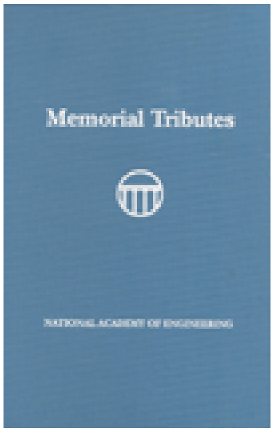

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Memorial Tributes

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FOREWORD

THIS IS THE TWELFTH VOLUME in the series of *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 bring 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

WILLIS ALFRED ADCOCK

1922–2003

Elected in 1974

"For contributions to the advancement of silicon material and device technology."

BY SANJAY BANERJEE,
EARL SWARTZLANDER, AND DAVID BEER
SUBMITTED BY THE NAE HOME SECRETARY

WILLIS ALFRED ADCOCK was born in St. John's, Quebec, Canada, on November 25, 1922, and died in Austin, Texas, on December 16, 2003. He immigrated to the United States in 1936 and became an American citizen in 1944. Dr. Adcock was an inventor, physicist, electrical engineer, and educator. After a distinguished career with Texas Instruments (TI), he became a professor of electrical and computer engineering (ECE) at the University of Texas (UT) in 1986. In the same year, he was appointed to the Cockrell Family Regents Chair, a position he held until becoming chair professor emeritus in 1993.

After graduating high school in upstate New York, Dr. Adcock attended Hobart College, where he earned a B.S. cum laude in 1943. In 1944, he joined the U.S. Army and became a member of the technical staff of the Clinton Laboratories at Oak Ridge, Tennessee, where he was a very junior member of the team that worked on the development of the atomic bomb. He loved to tell the story of when an army officer took him into Knoxville, found a federal judge, and ordered that G.I. Adcock be naturalized so he could be given security clearance. The judge could only ask for his name, rank, and serial number.

After the war, Dr. Adcock pursued graduate studies at Brown University, where he received his Ph.D. in physical chemistry in 1948. Once he graduated, he was a technical staff member for Stanolind Oil and Gas Company in Tulsa, Oklahoma, until

1953, when he joined TI, where, as manager of the Development Department and Integrated Circuits Department, he made significant contributions to his field. He recruited Jack Kilby and then supported the research that led to the invention of the integrated circuit in 1958.

Dr. Adcock's work at TI included growing the first silicon boule, which enabled the construction of the silicon transistor, thereby making the company a world leader in semiconductors. This achievement, by Dr. Adcock and his colleague Gordon Teal, was a technological tour de force, because silicon was much more difficult to purify and crystallize than germanium, which was the element then used for transistors. The technological impact of silicon transistors on microelectronics cannot be overemphasized.

In May 1954 at the National Conference on Airborne Electronics, Drs. Adcock and Teal presented a seminal paper entitled "Some Recent Developments in Silicon and Germanium Materials and Devices" describing the first working silicon transistors. In *Crystal Fire*, a book by Michael Riordan and Lillian Hoddeson (W.W. Norton and Co., 1997), the authors describe how they demonstrated the superior electronic properties of silicon and the reduction of electrical leakage at high operating temperatures. They first dunked an amplifier made of germanium transistors into hot oil, causing a record player to stop working instantly. When an amplifier made of brand new silicon transistors was dunked into the same oil, the record player continued emitting the dulcet tones of Artie Shaw's "Summit Ridge Drive." Silicon transistors rapidly supplanted prevailing germanium devices. To take just one example, silicon devices were a godsend for the development of military electronic hardware that had to function in environmentally extreme conditions.

Dr. Adcock left TI briefly in 1964 to work as technical director for Sperry Semiconductor in Norwalk, Connecticut, but he returned to TI in 1965 as manager of advanced planning and technical development. He was later made assistant vice president and finally vice president of corporate staff from 1982 to 1986. He retired from the company in 1986 as vice president and principal fellow.

Dr. Adcock then moved to Austin, Texas, where he held the Cockrell Family Regents Chair in ECE at UT. Dr. Adcock established a vigorous research program on semiconductor manufacturing and developed a graduate course on statistical process control and design of experiments. When SEMATECH, the research consortium, was created to reestablish U.S. leadership in semiconductor manufacturing in the face of Japanese competition, Drs. Adcock and Al Tasch were instrumental in establishing the SEMATECH Research Center of Excellence at UT. Dr. Adcock was the founding director of the center, which led to fruitful interactions between the university and SEMATECH. In 1993, Dr. Adcock became chair professor emeritus of the ECE department.

Dr. Adcock was a fellow of the Institute of Electrical and Electronics Engineers and American Association for the Advancement of Science and a member of the National Academy of Engineering and American Chemical Society. He was also a member of Sigma Xi and Phi Beta Kappa and a principal fellow of Texas Instruments. In 1989, he was awarded an honorary degree from his alma mater, Hobart College. Among his many other accomplishments, Dr. Adcock held a number of basic patents for digital photography and, at the time of his death, was working on a unique torque converter. His first patent in this area was issued on June 3, 2003, just seven months before he died.

Thus, even in retirement, he was as active as ever. He served for a time as president of both the TI Austin Retirees Club and the Austin English Speaking Union. He was a member of the McDonald's Observatory Visitors Council, and he and his wife, Sara, often attended performances by the Austin Symphony and Austin Lyric Opera. The couple also loved to travel and made numerous trips, including tours of the British Isles and Ireland, with groups from their church, the Episcopal Church of the Good Shepherd.

Dr. Adcock married Eleanor Goller in 1943, and the couple had four children before Eleanor passed away. In December 1970, he married Sara McCoy. Everyone who knew Willis would happily concur with the description of him by T.R. Reid in his classic book, *The Chip: How Two Americans Invented the Microchip and Launched a Revolution* (Simon and Schuster, 1984). Willis Adcock was "a zesty sprite who talks a mile a minute and still can't keep up with his racing train of thought." Those who knew him best would agree that these were the marks of the brilliant mind of a warm and lovable human being.

ROBERT ADLER

1913–2007

Elected in 1967

"For development of microwave tubes."

BY JOHN J. PEDERSON AND JOHN I. TAYLOR
SUBMITTED BY THE NAE HOME SECRETARY

DR. ROBERT ADLER, a prolific inventor and renowned physicist, perhaps best known as creator of the ultrasonic wireless remote control for television, died February 15, 2007, at the age of 93. Elected to the National Academy of Engineering in 1967, Dr. Adler made many scientific contributions to the electronics industry, including landmark inventions in consumer products and sophisticated, specialized communications equipment. His technical achievements and contributions are documented in his nearly 200 U.S. patents, his numerous honors, and his voluminous technical publications.

Leader, Mentor, and Communicator

Although he will be remembered for his technical achievements, Bob Adler's simple humanity, strength of character, and outstanding leadership skills were his most memorable traits. A gentle, modest, patient, selfless, and soft-spoken man of unimposing appearance and demeanor, he had a comprehensive knowledge of the laws of physics. His avid appetite for reading, coupled with the extraordinary scope of his scientific curiosity, enabled him to assimilate new discoveries and advances almost instantly. He also had outstanding mentoring and teaching skills and a natural talent for finding a middle ground between conflicting hypotheses and points of view.

Bob had a better command of English than most native speakers. In presentations, he had an uncanny intuition about the level of understanding of his audience and an ability to adjust to that level. Even when discussing sophisticated scientific subjects, he never "talked down" to his listeners. In fact, he conversed equally well with colleagues, secretaries, janitors, and chairmen of the board.

Bob was not an ivory-tower scientist. It was important to him that his innovations be manufactured cost-effectively and sold profitably to consumers. Practical to the core, he had a unique ability to see his inventions, and those of his colleagues, through the whole process, from concept to commercial application.

Bob had little patience for administrative tasks and paperwork, which he assigned to an associate research director. Thus he was free to provide full-time oversight and to participate actively in ongoing scientific projects. He was an expert in multitasking long before the computer era. Bob was appreciated as a respected colleague and teacher, not just a department head or boss, by everyone who knew and worked with him.

Engineering Career

Born in Vienna, Austria, on December 4, 1913, to Jenny Herzmark Adler, a physician, and Max Adler, Ph.D, a sociologist, Bob received his doctorate in physics at the University of Vienna in 1937, a year before the *Anschluss* (Hitler's bloodless coup deposing Chancellor Kurt Schuschnigg and annexing Austria). At the time, the property of Austrian Jewish citizens was summarily expropriated, and Jews were stripped of their civil rights. To avoid persecution, Bob fled to Belgium in 1939. From there he went to England and, in 1941, to the United States, where he was discovered by top engineering executives of Zenith Radio Corporation. He began a six-decade-long career with Zenith when he joined the research division in Chicago in 1941.

When the United States entered World War II, Zenith focused all of its production on supporting the war effort. However, Bob had not yet become a U.S. citizen and was technically considered a German national, so he did not qualify for security clearance for classified materials. Zenith management set him up in an isolated lab facility and gave him carte blanche to work on unclassified projects of his own design for the duration of the war.

Bob's pioneering developments spanned the decades from the Golden Age of television to the era of high-definition TV. Bob was named associate director of Zenith in 1952, vice president in 1959, and vice president and director of research in 1963. He retired as research vice president in 1979 and served as a technical consultant to the company until 1999, when Zenith merged with LG Electronics. Bob's inventions found their way into Zenith products, as well as the products of his post-Zenith clients and, from time to time, the products of competitors. Bob Adler was a vital part of Zenith's lifeblood during the company's glory years.

Scientific Achievements

Bob's early work included the development of the gated-beam tube, which, at the time, represented an entirely new concept in vacuum tubes. This invention greatly simplified the sound system and improved reception in television receivers by screening out certain types of interference. At the same time, it lowered the cost of the sound channel. Bob was also instrumental in originating and developing Zenith's "fringe lock" synchronizing circuit, which improved stability in fringe areas of television reception. This invention was widely used for many years, and its principles are still used in many fields, from home entertainment to space exploration.

The electron-beam parametric amplifier, developed in 1958 by Zenith's Bob Adler and Glen Wade, then of Stanford University, was the most sensitive practical amplifier for ultra-high-frequency (UHF) signals at that time. The device was used by radio astronomers in the United States and abroad and by the U.S. Air Force for long-range missile detection.

Bob's original work in the field of acousto-optical interaction was instrumental in the 1966 public demonstration, by a team of Zenith engineers, of an experimental television display using ultrasonic deflection and modulation of a laser beam to produce a giant TV picture on a wall without a cathode ray tube. In addition, his early work on electromechanical filters paved the way for the development of the highly compact filters widely used in aircraft receivers after World War II. In the mid-1960s, he pioneered the use of surface acoustic waves (SAWs) in intermediate-frequency filters for color television sets, a technology that has since become universal, not only in televisions, but also in cellular telephone handsets.

In the early 1970s, when Zenith's research operations were reorganized, Bob led the company's technical team in solid-state plasma-display panels, visible light-emitting diodes, acousto-optic devices, laser-measuring and display systems, thermoelectric semiconductor devices, SAW filters, and touch-screen displays.

By 1978, the U.S. home electronics industry had to be restructured to meet competition from foreign imports. Rather than preside over the downsizing of Zenith's research operations, Bob resigned, at the age of 65, but he continued to be a technical consultant for Zenith, EloTouch Systems (now Tyco Electronics), and others for the next quarter century. Bob pioneered the use of SAW technology for touch screens, which are now widely used in airport kiosks and museums.

Accolades, Honors, Emmys, and the Hall of Fame

Bob Adler is widely recognized in the consumer electronics field as the inventor of Zenith's wireless "Space Command" ultrasonic remote control for TV sets, which was introduced in 1956 and revolutionized TV viewing worldwide. He received the 1958 Outstanding Technical Achievement Award of the Institute of Radio Engineers (now the Institute of Electrical and Electronics Engineers [IEEE]) for his "original work on ultrasonic remote controls" for television. He had been a fellow of IEEE since 1951, a professional honor conferred by the IEEE board of directors for "eminence and distinguished service." Bob was cited for "developments of transmission and detection devices for frequency-modulated signals and of electromechanical filter systems."

In 1967, Bob was the recipient of the first Inventor-of-the-Year Award from George Washington University's Patent, Trademark, and Copyright Research Institute for his inventions of electronic products, devices, and systems used in aircraft communications, radar, TV receivers, and FM broadcasting. In 1970, IEEE honored him with the Consumer Electronics Outstanding Achievement Award, which is given annually to an engineer who has contributed significantly to the advancement of consumer electronics through engineering.

In 1974, Bob received the IEEE Outstanding Technical Paper Award for "An Optical Video Disc Player," a report on his early work on what became the digital video disc, or DVD. IEEE also awarded him the Edison Medal, its principal annual award presented for a career of meritorious achievement in electrical science, electrical engineering, or electrical arts. In 1981, he received the IEEE Sonics and Ultrasonics Achievement Award.

With Zenith colleague Eugene Polley, Bob Adler was honored in 1997 by the National Academy of Television Arts and Sciences with an Emmy Award for his pioneering work on wireless TV remote control. He was a charter inductee in the Consumer Electronics Hall of Fame in 2000, the same year he was inducted into the Television Academy's Emmy Silver Circle.

A Renaissance Man

Bob had a pervasive love and appreciation for the natural wonders of the world and the universe. He was a devotee of the fine arts, a cat lover, and a private pilot. For decades he was active in the Chicago cultural community, including the Art Institute of Chicago, the Chicago Symphony Orchestra, Music of Baroque, and community theater. He was as passionate about hiking and skiing as he was about science and the arts. At the age of 89, he was still an avid downhill skier and enjoyed hiking with his wife. A world traveler for both pleasure and business, Bob was fluent in German, English, and French (he was an active participant in a Chicago-area French club for 35 years).

In preparation for technical conferences abroad, he studied other languages, specifically Russian and Japanese, so he could communicate with featured speakers in their native tongues and react to comments and questions from the floor. In 1969, for example, when he arrived in Moscow as a member of the IEEE delegation to the Popov Society meeting, he had taught himself Russian so that, as a goodwill gesture, he could present his paper in that language.

Technology, of course, was his passion, and he was still inventing in his 90s. Thirty-nine of his 200 U.S. patents were granted during the twilight phase of his career. The U.S. Patent and Trademark Office published his latest patent application, for advances in touch-screen technology, in early February 2007, just days before he died.

Dr. Robert Adler will long be remembered for the scope of his scientific vision, his modest and gentle manner, his extraordinary patience and communication skills, and his contributions to the advancement of technology.

He is survived by his wife, Ingrid Adler (nee Koch).

John J. Pederson worked with Bob Adler beginning in 1947 when Mr. Pederson joined Zenith as patent solicitor. He was manager of Zenith's Patent Department in 1952, was named general patent counsel and director of patents in 1972, and was elected vice president, patents and consumer affairs, in 1981. He has been active in volunteer executive counseling for 10 years following his 1991 retirement from Zenith.

John I. Taylor is the third head of public relations for Zenith in the company's 90-year history. Now also a vice president of Zenith's parent company LG Electronics USA, Taylor joined Zenith in 1981. He was named head of public relations in 1987 and vice president in 1993. Mr. Taylor worked with Bob Adler for a quarter century.

RUTHERFORD ARIS

1929–2005

Elected in 1975

"For contributions to the literature of chemical engineering on control theory and optimization and on the theory of reaction and diffusion."

