The giant Snyder project (SACROC unit) had 1,256 wells and had produced 500 million barrels of oil by 1972. The new project required CO_2 to be transported through a 220-mile pipeline from the Val Verde Basin gas fields in southwestern Texas to the SACROC unit. This required 81,000-HP compressors to deliver the CO_2 at a pressure of 2,400 psi to the 202 injection wells. The project was very successful, and injection continues to this day.

In 1972, Glenn moved back to New Orleans as assistant general manager of operations for a period of two years. His next assignment as vice president of production for the Rocky Mountain Division was cut short after six months because of the urgent need for someone of Dr. Schurman's ability to go to London as managing director of Chevron's U.K. properties. In 1975, Chevron had just taken over operatorship of the Ninian field, which at that time was the third largest in the U.K. North Sea.

This was an important period in the history of the oil industry because the billion barrel oil fields recently discovered in the North Sea required innovative technology to be successful in the hostile environment of the North Sea. During this period, the first massive concrete structures were constructed for such giant fields as Ekofisk, Beryl, Statfjord, and Ninian. Glenn's task was to coordinate the myriad interests of the Ninian partners, contractors, government agencies, and public concerns to build, install, and produce oil and gas in a hostile environment while meeting all the required safety and environmental requirements. The Ninian Central Platform, weighing 600,000 tonnes, was at that time the biggest structure ever floated to a location. It was built at the Doris facility in Loch Kishorn, Scotland, using the slip-forming technique in which concrete is placed in layers into well formworks continuously raised by hydraulic jacks. The diameter at the base was 140 m and the height was 156 m. The steel deck was constructed at a separate site and weighed 6,700 tonnes. It was decided to place the deck onto the platform at the construction site. The steel deck was transferred to two catamaran barges for transit to the mating site. The concrete platform was submerged to 13 m of freeboard, and then the deck was floated over it. Deballasting the platform then commenced to accept the deck weight and release the barges. This was the first submergence mating of a complete deck in the United Kingdom. The platform was successfully installed on location in May 1978 after an 11-day tow of 480 miles. In recognition of his achievement in successfully managing this enormous project, the British government awarded him an honorary CBE (Commander of the British Empire).

Glen returned to San Francisco in 1981, joining Chevron's home office staff as corporate vice president for oil field development and operations worldwide. During this period Glenn helped merge the production operation of Chevron and Gulf Oil Company. He retired in 1987.

Glenn was a member of the Society of Petroleum Engineers, the American Society of Mechanical Engineers, and Tau Beta Pi, and he was a registered professional engineer in the state of California. He was elected to the National Academy of Engineering in 1980. He is a distinguished alumnus of Washington State University and the California Institute of Technology.

Glenn was devoted to his work but always made time for his wife, Patricia, and their three children. He enjoyed early mornings on the golf course, camping on lakes and rivers throughout California, and summer vacations visiting national parks. Glenn was an amateur photographer and documented the life of his children and grandchildren using the latest developments in film and video. Glenn and Pat shared many good times at Sweet Adeline performances and competitions in New Orleans, Denver, London, and San Francisco. During their stay in London, they traveled throughout Europe and visited China, Russia, and India. After Glenn's retirement, they continued their travels and hosted family reunions for their children and seven grandchildren. Glenn lived a rich, full life and is survived by his wife of 66 years, Patricia, his three children, and their families.

L. E. (SKIP) SCRIVEN

1931–2007

Elected in 1978

"For application of fluid mechanics to fundamental problems of absorption, interface stability coating flows, surface wetting, and oil recovery."

BY CHRIS MACOSKO

LAURENCE EDWARD (SKIP) SCRIVEN, faculty member of the Department of Chemical Engineering and Materials Science and Regents Professor at the University of Minnesota, passed away on August 3, 2007, of complications from pancreatic cancer.

Laurence Edward Scriven was born on November 4, 1931, in Battle Creek, Michigan. He was called Skipper as a boy, and the nickname Skip soon stuck. After stops in London and Washington, his family moved to Hillsborough, California, when he was in the seventh grade. In that class he met Dorene, his wife to be. He received his B.S. from the University of California, Berkeley, where he was the "Most Distinguished Student of the Class of 1952." In 1956 he received his Ph.D. from the University of Delaware under the supervision of Robert Pigford. He worked as a research engineer for Shell Development Company in Emeryville, California, before joining the chemical engineering department at the University of Minnesota in 1959 as an assistant professor. In 1960 he received the Allan Colburn Award of the American Institute of Chemical Engineers. Skip was named a full professor in 1966 and was elected to the National Academy of Engineering in 1978. In 1988 he was selected as regents professor of chemical engineering and materials science, the highest honor a professor can receive from the University of Minnesota.

During his illustrious career, Professor Scriven authored over 400 publications and advised over 100 Ph.D. students. His research program was internationally renowned, focusing on coating and coating processes. The program excelled at combining experimental, theoretical, and computer modeling approaches in order to better understand industrial coating application processes. "Research education sets the University apart yet industrial interaction is absolutely essential." Skip believed in a comprehensive approach to research. Turning a familiar adage around, he instructed students that ". . . no experimental results can be believed until they are confirmed by theory" (paraphrased). His trajectory for "the education of an engineering scientist" has been adopted by many research advisors:

"Begin with advanced courses for breadth and depth. Simultaneously make a fast start at research with a warm-up problem tracked in weekly meetings and group seminars. Access to multiple advisors, academic experts and industrial visitors is essential. Full-time research required in the first summer with formal presentations in group seminars leading to a thesis plan defended in the spring of the second year."

"As a full PhD candidate, strive for two or more thesis topics. Include experiment, analysis and theory. Learn leadership with supervision of undergraduate researchers and teamwork through collaborations with others, especially industrial researchers. Present research outside to industrial labs, advanced seminars, scientific and engineering societies and employment interviews. All of which leads to a polished thesis which includes already refereed publications" (adapted from the Coating Process Fundamentals Program report at the IPRIME Annual Meeting, 2007).

Professor Scriven was an exacting author, precise with words. One of his former students (Eric Kahler, current president of the University of Minnesota) still has the draft for a first publication nearly solid red with Skip's edits. His 3" x 5" cards in elegant script with pithy research recommendations or appropriate references appeared in the mailboxes of students and colleagues alike.

Skip interacted with and involved industrial engineers and scientists in his research program, and he was the preeminent authority on coating process fundamentals. He helped launch the International Society of Coating Science and Technology (ISCST) in the early 1980s, and in 1998 the ISCST instituted the L. E. Scriven Young Investigator Award to recognize outstanding young researchers in the field. Professor Scriven was a cofounder of the National Science Foundation's (NSF) Center for Interfacial Engineering (CIE) at the University of Minnesota. After NSF funding ended in 1999 at the urging of its industrial members and through Skip's guidance CIE became IPRIME, or Industrial Partnership for Research in Industrial and Materials Engineering, over 40 companies strong today.

During his career he also made significant contributions to the fields of capillary hydrodynamics, enhanced oil recovery, colloid science, and the theory of interfacial phenomena. His most highly cited papers include analysis of the Marangoni effect (*American Institute of Chemical Engineering Journal,* 1959), a foundational explanation of the origin of bicontinuous structures (*Nature*, 1976), and a description of an apparatus that allows fast freezing of complex liquid specimens for cryomicroscopy (*Journal of Electron Microscopy Technique,* 1988).

Many an undergraduate was launched on a research career by serving as a library runner for Skip. But in addition to his research program, Skip was very much involved in undergraduate instruction in the department. He was the champion for the Unit Operations Lab, the most important chemical engineering lab taken by undergraduates. His Socratic method in the lab was famous. Professor Scriven was also an advocate for and much involved in the team teaching program, a hallmark of Minnesota's Chemical Engineering and Materials Science Department. Skip's graduate course in fluid mechanics was one of a kind. He spent years polishing, sharpening, and perfecting the course.

Professor Scriven held many distinguished visiting professorships and lectureships, and he served on committees for outside and national organizations. He was a fellow of the American Institute of Chemical Engineers and the

Technical Association of the Pulp and Paper Industry. In 1986 he was invited to give the Josiah Willard Gibbs Lecture by the American Mathematical Society. Some of the more recent awards he received included two Roon Awards from the Federation of Societies of Coatings Technology (1993 and 2002), the American Chemical Society's Murphree Award in Industrial and Engineering Chemistry (1990), the Tallmadge Award in Coating Science and Technology (1992), and the Founders Award from the American Institute of Chemical Engineers (1997). Most recently, he received the Roy W. Tess Award in Coatings for 2007 from the American Chemical Society, in recognition of outstanding contributions to coatings science and technology.

Skip very much enjoyed his 18-year tenure as a member of the advisory panel for the David and Lucile Packard Foundation, awarding generous fellowships to young American professors in science and engineering. At his own university, Skip established the Summer Undergraduate Research Participants Endowment and, upon his death, the L. E. and D. H. Scriven Graduate Research Fellowships in the Chemical Engineering and Materials Science Department of the College of Science and Engineering.

In addition to teaching and research, Skip was very involved with the chemical engineering profession and wrote a number of articles on its history. One example is published in *Perspectives in Chemical Engineering*, edited by C. K. Colton (Academic Press, 1991, vol. 16, pp. 1–40).

Although Skip's professional life and work were foremost, he loved music—classical, jazz, South American—and he pursued and actually traveled early western American history. He was an excellent birder, identifying unseen avian singers with his keen ear. He enjoyed the natural life at the family "dacha" in the country, where he also kept a desk, music, and many books and had annual barbeques for his students. Skip is survived by his wife of 58 years, Dorene; their three children, Ellen, Terry Ann, and Mark; five grandchildren; and one great-grandchild.

JOANNE SIMPSON

1923–2010

Elected in 1988

"For far-reaching advances in the mechanisms of atmospheric convection, clouds, and precipitation and their application to weather prediction and modification."

BY DAVID ATLAS AND MARGARET A. LEMONE

JOANNE SIMPSON (*nee* Gerould), former leader of the Tropical Rain Measuring Mission and storm modeling program at the National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center and the "mother" of modern research on tropical clouds and hurricanes, died on March 4, 2010, at the age of 86.

She was born Joanne Gerould on March 23, 1923, in Boston to two journalists. Her father, an outdoor enthusiast with an interest in aviation, introduced her to sailing and flying. Simpson became interested in clouds while learning to sail and as a student pilot.