BY NEAL R. AMUNDSON AND W. HARMON RAY

RUTHERFORD ARIS, regents professor emeritus of chemical engineering and classics at the University of Minnesota, died on November 2, 2005, after a long and distinguished career. Aris was born in Bournemouth, England, on September 15, 1929 to parents Algernon and Janet Aris. He had all his formal education in Great Britain. Aris completed a first-class honors B.Sc. degree in mathematics, with a minor in physics, at the University of London at the age of 16. However, the university did not think it proper to award a degree to someone so young, requiring him to wait until 1948, when he was 19, to receive the degree. Meanwhile, he worked in industry at Imperial Chemical Industries (ICI) Ltd. as a laboratory assistant from 1946 to 1948. From 1948 to 1950 he pursued postgraduate studies at the University of Edinburgh, supported by ICI, and rejoined ICI as a technical officer during 1950–1955. At the invitation of Neal Amundson, Aris spent the year 1955–1956 at the University of Minnesota as a research fellow. He returned to England and was a lecturer in technical mathematics at Edinburgh University in the period 1956–1958. In 1958 he was invited to join the Chemical Engineering Department at Minnesota as an assistant professor even though he had no Ph.D. degree. At the same time he became an external Ph.D. student at the University of London and completed his Ph.D. in mathematics and chemical engineering in 1960. In 1961, Aris' Ph.D. thesis, "The Optimal Design of Chemical Reactors," was published as a monograph by Academic Press and was so popular that it appeared also in Japanese, Russian, and Czech. In 1964, the University of London also awarded him the D.Sc. degree. Aris had a long and distinguished career at Minnesota, becoming a full professor in 1963 and receiving a regents professorship in 1978. He served as chairman of the Chemical Engineering Department from 1974 to 1978. Aris retired in 1996 and remained active as a regents professor emeritus until 2005.

Over his career, Aris held many distinguished visiting professorships in the U.S. and in England; these include National Science Foundation and Guggenheim fellowships at Cambridge University (1964-1965 and 1971-1972), Fairchild Distinguished Scholar at Caltech (1976, 1980-1981), Olaf Hougen Professor at the University of Wisconsin (1979), Brotherton Professor at the University of Leeds (1985), and visiting professor at the School of Historical Studies, Institute for Advanced Studies, Princeton University (1994). Also, Aris has been further recognized by honorary degrees from universities in the U.S. and abroad: University of Exeter (D.Sc. 1984), Clarkson University (D.Sc. 1985), University of Notre Dame (D. Eng. 1990), and National Technical University, Athens (D. Eng. 1999).

Aris had an enormous impact on the field of chemical engineering through his publications (13 books and more than 300 research articles), teaching and advising (he received prestigious teaching awards and mentored more than 65 master's and Ph.D. students), and his influence on the directions of the profession. Among Rutherford Aris's most important technical contributions are his detailed explanations for sudden temperature runaways and oscillating behavior of processes involving chemical reactions. His work in this area led to better design and control of potentially explosive chemical processes and safer industrial operations. From the beginning of his career, he led the way in developing new mathematical techniques for optimizing and controlling chemical manufacturing processes and teaching these new methods to engineering students and industrial practitioners. His work on chemical kinetics and chemical reactor design provided a deeper understanding of observed phenomena and allowed much improved design of chemical processes. Today we have safer, more cost-effective, and more energy-efficient industrial manufacturing because of Aris's discoveries, teaching, and influence on his field.

In the latter part of his career, Aris also pursued his deep interest in paleography (ancient manuscripts) by taking a part-time appointment in the Classics Department where he taught students and published research articles. In this field he also published two monographs: "Index of Scripts in E. A. Lowe's 'Codices Latini Antiquores' Pts. I-XI & Supp." in 1982 and "Explicatio Formarum Litterarum. The Unfolding of Letterforms" in 1990.

Aris's professional contributions have been recognized by numerous honors and awards. Among these are more than 20 distinguished lectureships from universities in the U.S. and Europe and a large number of prestigious awards from engineering and scientific societies here and abroad. These include awards from the British Institution of Chemical Engineers, the German DECHEMA, the American Automatic Control Council, the International Symposium on Chemical Reaction Engineering, and the American Institute of Chemical Engineers (Alpha Chi Sigma, Wilhelm, W. K. Lewis, and Founders' awards). Aris was elected to the National Academy of Engineering in 1975 and to the American Academy of Arts and Sciences in 1988.

Rutherford Aris had a wonderful sense of humor and enjoyed pranks. Some time after he was listed in "Who's Who," the publisher began sending him a second questionnaire to complete under the name Aris Rutherford. Even after repeated letters to the publisher stating that there was no such person, the questionnaires kept coming. So Aris completed the questionnaire for this fictitious person in his wonderful style. Aris Macpherson Rutherford was listed as a colorful professor of distillation who had trained at the Strath Spey and Glenlivit Institute of Distillation. Among his publications were books entitled "Sampling Techniques" and "American Football–A Guide for Interested Scots." After the newspapers were alerted to this entry in "Who's Who," the prank was uncovered.

Having a remarkable facility with language, Rutherford Aris once published a technical paper written entirely in Latin, and throughout his life he wrote delightful poetry providing enjoyment for friends and colleagues. For more than 25 years Aris composed clever and hilarious poems to "roast" each year's Lacey Lecturer at Caltech. As a result of his intense interest in medieval manuscripts, he became a superb calligrapher who encouraged this art in others. In 1964, Aris founded a series of departmental seminars having eclectic themes from all fields in order to further an appreciation of the arts in his engineering students and colleagues. This popular seminar series continues today with financial support from alumni.

A devout Christian, Rutherford Aris was an exemplary gentleman and scholar who stimulated the best professional and personal qualities in his students and colleagues. His former students have attained high positions in industry and distinguished professorships at leading universities in this country and abroad, but Aris's values of high moral and ethical standards and his practice of helping others are the most important lessons he taught.

Aris is survived by his wife of 47 years, Claire Holman Aris; brother, John (Ursula); sisters, Margaret Boyt (Dennis) and Dorothy Slater (Thomas); brother-in-law, Charles Holman (Gloria); special niece, Trea Cannoy, and grand nephews, Jacob and Brendon; as well as several other nieces and nephews.


Stanley Backer

STANLEY BACKER

1920–2003

Elected in 1992

"For enhancing the understanding and engineering of fibrous materials to improve their performance in ocean and other engineering applications."

BY SUBHASH K. BATRA
SUBMITTED BY THE NAE HOME SECRETARY

STANLEY BACKER, professor emeritus, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, succumbed after a prolonged illness on January 18, 2003, at the age of 82. Born on February 9, 1920, he was the second of three sons of Harry Backer, an immigrant from Lithuania, who owned the Central Clothing Company of Boston, MA. Stan, to his friends and to his students in their later life, attended Boston Latin High School and then entered MIT in 1937. He received his B.S. in engineering and management in 1941.

Upon graduation, Stan joined the military, where his supervisors soon recognized his talents and appointed him technical officer in the Materials Section of the U.S. Quartermaster Corps (QMC). In addition to his duties as a soldier, Stan engaged in research on problems related to textiles used by QMC and was soon promoted to the rank of major.

In 1944, when he completed his military service, he decided to stay on with QMC as a civilian, helping to organize and then direct the Laboratory for Fibrous Materials—a position he held until 1949. During that time he also completed the requirements for an M.S. in textile technology and received his degree from MIT in 1948.

In 1949, Stanley Backer married Esther Ross, a graduate of Radcliffe College with degrees in economics and social work. Esther Backer played a pivotal role in Stan's career. She was not only mother to his children but also a friend and a very gracious host to his visitors and associates; in some ways, she helped raise/mentor some of his students and/or their spouses.

Stan and Esther had two sons, Richard, now an attorney in the San Francisco area, and John, now professor of molecular pharmacology at Albert Einstein Medical School, in New York. John married Amy Ehrlich, an assistant professor of gerontology and director of the Outpatient Clinic at Montefiore Hospital. The couple's three sons, Samuel, Jacob, and Saul, were a source of much joy and pride to Stan in his later years.

When Stan left QMC, he spent a sabbatical year in the United Kingdom, after which he joined MIT as an assistant professor. In addition to teaching, he pursued research under Edward R. Schwarz to complete the requirements for an Sc.D. in mechanical engineering in 1953. He was one of a select group of individuals from around the world dedicated to raising the *craft* of textiles to the *science* of textiles and fibrous materials. The members of this group considered fibers engineering materials and textiles engineered structures.

Some among them, including Stan, approached problems in textile processing as machine-material interactions to be analyzed as engineering problems. These themes became Stan's passion in teaching and research for the rest of his life. Thus, although Stan never joined the family business, his curiosity about fibers and textiles remained the driving force in his teaching, research, and work as a consultant to the government and industry.

Stan's contributions to the understanding of the mechanics of yarns and fabrics, as well as the engineering fundamentals of fiber processing, were acknowledged on both sides of the Atlantic. John Hearle (UMIST), Percy Grosberg (Leeds), Joel Lindberg (Sweden), Joachim Lunenschloss (Aachen), Gerhard Egbers (Denkendorf), and many other contemporaries in Europe became his collaborators in research and related professional activities. Others came to MIT from Australia, Japan, and Ireland to work with him as research associates. In 1962, his achievements earned him the rank of professor of mechanical engineering, as well as head of the Fibers and Polymers Laboratories at MIT.

Peter Popper, a former student, described Stan as a teacher: "His love of fibers, his technical knowledge, and his ability to make complex problems understandable made him a truly great teacher. Over the years he taught *fiber technology* to several hundred students. Of these, many joined academia, and each of them probably taught well over 100 more. So, Stan's methods have been taught to thousands of 'grand-students' [Stan's invented term]."

Ron Postle, who was visually impaired and who spent a semester at MIT as a visiting professor during the early 1970s, commented: "My strongest impression is the way Stan formulated and articulated basic concepts of textile engineering problems. These strengths are well documented in his publications, such as *Structural Mechanics* (coauthored with Hearle and Grosberg). Stan presented his work in such a clear and lucid manner that I could fully appreciate his presentations and ideas without the benefit of being able to see his visual aids."

Victor Li, a colleague, expressed similar sentiments: "Although not widely known, Stan has had a significant impact on the safety and durability of civil infrastructure systems through his involvement in synthetic fiber reinforced concrete material. This has led to a metal-like ductile ECC material recently recognized in *Popular Mechanics* and *Architectural Records*. ECC is now in earthquake resistant buildings and durable bridge decks."

Stan was one of the first to recognize the interdisciplinary nature of the problems in textiles.

In the mid-1960s, under the sponsorship of the U.S. Department of Commerce, he undertook the Textile Information Retrieval Project, a massive project to develop a comprehensive thesaurus of textile terms and phrases (8,000 keywords and 72,000 related terms). The thesaurus was translated into seven languages and became the foundation for the first online information retrieval system, allowing simultaneous access to a database of textile information by 25 separate users on two continents. The project involved numerous students, research associates, and corporate and university librarians over many years in seven nations. Throughout this project, the third floor of his house was a repository for files and papers arranged in systematic stacks.

In the early 1970s, Stan worked with MIT colleagues, T. Y. Toong, who was knowledgeable in combustion; G. C. Tesoro, who was knowledgeable in the chemistry of flammability of textile materials; and N. A. Mousa, a graduate student, interested in the problem. Menachem Lewin of the Israel Fiber Institute, Hebrew University of Jerusalem, and Polytechnic University of New York, described the collaboration "Backer's famous paper published in the form of a small book, *Textile Fabric Flammability*, co-authored with Tesoro, Toong and Mousa (MIT Press, 1976), is an ingenious paper. A unique contribution of this paper was the effect of fabric structural parameters, such as density of weave, fabric weight, distance from the skin (in apparel), on the temperature of the flame, on the rate of propagation of the flame and on the burn injury suffered."

Stan was always quick on his feet, as was evident to technologists and engineers in DuPont, Burlington Industries, and other companies for which he was a consultant. Paraphrasing Sam Winchester of DuPont, when Stan was "given a description of product-performance or a processing problem, he immediately began defining a plausible model. If given additional facts that called into question the assumption of the model, he easily formulated a revised model to achieve the same goal." As Peter Popper described him, "Stan helped formulate and execute literally hundreds of research programs related to new fibers, spunbond fabrics, composites, specialty materials, and innovative processes. His consulting style always stimulated new ideas and energized all who came in contact with him."

Similarly, for Salim Ibrahim of DuPont: "Stan's creativity and knowledge of engineering materials, processes and mechanics fitted perfectly with the developments of new generics (polyesters, nylons, acrylics, aramids, spandex, spunbond and spunlaced materials) as well as new yarn and fabric structures (texturing, open-end spinning, bulk-continuous yarns) that required entirely new knowledge to optimize their properties for applications in apparel, homes, industry, and the military. He was able to distill complicated problems into basic elements in a way that enabled even less knowledgeable participants to understand them and therefore contribute to their solutions. One rarely left a meeting with Prof. Backer without getting an insight and a direction of where to go next. His gift for enabling his audience to understand complex concepts made him a very popular lecturer and his lecture rooms were always full."

Stan was extensively involved in professional societies, journals, and governmental committees. He was member of the Society of Rheology (1957-1995), American Academy of Mechanics (1978-1995), TAPPI (1984-1990), ASME (1957-), and the Textile Institute (1954-). He joined the Fiber Society in 1950, later served as a member of the Governing Council and as president; he remained a mentor throughout his life to those who followed. He inspired the formation of the Textile Information Users Council (TIUC). He was named an honorary member of ASTM in 1972 and served as member and chair of the Committee D-13 (1975-1979); in addition he was a member of the ASTM Howard DeWitt Smith Award Committee for many years. He served on the editorial boards of the *Journal of Composite Materials* (1966-1971), *Textile Research Journal* (1972-1999), and Marcel Dekker, Fiber Series (1978-1997) and was a consulting editor for *Fiber Science and Technology Journal* (1968-1985) and the *International Journal of Mechanical Engineering Education* (1981-1988).

His public service included several years as chair of the National Research Council (NRC) Quartermaster Advisory Board, Committee on Textile Fabrics (1957-1966), chair of the NRC ad hoc Textile Research Committee (1961-1962), public member for Massachusetts on the New England Governors Textile Committee (1958-1961), member of the NRC ad hoc Committee on Personnel Selection for Army Laboratories at Natick (1972-1973), member of the NRC Advisory Board on Military Personnel Supplies, Commission on Socio-Technical

Systems (1974-1977), and member of the NRC Committee on Renewable Resources for Industrial Materials, Fiber Panel (1975-1976).

His achievements are reflected in his more than 90 papers, contributions to three books, and seven patents. For his scholarly publications and lectures and his public service he received numerous honors and awards: Harold DeWitt Smith Medal; ASTM D-13 (1962); first Academic Fiber Society Lecturer (1964-1965); Honorary Member, ASTM (1972); Honorary Life Member, European Council of Textile Research Directors (1972); TIUC "Backer" Award (1972); Honorary Fellow, Textile Institute (1973); the first Kenneth L. Hertel Lecturer (1976); Edward E. Schwarz Memorial Lecturer, ASME (1979); Gossett Lecturer, North Carolina State University (1981); Honorary Member, The Fiber Society (1986); Member, National Academy of Engineering (1992); the first Carothers Medal, Textile Institute, UK (1992).

After a long and distinguished career in teaching and research, at the age of 69, Stan retired to become an emeritus professor and senior lecturer in the Department of Mechanical Engineering. This remarkable, brilliant, unforgettable person and man of honor respected all others and helped many to pursue their education, careers, and even personal lives. His love for his colleagues and students is apparent in his last publication, *100 Years of Textiles at MIT,* a volume that contains brief biographies of most of those who were touched by him.

He is survived by his wife, Esther Backer; his sons, Richard and Jonathan Backer; his grandsons, Samuel, Jacob, and Saul Backer; and his brother, Morton Backer.

W. O. Baker

WILLIAM OLIVER BAKER

1915–2005

Elected in 1975

"For contributions leading to the exploitation of synthetic polymers in communications equipment, synthetic rubber, ablation heat shields, and rocket propellants."

BY A. MICHAEL NOLL
SUBMITTED BY THE NAE HOME SECRETARY

WILLIAM OLIVER BAKER, former president and chairman of Bell Telephone Laboratories, died on October 31, 2005, at the age of 90, after a slow decline in his health. During his last years, many friends and colleagues were able to visit with him at the nursing home where he stayed and where his son Joseph tended daily to his needs. Bill might be characterized as a "diplomat of science" or a "science patriot" for his significant contributions to the nation. He might also be called a "science humanist" for his advocacy of using science for the benefit of humanity.

Bill was an advisor to nearly every president since Truman, including Eisenhower, Kennedy, Johnson, Nixon, and Ford. He had a close relationship with President Eisenhower, who asked him to create the first White House science advisory body and to help create the Defense Communications Agency to facilitate the use of communications technology by the intelligence community. As a tribute to Bill's contributions to national defense, particularly to intelligence activities during the Cold War, the Security Affairs Support Association established a prestigious yearly award in his name. Bill was the longest serving member of the President's Foreign Intelligence Advisory Board; he resigned in 1990.

Bill was a board member of many philanthropic organizations, universities, companies, and government agencies, including the Aerospace Corporation, Johnson & Johnson, and Princeton

University. He also had a close relationship with Paul Mellon and was the founding chairman of the Andrew W. Mellon Foundation, which was created from the trusts of Paul and his sister. Bill's wise, humane counsel was respected and valued by all of the organizations and individuals he advised, and he received many honors, including the National Security Award (1982), National Medal of Science (1988), and Benjamin Franklin Medal of the American Philosophical Society (2000).

William Baker was born on July 15, 1915, in an old farmhouse in Quaker Neck, Maryland. He attended a one-room public school in Quaker Neck and graduated from Chestertown High School in 1931. He then entered Washington College and graduated, maxima cum laude, in 1935 at the age of 19. Immediately after earning his doctorate from Princeton University in 1939, he began working as a researcher in polymer chemistry at Bell Telephone Laboratories, where his unique abilities were soon recognized. He was very quickly promoted to department head, research director, and vice president for research in 1955.

He became president of Bell Labs in 1973 and was elected the first chairman of the company in 1979. He retired as chairman of the board in 1980 but continued to come to his office and offer his counsel to those wise enough to appreciate it. Bill was devoted to Bell Labs and the Bell system—both the organization and the people. Although he was offered positions at many other research and academic institutions over the years, he could not be enticed away.

He frequently said that very few people at Bell Labs knew what he *really* did, and his substantial work outside the company was indeed invisible to most of his colleagues. But our nation today enjoys the results of his influence on many, many aspects of our lives, including education, libraries and information science, chemistry and materials, communications, and national security.

Bill also kept his personal life private, although it is known that he had a strong affection for his beloved wife Frances, who passed away a few years ago, and for his devoted son Joseph, who was his constant companion in the last years of his life.

Bill's mother, Helen M. Baker, had a considerable influence on him. She married Harold Baker in 1912, and in 1913, the couple purchased a 235-acre farm in Maryland, where they lived from then on. After a few difficult years as general farmers, Helen decided to try raising breeder turkeys. She ultimately became the premier turkey breeder in the United States. When Bill was growing up, he watched as she used various chemicals to treat diseases in her turkeys, which undoubtedly stimulated his interest in chemistry. Helen later wrote a very popular book on turkey breeding, which she dedicated to William.

A simple man who wanted no fancy clothes, cars, or other trappings of wealth and power, Bill was extremely attentive to the people with whom he worked, regardless of their organizational titles. He was always open to new ideas, new ways of doing things, and new people. He was a true innovator and "catalyst," who motivated and changed everyone with whom he came in contact. Indeed, self-effacing people like Bill who devote themselves to higher pursuits seem to be an endangered species these days. He guided research at Bell Labs through some extremely productive years, championing digital switching and optical communication and steering the Bell system through the razzle-dazzle of digital and electronic technology.

As a young man, Bill enjoyed sailing. He also loved poetry and would frequently quote it in his presentations. Thus, the words of Walt Whitman seem appropriate to memorialize the accomplishments of this extraordinary man:

> Sail forth, steer for the deep waters only,
> For we are bound where mariner has not yet dared to go,
> And we will risk the ship, ourselves, and all.
>
> From Whitman's poem *Passage to India*

Note: This memorial tribute is based on materials on the William O. Baker website *(williamobaker.org)*, which was created with the support of the Andrew W. Mellon Foundation. The site includes a biography, list of publications, extracts from selected manuscripts, list of awards, photographs, interviews, and other materials documenting and celebrating Baker's life and accomplishments.

Howard C Barnes

HOWARD C. BARNES

1912–2003

Elected in 1974

"For leadership in projecting electric power transmission to 765 kV and researching the 1000-1500 kV range."

BY STAN HOROWITZ

HOWARD BARNES, one of the world's leading power engineers, was recognized internationally for his role in the development of state-of-the-art power-system protection concepts and the promotion of extra-high-voltage (EHV) transmission systems for medicine and other applications. It was his work on the 765kV lines (with Philip Sporn & AEP's backing) which led to the creation of the Johns Hopkins University research project that resulted in the development of the "defibrillator." Born in Terre Haute, Indiana, in 1912, Howard died on May 16, 2003, at the age of 91.

His career in electrical-power engineering and management spanned more than 40 years. He was a senior vice president and manager of the Power Systems Division and a member of the Board of Directors at Charles T. Main Inc., an electrical engineering consulting firm. Before assuming this position, he was assistant vice president of engineering at American Electric Power (AEP), one of the country's leading electric utilities.

Howard received his B.S.E.E., with honors, from the Rose Polytechnic Institute (now Rose-Hulman Institute of Technology) and was awarded an honorary doctor of engineering degree. He continued postgraduate studies at the University of Michigan, Adelphi College, and Massachusetts Institute of Technology. He was a member of Tau Beta Pi, a fellow of IEEE, and a registered professional engineer in

Massachusetts, New York, Ohio, Kentucky, Arizona, and Virginia. In 1974, he was elected to membership in the National Academy of Engineering (NAE).

Howard received the IEEE Power Life Award for his work on the physical and medical effects of AC electric-field effects, the Habirshaw Medal, and the IEEE Meritorious Service Award. He was the first president of the IEEE Power Engineering Society and later chaired the committees on power-system protection, power generation and transmission, and power and environmental sciences. He was also active in the Edison Electric Institute (EEI), serving as chairman of the research project steering committees for superconductors in large synchronous machines, UHV, and advanced developments. His international activities included participation in the International Council on Large Electric Systems (CIGRE), where he was chairman of Study Committee 31, Transmission Systems, and a member of the CIGRE Executive Committee.

At AEP, Howard was instrumental in the development of new concepts in power-system protection based on electronics, then solid-state circuits, and then digital relays, which have become the relays of choice throughout the world. He was also intimately involved in the development of EHV transmission systems, the AEP-Westinghouse 500kV Apple Grove Test Program, and the AEP-ASEA 2000kV Test Station. As deputy chief engineer, Howard supervised the introduction of AEP's 765kV transmission system, at the time the world's highest transmission voltage. A brochure of IEEE technical papers on the design and engineering of this system, coauthored by Howard, is still the best primer available on EHV technology.

Howard was the author or coauthor of more than 50 seminal technical papers presented at IEEE and CIGRE conferences. His expertise ranged from new concepts for power-system protection on 345kV and 765kV transmission systems and safety aspects of bare-hand maintenance to advanced concepts in steam-powered electric generation.

A colleague and protégé of Philip Sporn (president and CEO of AEP and member of NAE and the National Academy of Sciences) and a giant in the electric power industry, Howard

Barnes encouraged his employees to participate in IEEE, EEI, CIGRE, and other engineering and standardizing organizations and paved the way for their advancement and recognition. One of his assistants became CEO of the largest electrical utility in New York City. Another followed him as president of the IEEE Power Engineering Society. Virtually every technical manager in Howard's employ became a chairman of an industry technical organization.

Howard regularly involved younger engineers in meetings and presentations before AEP executives to help them develop the skills necessary to become engineering leaders. He often used these younger engineers as "gofers," thus exposing them to decision-making processes by senior executives and industry leaders. In this way, young engineers also became known to industry leaders.

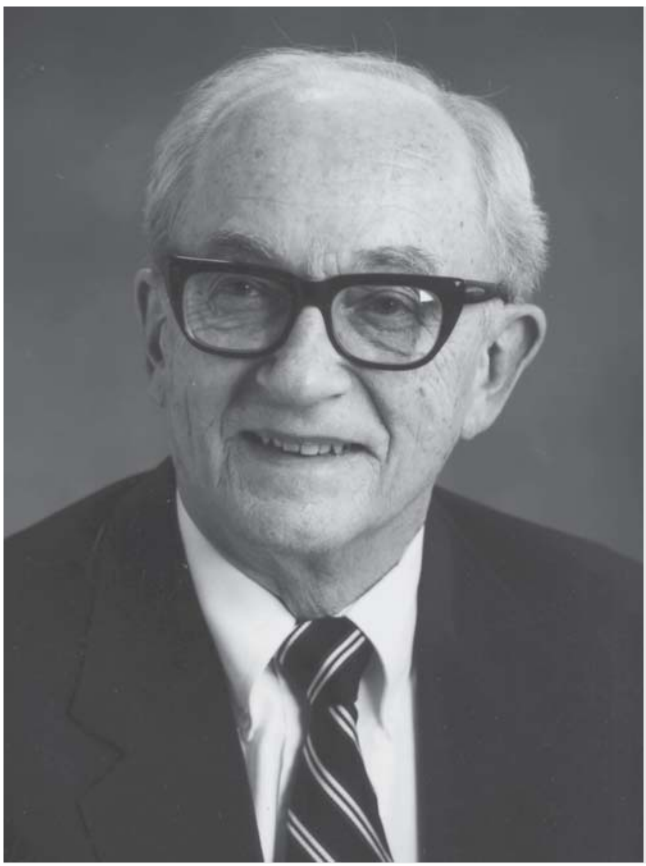
Howard made it a point to interact socially with all of his employees. Every summer, he and his wife Gen hosted countless engineers and their wives at their home in Levittown, Long Island. Many current leaders of AEP, IEEE, and CIGRE recall these events with affection and gratitude.

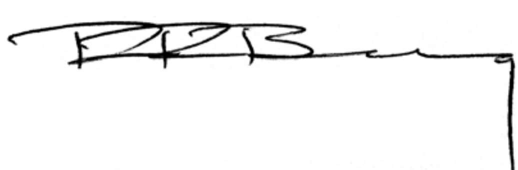
Howard was easy to like and quick to grasp new concepts. He embraced and developed new standards of performance for electrical transmission and distribution systems. At a time when electrical demand was doubling every 10 years, new methods and systems affecting every facet of power system hardware and controls had to be integrated with the old without interrupting the reliable, economical delivery of power. And this had to be done in a way that was compatible with environmental regulations. Howard's projects were always completed professionally and on schedule.

After the death of his wife Gen (his "Bride of 70 Years") in 2002, he resided with his son and daughter-in-law, Howard A. and Melissa L. Barnes at their home in Green Valley, Arizona. Howard and Gen had three children: a daughter, Dorothy Jo, and two sons, Allen Forest and Howard Allen. He passed on peacefully on May 16, 2003, precisely 71 years from the day he had asked for Gen's hand in marriage with his most prized professional achievement, the IEEE Power Life Award for "international leadership in the evolution of systems for the future welfare of society" on the side table.

He is survived by his youngest son, five grandchildren: Michelle Gagne-Sustaita, Monique Gagne-Escaler, Norman Gagne, Edward Barnes, and Deborah Barnes-Taylor, and four great-grandchildren.

Howard loved to invent the future. He was stern yet fair and happy on the job, and he treated younger engineers as peers. He knew how to follow a leader, even as he developed his own followers along the way. When Philip Sporn died, it was said that "a giant redwood had fallen." Howard Barnes was a tree in the same forest.





ROBERT R. BERG

1924–2006

Elected in 1988

"For outstanding contributions concerning the migration, accumulation, and production of oil through the development of concepts to quantify reservoir depositional systems."

BY LUC IKELLE
SUBMITTED BY THE NAE HOME SECRETARY

ROBERT RAYMOND BERG, professor of geology at Texas A&M University, died peacefully on June 13, 2006, at the age of 82, after a rich and harmonious life. Bob's 42-year professional life can be divided into two parts. From 1951 to 1967, he was an exploration geologist and geophysicist for various oil and gas companies, including the Embar Oil Company, a consulting company he founded. From 1967 to 1995, he was an educator, scientist, and academic administrator at Texas A&M. For me the second part of his professional life is more fascinating, perhaps because he contributed to my own education during that time.

Bob made abundant contributions to the body of geological knowledge, especially in the area of sedimentology. His studies were focused on the origins and characterization of sandstone reservoirs, from which more than 50 percent of the world's petroleum is produced. One of Bob's most significant contributions was the turbidite exploration model, which proved the existence of sandstone reservoirs in basinal systems that were thought to be "sand poor." This model was important for oil and gas exploration, especially for deepwater reservoirs in the Gulf of Mexico and West Africa, two key focus areas today.

During those same years, Bob found the time and energy to head the Geology Department at Texas A&M. He later became director of the Office of University Research and supervised 112 graduate students, many of whom are now industry leaders.

Bob was elected to the National Academy of Engineering in 1988, the first member of the geology and geophysics faculty at Texas A&M to receive such an honor. He served a term as president of the Rocky Mountain Association of Geologists (1966) and president of the American Institute of Professional Geologists (1971), and he was an honorary member of the American Association of Petroleum Geologists (AAPG), American Institute of Professional Geologists (AIPG), and Gulf Coast Association of Geological Societies. In 1981, he was awarded the AIPG Ben H. Parker Medal for outstanding service to the profession, and in 1992 he received the Outstanding Achievement Award from his alma mater, the University of Minnesota. In 1993, he received the AAPG Sidney Powers Memorial Award for outstanding contributions to petroleum geology. He also received many teaching and research awards.

Bob was born on May 28, 1924, in St. Paul, Minnesota, where he attended school and graduated from Central High School in 1942. From 1943 to 1946, he was a weather observer for the U.S. Army Air Corps in the western United States, the Pacific, and Japan. After World War II, he earned his B.A. (1948) and Ph.D. (1951) in geology from the University of Minnesota.

Bob began his professional career with the California Company (now Chevron), supervising exploration in both structural and stratigraphic plays in the Rocky Mountains area. In 1959, he formed Embar Oil Company in Denver, Colorado, which was not only a consulting company, but also generated prospects for oil companies. In 1967, Bob was hired by Texas A&M, which was looking for an enthusiastic scholar with experience in the oil and gas industry to head its Department of Geology. The resulting relationship proved to be extremely beneficial for both parties. From 1967 to 1972, Bob guided the research of 112 graduate students and published more than 70 papers and a popular textbook, *Reservoir Sandstones*

(Prentice-Hall Inc., 1986), based on his own research. He created an academic environment in which many other scientists flourished.