Simpson broke family tradition by going west to the University of Chicago, after reading about its approach to education. Her interest in flying led her to enroll in Rossby's course in meteorology. By the time she received her bachelor's degree in 1943, she was able to go to New York University to teach "war courses" to future military forecasters. She returned to Chicago in 1944, continuing to teach war courses. She obtained her master's degree in meteorology under Carl-Gustaf Rossby at the University of Chicago in 1945. Although she was first discouraged from pursuing a Ph.D., a class by Professor Herbert Riehl reignited her interest in clouds, which became the topic of her Ph.D. studies, with Riehl as her advisor. She obtained support by teaching courses at the

Illinois Institute of Technology, which, combined with taking courses there cost-free, broadened her scientific education. During the summers she would pursue her research at Woods Hole. She received her doctorate in 1949, the first woman to have done so, and moved to Woods Hole in 1951.

While at Woods Hole (1951–1960), she developed the first numerical model of a cloud, which was developed and validated using data from an instrumented patrol bomber (PBY) aircraft on loan from the U.S. Navy. Although the Navy did not want her to fly on the airplane, the Woods Hole director and the Office of Naval Research said that they did not want the airplane if she did not fly on it. Indeed, she was instrumental in breaking barriers for women in subsequent field programs.

Simpson's conceptual model of cumulus clouds differed from that espoused by Richard Scorer and Frank Ludlam of Imperial College, leading to sharp exchanges both in the literature and in person and then to a visit to Imperial College in 1954. There, based on laboratory experiments, theory, and observations of glider pilots, she and Scorer developed the first finite-difference model of a cumulus cloud, which was envisioned as a buoyant bubble entraining air from the environment, which, thanks to Rossby, was run on a computer in Stockholm, Sweden, in 1955.

She subsequently collaborated with Riehl on seminal papers (1958, 1979) on the role of "hot towers" or convective clouds in maintaining the trade wind circulation, providing the solution to an apparent paradox. As every school child knows, air in the trade-wind belts converge near the Equator, where it rises and carries the excess heat energy aloft and then poleward into both hemispheres. However, observations in the early to mid-1950s showed a minimum in energy at midlevels separating high-energy values near the surface and aloft. Clearly this was not possible for a broad rising updraft. With Riehl she showed that the energy exchange could be explained by updrafts in convective clouds carrying high-energy air through midlevels. Occupying only a small fraction of the area, these "hot tower" clouds were missed in observed energy profiles.

During the same period, she also collaborated with Riehl on a set of papers explaining aspects of the mature hurricane, including structure and maintenance of the eye, and the hurricane's inflow area. Once again, the "hot towers" would play a significant role.

It is notable that Riehl and Simpson recognized that hot towers had to be imbedded in mesoscale convective systems that were an order of magnitude larger in area than the towers themselves. This awareness foreshadowed the more recent work by others on convective updraft in clouds and the role of convective clouds in mesoscale convective systems.

Simpson started working on weather modification while at the University of California at Los Angeles (1960–1964). By 1963 she was associated with Project Stormfury, aimed at weakening hurricane winds, first as a member of the advisory panel (1962–1965) and then as director (1965–1966). Although she believed that the preliminary results were promising, the program was discontinued because of the possibility that the seeding might change the path of the storm.

From 1965 to 1974, Simpson directed the National Oceanic and Atmospheric Administration's Experimental Meteorology Laboratory in Coral Gables, Florida, dealing mainly with the Florida Area Cumulus Experiment (FACE). Simpson pioneered the development of a one-dimensional model that was used to evaluate the effect of cloud seeding on individual tropical cumulus clouds. While seeding was found to increase cloud heights significantly, evidence for the increased areawide rainfall was questionable. Nevertheless, others have gone on to similar experiments elsewhere with claims of positive results.

Simpson moved to the University of Virginia in 1974. However, the quiet, reflective academic life with a few students evidently did not suit her tastes after the excitement of Stormfury and FACE. So in 1979 she accepted an offer to lead the Severe Storms Branch at the NASA Goddard Space Flight Center. There her research first focused on convective cloud systems and tropical cyclones using advanced numerical models and observations. In 1986, NASA asked Simpson to lead the study for the proposed Tropical Rainfall Measuring Mission (TRMM), a joint program with Japan. The satellite would carry the first *spaceborne* rain radar and a passive microwave system to accurately measure rainfall across the tropics. In 1987 she became the project scientist for TRMM, bringing it from concept to reality. No longer was there any doubt that a woman could handle a job of this magnitude.

Like many other satellite systems, TRMM has led to many new insights that were not originally anticipated. It has exceeded by far its original goal of advancing our understanding of the distribution of tropical rainfall and its relation to global water and energy cycles. It has become the primary satellite in a system of research and operational satellites used for analyzing precipitation characteristics on timescales from three hours to interannually and beyond. In particular, it is now used operationally to monitor convective systems and tropical cyclones. One cannot imagine the many Eureka moments of discovery that TRMM has yielded. It is for these reasons that Simpson often stated that TRMM was the most important accomplishment of her career.

The TRMM satellite and instruments are in excellent shape, and there is sufficient fuel on board to maintain scientific operations until 2014, thus providing a 17-year record for climatological purposes. If it continues until 2014, it will overlap the launch of the Global Precipitation Mission in 2013, thus extending the record and providing for intercalibration between the TRMM and GPM.

Simpson played a major role in planning and leading large observational experiments on convective cloud systems while she was a member of the various institutions mentioned above. She was a leading participant in the aircraft aspects of several Global Atmospheric Research Program (GARP) experiments in the 1970s, particularly the GARP Atlantic Tropical Experiment (GATE), Monsoon Experiment (MONEX), and Tropical Oceans Global Atmosphere (TOGA)–Coupled Ocean Atmosphere Response Experiment (COARE, 1992–1993).

Simpson's many awards and recognitions include the following from the American Meteorological Society: Meisinger

Award (1962), Rossby Medal (1983), Charles Franklin Brooks Award (1992), Charles E. Anderson Award (2001), fellow (1969), president (1989), and honorary member (1995). Other awards include the U.S. Department of Commerce Gold (1972) and Silver (1967) medals, NASA medals for Exceptional Scientific Achievement (1982) and Outstanding Leadership (1998), and the first William Nordberg Memorial Award for Earth Sciences (1994). She was elected a fellow of the American Geophysical Union (1994), an honorary member of the Royal Meteorological Society (1999), and a member of the National Academy of Engineering (1988). She received the prestigious International Meteorological Organization Prize from the World Meteorological Organization in 2002 and was inducted into the American Academy of Arts and Sciences in 2006.

In addition to her distinguished scientific career, Simpson is known for lowering the barriers for future generations of women. She was instrumental in enabling women to participate in field programs. She demonstrated to younger women that it was possible for them to be successful in the field. She spoke out in favor of opportunities for women, but she picked her battles wisely. She backed up her talk by providing qualified women with a chance to succeed by hiring them, suggesting them to colleagues seeking new hires or collaborators, and choosing them for volunteer jobs in the American Meteorological Society. She was a valued mentor not only to women but also to men, both younger and older.

This tribute to Joanne Simpson must acknowledge Bob, her husband of 45 years. He was the first director of the Hurricane Research Project and coauthor of the Saffir-Simpson hurricane intensity scale. Much of her work was stimulated by discussions with Bob.

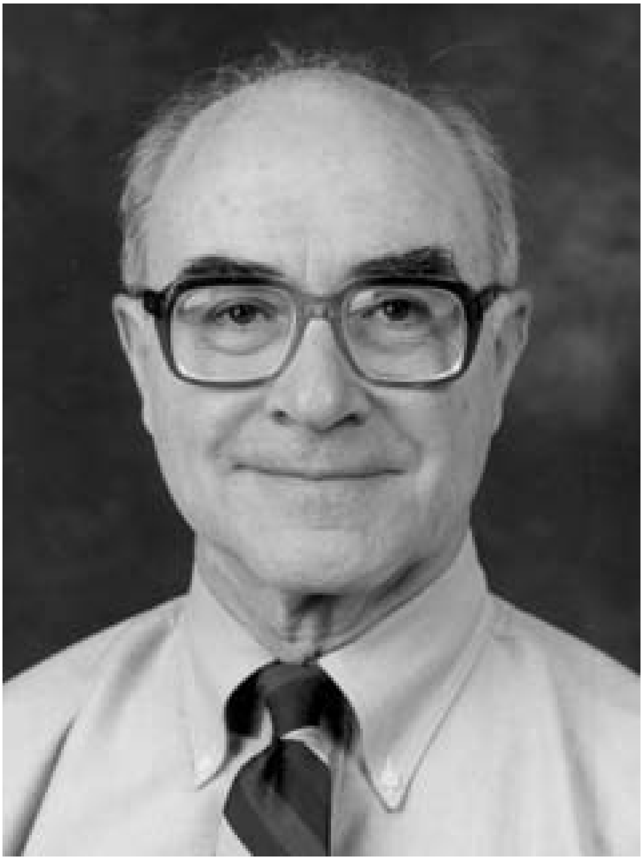
Joanne and Bob Simpson greatly enjoyed sailing, until they could no longer handle the boat themselves. They frequently invited associates and friends to join them. Just as he kept her on a true course in their sailing adventures, he did the same in their lives at home.

They lived on the eighth floor of a high rise in southeast Washington, D.C., with a wonderful view of the Potomac

River, so that they could continue to enjoy sailing vicariously. They also had a wide view to the West to carry on their cloud observations. Their location was an easy drive to the Kennedy Center and the Shakespeare Theater to take pleasure in music, opera, and theater and also to the Cosmos Club to savor gourmet dinners. They also gave of their time to authors who needed advice on the authenticity of their accounts of thunderstorms and hurricanes.

Joanne is survived by her husband, Robert H. Simpson; her children, David Starr Malkus (of Madison, Wisconsin), Steven Malkus (of Falmouth, Massachusetts), and Karen Malkus (of Brewster, Massachusetts); her brother, Dan Gerould (of New York City); six grandchildren; and two great-grandchildren.

Joanne Simpson certainly did not live a peaceful lifestyle. That was impossible for her. There are surely hundreds of us who owe our success in various endeavors, even our careers, to her inspiration and encouragement, her courage and determination, and her friendship.



ROBERT J. SPINRAD

1932–2009

Elected in 1993

"For contributions to the application of computers to data acquisition, analysis, and control for scientific experiments."

BY JOEL S. BIRNBAUM

ROBERT J. SPINRAD, a computer pioneer and one of the fathers of modern laboratory automation, died on September 2, 2009, of Lou Gehrig's disease (ALS) at his home in Palo Alto, California. He was 77 years old.

Born in Manhattan, New York, on March 20, 1932, Spinrad attended the Bronx High School of Science, where, in addition to whetting his already burgeoning interest in science and engineering, he met fellow student Verna Winderman; the high school sweethearts were wed in June 1954 and were married for 55 years. He is survived by Verna, two children, and three grandchildren.

Bob attended the Columbia University School of Engineering, receiving a B.S. in electrical engineering in 1953. He was a regents scholar and the student council president, and in his senior year he built his own computer from discarded telephone switching equipment. Computer science was not yet part of the curriculum, and most people had no interest in his machine. "I may as well have been talking about the study of Kwakiutl Indians, for all my friends knew," he told an interviewer for the *New York Times* in 1983. Bob was named a Samuel Willard Bridgham Fellow and earned an M.S. in electrical engineering from Columbia in 1954.

In 1955, Bob joined the staff of the Brookhaven National Laboratory, where he worked until 1968, with four years' leave to attend the Massachusetts Institute of Technology (MIT), where as a Whitney Fellow he received a Ph.D. in electrical engineering in 1963. He also spent a summer at Los Alamos National Laboratories, learning about scientific computer design; back at Brookhaven he designed a room-sized computer he named Merlin, using vacuum tubes, as the use of transistors was not yet prevalent. From 1965 on, Bob was head of the Computer Systems Group and supervised the design of elegant, innovative systems that helped make the control of experiments and the collection, display, and analysis of data both more efficient and effective. While he had novel ideas about the potential interplay between instruments and computers, he realized that the critical link in the experimental feedback loop was the scientist. He blazed new trails in user interfaces and data visualization and was one of the first people to realize that the course of an experiment could be dramatically affected by properly presented real-time measurements. His widely emulated work resulted in a number of classic papers and talks and in his being invited to write an influential cover article on laboratory automation for *Science* in 1967.

In 1968, Bob left Brookhaven to join the newly formed Scientific Data Systems, where he became vice president of programming. SDS made innovative scientific machines that became popular in laboratories and universities. It was acquired by Xerox in 1969, where it became known as XDS. Bob and his family moved to Southern California, where he led the work in office automation, prototyping communicating word processors, laser printers, and local area networks. The SDS 930 was used by Project Genie at Berkeley in some of the earliest time-sharing experiments; that group formed the Berkeley Computer Corporation, which in turn became the nucleus of the Xerox Palo Alto Research Center (PARC), where much of the technology that led directly to modern personal computers and the local area networks that connect them was invented in the early and mid-1970s.

Bob was named vice president of research and headed PARC from 1978 to 1983, during the period when the laboratory's technology was commercialized, including the first modern personal computer, the Ethernet, and the laser printer. Some of the researchers, frustrated by Xerox's uncertainty about competing in the general computer business, left to form or join new companies based on the PARC technology; these included Apple, Adobe, and 3Comm, to name just a few.

During this period, and for the remainder of his Xerox career, Bob was an eloquent spokesman for a vision of computing that incorporated networks of personal and shared devices backed by a global information infrastructure that is similar to the situation today. He became the leader of Xerox Technology Analysis and Development and remained an influential thought leader in the company's evolution until his retirement.

Throughout his long and productive career, Bob Spinrad was a sought-after speaker and a trusted advisor to a diverse set of government organizations and universities. These included Harvard, Stanford, MIT, the University of California at Berkeley, the Jet Propulsion Laboratory, Educom (the trade name for the Interuniversity Communications Council, Inc., an organization dedicated to the idea that digital computers offered an incredible opportunity for sharing among institutions of higher education), the National Science Foundation, the National Research Council, the Council on Foreign Relations, the U.S. Department of Defense's Advanced Research Projects Agency, and the California Council on Science and Technology, to name some of the many that benefited from his insights and dedication. Bob was a superb industry citizen, serving on many conference program committees, editorial boards, and visiting committees. In recognition of his achievements, he was elected to both the National Academy of Engineering and the American Academy of Arts and Sciences.

His quiet, gentle manner helped him lead by example, and the passion he felt for technology and its application was infectious. These qualities, coupled with an innate patience and compassion, proved important in the development of many colleagues who became industrial and educational leaders in their own rights. Bob had as much pride in their accomplishments as in his own, but his greatest delight was to witness the inexorable march of technology in the directions that he had so accurately predicted and which he had done so much to help make real. He was, until the end, modest and positive and enjoyed the respect and affection of all who knew him. He was one of those rare individuals who made our world a far better place than he found it.

H. GUYFORD STEVER

1916–2010

Elected in 1965

"Outstanding contributor to the nation's space engineering effort."

BY SHEILA E. WIDNALL

H. GUYFORD STEVER, a legendary figure in the history of science and technology as well as one of the most influential developers and executors of science policy during and following World War II, died on April 9, 2010, at his home in Gaithersburg, Maryland, at the age of 93.

Horton Guyford Stever was born on October 24, 1916, in Corning, New York. He received his B.S. in physics in 1938 from Colgate University on a scholarship and his Ph.D. in physics from the California Institute of Technology (Cal Tech) in 1941. He worked in cosmic rays and mechanisms with Geiger counter discharge. With the founding of the Radiation Laboratory in 1940, his thesis advisor, Dr. Victor Neher, went back to the Massachusetts Institute of Technology (MIT) and assigned a young instructor at Cal Tech, William Pickering, to act as his thesis advisor. One part of his thesis was on the lifetime of the meson.

Stever then proceeded to the Radiation Laboratory at MIT, where he was actively involved in the development of radar. He observed that the education of physicists allowed them to effectively develop this new technology; such observations were to have a profound effect on engineering education.

His ability to operate at the interface, a skill that surfaced often during his career, caused him to accept an assignment to go to England and be an interface between British and American scientists. As part of a scientific delegation, he accompanied American troops during their push into Germany. His mission was to obtain materials from German scientific sites at the earliest possible moment. His group did this so well that they reached a German radar site ahead of the American ground troops; fortunately, the Germans surrendered to the American scientists. It was a legendary tale and by all accounts a great party as well!

Along with Vannevar Bush and other senior and seasoned scientists, Stever was instrumental in helping to shape the important transition in government funding of research for national needs and the founding of the National Science Foundation (NSF), which he later directed.

After World War II, Guy went to MIT, where he served in a number of positions: faculty member in aeronautics; associate dean of engineering; and department head of mechanical engineering, naval architecture, and marine engineering. During this time he served as member and later chair of the Air Force Scientific Advisory Board and later as chief scientist of the U.S. Air Force. I first met him in 1958 when I was a junior at MIT; he regaled the MIT students with stories of his wartime adventures.

With the launch of *Sputnik* in 1957, Guy was called on to chair the committee to reexamine the nation's space program. The work of this committee led directly to the formation of the National Aeronautics and Space Administration out of the earlier National Advisory Committee for Aeronautics. He also chaired a National Research Council committee that examined and monitored the redesign of the booster following the *Challenger* accident.

He became president and actually the creator of Carnegie Mellon University where, during his tenure from 1965 to 1972, he oversaw the merger of Carnegie Institute of Technology and Mellon Institute to form Carnegie Mellon University.

In 1972, Stever became head of NSF during the Nixon administration. President Nixon abolished the White House Office of Science and Technology; the president said he was not pleased with its advice concerning antiballistic missiles and supersonic planes. As head of NSF, Stever then functioned as a dual-hatted science advisor for three years but was kept at a distance, for the most part meeting the president only at ceremonies.

In 1976, at President Ford's request, Congress reestablished the Office of Science and Technology, and Ford chose Dr. Stever to lead it. In that post he worked to promote exchanges between American and Soviet scientists, greatly expanded NSF's support of research in renewable energy sources, and supported efforts to commercialize solar heating. He was effective at lobbying for financing of basic research. Stever strengthened the Office of the President's Science Advisor by establishing an advisory committee that was the forerunner of PCAST in the Office of Science and Technology Policy (OSTP).

I was in Washington, D.C., during these years as head of university research for the U.S. Department of Transportation. I chatted with Guy, and he mentioned that he was going to send a letter to agency heads urging increased support of basic research. I said that, given the budget process, it would be good for my program if he would do that this week, which he did. The letter he wrote to the secretary of transportation then landed on my desk for me to prepare a response stating that our program was well funded, thank you. I guess I learned something from that.

Guy was elected a member of the National Academy of Sciences in 1973. Following his departure from NSF and OSTP, he took up a number of board and committee activities, making his talents available to a wide variety of scientific and technical organizations. Guy served as foreign secretary of the National Academy of Engineering from 1984 to 1988. He also served on the Carnegie Commission on Science, Technology, and Government from 1986 to 1987 and as chairman of the Policy Division of the National Research Council in 1995. He served as a director of TRW, Goodyear, and Schering-Plough

Corporation and as a trustee of Woods Hole Oceanographic Institute.

He was awarded the National Medal of Science in 1991, "for his scientific and engineering leadership in applying new results of scientific research and technological development to the purposes of government, industry, and academie." In 1999 he received the Arthur M. Bueche Award from the National Academy of Engineering. The citation read: "For a lifetime of exceptional service to engineering and society as a researcher, university president, and government official, and for the style of leadership that has made him a preeminent U.S. statesman in science and technology." He was awarded the Vannevar Bush Award in 1997 from the National Science Board. In 2002, Guy wrote an autobiography, *In War and Peace: My Life in Science and Technology* (Joseph Henry Press), recommended reading for anyone who wants to understand the processes that took us from World War II to the present interactions between science, technology, and government.

He was a member of the American Academy of Arts and Sciences and a fellow of the American Physical Society, the American Institute of Aeronautics and Astronautics, the Royal Aeronautical Society, and the Royal Society of Arts.

Many of Guy's happiest moments were spent with his family at their summer home in Randolph, New Hampshire. Fly fishing, baseball games, climbs, and camping trips filled summer vacation times. An avid Red Socks fan, he felt privileged to see the "Sox" win the World Series not once but twice. He is survived by his sons Guy Jr. and Roy and daughters Sara Stever and Margaret Weed. Guy joins his wife "Bunny," the former Louise Risley, who died in 2004.

MARTIN SUMMERFIELD

1916–1996

Elected in 1979

"For contributions to the development of rocketry, combustion research, and the international literature in aeronautics and astronautics."

BY YVONNE C. BRILL AND LEONARD H. CAVENY

MARTIN SUMMERFIELD, pioneer in rocket propulsion and combustion research who transformed the American Rocket Society into a leading professional organization and precursor of the American Institute of Aeronautics and Astronautics, died in Hightstown, New Jersey, on July 18, 1996.