In 1972, he was appointed the first director of the Texas A&M Office of University Research, where his responsibilities included managing funds for research and monitoring all research activities at the university. During his 10 years in that office, total research expenditures at the university increased from $26 million to $90 million per year. Nevertheless, Bob continued to carry a full-time teaching load, advise graduate students, and conduct his own research. In 1982, Bob was awarded the Michel T. Halbouty Chair in Geology. In 2000, at a symposium in his honor, his former students presented papers based on insights based on the studies of their beloved professor. Following the symposium, the Robert R. Berg Professorship was created. By the time I joined Texas A&M in 1997, Bob had officially retired, but as professor emeritus he continued to teach and supervise students until the summer of 2005, when he was forced to stop for health reasons.

Bob Berg was a devoted father and avid fly fisherman and sportsman. With three sons, many family activities were centered upon camping when the family lived in Denver. Geology was always on his mind, though, and every outing and road trip was also a geological field trip. It is not surprising that two of his sons became geologists. Bob was a Boy Scout when he was young, and he continued in the scouting tradition as an adult scout leader for his sons' scout troop. Upon moving to Texas, Bob joined a goose-hunting lease near Columbus, Texas, and he and his sons spent many hours calling in the geese while lying in water-logged rice fields.

In addition to fly fishing, Bob was very athletic in his younger days and was an expert alpine skier. As many graduate students and faculty colleagues can attest, Bob was an avid racquetball player and a fierce competitor. He was also interested in music and had very eclectic musical tastes, but his favorite music was traditional Dixieland jazz. He was also an accomplished harmonica and ukulele player.

Bob and his wife, Jo, loved to travel. They spent many skiing vacations in Aspen, Colorado, and Jackson, Wyoming. When they could no longer ski, they made annual treks to vacation in Aspen during the summer to enjoy fly fishing and music festival concerts. They also made two trips to Scandinavia where they researched Bob's family history; his grandfather had emigrated from Sweden in the late 19th century. Fascinated with genealogy, he researched both his and Jo's family histories, and his research provided valuable information to his children and grandchildren.

Bob led a very challenging but satisfying life characterized by his compassion and his devotion to excellence. He was the quintessential scientist and scholar. His influence as an educator will live on in the lives and careers of his students, and he will be remembered with respect and admiration by all of his contemporaries and colleagues.

James Robert Berg, a son, preceded Bob in death. Dr. Berg's survivors include his wife, Jo, of Bryan, Texas, whom he met at Central High School in St. Paul, Minnesota. They were together in marriage for almost 60 years. Bob is survived by two sons: Charles, and wife Sarah, of The Woodlands, Texas, and William, and wife Theresa, of Fort Collins, Colorado, and three grandchildren, Matthew, Amanda, and Camille. Charles, a geophysicist, and William, a petroleum geologist, are fortunate to have inherited their father's love of geology and learning. Bob was devoted to his grandchildren, and they benefited greatly from his presence in their lives.


Frederick Stucky Billig

FREDERICK STUCKY BILLIG

1933–2006

Elected in 1995

"For analytical and experimental contributions to supersonic/hypersonic combustion and ramjet engine technologies."

BY BEN T. ZINN AND JOSEPH A. SCHETZ

FREDERICK STUCKY BILLIG, a pioneer in the field of high-speed air-breathing propulsion, died on June 1, 2006, at the age of 73. Fred was elected to the National Academy of Engineering in 1995.

Born on February 28, 1933, in Pittsburgh, Pennsylvania, Fred grew up and spent his adult life and career in the Maryland suburbs of Washington, D.C. Always an avid sports fan, as a boy he participated in many contests on baseball statistics. While attending Johns Hopkins University (JHU), he contributed to the cost of his schooling by taking part-time jobs, which included assisting in the design of antennas for radio stations.

After completing his B.E. in mechanical engineering at JHU in 1955, Fred joined the Applied Physics Laboratory (APL) there and began working on hypersonic propulsion and vehicles. In the early days, he was mentored by Drs. William Avery and Gordon Dugger. Fred was very productive in those early years, and the important contributions made by him and his group are reflected in the many patents and publications that bear their names. In recognition of Fred's contributions to the field, he was promoted to the position of senior engineer and supervisor of hypersonic ramjets in 1963. During that period, Fred was also a part-time graduate student in mechanical engineering at the University of Maryland, where he obtained an M.S. in 1958 and a Ph.D. in 1964.

Fred received numerous awards during his long career. Early on, he earned the Phi Kappa Phi Outstanding Graduate Student Award (1964), Distinguished Young Scientist Award from the Maryland Academy of Science (1966), and Silver Medal for the Outstanding Paper at the 12th International Symposium on Combustion (1970). In the 1970s, Fred accepted a new assignment in the Submarine Security Program at APL/JHU, a critical national security program to which he made significant contributions. He later returned to the Aeronautics Department at APL, where he rose to the position of chief scientist in 1987.

Fred was always interested in students and education, and he taught graduate courses at the University of Maryland, serving as an adjunct professor in the Department of Aerospace Engineering from 1964 to 1989, and at Virginia Tech. In fact, he served on Ph.D. committees at Virginia Tech up until the time of his death. He was also widely known in his neighborhood as someone who was willing to help the school-age children of neighbors and friends with their homework. In addition, he mentored a number of young researchers at APL/JHU who subsequently rose to positions of prominence.

Fred was very active in professional societies, primarily the American Institute of Aeronautics and Astronautics (AIAA) and the International Society on Air Breathing Engines (ISABE), of which he was a founding member. He became a fellow of AIAA in 1978 and presented the Honorary AIAA Dryden Research Lecture in 1991. He also served on many government committees and panels sponsored by the U.S. Navy, National Aeronautics and Space Administration, and U.S. Air Force (USAF), including the USAF Scientific Advisory Board. Fred was a key contributor to the National Aerospace Plane (NASP) Program, for which he was honored with the Pioneer Award in 1991. For his lifetime of work in the scramjet field, he earned the USAF Meritorious Civilian Service Award, the Bondaruck Award from the Soviet Academy of Sciences, and the USSR Aviation Sport Federation Award, all in 1992. He received the Engineering Innovation Hall of Fame Award from the University of Maryland Clark School of Engineering in 1997.

Fred "retired" from APL/JHU in 1996 to become the full-time president of Pyrodyne Inc., a position he held at the time of his death. Even in his later years, he continued to make significant technical contributions and to mentor young researchers. Fred leaves a rich legacy of pioneering ideas and publications and many active engineers whose careers he influenced and promoted. These engineers will continue to pursue Fred's dream of developing a practical, hypersonic, air-breathing vehicle.

Fred enjoyed golfing and swimming and was looking forward to retiring to his home in Florida. He was a loving husband, father, and grandfather, as well as a wonderful friend to people throughout the United States and abroad.

He was preceded in death by Peggy, his wife of 50 years. He is survived by his four children: Linda Baumler and husband Robert, Donna Bartley and husband Dave, Fred Billig and wife Trish, and Jimmy Billig and wife Stephanie. He is also survived by 10 grandchildren, whom he adored: Bobby, Jennifer, Christina, Marissa, Lauren, Christopher, Kelly, Stephen, Jackie, and Caroline.

RICHARD HENRY BOLT

1911–2002

Elected in 1978

"For contributions to acoustics and leadership in engineering enterprises and public service."

BY LEO L. BERANEK

RICHARD HENRY BOLT, cofounder of Bolt Beranek and Newman (BBN), a leading acoustical design company, and inventor of the ARPANET, died January 13, 2002, in his 90th year. Dick was a many-faceted "diamond," a gem of a man with a broad range of interests, the ability to communicate with just about anyone, and a passion for helping his colleagues and students.

Dick was born April 22, 1911, in Peking, China, to a medical missionary couple, Richard Arthur Bolt and Beatrice French Bolt. The family returned to the United States in 1916, where Dick completed his schooling at Berkeley High School. In 1928, he entered the University of California at Berkeley, where he received a B.A. in architecture in 1933. His interest in acoustics was sparked by some articles he read in architectural journals.

Dick married Katherine Mary Smith immediately after graduation, and the couple honeymooned in Europe, where Dick was introduced to Professors Erwin Meyer and Hermann Biehle, who were teaching acoustics in Berlin. In just six weeks, Dick learned enough German to enroll in fall classes, Meyer's at the Heinrich Hertz Institute and Biehle's at his own institute. Kay provided the finances for this venture. She wrote a play for Berlin shortwave radio and acted in it, earning enough money to continue the honeymoon and finance Dick's education for 10 months.

After returning to Berkeley in 1934, Dick enrolled in Physics A and D in summer school as qualifications for entry into the graduate physics program. It was the middle of the Great Depression then, and Kay returned to teaching to support Dick's studies. She taught English and dramatics in a junior high school for the next three years, until 1937, when Dick passed the qualifying examinations for entry into a Ph.D. program. For the next two years, until 1939, the Bolts were supported by financial assistance from academic fellowships.

Working under Professor Vern O. Knudsen at UCLA, Dick earned his Ph.D. (officially from Berkeley) in June 1939. The next academic year he spent at Massachusetts Institute of Technology (MIT) doing research and publishing papers jointly with Philip M. Morse, Albert Clogston, and Herman Feshbach on aspects of sound in variously shaped rooms. For two years, starting in 1940, he directed MIT's Underwater Sound Laboratory, and in 1943, he was named scientific liaison officer in subsurface warfare to the Office of Scientific Research and Development in London.

At the end of World War II, Dick was appointed director of a newly conceived acoustics laboratory at MIT. At its peak, the laboratory employed more than 80 people, and in just 12 years, 108 graduate theses were completed. Dick taught an acoustics course in the MIT School of Architecture and Planning based largely on physical principles; he also taught a course titled "Advanced Seminar in Architectural Acoustics" to students in the Acoustics Laboratory.

In 1946, MIT received a request from the renowned New York architectural firm Harrison and Abramowitz for a proposal for consultation on the acoustics of the United Nations headquarters buildings in New York. MIT asked Dick to respond, and, following a competition, he received the commission. When the project proved to be too big for a single person, he invited Leo L. Beranek to join him; thus the firm Bolt and Beranek was born in November 1948. A year later, Robert B. Newman, then a member of the faculty of the MIT School of Architecture and Planning, joined as a partner. In 1951, BBN was incorporated, with Dick as chairman of the board, Beranek as president and chief executive officer, Newman and Samuel Labate as vice presidents, and Jordan Baruch as treasurer.

As BBN grew, it moved first to 16 Eliot Street (in Cambridge) and, in 1956, to 50 Moulton Street, which, when augmented by a two-story building designed largely by Dick, remained BBN's Cambridge headquarters offices and laboratories for several decades. Dick remained full time at MIT, devoting one day a week to work at BBN.

The MIT Acoustics Laboratory closed in early 1957, when funding from the U.S. Navy Bureau of Ships was terminated. The same year the National Institutes of Health appointed Dick principal consultant in biophysics to work with a new study section in that field. By the summer of 1958, he had organized a successful international conference, held in Boulder, Colorado, to explore future directions for biophysical science. Attended by 117 people, the conference stimulated a step-function of activity in the biological sciences. Ninety of the participants in the conference received collaborative research contracts, and six of them were later awarded Nobel Prizes.

The conference brought Dick national visibility. Beginning in 1960, he spent three years as associate director of the National Science Foundation in Washington, D.C. The next year he worked as a fellow in the Center for Advanced Study in Behavioral Sciences at Stanford University. On his return to MIT, he was a lecturer in the Department of Political Science for several years, during which he helped agency after agency and committee after committee to organize their deliberations and oversee their published proceedings.

In 1973, Dick chaired a committee of six experts investigating the 18-minute gap on a tape made in President Nixon's office three days after the Watergate break-in. Although the committee was unable to discover who erased the tape, Dick concluded that the erasure was not accidental because it had been started over at least five times during the gap.

The Acoustical Society of America awarded Dick the first R. Bruce Lindsay Award, which is granted to a member of the society 35 years of age or younger. In all, he published more than 50 papers on acoustics and coauthored, with Theodore

F. Hueter, *Sonics: Techniques for the Use of Sound and Ultrasound in Engineering and Science* (John Wiley & Sons, 1955). From 1944 to 1947, while serving on the Executive Council of the Acoustical Society of America, he undertook to rewrite the society's constitution. The following year he became the first person to serve as president-elect of the society under one of the newly written bylaws; in 1949, he served a term as the society's president. On the 50th anniversary of its founding in 1979, the Acoustical Society honored him with its Gold Medal Award. The citation reads: "For outstanding contributions to acoustics through research, teaching, and professional leadership, and for distinguished administrative and advisory service to science, engineering, and government." He was also an active member or fellow of several other prestigious professional societies, including the American Physical Society, National Academy of Engineering, American Academy of Arts and Sciences, IEEE, and Institute of Noise Control Engineering. When the International Congress on Acoustics was founded in 1953, Dick was chosen to be its first president.

Dick was chairman of the BBN Board of Directors from 1953 to 1976 and continued to be a member of the board until 1981. He maintained an office at BBN until well into the 1990s and acted as a consultant on various projects.

Bill Cavanaugh, an MIT architectural student who later became a division leader at BBN, says, "I resumed my training in acoustics amidst the remarkable group of individuals assembled at BBN to work on acoustical problems of all types. I will never forget the enormous influence Dick Bolt had on me personally during my professional career. His charisma and enthusiasm were infectious. At BBN, he was involved in countless architectural acoustics projects."

Dick was an avid pianist who loved to play classical music and write songs. Jogging was another favorite pastime. Always upbeat, he enjoyed parties and telling jokes. In his younger days he was a fine water colorist and throughout his life he designed logos.

Dick's wife, Katherine, died in 1992 after an extended illness. He is survived by one son, Dick Bolt; two daughters, Bea Scribner and Deborah Bolt-Zieses; seven grandchildren; and eight great-grandchildren.


Leon E. Borgman

LEON E. BORGMAN

1928–2007

Elected in 1999

"For contributions to the theory and practice of ocean wave statistics, probabilistic hydrodynamic loading, and risk analysis of ocean structures."

BY JEFFREY A. MELBY
SUBMITTED BY THE NAE HOME SECRETARY

LEON E. BORGMAN, distinguished emeritus professor of geology and geophysics and statistics, University of Wyoming, and the father of modern ocean-wave statistical analysis, died on February 5, 2007, at the Cheyenne Regional Medical Center in Cheyenne, Wyoming. Born in Chickasha, Oklahoma, on February 16, 1928, he received a B.S. in geological engineering from the Colorado School of Mines in 1953 and, from 1953 to 1959, worked for the Shell Development Company, Houston, Texas, as an oceanographic engineer. He received an M.S. in mathematics from the University of Houston in 1959 and a Ph.D. in statistics from the University of California, Berkeley, in 1962.

Leon began his academic career in 1961 at the University of California, Davis, where he taught for six years, and the University of California, Berkeley, where he taught for three years. He came to the University of Wyoming in 1970 as professor of geology and statistics and retired in 1997 as distinguished emeritus professor of geology and geophysics and statistics. During that time, he mentored many students, both at the university and in the greater engineering community. After his retirement and until the time of his death, he was a private consultant.