Martin Summerfield was born in Brooklyn on October 20, 1916. He graduated from Brooklyn College with a B.S. in physics at the age of 20. In 1936, the middle of the Great Depression, with no prospects for employment in science or technology, he immersed himself in the NYC neutral-accent speech-training program in hopes of qualifying as a teacher. An assistantship to the California Institute of Technology (Caltech) involving optical physics laboratory work enabled him to extend both his studies and associations. Even then he had no illusions about gaining employment as a scientist after graduation. His associations with Professor Theodore von Kármán and the technological buildup accompanying World War II changed everything and immersed him into a lifelong whirlwind of activity.

He received an M.S. in 1937 and a Ph.D. in 1941, both in physics from the Caltech. He was Professor John Donavan Strong's first Ph.D. student. Martin began his pioneering career in rocket research while he was a graduate student. In the 1940s he worked closely with Professor von Kármán on the Air Corps Jet Propulsion Project, serving as assistant chief engineer. He made early discoveries enabling modern high-thrust liquid rocket engines. He guided the development of liquid propellant rocket engines leading to the first practical U.S. jet-assisted takeoff (JATO) of aircraft.

By 1942 development of the JATO units was so successful that the Army Air Corps asked the Caltech researchers to go into production, by producing 2,000 units by the end of 1943. That entailed von Kármán, Edward S. Forman, Andrew G. Haley, Frank J. Malina, John W. Parsons, and Martin Summerfield forming the start-up company that they named the Aerojet Engineering Company. In 1944, Aerojet, located 15 miles east of Pasadena in Azusa, was bought out by General Tire & Rubber of Akron, Ohio, which could provide the expansion of the products desired by the U.S. Department of Defense. The company was accordingly renamed Aerojet General. During the hectic JATO development, Martin worked with the colorful John W. Parson, credited with the key invention of case bonding solid propellants. From 1945 to 1949, he continued his research at the Jet Propulsion Laboratory of Caltech, as chief of the Rocket Research Division. Martin rarely commented on his Caltech and early rocketry experiences. His focus was on the future.

In 1949 he accepted an invitation to move to Princeton University to become general editor of the new Princeton Series on High Speed Aerodynamics and Jet Propulsion, whose purpose was to provide the literature for these rapidly developing fields. In 1952 he turned over the editorship to Joseph V. Charyk and continued full time as a professor.

Martin Summerfield and Eileen Budin were married on August 31, 1945; their daughter Jacqueline is a musician in California. His two grandchildren are pursuing careers in materials science and astronomy. The Summerfields maintained ties to California and always found time to spend a month or so at their beachfront second home at Capistrano Beach.

From the mid-1950s to the mid-1970s, Professor Summerfield established a world-class combustion and solid propulsion laboratory at Princeton University for student research. The propellant processing, motor fabrication, motor testing, combustion, and diagnostic capabilities were full featured and among its distinguishing physical features. He recruited and trained professional staff and technicians to work with forefront high-energy solid propellants and high-pressure systems. The 30 years of operation with no injuries or accidents is a testimony to his exacting leadership. Martin's activities were part of the Princeton University Mechanical and Aerospace Engineering Propulsion Sciences Center in the Guggenheim Laboratories, which included Luigi Crocco and David T. Harrje (liquid propulsion), Irvin Glassman (ramjets and monopropellants), Robert G. Jahn (electric propulsion), and Jerry Grey (nuclear propulsion).

His collegial ties to the basic research leaders in the U.S. Department of Defense, National Aeronautics and Space Administration (NASA), and U.S. Department of Energy helped shape national technology policy. He enjoyed continuous funding from those agencies. Of the 47 dissertations and theses he supervised, all dealt with some aspect of combustion.

He maintained a dynamic stability in his staff and continuity in his students. From this base he ventured into new challenges, including the 1970s focus on airliner fire safety, understanding tobacco combustion in the pursuit of a safer cigarette, coal gasification, and jet engine noise reduction. His laboratories, on the sprawling Forrestal Campus, occupied about a third of the New Guggenheim Laboratory Building, a 1964 three-story office and high-bay laboratory complex partially funded by a NASA construction grant. His unique propellant processing and high-pressure test stands were in adjacent specially constructed buildings.

Martin was tireless. His staff members were certain his stamina and drive would outlast them all. He looked forward to the holidays and breaks between classes, the time all the graduate students could spend full time in his laboratories.

Premier laboratories often have a leader who sets high standards and pursues excellence at the expense of immediate popularity and personal time. Martin was such a leader.

He set difficult and deliberate agendas for his graduate students. He stressed thinking beyond the immediate problem so their Ph.D. research would not be the intellectual high point of their careers. He led his students by a dynamic process of adjusting their research goals to topics that made a difference. His list of publications reflect how quickly he moved on to the next challenge rather than engage his students in projects that might have been variations on a theme. Where plausible, he insisted his students get the full research experience ranging from designing an apparatus, checking it out, and taking the data, while being enmeshed in the development of a theory to interpret the results. This process was always uncertain and often caused his talented students to reach for another level of resilience. Enthusiastically, he added topics to a graduate student's thesis requirements. Many of his students entered the propulsion community, on graduation, fully up to speed and well connected, in part the result of multitopic dissertation research.

His strong sense of international involvement was reflected in his selection of graduate students. Most of his international students were a direct result of one of their professors or mentors visiting his laboratories and subsequent recommendations. The students who returned to their home countries maintained strong ties to him and their U.S. colleagues.

He relished the broad international nature of the aerospace research. The parties he and his wife Eileen had at their home on Lake Carnegie in Princeton were memorable for the broad cross section of staff, students, colleagues, and friends. They were truly international affairs, often prompted by visiting foreign scientists. He recognized the benefits of international scientific exchanges as a precursor to better world relationships. For example, the ties he helped maintain with the Russians in the 1960s and 1970s are the basis for the present-day interactions by his students and staff. He relished assigning offices to visiting scientists. For example, Arie Peretz of Israel's Rafael Systems, Ltd., and his new officemate Vadim B. Librovich of Moscow's Institute of Problems in Mechanics soon became good friends, just as the professor planned. He expertly kept in touch with his international counterparts through such activities as being vice president of the International Astronautical Federation from 1963 to 1965 and editor-in-chief of its journal, *Acta Astronautica,* from 1966 to 1973.

He loved the Joint Army, U.S. Navy, NASA, and Air Force Interagency Propulsion Committee's combustion meetings. They were his forum for *works in progress* prior to submission to peer review. He would wait out the obviously weak presentations and save his comments for his peers. The sight of Professor Summerfield entering a conference room (often to the right of the speaker, to benefit his better ear) and taking a seat near the front brought anticipation to the audience that a good presentation would be followed by pointed questions and observations. They were seldom disappointed. After carefully listening to the speakers' interpretation of their data set, he would offer his unique insights. During a session break, he was the first to approach the speakers for more discussion. He was content to let his staff and students make national presentations. They too could anticipate new observations from their coauthor following the presentation.

He was committed to the embryonic American Rocket Society (ARS) and its successor, the American Institute of Aeronautics and Astronautics (AIAA). As editor of the *ARS Journal,* he was the major force transforming ARS into a technical society to be taken seriously and ready for its leadership position in time for the late 1950s Space Race. *ARS Journal* readers were never far from the practical, since the journal included hardware and employment ads, patent summaries, book reviews, and so forth. In 1962, during the critical merger forming AIAA, he served as ARS president.

In 1960, Martin was the founding editor-in-chief of its book series ARS and later *AIAA Progress in Astronautics and Aeronautics.* These types of contributions earned him the Pendray Award for literature in 1954. He served as volume editor of and contributor to *Solid Propellant Rocket Research,* Volume 1 of the Progress Series, published in 1960. Later, he coedited with former students several additional volumes for the series. In 1963–1964, Martin served as the AIAA's first vice president for publications. He continued to be very active on the Publications Committee as an honored emeritus member.

He always gave high priority to ARS and AIAA. Any author in his Progress Series will testify to the difficult standards he set. He found the first disclosure in the form of an AIAA preprint satisfying and would often engage the next challenge without offering his preprints for journal publications. Since the aerospace profession will never have a more effective champion of its refereed publications, this is a contradiction. Readers of his papers never have to hunt for the significance of his results, figures, and tables; he taught two generations how to highlight results.

Professor Summerfield, the rather formal leader of a laboratory, became the congenial guest when he visited a staff member's home. He could be expected to bring something to amuse his guest's children—for example, a trick way to fold a dollar bill.

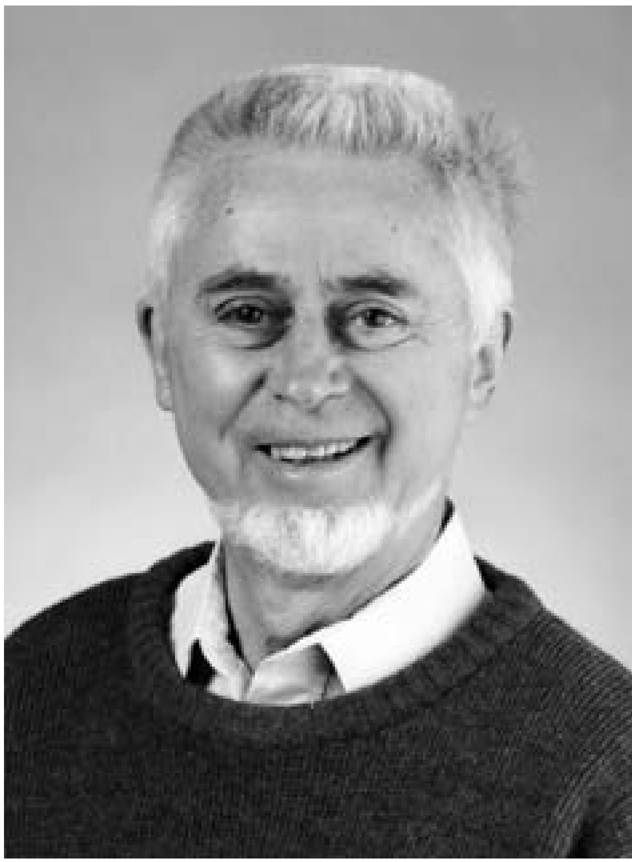
Martin relished taking combustion and propulsion research into new and topical areas. He thrived on the intellectual challenge of convincing others how spinoffs of his research facilitated addressing other problems. Examples of this include jet engine noise, coal gasification, oil fires, smoldering of construction, and upholstery foams. His involvement with the National Academy of Engineering, government panels, and industry consulting were constant sources of new relevant research. In 1977 the AIAA Wyld Award commended his wide-ranging contributions to rocket propulsion.

The Princeton community debate over the Vietnam War referred to the Defense Department's funding of some of Martin's research. Threats to march on his laboratory to confiscate files were met with cordial invitations to tour all aspects of the laboratory. Martin loved to talk about his research, particularly the physics of the phenomena. The groups there to question his activities left with the knowledge that the research was being done in a "fish bowl" for all to judge.

Martin satisfied his entrepreneurial zeal by forming

Princeton Combustion Laboratory, Inc., in 1975, with two young associates. He and Neale A. Messina evolved the company into Princeton Combustion Research Laboratories (PCRL), well respected in the community and noted for its combined experimental and analytical treatment of complex high-pressure combustion systems. Around 1994 the company was acquired initially by Lockheed Martin. Shortly thereafter, Martin began to reduce his activities due to failing health and relinquished his role in PCRL. He remained active as an advisor and a vigorous campaigner for technical approaches in the national interest. In 1996 he was elevated to honorary fellow by the AIAA, our aerospace community's highest honor.

Martin Summerfield was a genius. Anyone who worked with him will testify to that. He surrounded himself with the most capable people, recruited the brightest students, and attracted colleagues who would challenge him technically. In the final analysis, Martin's insights were often the defining interpretation of difficult physical problems . . . and he loved it. He had the ability to see through the first interpretation to a more satisfying one.



MILTON D. VAN DYKE

1922–2010

Elected in 1976

"For solving complex problems in aerodynamics, specifically in designs of airplanes and missiles."

BY LEONARD SCHWARTZ, PETER BRADSHAW, AND WALTER G. VINCENTI

MILTON DENMAN VAN DYKE, emeritus professor of engineering at Stanford University, died of complications of Parkinson's disease on May 10, 2010, at the age of 87.

First at the National Aeronautics and Space Administration's (NASA) Ames Research Center and then at Stanford, Milton made many contributions to fluid mechanics, especially the mathematical/computational analysis of compressible flow. In the early 1950s he solved the very difficult numerical problem of calculating hypersonic flow and heat transfer over a blunt-nosed body. His program was used in the design of all Mercury, Gemini, and Apollo reentry modules. It was one of many cases in which he carried out a subtle mathematical analysis before devising a method of numerical solution. He was the founding coeditor of *Annual Review of Fluid Mechanics* and the compiler and publisher of *An Album of Fluid Motion* (Parabolic Press, 1982).

Milton was born on August 1, 1922 in Chicago, the son of James and Ruth Van Dyke. His father, with a degree from Pennsylvania State University, was a teacher of mechanical engineering, and his mother was a Phi Beta Kappa mathematics graduate of the University of Minnesota. The Depression of the 1930s made it difficult for either of them to find satisfactory permanent employment, and the family moved frequently.

Milton spent his three high school years, grades 10–12, in the small town of Portales, New Mexico. He said that much of the credit for his subsequent successes was due to the good education he received there. In 1940, Milton won the scholarship that Harvard awarded each year to students in a handful of poor states, including New Mexico.

Milton completed his course in engineering science in three years, graduating summa cum laude. He was elected to Phi Beta Kappa in his junior year. He used to point out that his shortened time at Harvard was due, in some measure, to the U.S. entry into World War II during his sophomore year. Engineering students were encouraged to finish quickly so that their skills could be used in the war effort.

Milton's job choices included working as a mathematician and code breaker in Washington, D.C., or going to the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics (NACA, now NASA Ames Research Center), which cohabited Moffett Field, California, with the U.S. Navy until the naval air base was closed in 1994. Milton chose to go to Ames. Men of military age in occupations that were important for the war effort could have their call-up "deferred" but only for a limited time. Therefore, the aerodynamicists were all inducted into the "Ames Detachment" of the U.S. Navy and then assigned back to their day jobs, but with some naval duties. Milton was ultimately promoted to the rank of lieutenant junior grade.

Milton always regarded himself as an engineer rather than a mathematician, and indeed his first assignment was to assist Harvey Allen and Walter Vincenti with experimental work in the newly built 1-foot by 3.5-foot transonic wind tunnel.

The famous Ames compilation of basic information and numerical results for compressible flow (the 70-page NACA Report 1135, issued in 1953, and now available online) was a group effort and was attributed to anonymous members of the Ames staff. In fact, Milton was responsible for the material on flow of perfect gases in thermodynamic equilibrium (up to a rather hopeful M = 100), which forms the major part of the report. Note that all of the numerical results were generated by Milton's assistants using mechanical desk calculators. This report became NACA's all-time best seller, and its presentation of formulas and figures has been followed in many textbooks on compressible flow.

In 1946, after leaving the Navy, Milton won a National Research Council scholarship for graduate study at the California Institute of Technology. By June 1949 he had received an M.S. and a Ph.D. (magna cum laude). His thesis was on the delicate problem of second-order supersonic flow theory. His advisor was Paco Lagerstrom. After a postdoctoral year with Lagerstrom, he returned to the NACA Ames Laboratory in 1950.

Harvey (Harry Julian or H. Julian) Allen had discovered that a round-nosed body should be better able than a sharp-nosed body to withstand the high temperatures that occur during hypersonic reentry into the atmosphere. This was a remarkable, counterintuitive result. Allen later became director of the NASA Ames Research Center (1965–1969): coincidentally, he was the subject of the first Memorial Tribute in the first volume of this series, written by Nicholas Hoff in 1979. The vacuum-tube digital computers of the 1950s did not have the power to calculate the hypersonic flow over a given body directly, and "inverse" methods, in which an assumed shape of the bow shock wave was adjusted until the right body shape appeared, had failed to converge. The problem was assigned to Milton, whose contribution was twofold. First, he provided a clear mathematical explanation for the failure of previous "inverse" computations. Second, in collaboration with Helen Gordon, he created a successful inverse algorithm.

It was only in the 1970s, after computer power had increased by about three orders of magnitude (and after the U.S. manned lunar program had been abandoned) that Milton's inverse scheme was replaced by truly direct schemes. Thus, the predictions of fluid flow and heat transfer during ballistic reentry of the three generations of U.S. spacecraft (Mercury, Gemini, and Apollo) were all made using the Van Dyke–Gordon algorithm.

While still at NACA Ames, Milton was awarded a

Guggenheim Fellowship and a Fulbright grant to spend the 1954–1955 academic year with George Batchelor at Cambridge University. During this sabbatical year Milton lectured extensively in Western Europe. In Cambridge he became well acquainted with G. I. Taylor. It was a friendship that continued until "G.I." died in 1975. Milton was especially proud of the fact that he wrote appendixes to two of G.I.'s papers during the 1960s.

Paul Germain (NAE 1979) invited Milton to spend the academic year 1958–1959 as a visiting professor at the University of Paris. Milton gave a 23-lecture course on hypersonic flow theory—in French, which he taught himself in six months. He also supervised a Vietnamese Ph.D. student, and Germain alleged that he developed a Vietnamese accent. The Van Dyke family remembers Germain as a valued friend. (In 1965, Milton spent three months at A. A. Dorodnitsyn's computing center in Moscow and again learned the language sufficiently well that he was able to lecture in Russian.)

While he was in Paris, Milton was invited to join the faculty of the newly opened Aeronautics Department at Stanford, as a full professor, and he arrived in 1959. He introduced a course on perturbation methods, leading to his book, *Perturbation Methods in Fluid Mechanics* (Academic Press, 1964), which contained much original work, and two other courses, one on symmetry and similitude in fluid mechanics and the other on hypersonic flow theory. His appointment was held jointly in the aeronautics department and the applied mechanics group of the mechanical engineering department. He continued to work on supersonic/hypersonic flow and on higher-order boundary-layer theory. He was an enthusiastic and innovative teacher. When told of his death, a former Ph.D. advisee of one of Milton's Stanford colleagues—now a prominent figure in computational aerodynamics—said simply, "He was my hero." Milton's own 40-odd Ph.D. students would say much the same, as would the many academic friends to whom he gave a helping hand in times of professional, personal, or political trouble. It was said of him that if he felt that a wrong had been committed, no matter how small or how large, he was absolutely stubborn about seeing that it was made right. Milton nominally retired in 1992 but kept an office on campus until his last illness.

Milton, with W. R. Sears (then of Cornell University) was invited by Annual Reviews Inc. to edit a new series, and the first volume of *Annual Review of Fluid Mechanics* appeared in January 1969. In the Preface the editors stated that it "stems from the conviction that fluid mechanics is now such a broad subject, with implications in so many areas of science and technology, as to require, periodically, expository reviews by specialists in its various branches." The list of contributors is impressive and a tribute to the editors' powers of persuasion: nearly all the names are instantly recognizable even after 40 years. Milton, with various colleagues, remained an editor for 30 years.

Milton believed strongly that textbooks should be sold as cheaply as possible. He refused to let the publisher of *Perturbation Methods in Fluid Mechanics* (Academic Press, 1964). increase the price, and when the publisher let the book go out of print, Milton published an annotated edition himself for the original price of $7 under the imprint of Parabolic Press (1975). The press began to publish wholly new books because of an apparently trivial incident. Milton had once seen, in a little bookshop on the Left Bank in Paris, a beautiful collection of black-and-white photographs from optical research and realized that students of fluid mechanics needed a similar collection. So, many years later, Parabolic Press published *An Album of Fluid Motion* (1982), which Milton designed himself. It contains about 400 photographs selected from 1,000 sent to him by friends all over the world (another tribute to his persuasive powers). Many of these photographs are intrinsically beautiful, and black-and-white prints make a pleasant change from contour plots in primary colors. The album is sold at no more than cost price. To date, over 40,000 copies have been sold, and a pleasant custom has arisen, not only at Stanford: a lecturer will give the top student in a class a copy, as an informal prize. Another Parabolic Press book is *Stories from a 20th-Century Life* (1994), the lighthearted autobiography of Milton's *Annual*

Review collaborator, the late Bill Sears, written "with malice toward none, with charity for all" (except airport managers: Bill logged nearly 8,000 hours as a private pilot).

As well as receiving several fellowships for research abroad, Milton received the Otto Laporte Award of the American Physical Society in 1986 and the Fluid Dynamics Award of the American Institute of Aeronautics and Astronautics in 1997. He is also remembered for three outstanding works of public service—NACA Report 1135, *Annual Review of Fluid Mechanics*, and the "Album."