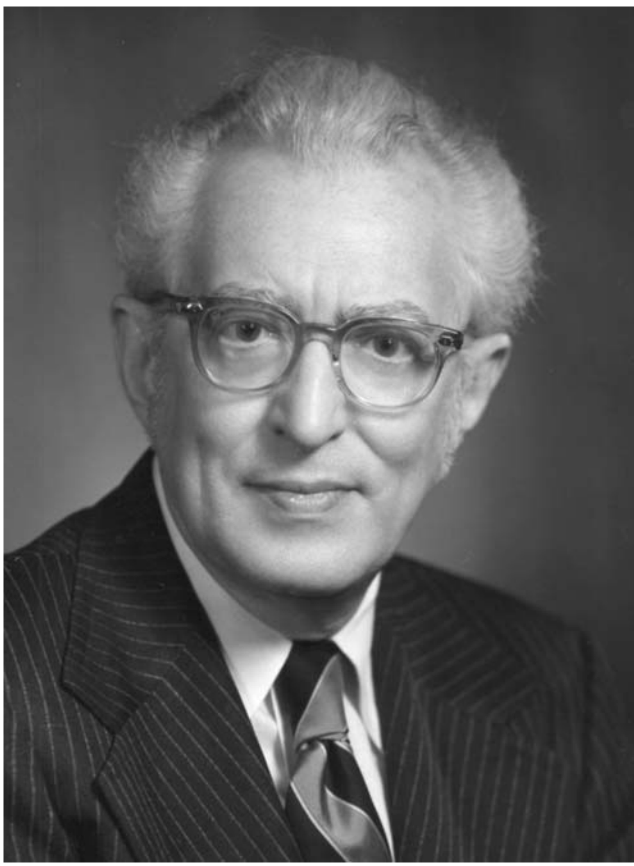
Leon Borgman was well known in several disciplines for his extraordinary ability to use cutting-edge statistical theories and concepts to solve complex engineering and scientific problems. The subjects of his research included the theory and practice of ocean-wave statistics, probabilistic hydrodynamic loading, risk analysis in coastal engineering, statistical simulation for geophysical modeling, geostatistics of mineral deposits and environmental assessment, and fracture mechanics. In his distinguished career, he produced more than 40 refereed journal articles and 160 total publications. He was also well known for producing widely used computer programs for ocean, coastal-wave, and water-level analyses and simulations, as well as geophysical and groundwater analyses and simulations.

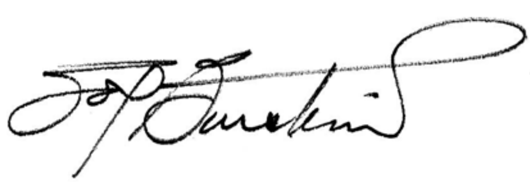
Leon was the recipient of numerous honors and awards, including the University of Wyoming's George Duke Humphrey Distinguished Faculty Award in 1981 and the International Coastal Engineer Award from the American Society of Civil Engineers in 1994. In 1998, he was recognized for professional distinction by the Offshore Technology Research Center (Texas A&M University) and was inducted into the Texas A&M Technology Hall of Fame. In 1999, Emeritus Professor Leon E. Borgman became the first University of Wyoming faculty member ever inducted into the National Academy of Engineering, the highest honor an engineer can receive.

Leon had many outside interests and was an accomplished calligrapher, custom knife maker, and dog trainer. He was an outdoorsman who treasured time spent with his family while hiking, fishing, camping, or just collecting rocks. He had a lifelong passion for learning and the following quote by John Muir seemed to fit him well:

> As long as I live, I'll hear waterfalls and birds and winds sing. I'll interpret the rocks, learn the language of flood, storm, and the avalanche. I'll acquaint myself with the glaciers and wild gardens, and get as near the heart of the world as I can.

Leon is survived by his wife, Betty, his sons and their wives, Eric and Julie, and Michael and Cherilyn, and grandchildren, Chance and Chelsea. Also surviving are four brothers and two sisters and their families. A memorial service to celebrate his life was held on April 28, 2007, in the University of Wyoming Fine Arts Center Theater.





SOL BURSTEIN

1922–2002

Elected in 1985

"For technical leadership in the design, construction, and highly successful operation of pioneering commercial nuclear electric generating plants."

BY JOHN TAYLOR

SOL BURSTEIN retired from the Wisconsin Electric Power Company in 1987, capping a highly productive and successful career in power engineering; the design, construction, and operation of nuclear-powered electricity-generating plants; and electric utility management. Sol was the public face of nuclear power for many years; he spent numerous hours testifying before state, federal regulatory, and congressional committees about nuclear power: its promise, its risks, and keeping it safe. Not content to rest on his laurels in his later years, he undertook consulting work—largely pro bono—on nuclear power safety and radioactive waste management. Congestive heart failure led to his death at the age of 79 in Falls Church, Virginia, on January 28, 2002.

Sol was born in Chelsea, Massachusetts, in a tenement building, at 69 4th Street Rear. With $100 that he'd borrowed from his brother Joe, Sol went to Northeastern University on the co-op plan and graduated with a degree in mechanical engineering in 1944. His co-op work, design, and sea trials of Baltimore-class heavy cruisers at Bethlehem Steel's Fore River Shipyard in Quincy, Massachusetts, became his first job after college. At the shipyard, Sol witnessed a terrible accident: a 360-ton-capacity crane moved a 300-ton load without incident; the second load of only 15 tons snapped a cable and killed several workers. The accident left a profound impression, and safety became Sol's obsession for the rest of his professional life.

In the late 1940s, he joined the Stone and Webster Engineering Corporation, where he worked for nearly 20 years as a project mechanical engineer and, subsequently, as a major troubleshooter for the company; his list of service posts ranged round the world, from Jamaica to India, to the Dominican Republic to England. Sol worked on the complete range of projects that Stone & Webster ("S&W" which he used to refer to as "Sweat & Worry") bid as A&E contractors, everything from building power plants, refineries, distilleries, and chemical processing plants, to converting Los Angeles from DC to 110V AC. In 1963, Sol was posted to Wisconsin Electric Power (WEP) as S&W's on-site consultant. His job was to develop a plan for modernizing the old moribound utility, whose newest plant had been built in 1929. Three years later WEP hired him as head of the power plant department, where he began executing that modernization plan, which took roughly two decades to complete. Sol moved up the corporate ladder rapidly, becoming vice president in 1967, senior vice president in 1969, executive vice president in 1973, vice chairman of the board in 1984, and finally vice president and director of Wisconsin Energy Corporation, the parent holding company of Wisconsin Electric Power Company, Wisconsin Natural Gas Company, and nonutility energy subsidiaries, Wispark Corporation, Wisvest Corporation, and Badger Service Company.

Sol's early work was focused on the design of heat cycles for marine applications and then for power plants of all types. Notable early applications were the steam-to-steam thermodynamics of saturated steam-turbine systems and digital computer solutions to complex pipe-stress analyses. His work led to the development of industry codes and standards to ensure the safety and reliability of heat and energy systems.

Sol became involved in work on nuclear power during its early commercial deployment in the United States. He was responsible for the overall system design, licensing, construction, and operation of two 520-MW nuclear electricity-generating plants, Point Beach 1 and 2, in Two Creeks, Wisconsin. Completed in record time (a little more than four years), these plants began producing electricity in 1970 and 1972, respectively. Point Beach 1 was the fifth commercial nuclear plant to be completed of the 104 now operating in the United States. Point Beach 1 and 2 achieved an exceptional level of safety and reliability through 35 years of operation and are still going strong. The lion's share of the credit for this accomplishment goes to Sol, not only for his leadership but also for his technical mastery in dealing with the myriad complex issues involved in bringing this new technology to fruition.

In getting a job done, Sol loved finding ways for maximizing efficiency, reliability, time-to-delivery, and cost-effectiveness; it was generally a matter of balancing them. One example serves as an exemplar: At the end of every workday, Sol reviewed hundreds of pages of summaries of whatever work was in process. He would scrutinize expenditures and frequently call the engineer in charge to ask a question. In building the Valley Plant, a coal-fired unit in Milwaukee's industrial center, Sol noticed a line item of $2,000 for a stainless steel flagpole. He called the engineer and asked what the alternatives were, and the engineer replied that a spun aluminum pole could be bought for $300, but that its design life was only 35 years, whereas the stainless steel version would last 100 years. Sol pointed out that the plant's life was 40 years, and that the actual life was likely to be much longer than the quoted design life. Moreover, the item was non-critical and very easy to replace. WEP got the aluminum flagpole. He leaned back and said, "That's how I justify my being here today. The goal is to get the engineer to spec the aluminum pole in the first place."

All of this, of course, was interwoven with the human dimension. As an example, Sol was dedicated to affirmative action, though he despised most affirmative action programs; he believed that they were set up so that the participants couldn't fail and that this was a disservice to both the participants and to the company. At WEP, he plucked promising affirmative action participants out of the official program, and he installed them in make-or-break positions, e.g., head of a line crew. Sol reveled in their successes, and a number of them corresponded with him until he died.

In spite of his heavy responsibilities, Sol was an active participant in professional activities. He was elected a member of the American Society of Mechanical Engineers (ASME) in 1954 and a fellow in 1980. He was honored as Engineer of the Year by the Milwaukee Council of Engineering and Scientific Societies and was elected a fellow of the Wisconsin Academy of Sciences and Letters in 1986. He was honored nationally by his election to membership in the National Academy of Engineering in 1985; his primary membership was in Section 6, Electric Power/Energy Systems Engineering, and his secondary membership was in Section 10, Mechanical Engineering. His election citation reads: "For technical leadership in the design, construction, and highly successful operation of pioneering commercial nuclear electric generating plants."

Over the years, Sol was engaged in many important studies. He served on the following National Academies Committees: Committee on Electrometallurgical Techniques for DOE Spent Fuel Treatment; Committee on Decontamination and Decommissioning; Committee on Technical Bases for Yucca Mountain Standards; and Committee on Separations Technology and Transmutation Systems. The reports emanating from these studies established the technical bases for government policies and the implementation of the storage, disposition, and management of radioactive wastes. Sol also participated in government advisory groups as a member of the Nuclear Research Advisory Committee of the Nuclear Regulatory Commission and advisory committees to the Federal Power Commission and the U.S. Department of Energy.

Sol also was affiliated with many industrial professional organizations. He was a member of the Board on Nuclear Codes and Standards of ASME; a member or chairman of the utility advisory committees overseeing research and development (R&D) programs of the Electric Power Research Institute in nuclear power, exploratory research, strategic research, and seismic design; a member of the Policy Committee on Nuclear Regulation of the Atomic Industrial Forum; a member or chairman of the Edison Electric Institute advisory committees—Research, Prime Movers, Utility Nuclear Waste Management, and Executive Advisory Committee on Nuclear Power; and chairman of the Environment Committee of the Association for Edison Electric Illuminating Companies.

Sol worked closely with the Institute for Nuclear Power Operations (INPO), the self-regulatory utility group that monitors all U.S. plants for safety performance and compliance with high operating standards. He welcomed their peer reviews and volunteered his expertise in nuclear plant operational safety for dissemination among all nuclear utilities.

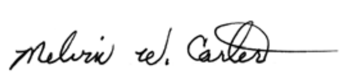
Sol had a strong interest in engineering education. A longtime supporter of the Department of Engineering Physics at the University of Wisconsin-Madison, he was a member of the department's industrial advisory board, which worked to improve the nuclear engineering curriculum and research program through the integration of nuclear plant operational and maintenance skills with design and analytical technologies. He was honored for his engineering accomplishments by the University of Wisconsin in 1975 and by Marquette University in 1983. In 1987, Sol was awarded an honorary D. Sc. from the University of Wisconsin-Milwaukee.

Sol was, above all, a leader, a person of unquestionable integrity, keen mind, and indefatigable work ethic. He had a gruff demeanor and always "told it like it was," which might have been a bit frightening to young engineers on his team. But it didn't take long for them to develop great respect for his openness and high standards. As a committee member, he never hesitated to express his opinions forthrightly, even when they were out of the mainstream. In the end, his ideas usually proved to be accurate. Behind his tough exterior, Sol had a timely sense of humor. He understood human rhythms and how long or tense a session could become before nerves began to fray. During intense discussions on controversial technical issues, Sol would often break the tension with a quick joke. Sometimes he just told a joke that he liked, even without the tension. As a young engineer working on a power plant siting in Louisiana, most of the bayous on the map had been identified, many with the names of the families that lived there, for instance, the Jones Bayou or the Smith Bayou. One possible site had no name, and Sol had very carefully stenciled in the name "Howzit Bayou" in the same size/script as that of the map font. He could still recall 40 years later how he and the other S&W engineers could barely contain their laughter when the customer kept referring, in a deep Southern drawl, to the "Howzit Bayou" in their meeting.

Sol was always aware of his mission: to build safe, reliable power plants, to get power to the people, and to grind through all the details to their very end. He left no hanging threads, neither technical nor human.

Sol was devoted to his job, but after his retirement was finally able to find domestic bliss with his companion Joy Taylor and to spend time with his family: his son Paul and wife Dotty, and his daughter Nadine and her husband Jim Hubbell. He was crazy about his grandchildren, Rachel and Will, whom he tried to spoil; it was the one endeavor in which "Poppy" utterly failed, much to everyone's (including Sol's) delight.

As his health failed, it became impossible for Sol to leave the Washington D.C. area, and he spent a lot of time at the National Academy. One of his favorite spots for sitting was at the Einstein statue at the National Academy. It's interesting that that spot appealed to Sol just as it does to legions of young students every day.



MELVIN W. CARTER

1926–2007

Elected in 1999

"For leadership and teaching in radiation protection, health physics, and public health standards and practices."

BY A. ALAN MOGHISSI
SUBMITTED BY THE NAE HOME SECRETARY

MELVIN W. CARTER, Neely Professor Emeritus, Georgia Institute of Technology, an internationally recognized health physicist and radiological engineer, died on August 15, 2007, at the age of 80. He was elected to the National Academy of Engineering in 1999 and participated in numerous studies and other activities of the National Academies.

From humble beginnings in East Atlanta, Georgia, Mel Carter built a career based on hard work, perseverance, loyalty, and dedication to his family. As a second-generation American, he understood the need for mentoring immigrants, and he successfully attracted scientists and engineers who immigrated to the United States after World War II to his program.

Born in 1926 in Atlanta, Georgia, to a blue-collar family (his father was a brick mason), Mel was a member of "the greatest generation." He was raised during the Great Depression and served in the Army Air Corps during World War II. After returning to civilian life and unloading a railroad car with a shovel, he decided to pursue an education so he would not have to make a living "with his back."

Mel studied civil engineering at the Georgia Institute of Technology and received a B.S. in civil engineering in 1949. Around this time, he married his wife, Anne, who helped him through his graduate education. He earned a master's degree in public health engineering from Georgia Tech in 1951 and a Ph.D. in radiological and environmental engineering from the University of Florida in 1960. His devotion to public health, in general, and radiological health in particular, continued throughout his career.

Mel joined the U.S. Public Health Service as a commissioned officer in 1951 and worked at the famed Environmental Health Center in Cincinnati, Ohio. Shortly thereafter, he was assigned to Oak Ridge National Laboratory, where he studied the fate of radioactive materials in the environment and the management of radioactive waste. While at Oak Ridge, he was briefly assigned to the Off-Site Safety Program for the Upshot-Knothole Series of nuclear weapons tests at the Nevada Test Site.