Milton's private interests included music—he played violin in a Harvard orchestra—and all kinds of outdoor activities from camping to mountain climbing. He was also good at making things, including much of the furniture in his first house.

He is survived by his wife of 48 years, Sylvia, who nursed him at home until his death; his sons Russell, Eric, Christopher, Brooke, and Byron; his daughter, Nina; and nine grandchildren.

WILLIAM L. WEARLY

1915–2010

Elected in 1990

"For leadership in the development and manufacture of equipment contributing to safety and productivity in mining and in related industries."

BY WILLIAM POUNDSTONE

WILLIAM L. WEARLY was the distinguished leader of two of the nation's leading manufacturing companies: Joy Manufacturing (now known as Joy Global) and Ingersoll Rand. He was born in Warren, Indiana, on December 5, 1915. Bill died in Carefree, Arizona, on April 30, 2010, at the age of 95.

He was an outstanding student in his precollege days and attended Purdue University, where he received a B.S. in electrical engineering in 1937. While in college he was awarded membership in Eta Kappa Nu and Tau Beta Pi and served as the president of the American Institute of Electrical Engineers (AIEE). Bill was named a distinguished student at Purdue University in 1934, 1935, and 1936.

After graduation Bill went to work for Joy Manufacturing with their electrical design staff. He was promoted to the position of service manager in 1939. Two years later he became the general sales manager. Bill held this position until 1956, when he was promoted to the position of executive vice president.

He held this job for a year until he was named president and chief executive officer. Bill held this position until 1962. In 1962 Bill joined the Ingersoll-Rand Company as a vice president and director. In 1967 he was named chairman and chief executive officer. He held this position until his retirement in 1980. After retirement he continued to serve Ingersoll-Rand as a director and chairman of the Executive Committee.

In 1959 Bill Wearly was awarded an honorary doctor of engineering by Purdue University. In 1972 he was also awarded an honorary doctor of humanities by Wilkes College.

Bill Wearly had active affiliations with many industry organizations. He served as director of the Bituminous Coal Research Corporation, as director of the American Mining Congress, and as chairman of the Manufacturers Committee of the American Mining Congress. He was also director of the Bituminous Coal Association and director of the National Association of Manufacturers. In addition, he was chairman of the International Committee of the National Association of Manufacturers and chairman of the European–American Business Council and chairman of the British–North American Committee Management Executive Society. He also served as director of the Machinery and Allied Products Institute and as director of the Logistics Management Institute.

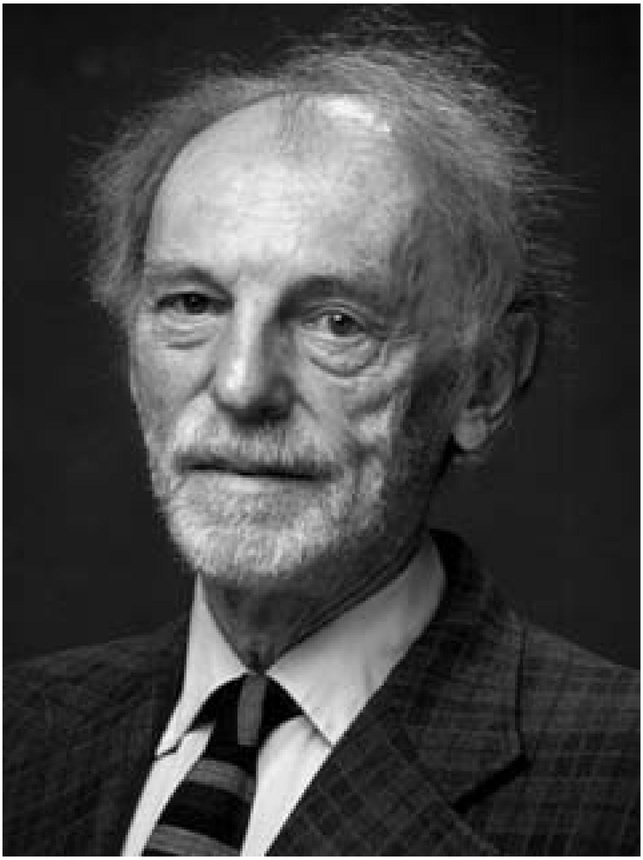
In addition to his membership in the National Academy of Engineering, Bill Wearly was a member of the Institute of Electrical and Electronics Engineers (IEEE); the American Institute of Mining, Metallurgical, and Petroleum Engineers; and the Society of Mining Engineers.

Wearly was also director of a number of corporations. These included the Bank of New York, Babcock & Wilcox, McDermott, American Cyanamide Corporation, Sperry Corporation, U.M.C. Inc., Asarco, Cummins-American Corporation, United Engineering & Foundry, ASA Ltd., and Driall Inc. Bill also served on the President's Grace Commission on Government Waste and was co-chairman of the Veterans Administration.

Bill Wearly made many noteworthy contributions to the development of more efficient industrial and mining machinery. He authored numerous publications on mining and held a number of patents on mining machinery.

His son remembers him as an avid golfer, shooter, ocean sailor, and racer. Social memberships included Indian Harbor Yacht Club, The Blind Brook Club, Desert Forest Golf Club, and member and past president of the Clove Valley Rod and Gun Club. Awarded the Commander of the Order of the British Empire by Elizabeth II in 1975, he resided in Greenwich, Connecticut, and Carefree, Arizona.

Preceding him in death was his first wife, Mary Jane Wearly. Together they are survived by four children and nine grandchildren. Mr. Wearly is also survived by his wife of the last 15 years, Margaret Campbell Wearly.



JOHN V. WEHAUSEN

1913–2005

Elected in 1980

"For contributions in applied mathematics and its use in solving important engineering problems in ship design."

BY RONALD W. YEUNG, SARAH WIKANDER, AND J. RANDOLPH PAULLING

JOHN VROMAN WEHAUSEN, professor of engineering science, emeritus, at the University of California, Berkeley, and a world leader in the field of marine hydrodynamics, died peacefully at the Kaiser Oakland Medical Center on October 6, 2005, at the age of 92.

John Wehausen was born on September 23, 1913, in Duluth, Minnesota, and grew up in Oak Park, Illinois. At the University of Michigan he received his undergraduate degree in mathematics in 1934, followed by a master's in physics in 1935, and a doctorate in mathematics in 1938.

In 1937, Wehausen began his first teaching position as an instructor in mathematics at Brown University. It was there that he met his future wife, Mary Katherine Wertime, a Ph.D. candidate in mathematics. They had been married 62 years when she passed away in January 2001.

After holding teaching positions at Columbia University and the University of Missouri, Wehausen contributed to the government's efforts at the end of World War II by working for the U.S. Navy in operations research. He joined the David Taylor Model Basin in Bethesda, Maryland, as a mathematician and, during his three-year tenure there, met George Weinblum, the renowned German ship hydrodynamicist. His interest in water-wave theory and ship hydrodynamics can be traced to that time and mentor.

Used with the permission of the Academic Senate of the University of California.

Wehausen's training in mathematics and his exceptional language abilities were recognized when he was selected as executive editor of *Mathematical Reviews* in 1950, a post he held until 1956, when he was recruited by UC Berkeley. There he helped establish the Department of Naval Architecture, developing a graduate-degree program that stressed hydrodynamics and structural mechanics in the marine field. That rigorous academic curriculum eventually became a model for similar programs worldwide. In 1996 the department became a Graduate Group in Ocean Engineering within the Graduate Division. Starting in the fall of 2005, the group became a major field of study within UC Berkeley's Department of Mechanical Engineering.

Besides being a popular and dedicated teacher, Wehausen contributed to original scientific research in the areas of ship waves, ship maneuverability, floating systems in waves, and ship-generated solitary waves. He was an advocate of systematic theoretical analysis based on rational mechanics principles. In an era when engineers are building container ships with capacities of 10,000 containers, floating offshore oil production systems for operation in water depths exceeding 2,000 meters, and marine vehicles that travel at extreme speeds in high sea states, his visionary approach based on first principles has become all the more important.

His review articles are especially highly regarded. In 1960 he published the 350-page article "Surface Waves" (with the late UC Berkeley Professor Edmund Laitone) in *Handbuch der Physik.* This synthesis of the field has had such a wide and long-lasting impact that it was republished in 2002 in an online version to provide free access for a worldwide audience (*http://www.coe.berkeley.eduSurfaceWaves*). Two other authoritative reviews—"The Wave Resistance of Ships" in *Advances in Applied Mechanics* (1974) and "The Motion of Floating Bodies" in *Annual Review of Fluid Mechanics* (1972)—are considered classics in his field.

Wehausen retired from UC Berkeley in 1984, but for many years remained active in research and university affairs. Among his other activities, he chaired the Committee on Memorial

Resolutions of the Academic Senate from 1991 to 1997. He was a member of the National Academy of Engineering and a life fellow of the Society of Naval Architects and Marine Engineers, which awarded him the Kenneth Davidson Medal for outstanding scientific accomplishment in research. Among the many other honors he earned throughout his career was an honorary doctorate degree from the Joseph Fourier University in Grenoble, France, where he had taught during a sabbatical leave.

In June 2002 international colleagues and former students paid tribute to Wehausen by organizing a special symposium during the Offshore Mechanics and Arctic Engineering Conference in Oslo, Norway. At that event he was awarded the Lifetime Achievement Award of the American Society of Mechanical Engineers International.

Wehausen had a great interest in languages. He was fluent in German and French, read Russian well, and had a working knowledge of other Western European and Slavic languages. To try his hand at a non-Indo-European language, he studied Turkish and lectured in that language during a sabbatical leave at the Technical University of Istanbul. For many years he read daily papers in three languages. He wrote articles in French and German and gave lectures in these languages. He also had a great love for classical music, which was strengthened by Kay Wehausen's musical background and training. That love was passed on to their four children. After moving to Berkeley, he taught himself the recorder and bought the family a harpsichord so they could play chamber music together.

Wehausen is survived by his four children—Sarah Wikander and her husband Carl, Peter Wehausen and his wife Suzanne, Julia Wenk and her husband Rudy, and John Wehausen and his wife Carolyn—and by six grandchildren and one great-grandson.

In June 2006, thanks to the generosity of family, friends, and former students, a John V. Wehausen Memorial Endowment was established at the UC Berkeley Foundation to provide a scholarship for graduate study in Wehausen's areas of professional interest.

MAX T. WEISS

1922–2006

Elected in 1986

"For research into the use of ferrites in microwave components, and for extensive contributions to the research, engineering, and development of military space systems."