He later returned to Cincinnati to work on decontamination and radioactive waste disposal mostly for the U.S. Air Force. In 1955, he was appointed deputy officer-in-charge of the Health and Safety Program established by the U.S. Public Health Service and attached to the Atomic Energy Commission. His responsibilities included serving as off-site radiological safety officer for the nuclear test series conducted at the Pacific Proving Grounds in 1956 and 1958. After receiving his Ph.D. in 1960, he was appointed officer-in-charge/director of the Southeastern Radiological Health Laboratory in Montgomery, Alabama, and later to the same position at the much larger Southwestern Radiological Health Laboratory, in Las Vegas, Nevada, which eventually became the National Environmental Research Center, part of the Environmental Protection Agency (EPA).

Mel had a unique style of leadership—he was soft-spoken but determined. As the leader of multidisciplinary research and operations, he had to understand the needs of investigators in medicine, ecology (including wildlife management), toxicology, farming, chemistry, physics, and various branches of engineering. He knew how to encourage investigators to be creative while responding to the demands of government agencies that had highly visible missions, maintaining an infrastructure, and ensuring the financial integrity of the lab.

After EPA was formed, he became frustrated that legal issues began to dominate the decision process to the detriment of science and public health. So, in 1973, he left the newly formed National Environmental Research Center and returned to his alma mater, Georgia Tech, where he became a professor and director of the Bioengineering Center and later the founding director of the Office of Interdisciplinary Programs. After heading interdisciplinary programs for the government, he now felt very much at home directing interdisciplinary academic programs.

Once Mel got used to academic life, he started to develop programs that survived for a long time. For example, he negotiated with the state of Georgia to set up a state environmental laboratory for radioactive materials at Georgia Tech and organized numerous training courses for teachers, government employees, and others and secured funding for research projects. Upon formally joining the then School of Nuclear Engineering, he taught numerous courses. He found that he enjoyed academia enormously, and he soon became active in a number of scholarly activities. In 1980, he was appointed Neely Professor in Nuclear Engineering and Health Physics, and upon his retirement in 1988, he became Neely Professor Emeritus at Georgia Tech.

Mel was elected a member of the National Council on Radiation Protection and Measurements and served on numerous committees of that organization as well as the Board of Directors. In 1980, he was elected president of the Health Physics Society after having served in numerous capacities in that organization. He was the president of the International Radiation Protection Association, the umbrella organization of the global health physics community.

In 1989, President Reagan appointed Mel to the Nuclear Waste Technical Review Board, which established fundamental criteria for the high-level radioactive waste repository. Because of his familiarity with various aspects of Yucca Mountain, a neighbor to the Nevada Test Site, Mel brought a unique perspective to bear on the board's decisions. Many years earlier, he had coauthored a paper suggesting that the Nevada Test Site, where several hundred atomic weapons had been detonated, be used for the disposal of radioactive waste rather than a new site.

Mel participated in a number of peer reviews and scientific assessments by the American Society of Mechanical Engineers, in cooperation with the Institute for Regulatory Science. In 2001, he chaired a panel that reviewed the U.S. Department of Energy's plans to remedy groundwater contamination as a result of nearly 1,000 "events" at the Nevada Test Site. The panel met in public to report the results of the review. At the end of the meeting, a woman who had been strongly opposed to nuclear energy development said she would sleep better after listening to the panel. Mel also chaired a panel that evaluated certain EPA activities mandated by Congress. Under his leadership, the panel established metrics for evaluating the positive and negative effects of those activities on the environment.

Mel's election as a member of the National Academy of Engineering followed his participation in a number of National Academies committees, which continued after his election. He was also active in many other professional, humanitarian, and other organizations, published numerous papers, edited several books, and encouraged the publication of useful information.

Mel Carter leaves a legacy of enormous accomplishment. The engineering profession and the nuclear and health physics communities have lost an articulate and effective proponent.

Harold Chestnut

HAROLD CHESTNUT

1917–2001

Elected in 1974

"For contributions to the theory and practice of control systems, and systems engineering."

BY STEPHEN KAHNE
SUBMITTED BY THE NAE HOME SECRETARY

HAROLD CHESTNUT, engineer and visionary, died in Schenectady, New York, on August 29, 2001, at the age of 83. He was born a few miles from where he died, worked much of his life at the General Electric Company (GE) nearby, and made major contributions to engineering and the engineering profession throughout the world.

Hal earned a B.S. (1939) and an M.S. (1940) in electrical engineering from the Massachusetts Institute of Technology (MIT) and was later awarded honorary doctorates in engineering from Case Institute of Technology (1966) and Villanova University (1972). Although he was not an academician, he was involved in education from his early years as an engineer, when he was both a student and an instructor in the well-known GE Advanced Engineering Program (Electrical Engineering Course) from 1940 to 1943. At that time there were very few engineering doctoral programs at U.S. universities, and GE's in-house program set a high standard for industry-developed advanced technical education attuned to the needs of the company.

In the 1950s and 1960s, Hal wrote four textbooks in the fields of control and a two-volume work, *Servomechanisms and Regulating Systems Design,* coauthored with Robert W. Mayer (John Wiley & Sons, Volume 1 in 1951 and Volume 2 in 1955). *Servomechanisms* established Hal's international reputation, which was a significant factor in his future leadership in the industry.

In his early years at GE, Hal contributed to studies of the stability of electric power systems and brought some of the lessons from this work into the classrooms of the Advanced Engineering Program. From the middle of World War II to the mid-1950s, working in the GE Aeronautics and Ordnance Department, he contributed to the design and development of various fire-control, aircraft, and guided-missile systems. He later managed the Systems Engineering and Analysis Branch of the GE Advanced Technology Laboratory, which eventually merged into the GE Corporate Research and Development Laboratory in Schenectady, where he was responsible for aspects of automatic control and information systems on many projects, including rapid transit and the Apollo mission.

Hal was always interested in communication among professionals, and he ultimately achieved the top leadership roles in two major professional technical societies. After the success of *Servomechanisms,* he was one of the best-known American personalities in the field of control engineering, and in 1957, when the International Federation of Automatic Control (IFAC) was founded, Hal was elected its first president.

IFAC was founded during the cold war, and the organizers were faced with choosing a Russian or an American for president. Although Hal was not a member of the provisional committee that founded IFAC, Rufus Oldenberger, a professor of mechanical engineering at Purdue University who led the American "delegation," argued that Hal was the best person for the job. Although it had been agreed that the biannual (later triennial) World Congresses of IFAC would be held in the home country of the president, in light of cold war realities, a decision was made that an American would be the first president but the first World Congress would be held in Moscow. So although the first president, Hal, was an American, the second president, Alexander Letov, a Russian, presided over the first IFAC World Congress in Moscow in 1960.

In the 1950s and 1960s, Chestnut took on leadership roles in the American Institute of Electrical Engineers (AIEE) and Institute of Radio Engineers (IRE). When these two organizations merged into the Institute of Electrical and Electronics Engineers (IEEE) in 1963, he was an active participant in the new organization, in which he served as vice president and leader in several technical branches and in IEEE publications. In 1973, he was elected president of IEEE, which by then had members in nearly 100 countries. During his IEEE years, Hal was an editor of *AUTOMATICA,* a commercial journal published by Pergamon Press, and a book series on systems engineering and analysis, published by John Wiley and Sons; he was still editor of the series when he retired from GE in 1983.

Late in his career and then after retirement, Hal became interested in promoting global stability by applying the fundamental principles of control engineering to resolving international conflicts. He reasoned that principles of control engineering might provide insights into international conflict resolution, so he formed a group in IFAC and organized workshops to explore the idea. The results of the workshop discussions involving control specialists from many countries were published in a series of workshop proceedings. In 1981, the Honda Foundation awarded Hal the Honda Prize "for his achievements associated with the promotion of humanitarian use of technology and as a world leader in systems engineering that encompasses electrical, electronic, instrumentation, and automatic control." Hal used the Honda Prize stipend to create a small organization, the Foundation on Supplemental Ways to Increase International Stability (SWIIS), and he remained passionately devoted to SWIIS for the rest of his life. After retirement, he frequently called his younger colleagues who held leadership positions in professional societies to encourage them to broaden their views to reflect the impact of technology on international conflict resolution.

Hal received many honors during his lifetime, including election to the National Academy of Engineering in 1974. He was a licensed professional engineer in New York state and, in 1965, was given the Engineer of the Year Award by the Schenectady Chapter of the National Society of Professional Engineers. In addition to IEEE, he was a fellow of the American

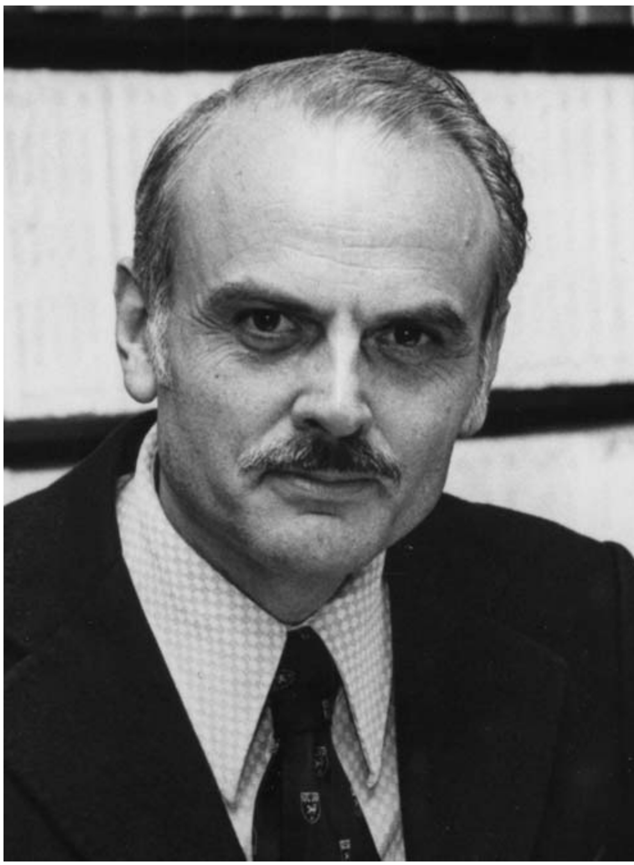
Association for the Advancement of Science and the Instrument Society of America, president of the American Automatic Control Council (AACC) in 1962 and 1963, and recipient of the AACC Bellman Heritage Award in 1983. Case Western Reserve University named him a Case Centennial Scholar in 1980, and he was an IEEE Centennial Medalist in 1984. In 1990, he was awarded the Rufus Oldenberger Medal of the American Society of Mechanical Engineers and IEEE Richard Emberson Award for "distinguished service to the technical objectives of the IEEE." In 1988, Dr. Chestnut and his family endowed the IFAC Control Engineering Textbook Prize, now known as the Harold Chestnut IFAC Control Engineering Textbook Prize, which is awarded triennially.

Hal began visiting at Lake Luzerne, New York, at age 5 and continued to visit the Adirondacks throughout his life. He enjoyed family gatherings, and sailing his *Sunfish,* and he was a lifelong swimmer. He also skied and played tennis. Many of these activities were shared with his family. Hal was a gardener who cultivated lilies and roses especially. He served as president of his local YMCA and was active in the Boy Scouts of America, attaining the rank of Eagle Scout. He served as president of his local Parent-Teacher Association and the First Unitarian Society of Schenectady, New York. He served on the World Federalist Board of Directors and a local citizens committee for public schools.

Hal had a special interest in keeping in touch with colleagues throughout the world, even after his own formal leadership roles were finished. He was a voracious reader, and it was not unusual for a friend in a leadership position in some professional organization to receive a call from Hal to discuss an issue that had appeared in a recent society newsletter or meeting minutes. His involvement in his profession was truly a lifetime commitment.

Hal is survived by his wife of 57 years, Erma Ruth Callaway Chestnut. His other immediate survivors include son Peter Callaway Chestnut, wife Elizabeth Akiya Chestnut, and daughter Caitilin Asako Chestnut; son Harold Thomas Chestnut, wife Laura Ross Chestnut, and daughters Whitney

Ross Chestnut and Taylor Callaway Chestnut; son Andrew Trammell Chestnut, wife Heather Bee Chestnut, and daughter Christina Callaway Chestnut and son Zachary Blake Chestnut. Hal and Erma Ruth's long marriage was a source of great strength and satisfaction to both of them. Erma Ruth earned a bachelor's degree in mathematics from the University of Colorado and a master's degree in guidance and a doctorate in education administration, both from the State University of New York at Albany. She accompanied Hal on many of his trips around the world, especially when he held leadership positions in IFAC and IEEE.



EDGAR F. CODD

1923–2003

Elected in 1981

"For the origination of the relational approach to the organization of large data bases."

BY C. J. DATE
SUBMITTED BY THE NAE HOME SECRETARY

BY NOW ALMOST EVERYONE in the database community is aware that Dr. E.F. Codd passed away on April 18, 2003, at the age of 79. Dr. Codd, known universally as Ted to his colleagues and friends—among whom I am proud to count myself—single-handedly put the field of database management on a solid scientific footing. The entire relational database industry, now worth many billions of dollars a year, owes its existence to Ted's original work; the same is true of all relational database research and teaching programs in universities and similar organizations worldwide. Indeed, all of us who work in this field owe our careers and livelihoods to Ted's contributions from the late 1960s to the early 1980s. This tribute to Ted and his achievements is offered in recognition of the great debt we all owe him.

Ted began his computing career in 1949 as a programming mathematician for IBM working on the selective-sequence electronic calculator. He subsequently participated in the development of several important IBM products, including the 701 (IBM's first commercial electronic computer) and STRETCH, which led to IBM's 7090 mainframe technology. Then, in the late 1960s, he turned his attention to the problem of database management—and over the next few years he created the relational model of data, with which his name will forever be associated.

The relational model is widely recognized as one of the great technical innovations of the twentieth century. Ted described it and explored its implications in a series of staggeringly original research papers published between 1969 and 1981. The effect of those papers was twofold: First, they changed for good the way the IT world perceived the database management problem; second, they laid the foundation for a whole new industry. In fact, they provided the basis for a technology that has had, and continues to have, a major impact on the very fabric of our society. It is no exaggeration to say that Ted is the intellectual father of the modern database field.

To give an idea of the extent of Ted's accomplishments, I will briefly survey some of his most significant contributions. The biggest of all was, of course, making database management into a science (thereby introducing clarity and rigor in the field). The relational model provided a theoretical framework within which a variety of important problems could be attacked scientifically. Ted first described his model in an IBM Research Report (RJ599) published on August 19, 1969, *Derivability, Redundancy, and Consistency of Relations Stored in Large Data Banks.* The following year he published a revised version of this paper, "A Relational Model of Data for Large Shared Data Banks" (*Communications of the ACM* 13(6): 377–387), which is usually credited with being the seminal paper in the field.

Most of the novel ideas described in outline in the following paragraphs, as well as numerous subsequent technical developments, were foreshadowed in these first two papers; some of these ideas have still not been fully explored. In my opinion, everyone professionally involved in database management should read, and reread, at least one of these papers every year.

Incidentally, it is not as widely known that Ted not only invented the relational model in particular, he invented the whole concept of a data model in general (cf., "Data Models in Database Management," *ACM SIGMOD* Record 11, No. 2 (February 1981)). For both the relational model and data models in general, he stressed the importance of the distinction between a data model and its physical implementation.