BY WANDA M. AUSTIN

MAX TIBOR WEISS died June 10, 2006, in Los Angeles, California, at the age of 83. At the time of his death, he was survived by his wife Melitta and their three children: sons Herschel and David and daughter Deborah Berkowitz. Other survivors include 19 grandchildren, seven great-grandchildren, and his brother Joseph Weiss. He was predeceased by his eldest son, Samuel.

Weiss was born in Hungary on December 29, 1922, and emigrated to New York City with his family in 1929, just before the beginning of the Great Depression. Like many immigrant families, Weiss's mother and father pushed education and professionalism as a way for their children to advance themselves in their adopted country. Weiss attended City College of New York from 1940 to 1943, majoring in electrical engineering, and following graduation he joined the U.S. Navy and served as a chief petty officer. When World War II ended, Weis enrolled at the Massachusetts Institute of Technology in 1946 for his graduate studies; he received his master's degree in electrical engineering and his Ph.D. in physics in 1951.

After receiving his doctorate, Weiss accepted a position at Bell Labs, where he worked for 10 years. While working at Bell, Weiss coauthored a paper with Philip Anderson, who was awarded the Nobel Prize in physics in 1977. Weiss described his tenure at Bell Labs as "a most wonderful experience . . . And one of the most important things you learn at Bell Labs is you ask questions, you don't take anything for granted. If there is a problem, if something unique happens in an experiment, you find out why. . . . And that questioning attitude was extremely useful to me in all kinds of situations, whether at Aerospace, or Northrop, or in my personal life."

After leaving Bell, Weiss moved to Los Angeles to work at Hughes Aircraft for two years. He first joined Aerospace in 1961, less than a year after the corporation was founded. Weiss is largely credited with establishing the Aerospace Corporation Laboratories in cooperation with Dr. Ivan Getting, the first president of Aerospace. He later described his move to Aerospace as "exciting times . . . a tremendous opportunity to fashion the laboratories." Weiss joined Aerospace as director of the Electronics Research Laboratory and initiated studies of lasers and related electro-optics. "Decision making was quick, and, for example, the laser was invented and within months we had a laser laboratory." He became assistant general manager of the Laboratories Division in 1963 and was promoted to general manager in 1964. He served in that capacity until 1967, when he left Aerospace to work for TRW, where he directed the microelectronics center.

He returned to Aerospace only a year later at Getting's request to serve as general manager of the Electronics and Optics Division, where he remained for 10 years. In 1978, during the Aerospace presidency of Dr. Eberhardt Rechtin (1977–1987), Weiss became vice president and general manager for laboratory operations. It was Weiss who decided that Aerospace needed engineering laboratories in addition to its existing research labs. He then served as the Engineering Group's vice president from 1981 until 1986, when he left Aerospace to work for Northrop Grumman. While employed at Northrop Grumman, Weiss oversaw the research laboratories for one year and then became vice president and general manager in charge of the Electronics Division.

Throughout his long career, Weiss received numerous awards for his research in physics and electrical engineering. He received the Institute of Electrical and Electronics

Engineers (IEEE) Centennial Medal in 1984 and was named an IEEE fellow in 1987. Weiss was elected to the National Academy of Engineering in 1986, based on his research into the use of ferrites in microwave components and for extensive contributions to the research, engineering, and development of military space systems. Weiss's additional honors included election to fellowships in the American Physical Society and the International Academy of Astronautics.

The IEEE awarded Weiss its Frederik Philips Award in 1993, citing his "leadership in building electronics research and engineering organizations for the development and operation of national security space systems." Even after his retirement from Northrop, Weiss remained active in the aerospace industry. He was appointed to serve as a council member of the California Council on Science and Technology (CCST) in 2001 and was serving his second term with the council at the time of his death. Always in touch with the latest scientific and technological advances, Weiss served on both the finance and new technologies committees of the CCST. He also served on the Defense Science Board/Air Force Scientific Advisory Board Task Force on Acquisition of National Security Space Programs, which released its findings in the so-called Young Report in 2003. The task force documented some shortcomings with space acquisition policies and urged the U.S. Air Force to continue its reform of the acquisitions process in order to field satellite systems on time and within budget.

In an interview conducted in 2005, Weiss was asked which career honor he was most proud of and he replied, "Probably election to the National Academy of Engineering, which came as a total surprise to me. . . . It was extremely satisfying, and of course that is one of the highest honors that any engineer can have." Reflecting on his career with the Aerospace Corporation, Weiss recalled a year before his death that "it was an exciting time for the space program, so I enjoyed it immensely. I think I made some contributions. . . . And on the whole I'm very, very grateful for the opportunities that both Eberhardt Rechtin and Ivan Getting gave me. So clearly I had an impact, and that is extremely satisfying."

RICHARD T. WHITCOMB

1921–2009

Elected in 1976

"For pioneering research and application in the aerodynamic design of high performance aircraft."

BY RICHARD H. PETERSEN
SUBMITTED BY THE NAE HOME SECRETARY

RICHARD T. WHITCOMB, aviation pioneer, died in Newport News, Virginia, on October 13, 2009, at the age of 88. The National Aeronautics and Space Administration (NASA) Langley Research Center engineer has been called the most significant aerodynamic contributor of the second half of the 20th century. His work changed the way we fly today with three design innovations that allowed airplanes to fly farther and faster using less fuel. He was elected to the National Academy of Engineering in 1976 for his "pioneering research and application in the aerodynamic design of high performance aircraft."

Born on February 21, 1921, in Evanston, Illinois, Richard Travis Whitcomb was the son and grandson of engineers. He grew up in Worcester, Massachusetts, in an era when aviation pioneers such as Charles Lindbergh were household names. He built and flew rubberband-powered model airplanes. His interest in aerodynamics continued into college at Worcester Polytechnic Institute, where he joined the aeronautics club and spent a lot of time in the school's wind tunnel.

Whitcomb came to what is now NASA's Langley Research Center in Hampton, Virginia, in 1943, during World War II, after graduating with a bachelor of science degree in mechanical engineering with highest honors. It was a busy time for aeronautical engineers working to improve America's military air superiority, and Whitcomb dived right in. In less than a decade he tackled and solved one of the biggest challenges of the day—how to achieve practical, efficient transonic flight.

In interviews over the years, Whitcomb told how he was sitting one day with his feet up on his desk when he had a "Eureka!" moment and came up with what is known as the Area Rule. He theorized that the shape of the fuselage could be changed to reduce the aircraft shock wave drag that occurs near the speed of sound. The basic idea was to ensure a smooth cross-sectional area distribution between the front and back of the plane. Because projections from the fuselage increase a plane's cross section, narrowing the fuselage where the wings and tail assembly attach reduces drag. "We built airplane models with Coke-bottle shaped fuselages and lo and behold the drag of the wing just disappeared," said Whitcomb. "The wind tunnel showed it worked perfectly." (The wind-tunnel model Whitcomb used to develop the Area Rule is displayed in the Smithsonian's Air and Space Museum.)

The Area Rule was first tested in flight on the Convair YF-102, a delta-winged jet fighter that flew well at supersonic speeds but had difficulty passing through transonic speeds. The plane was lengthened and given the now-famous "Coke-bottle" fuselage. In the words of a test pilot, the redesigned Convair YF-106 "slipped right past the speed of sound and kept on going."

For his development of the Area Rule the Langley engineer, aged 34, was awarded the National Aeronautics Association's Collier Trophy for the greatest achievement in aviation in 1954. Previous recipients included aviation pioneers such as Glenn H. Curtis, Glenn L. Martin, Elmer A. Sperry, and Donald W. Douglas.

Looking at almost any large airplane today—especially those that fly at transonic and supersonic speeds—one can see the genius of Dick Whitcomb. He developed three important aeronautical innovations while working at NASA Langley, one in each decade of his career. The Area Rule was Whitcomb's major accomplishment of the 1950s, but his "supercritical wing" revolutionized the design of jet liners after the 1960s.

The key was the development of an airfoil that was flatter on the top and rounder on the bottom with a downward curve on the trailing edge. That shape delayed the onset of drag, increasing the fuel efficiency of aircraft flying close to the speed of sound.

In the 1970s it was an article on birds that led Whitcomb to develop his third significant innovation—winglets—refining an idea that had been around for decades. Other engineers had suspected that end plates added to the wing tip could reduce drag. But the Langley engineer proved a simple vertical plate wasn't enough. "It is a little wing. That's why I called them winglets," said Whitcomb. "It's designed with all the care that a wing is designed." Winglets reduce wingtip vortex drag and increase lift, thus improving aerodynamic efficiency. Many airliners and private jets use winglets for better fuel performance.

Those who worked with Whitcomb remember him as brilliant, driven, and single-minded with aerodynamics dominating his thoughts at work and at home (he never married). He often would work a double shift, taking a short nap on a cot next to the wind tunnel where he tested, and then going right back to work. He was known for his intuitive sense of airflow and aerodynamics. "I didn't run a lot of mathematical calculations," he said, "I'd just sit there and think about what the air was doing, based on flow studies in the wind tunnel." His co-workers said he had an uncanny sense of aerodynamics, unbelievable concentration, and a phenomenal memory.

The famed aerodynamicist retired from NASA Langley in 1980, but his contributions remain some of the research center's greatest accomplishments. He continued to work as a consultant for NASA and for aerospace companies. He did not work for money and had little use for it. He often used expired checks as bookmarks.

Whitcomb earned many honors in his life. Besides the Collier Trophy, he received the U.S. Air Force Exceptional Service Medal in 1955, the first National Advisory Committee for Aeronautics Distinguished Service Medal in 1956, the NASA Exceptional Scientific Achievement Medal in 1959, the

National Medal of Science (personally conferred by President Richard Nixon) in 1973, and the National Aeronautics Association's Wright Brothers Memorial Trophy in 1974. He also was inducted into the National Inventors Hall of Fame in 2003 and the Paul E. Garber First Flight Shrine at the Wright Brothers National Memorial. Whitcomb's alma mater, Worcester Polytechnic Institute, also awarded him an honorary doctorate in 1956 and its Presidential Medal in 2003.

"There's been a continual drive in me since I was a teenager to find a better way to do everything," Whitcomb told the *Washington Post* in 1969. "A lot of very intelligent people are willing to adapt, but only to a certain extent. If a human mind can figure out a better way to do something, let's do it. I can't just sit around. I have to think."

MAURICE V. WILKES

1913–2010

Elected Foreign Associate in 1977

"For pioneering development of practical electronic computers and leadership in computer science."

BY MARTIN CAMPBELL-KELLY
SUBMITTED BY THE NAE HOME SECRETARY

SIR MAURICE VINCENT WILKES FRS, a pioneer of British computing and professor emeritus at Cambridge University, died on November 29, 2010, at the age of 97.

Wilkes was born on June 26, 1913, in Dudley, a town in the English midlands. His father was an administrator for the estate of the Earl of Dudley, his mother a housewife. He was educated at King Edward VI Grammar School in the town of Stourbridge. In his early teens he read *Wireless World* and built crystal sets—experience for which he was very grateful when it came to building electronic computers two decades later. He entered St. John's College, Cambridge University, in 1931, where he read mathematics.

In 1935 he became a research student at the Cavendish Laboratory, Cambridge University, working on the propagation of long radio waves. A turning point in his life occurred when he attended a lecture by Douglas Hartree, a computing expert and professor of mathematical physics at Manchester University. In 1937, when the university established the Mathematical Laboratory for practical computing, Wilkes leapt at the opportunity to become its manager.

On the outbreak of war, Wilkes was enlisted in the scientific war effort. He worked on radar and operations research, building up a network of contacts that would prove invaluable in the postwar period.

At the end of the war, Wilkes returned to Cambridge University, with the mission to rebuild the Mathematical Laboratory. Electronic computing was in the air. At the Moore School of Electrical Engineering, University of Pennsylvania, the ENIAC, the world's first electronic computer for defense calculations, designed by J. Presper Eckert and John Mauchly, had just been completed. Eckert and Mauchly, together with John von Neumann, subsequently produced a proposal for the EDVAC, the blueprint of the modern stored-program digital computer. In the summer of 1946, Wilkes was one of a handful of Britishers invited to attend a course on electronic computers at the Moore School. Sailing home on the *Queen Mary* he began the design of a machine he called the Electronic Delay Storage Automatic Calculator, EDSAC for short, an acronym consciously chosen as a tribute to the EDVAC.

Work started on building the EDSAC in early 1947. The following spring Wilkes married Nina Twyman, a classicist he had met in Cambridge; they had three children.

Almost everything in the EDSAC had to be done from first principles—memory technology, electronic arithmetic and logic, and control circuits. The machine sprang to life on May 6, 1949, the world's first practical electronic computer. (Manchester University had got there first in June 1948 with an experimental machine, but the EDSAC was the first capable of running realistic programs.) By the beginning of 1950 the Mathematical Laboratory was offering a regular computing service. Wilkes decided that the laboratory would specialize in writing programs rather than building computers. He was perhaps the first person to recognize that what we now call software (a term not used until about 1960) would prove to be a worthwhile academic pursuit. Heavy use of the laboratory's facilities was made by Cambridge University's researchers, including some of its luminaries—such as John Kendrew, Fred Hoyle, and Martin Ryle. Kendrew's calculations for determination of the molecular structure of myoglobin, for which he received a Nobel Prize in 1962, were largely done on the EDSAC.

EDSAC was soon loaded to capacity, and plans were laid for a successor, EDSAC 2. Wilkes came up with a new design principle—which he called microprogramming—that greatly simplified the logical design of the new computer. Microprogramming was Wilkes's most important scientific contribution to computing, and had he done nothing else he would be famous for that. In the early 1960s IBM based its world-beating System/360 computers around the idea, and it remains a cornerstone of computer architecture.

Wilkes played an influential role in promoting computing in Britain, being elected to the Royal Society in 1956, becoming inaugural president of the British Computer Society in 1957, and serving as the British representative for the International Federation of Information Processing Societies.

He was appointed professor of computer technology at Cambridge in 1965, a title deliberately chosen to distance himself from the theoretically minded professors of computing science who were by then being appointed in large numbers. At heart he was an engineer. He received the Association for Computing Machinery's (ACM) Turing Award in 1967 and the Harry Goode Memorial Award of the American Federation of Information Societies in 1968. Later honors included the Institute of Electrical and Electronics Engineers (IEEE)/ACM Eckert-Mauchly Award, the McDowell Award of the IEEE Computer Society, the Pender Award of the University of Pennsylvania, and the Faraday Medal of the Institution of Electrical Engineers.

Wilkes remained director of the Computer Laboratory (the name was changed from the Mathematical Laboratory in 1970) until he reached the statutory retirement age of 67 in 1980. His tenure had seen computers evolve from scientific instruments to information processing machines that were the basis of a worldwide industry.

Wilkes was deeply interested in the history of his subject. His early writings in the 1950s are almost unique for the historical context in which he placed contemporary developments. He became an authority on Charles Babbage, the Victorian computer pioneer, making a study of his manuscripts in the Science Museum Library, London—the first modern scholar to do so.

Wilkes loved America and Americans. Following his retirement from Cambridge University, he took up a position as a senior consulting engineer with the Digital Equipment Corporation in Maynard, Massachusetts. There he enjoyed the American way of life and hospitality and developed an abiding friendship with I. Bernard Cohen, professor of the history of science at Harvard University.

Quite incapable of retiring, in 1986 he returned to Cambridge, where he became a board member of Olivetti-AT&T Research Laboratories. He continued to make technical contributions and publish historical articles about Charles Babbage and his milieu. In 1992 he was the first recipient of the Kyoto Prize, the most prestigious and financially rewarding award that computer science can offer. He was elected a fellow of the ACM in 1994 and received the IEEE von Neumann Medal in 1997. He was knighted in 2000.

Sir Maurice is survived by his son, Anthony, and two daughters, Margaret and Helen; Lady Nina predeceased him in 2008.

APPENDIX

Members	Elected	Born	Deceased
William D. Alexander	1978	June 20, 1911	December 9, 2003
Lew Allen, Jr.	1978	September 30, 1925	January 4, 2010
Neal R. Amundson	1970	January 10, 1916	February 16, 2011
John H. Argyris	1986	August 19, 1913	April 2, 2004
Holt Ashley	1970	January 10, 1923	May 3, 2006
Kermit Earl Brown	1987	November 2, 1923	December 10, 2009
Praveen Chaudhari	1988	November 30, 1937	January 13, 2010
Aaron Cohen	1988	January 5, 1931	February 25, 2010
Charles Concordia	1978	June 20, 1908	December 25, 2003
Alfred John Eggers, Jr.	1972	June 24, 1922	September 22, 2006
Leopold B. Felsen	1977	May 7, 1924	September 24, 2005
Iain Finnie	1979	July 18, 1928	December 19, 2009
John A. Focht, Jr.	1986	August 31, 1923	October 22, 2010
George A. Fox	1988	April 19, 1920	May 17, 2001
Ferdinand Freudenstein	1979	May 12, 1926	March 30, 2006
Robert A. Fuhrman	1976	February 23, 1925	November 21, 2009
Haren S. Gandhi	1999	May 2, 1941	January 23, 2010
Joseph G. Gavin, Jr.	1974	September 18, 1920	October 30, 2010
Leslie A. Geddes	1985	May 24, 1921	October 25, 2009
Paul Germain	1979	August 28, 1920	February 26, 2009
Robert R. Gilruth	1968	October 18, 1913	August 17, 2000
Lawrence R. Glosten	1990	August 5, 1918	February 22, 2010
Wallace D. Hayes	1975	September 4, 1918	March 2, 2001
Ira Grant Hedrick	1974	February 10, 1913	January 14, 2008
David R. Heebner	1999	February 27, 1927	January 3, 2003
Allan F. Henry	1985	January 12, 1925	January 28, 2001
George Herrmann	1981	April 19, 1921	January 7, 2007
Walter Herrmann	1993	May 2, 1930	June 4, 2000
Walter R. Hibbard, Jr.	1966	January 20, 1918	February 24, 2010
John Hill	1976	February 21, 1921	January 14, 2008
David Clarence Hogg	1978	September 5, 1921	August 9, 2009
George W. Housner	1965	December 9, 1910	November 10, 2008
W. J. "Jack" Howard	1979	August 25, 1922	September 13, 2010
Frederick Jelinek	2006	November 18, 1932	September 14, 2010
Amos E. Joel, Jr.	1981	March 12, 1918	October 25, 2008
Roy G. Johnston	1981	January 7, 1914	March 13, 2008
James C. Keck	2002	June 11, 1924	August 9, 2010
Edwin E. Kintner	1990	May 1, 1920	May 7, 2010
Herbert J. C. Kouts	1978	December 18, 1919	January 7, 2008
Thomas R. Kuesel	1977	July 30, 1926	February 17, 2010
Joseph Talbot Kummer	1986	October 21, 1919	June 27, 1997

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Members	Elected	Born	Deceased
Michael James Lighthill	1977	January 23, 1924	July 17, 1998
Henry R. Linden	1974	February 21, 1922	September 13, 2009
A. L. London	1979	August 31, 1913	March 19, 2008
John (Jack) P. Longwell	1976	April 27, 1918	October 6, 2004
Fred E. Luborsky	1985	May 14, 1923	February 3, 2010
Alan G. MacDiarmid	2002	April 14, 1927	February 7, 2007
John H. McElroy	1998	June 27, 1936	September 14, 2007
Henry L. Michel	1995	June 18, 1924	May 23, 2001
Walter Shepard Owen	1977	March 13, 1920	October 13, 2007
William H. Phillips	1991	May 31, 1918	June 27, 2009
Thomas H. Pigford	1976	April 21, 1922	February 28, 2010
Brian H. Rowe	1983	May 6, 1931	February 22, 2007
Rustum Roy	1973	July 3, 1924	August 26, 2010
George S. Schairer	1967	May 19, 1913	October 28, 2004
Manfred Robert Schroeder	1979	July 12, 1926	December 28, 2009
Glenn A. Schurman	1980	September 6, 1922	December 30, 2010
L. E. (Skip) Scriven	1978	November 4, 1931	August 3, 2007
Joanne Simpson	1988	March 23, 1923	March 4, 2010
Robert J. Spinrad	1993	March 20, 1932	September 2, 2009
H. Guyford Stever	1965	October 24, 1916	April 9, 2010
Martin Summerfield	1979	October 20, 1916	July 18, 1996
Milton D. Van Dyke	1976	August, 1, 1922	May 10, 2010
William L. Wearly	1990	December 5, 1915	April 30, 2010
John V. Wehausen	1980	September 23, 1913	October 6, 2005
Max T. Weiss	1986	December 29, 1922	June 10, 2006
Richard T. Whitcomb	1976	February 21, 1921	October 13, 2009
Maurice V. Wilkes	1977	June 26, 1913	November 29, 2010