Ted recognized the potential of using predicate logic as a foundation for a database language. He discussed this possibility briefly in his 1969 and 1970 papers and then, using the predicate logic idea as a basis, went on to describe in detail what was probably the very first relational language to be defined, Data Sublanguage ALPHA, in "http://www.informatik.uni-trier.de/~ley/db/conf/sigmod/Codd71.html A Data Base Sublanguage Founded on the Relational Calculus" (Proceedings of 1971 ACM-SIGFIDET Workshop on Data Description, Access and Control, San Diego, Calif., November 11–12, 1971). Although ALPHA was never implemented, it was extremely influential on certain other languages, especially the Ingres language QUEL and to a lesser extent SQL.

Ted subsequently defined the relational calculus more formally, as well as the relational algebra, in "http://www.informatik.uni-trier.de/~ley/db/labs/ibm/RJ987.html Relational Completeness of Data Base Sublanguages," in *Database Systems: Courant Computer Science Symposia Series 6,* edited by Randall J. Rustin (Prentice-Hall, 1972). As the title indicates, this paper also introduced the notion of relational completeness as a basic measure of the expressive power of a database language. It also described an algorithm—Codd's reduction algorithm—for transforming an arbitrary expression of the calculus into an equivalent expression in the algebra, thereby proving the algebra was relationally complete (i.e., it was at least as powerful as the calculus) and providing a basis for implementing the calculus.

Ted also introduced the concept of functional dependence and defined the first three normal forms (1NF, 2NF, 3NF) in "Normalized Data Base Structure: A Brief Tutorial" (Proceedings of 1971 ACM-SIGFIDET Workshop on Data Description, Access and Control, San Diego, Calif., (November 11–12, 1971) and "Further Normalization of the Data Base Relational Model," in *Data Base Systems: Courant Computer Science Symposia Series 6,* edited by Randall J. Rustin (Prentice-Hall, 1972). These papers laid the foundations for the field of what is now known as dependency theory, a branch of database science. Among other things, it established a basis for a truly scientific approach to the problem of logical database design.

Ted defined the key notion of essentiality in "Interactive Support for Nonprogrammers: The Relational and Network Approaches," *Proceedings of the ACM SIGMOD Workshop on Data Description, Access, and Control, Vol. II,* Ann Arbor, Mich. (May 1974). This paper was Ted's principal written contribution to "The Great Debate"—the official title was "Data Models: Data-Structure-Set vs. Relational"—a special event at the 1974 SIGMOD Workshop subsequently characterized by Robert L. Ashenhurst as "a milestone event of the kind too seldom witnessed in our field."

The concept of essentiality introduced by Ted in this debate is a great aid to clear thinking in discussions on the nature of data and database management systems. The Information Principle (which I heard Ted refer to one occasion as the fundamental principle underlying the relational model) relies on it, albeit not very explicitly: "The entire information content of a relational database is represented in one and only one way: namely, as attribute values within tuples within relations."

In addition to all of his research activities, Ted was active professionally in other areas. He founded the ACM Special Interest Committee on File Description and Translation (SICFIDET), which later became an ACM Special Interest Group (SIGFIDET) and changed its name to the Special Interest Group on Management of Data (SIGMOD). He was also tireless in his efforts, both inside and outside IBM, to obtain acceptance for the relational model.

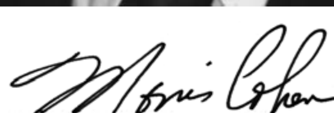
Ted's achievements with the relational model should not eclipse his original contributions in several other important areas, such as multiprogramming. He led the team that developed IBM's first multiprogramming system and reported on that work in: "http://www.informatik.uni-trier.de/~ley/db/journals/cacm/Codd59.html Multiprogramming STRETCH: Feasibility Considerations" (with "http://www.informatik.uni-trier.de/~ley/db/indices/a-tree/l/Lowry:E=_S=.html" E.S. Lowry, "http://www.informatik.uni-trier.de/~ley/db/indices/a-tree/m/McDonough:E=.html" E. McDonough, and "http://www.informatik.uni-trier.de/~ley/db/indices/a-tree/s/Scalzi:Casper_A=.html" C.A. Scalzi), *Communications of the ACM* 2(11): 13–17 (November 1959), and "Multiprogram Scheduling," Parts 1 and 2, *Communications of the ACM* 3(6) (June 1960); Parts 3 and 4, *Communications of the ACM* 3(7) (July 1960). In addition, his work on natural language processing was described in several publications, including "Seven Steps to Rendezvous with the Casual User," in *Data Base Management, Proceedings of the IFIP TC-2 Working Conference on Data Base Management 1974,* edited by J.W. Klimbie and K.K. Koffeman (North-Holland, 1974).

The depth and breadth of Ted's contributions are reflected in the long list of honors conferred on him during his lifetime. He was an IBM fellow, an ACM fellow, and a fellow of the British Computer Society. He was also an elected member of both the National Academy of Engineering and the American Academy of Arts and Sciences. And, in 1981, he received the ACM Turing Award, the most prestigious award in the field of computer science. He also received numerous other professional awards.

Ted Codd was a genuine pioneer and an inspiration to everyone who had the good fortune and honor to know him and work with him. He was always scrupulous about crediting other people's contributions, and, despite his huge achievements, he was careful never to make extravagant claims. For example, he would never claim that the relational model could solve all possible problems or that it would last forever. Yet those who truly understand that model believe that the class of problems it can solve is extraordinarily large and that it will endure for a very long time. Systems will be built on the basis of Codd's relational model as far out as anyone can see.

A native of England, Ted served in the Royal Air Force during World War II. He moved to the United States after the war and became a naturalized U.S. citizen. He held M.A. degrees in mathematics and chemistry from Oxford University and an M.S. and a Ph.D. in communication sciences from the University of Michigan. He is survived by his wife, Sharon; a daughter, Katherine; three sons, Ronald, Frank, and David;

six grandchildren; other family members; and friends and colleagues around the world. He is mourned and sorely missed by all.



MORRIS COHEN

1911–2005

Elected in 1972

"For elucidation of strengthening mechanisms of steel and unification of engineering disciplines with materials science."

BY EDWIN L. THOMAS AND GREGORY B. OLSON
SUBMITTED BY THE NAE HOME SECRETARY

MORRIS COHEN, institute professor emeritus at the Massachusetts Institute of Technology (MIT), passed away May 27, 2005, at his home in Swampscott, Massachusetts. Born in Chelsea, Massachusetts, in 1911, he began a lifelong association with MIT in the fall of 1929 when he enrolled as a freshman, expecting to apply a degree in metallurgy to the family business, which produced and refined lead-based alloys for metal type and solders. He earned a B.S. in metallurgy in 1933 and an Sc.D. in metallurgy in 1936, when he was appointed an instructor in the Department of Metallurgy. Rising through the academic ranks, he became a full professor in 1946, was named Ford Professor of Metallurgy in 1962, and was promoted to institute professor, MIT's highest honor, in 1975.

Morris's doctoral thesis, "Aging Phenomena in Silver-Copper Alloys," was supervised by the noted metal physicist Professor John T. Norton, and his early work on improving the strength and toughness of metals was quickly connected to investigations of the causes of dangerous cracking in all-welded ships during World War II.

As associate director of the Manhattan Project at MIT, Morris worked on the development of processes to convert uranium powder into solid uranium metal; the resultant castings were used for the famous "pile" built in Chicago. Also during the war, he helped develop nonmagnetic steel that could be used as armor plating on the bridges of ships and in locations near compasses in other military transport craft.

After the war, Morris and his students worked on explaining how heat treatment hardens and toughens tool and structural steels. They investigated the fundamentals of the martensitic transformation in steel and how this phase transformation improves its mechanical properties. Subsequent work on self-diffusion and interdiffusion led to studies of microstructural changes during the tempering of iron alloys. Over a period of 50 years, Morris and his students created a body of basic knowledge on strengthening steel and made practical the ultrahigh-strength steels used today. Morris's many seminal contributions to the mechanisms and kinetics of the martensitic transformation, tempering phenomena, strengthening mechanisms, age hardening of alloys, strain-induced transformations, and rapid solidification of alloys were milestones in the emerging field of materials science.

In 1971, Morris was elected a member of the National Academy of Sciences (NAS). When he received the phone message about his election, he thought it was a mistake because he was a metallurgist and an engineer, not a scientist, and he thought the call must have come from the National Academy of Engineering (NAE). However, a telegram confirmed that he had indeed been elected to NAS, one of the very few metallurgists to be so honored.

A year later, in 1972, he was elected to NAE. He subsequently served as a member-at-large of the National Research Council (NRC) Board on Assessment of the National Institute of Standards and Technology Programs (1986–1989), a member of the Steering Committee for the Materials Science and Engineering Study (1985–1989), and a member of the Panel for a Review of ONR Research Opportunities in Materials Sciences (1987–1988).

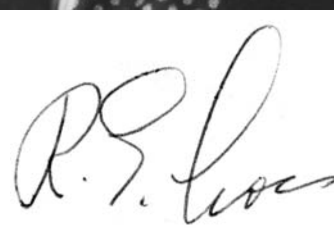
Morris's service to the nation included taking on advisory roles to NAE, NAS, the National Science Foundation, and the National Aeronautics and Space Administration. In recognition of his fundamental work on martensitic transformation and the strengthening of steel, President Carter awarded him the

National Medal of Science in 1977. Morris liked to tell how President Carter, after reading the citation, said, "We need more of that," which Morris interpreted as a presidential endorsement of martensitic transformations. A thorough review of his accomplishments, Morris and G.B. Olson, *Dislocation Theory of Martensitic Transformations* (Dislocations in Solids, Vol. 7, edited by F.R.N. Nabarro, North-Holland, 1986) was published at the time of his retirement from research. Most people in the field recognize that Morris did more than any other individual to advance the understanding of the martensitic mechanism and kinetics.

Morris was president of the American Society of Metals (ASM) and was twice presented with the ASM Howe Medal (1945 and 1949). In addition, he was a leader in the new field of materials science and engineering; he was co-chair of the NRC Committee on the Survey of Materials Science and Engineering that published *Materials and Man's Needs,* often called the Cohen report. This study has had a significant influence on national policy on materials education and research. In 1987, Morris was awarded the Kyoto Prize in Advanced Technology. He published more than 300 research papers and supervised more than 150 graduate and postdoctoral students during his long tenure at MIT.

A talented violinist in his youth, Morris had a lifelong interest in the arts. He had season tickets to the Boston Symphony Orchestra from the time he was a freshman at MIT and frequently provided his staff and students with tickets to musical and theatrical performances. He was an ardent collector of American impressionist paintings, particularly the works of John Joseph Enneking and Joseph Eliot Enneking; his collection was bequeathed to the Cape Cod Museum of Art. He was also a founder and past president of Temple Sinai in Marblehead, Massachusetts.

Morris Cohen is survived by his son Joel, two sisters, three grandchildren, and five great-grandchildren. His scientific vision and dedication to the field of materials science and engineering, as well as his warm and gracious manner, are deeply missed.



RALPH CROSS

1910–2003

Elected in 1968

"For development and application of automation principles as related to machine tools and manufacturing processes."

BY DENNIS CROSS
SUBMITTED BY THE NAE HOME SECRETARY

RALPH E. CROSS, a pioneer in the field of manufacturing engineering and father of automation, died peacefully in his home in Grosse Pointe, Michigan, on Thursday, June 26. He was 93. He was a resident of Boynton Beach, Florida, and Grosse Pointe.

Formative Years

Ralph Cross was born in 1910 in Detroit, Michigan where the Cross family had settled in the mid-1800s. His father, Milton Osgood Cross Sr., known as the Skipper for his love of boats, had started a small machine shop in Detroit in 1898, taking in his father, Charles, a cabinetmaker by trade, as partner. The company, Milton O. Cross & Co. Brass Goods, manufactured a variety of metal products, primarily brass goods and marine hardware. As the years passed and the company added to its product line, the Skipper's love for boats influenced his decision to start offering marine engines. In this early period of automotive history the company soon became established in the fields of marine and stationery engines. It also became known for its expertise in the making of gears. By 1910, the year Ralph was born, the company was building engines, transmissions, and axels for automobiles. Like many others in Detroit in that period, the Skipper built his own car, powered by a Cross marine engine.

Ralph E. Cross grew up in a manufacturing family. He spent much of his youth, together with his brother, Milton O. Cross Jr., in the shop helping his father, operating the various metal-shaping machines, and designing and making metal parts. Here he developed his lifelong interest in manufacturing processes, which he was later to transform forever.

He attended public school in Detroit where he was a top student. In 1928, he entered Chauncy Hall in Boston to pursue a one-year course of study to better prepare him for the Massachusetts Institute of Technology where he had been accepted. At MIT he studied manufacturing engineering and began to develop the concepts of automating machining processes, later to be known as "automation."

A Pioneer in the Development of Automation

With the onset of the Great Depression, the family's business prospects turned bleak. Following his graduation from MIT in 1933, he returned to Detroit to rejoin the family business, which had been renamed Cross Gear and Machine. In 1932, the Skipper turned the business over to the two brothers. Milton was the president and in charge of sales, while Ralph headed up manufacturing and engineering. The two brothers then decided to drop all products except machines, thus pointing the company in the direction that would ultimately make it the largest machine tool company in the United States.

In 1932, Ralph married his childhood sweetheart, Eloise Fountain of Detroit. In 1934 their first child, Ralph Emerson Cross Jr., was born.

As the economy began to recover in 1937 the company began to expand its machine tool product base by offering "special" nonstandardized machines that solved each customer's problem in the most efficient way. When World War II started, the company redirected its efforts to the manufacture of special machines for the country's war efforts, machines that would produce armaments, tanks, airplane parts, and other military equipment. During the war the company thrived, as its products were essential to the country's ability to produce war-related equipment.

In 1946, following World War II, as industry converted from wartime to peacetime products, the demand for special machine tools rose rapidly and fostered an era of unprecedented innovation in manufacturing methods and machines. This postwar period gave many companies the opportunity to replace previously scrapped or obsolete machines with new ones employing the latest technological advances. It was the period that gave birth to what eventually became known as "Detroit Automation," the in-line sequencing of manufacturing operations utilizing automatic material handling techniques. Automation transformed American industry, particularly the automobile industry, by making it possible to employ semiskilled workers in place of skilled machinists to perform sequences of differing machining operations on the same platform, to higher tolerances and at higher speeds than were heretofore possible. The Cross Company, as it had been renamed, emerged during this postwar period as the most technologically advanced and innovative company in the machine tool industry. In the years that followed, it pioneered in the development of the transfer machine, preset tools, tool control systems, sectionalized transfer lines, ballscrew feed units, and computerized machine tool systems. Behind all of these developments, both at the company and in the industry, was Ralph Cross, who was able to put into practice the concepts of automation he had developed while at MIT and thereafter. He was in many ways the father of automation and was to metalworking what Henry Ford was to the production line.

Later Developments

The Cross Company continued to prosper and expand throughout the postwar period. Following the path of the auto industry, the company began its expansion into overseas markets with the establishment in 1960 of Cross International AG, in Fribourg, Switzerland, for the purpose of marketing Cross machines on a worldwide scale. The company also founded a subsidiary in Germany, Cross Europawerk GMBH, to manufacture automation machinery for the European Common Market.

Further overseas expansion occurred in 1968 with the establishment of Cross International in Knowsley, England, to manufacture products for the Commonwealth countries, followed by the establishment in 1970 of Enshu Cross K.K., a joint venture in Japan to manufacture Cross machines for the Asian market.

In the early 1960s the company recognized the dramatic gains in productivity that could be realized by being able to intermix metalworking, assembly, and testing operations into more compact and efficient arrangements. It set out to become builders of integrated manufacturing systems. It developed the first integrated manufacturing system for machining, assembling, and testing transmission stator support assemblies; the industry's first nonsynchronous transfer machine for assembling and testing disc brake assemblies; and the industry's first automated "Cold State" engine diagnostic and test system.

In all of these developments the Cross Company was the clear industry leader, often introducing product innovations that became industry standards and expanding into markets years ahead of its competitors. It was Ralph Cross who was a guiding force behind these advances.

In 1967, upon the untimely death of his brother, Milton, Ralph was named Cross company chairman of the board, president, and CEO. He served in those positions until 1979 when he left to engineer the formation of Cross & Trecker Corporation, a holding company for the combination of the Cross Company and Kearney & Trecker, a Wisconsin machine toolmaker. At its formation, he acceded to the position of chairman emeritus of Cross & Trecker and remained until his final retirement in 1986.

Industry Service, Industry Recognition

During the 1960s and until his retirement from the industry in 1984, Ralph Cross was recognized as one of the leading experts in manufacturing engineering with unique experience in international trade. In that capacity he served in many honorary and advisory capacities and received many honors in recognition of his leading role in the machinery industry. Among his many accomplishments were:

- In 1954 he was asked to serve as a "dollar-a-year" volunteer in the Commerce Department, where he was responsible for mobilization preparedness of all of the hard goods industries. During this assignment he was special technical advisor to the U.S. team that negotiated East-West Export Control Agreements with 14 other NATO countries.
- From 1955 through 1959, he served as a part-time consultant to the Assistant Secretary of the Air Force for Material. In this capacity he monitored the development of numerically controlled machine tools for aircraft production.
- In 1955, he testified before the Joint Economic Committee of the Congress on the subject of "Automation and Technological Change," where he warned of the growth of world competition that he foresaw and the possible effects on the U.S. economy.
- In 1956, he received the American Society of Tool Engineers "Engineering Citation" for his work in the development and application of automation principles to machine tools and manufacturing processes.
- In 1968, he was elected a member of the National Academy of Engineering, America's most prestigious engineering organization.
- In 1974, he was elected president of the National Machine Tool Builders' Association for a one year term.
- In 1975, he visited the People's Republic of China as a member of the first Metalworking Technology Symposium and Trade Mission from the United States.
- In 1976, he was nominated World Trader of the Year by the World Trade Club of Detroit.

- In 1976, he received the Corporate Leadership Award from his alma mater, the Massachusetts Institute of Technology.
- In 1977, he received an honorary degree, doctor of engineering, from the Lawrence Institute of Technology.
- In 1979, he was made an honorary member of the Society of Manufacturing Engineers (SME).
- In 1979, he was made a trustee of the Lawrence Institute of Technology.
- In 1979, he was named president of the SME Education Foundation, an organization that makes grants to fund the education of students in manufacturing education.
- In 1992, he was inducted into the Machine Tool Hall of Fame of the American Precision Museum. He was one of only 20 to be so honored and the only living member at the time of his induction.

Philanthropy

Ralph Cross was an active philanthropist, supporting in particular MIT, where he established the Ralph E. Cross and Eloise F. Cross Professorship in Mechanical Engineering. He also established the Cross Lectureship in Manufacturing at MIT, sponsoring lecturers that cover all fields of manufacturing. When, with his financial backing, the Laboratory for Manufacturing and Productivity was formed at MIT in 1977, he became the first chairman of the Industrial Development Board.

He also contributed generously to the Ralph Cross Endowment Fund of the Society of Manufacturing Engineers Education Foundation, which makes grants to students in manufacturing education.

One of Cross's proudest moments occurred in 2000 when MIT dedicated the Cross Student Lounge and Cross CAD/Cam Laboratory.

He was a member and an active supporter of Grosse Pointe Memorial Church.

Fun and Family

Cross was a member of the Detroit Athletic Club, the Lochmoor Club of Grosse Pointe, the Delray Beach Club, and the Quail Ridge Country Club of Boynton Beach, Florida.

He was an avid golfer, trying to apply the same problem-solving approach that he perfected as a maker of machine tools, to his golf game, but with decidedly less success. Still, he was a good and steady player, who became a fierce chipper and putter when there was money on the line.

Ralph Cross is survived by his three children: Ralph Cross Jr. of Pasadena, California; Carol March Emerson Cross of Cambridge, Massachusetts; and Dennis Cross of New York, New York; nine grandchildren (Ralph Cross III of Madison, Wisconsin; Elizabeth Siudara of Metamora, Michigan; Nicholas Cross Wodtke of Santa Monica, California; Ashley Cross Chiampo of Boston, Massachusetts; Louisa Emerson Cross of Boston, Massachusetts; Andrew Cross of Seattle, Washington; Amy Cross Wishard of Pasadena, California; Francesca Cross Wodtke of New York, New York; and Eliza Sperry Cross of New York, New York), and four great-grandchildren.

George B. Dantzig

GEORGE B. DANTZIG

1914–2005

Elected in 1985

"For outstanding pioneering contributions to the science and practice of operations research."

BY SAUL I. GASS
SUBMITTED BY THE NAE HOME SECRETARY

GEORGE B. DANTZIG, pioneer in operations research and management science, mathematician, professor, educator, consultant, author, and "father" of linear programming, died on May 13, 2005, at the age of 90, in Stanford, California.

George's formal education was in mathematics, which reflected his early interest in the subject and the influence of his father, Tobias Dantzig, a mathematics professor. George's seminal work can be summed up as the recognition and definition of the broad class of practical problems that can be studied as linear programs and the development of the simplex algorithm for solving them. These developments were essential to the emerging field of operations research, which was developed by British scientists during World War II. Linear programming was barely mentioned in early books and reports on operations research, but, before long, it became a mainstay of research methods and applications in the field. An amazing story!

George was elected to the National Academy of Engineering in 1985. He was a fellow of the Econometric Society, Institute of Mathematical Statistics, Association for the Advancement of Science, and Institute of Operations Research and the Management Sciences. He was president of the Institute for

Management Sciences and a founder of the Mathematical Programming Society. He was the first recipient of the Operations Research Society of America's von Neumann Theory Prize and the first inductee into the International Federation of Operational Research Societies' Operational Research Hall of Fame. He was awarded the Silver Medal of the British Operational Research Society and the Harvey Prize in Science and Technology from Technion University. In 1975, President Ford presented him with the National Medal of Science.

George was born on November 8, 1914, in Portland, Oregon, the first of two sons of Tobias and Anja (Ourisson) Dantzig. Tobias, who was Russian, and Anja, who was Polish, met at the Sorbonne where they both studied mathematics; they moved to Oregon in 1910, where Tobias held a variety of jobs—lumberjack, road builder, housepainter—before he obtained a teaching position at Indiana University. He received his Ph.D. in mathematics there in 1916. He then taught at Johns Hopkins University and the University of Maryland, where he was chair of the Mathematics Department.

In the book *More Mathematical People* (Simon & Schuster, 1990), George recounts his struggles with ninth-grade algebra and how he became a top student in mathematics and science when he was introduced to geometry, which "really turned [him] on." The thousands of geometry problems Tobias fed George—to keep him from getting underfoot—helped George develop his analytical power. He attended the University of Maryland, College Park, where he received his A.B. in mathematics and physics in 1936. That summer he married Anne Shmuner and moved to Ann Arbor, where George received his M.A. in mathematics in 1938 from the University of Michigan.

Although he had taken only one graduate course in statistics, he qualified for the Civil Service as a junior statistician, and in 1937, he accepted a job at the U.S. Bureau of Labor Statistics in Washington, D.C. At first, he thought statistics was "just a bag of tricks," but, after learning many practical applications on the job and becoming familiar with the work of Jerzy Neyman, he changed his mind.

George wrote to Neyman, who had just moved to the University of California, Berkeley, about taking a Ph.D. under his direction. Neyman managed to get him a teaching assistantship, and George and Anne moved west in 1939. In those years, statistics was included in the Mathematics Department, and, although George had taken only two courses in statistics, both from Neyman, his dissertation was in statistics. That was when the George Dantzig "urban legend" originated.

If you search the Web for "urban legend George Dantzig," you will probably be directed to the URL for *"Snopes.com, The Unsolvable Math Problem."* That site recounts how George, coming in late for class, mistakenly thought two problems Neyman had written on the board were homework problems. After a few days of struggling, he turned in his answers. About six weeks later, at 8:00 a.m. on a Sunday morning, he and Anne were awakened by someone banging on their front door. It was Neyman, who said: "I have just written an introduction to one of your papers. Read it so I can send it out right away for publication." George's answers to the homework problems were proofs of two unproven theorems in statistics.

The Snopes website tells in detail how George's experiences ended up as a sermon for a Lutheran minister and the basis for the film *Good Will Hunting.* The solution to the second homework problem became part of a joint paper with Abraham Wald, who found the solution independently in 1950, unaware that George had already solved it until a journal referee called it to his attention. Neyman had George submit his answers to the "homework" problems as his Ph.D. dissertation.

In June 1941, prior to defending his dissertation, George accepted a job in Washington with the Army Air Force Combat Analysis Branch of Statistical Control. Thus he did not receive his Ph.D. in mathematics from Berkeley until 1946, at which time he was offered a teaching position there. He decided to stay at the Pentagon, however, and become the mathematical advisor to the comptroller of the newly established Department of the Air Force. The deciding factor in his decision was that the salary he was offered at Berkeley was "too little."

Although he considered the Pentagon a holding place until he found a decent-paying academic position, that job choice started him down a life-changing research path that led to the development of linear programming. Thus, his decision had momentous results: It set operations research on a new course of research and applications, and, more important, it made enterprises and governments everywhere more effective and efficient.

George's Pentagon colleagues challenged him to figure out how the Air Force could mechanize its planning process to speed up computation of the deployment of forces and equipment, training, and logistical support. Keep in mind that all he had then were desk calculators and IBM accounting equipment. Based on his study of Air Force requirements, he adapted and generalized the structure behind Wassily Leontief's interindustry model. Thus he was able to state mathematically, for the first time, a wide class of practical and important problems that fell into the newly defined structure of linear programming. This was in July 1947. By the end of that summer, he had developed the simplex method of solving such problems.

In June 1947, the Air Force had established a major task force to work on high-speed computation of its planning process, later named Project SCOOP (scientific computation of optimal programs), with George as chief mathematician. He remained with Project SCOOP until June 1952 when he joined the RAND Corporation as a research mathematician. George's accomplishments in his research for the Air Force included the first statement of the linear-programming problem and the recognition of its applicability to a wide range of decision problems; the invention of the simplex method (IEEE named the simplex algorithm one of the top 10 algorithms of the twentieth century); the testing and proof of the linear-programming model and the simplex method; the statement and proof of linear-programming primal-dual problems and their relationship via the simplex algorithm; the development of the simplex transportation algorithm; and the establishment of the equivalence between linear-programming and zero-sum, two-person games.

In 1960, George began an illustrious academic career as professor of engineering science and chairman of the Operations Research Center, University of California, Berkeley. He moved to Stanford University in 1966 as professor of operations research and computer science and was appointed to the C.A. Criley Endowed Chair in Transportation in 1973. He retired in 1985 as professor emeritus, but he continued to teach and maintain an active research agenda until the fall of 1997. During his academic career, he authored or coauthored seven books and more than 150 papers.

George's legacy goes far beyond his research and teaching, however. It includes his friendship, mentoring, and unselfishness with time and ideas. He guided more than 50 Ph.D. students through Berkeley and Stanford.

George was a frequent visitor to the International Institute of Applied Systems Analysis (IIASA), "a non-governmental research organization, headquartered in Laxenburg, Austria, that conducts interdisciplinary scientific studies on environmental, economic, technological, and social issues in the context of human dimensions of global change." In 1973–1974, he spent a sabbatical year at IIASA as head of the Methodology Group.

For more than 50 years, George's continuing innovations were of the highest order, and the scientific and economic impacts that have resulted from his work are immeasurable. How does one measure the fact that all major (and most minor) industries directly or indirectly use linear programming to aid them in the allocation of their resources and decision making; that all computer systems (mainframes and PCs) "learn" how to solve linear-programming problems as soon as they are "born"; that the simplex method is imbedded into all PC spreadsheet systems; that national economic planning for the third world and developing countries is being guided by linear-programming techniques; that strategic and tactical military planning, management of military personnel, and a wide variety of logistical (peacetime and combat) problems are solved using linear programming; that mathematical and computer science research such as combinatorics, numerical analysis, and the solution of large-scale problems have been aided by linear programming; and that such diverse applications as cancer screening, airlines scheduling, agricultural development, transportation and delivery systems, scheduling of personnel, and petroleum refinery operations have been influenced by the work of George Dantzig?

The professional and academic fields of operations research, management science, industrial engineering, as well as the mathematical and computer sciences, rest heavily upon his lifetime of work.

George was survived by his wife Anne (née Shmuner), who died August 10, 2006. They are survived by son David Dantzig (wife: Nancy) of Cleveland, Ohio; daughter Jessica Klass (husband: Michael) of El Cerrito, California; son Paul Dantzig (wife: Susan Abrams) of Scarsdale, New York; three grandchildren: Audra Zelvy (husband: Michael), Aron Dantzig, and Jeremy Dantzig; two great-grandchildren, Ivy and Brian Zelvy; and Anne's brother Daniel Shaw of Baltimore, Maryland.

JOHN LARRY DUDA

1936–2006

Elected in 1998

"For research on molecular transport in polymers and on tribology, and for leadership in engineering education."

BY RONALD P. DANNER
SUBMITTED BY THE NAE HOME SECRETARY

JOHN LARRY DUDA, preeminent researcher, dedicated teacher, and professor of chemical engineering at Pennsylvania State University, died on September 24, 2006, after a valiant struggle with pancreatic cancer.

Born in the steel-mill town of Donora, Pennsylvania, Larry was fond of noting that if a member of his family attended college, he did so thanks to a football scholarship, but he didn't make the team. Thus forced to pursue an academic path, he succeeded in getting a different kind of scholarship to Case Institute of Technology, where, influenced by his high school chemistry teacher, he elected to pursue the chemical engineering curriculum. He received his B.S. in 1958 and then his M.S (in 1961) and Ph.D. (in 1963) from the University of Delaware. In 1962, while still a student, he married Margaret Kathleen Barbalich, who remained his constant companion for the next 44 years.

After completing his formal education, Larry spent eight years with the Process Fundamentals Group of the Dow Chemical Company in Midland, Michigan, where he began a long and successful collaboration with Dr. James S. Vrentas. Their analyses of the transport properties in polymeric systems led to the development of the highly successful Vrentas-Duda free-volume theory that explains how the viscous behavior of polymer melts is coupled to the diffusional behavior in binary solutions. During this same period, Larry was granted a patent for a latent heat storage component in insulation to prevent the Alaska pipeline from melting the permafrost in summer.

In 1971, when Larry accepted a position as an associate professor of chemical engineering at Penn State, he began a long and remarkable academic career. In 1975, he was promoted to professor, and during 1978–1979, was a visiting professor at the National Taiwan University. For 17 years, he served as department head, retiring from that position in 2000. From 1990 until his death in 2006, he was co-director of the Center for the Study of Polymer-Solvent Systems. Unlike most administrators, however, he continued to teach courses and maintain a strong focus on his research and his students.

Working with his longtime colleague Jim Vrentas, he extended the free-volume theory and developed experimental techniques and methods of analysis to determine accurate diffusivity data over the wide range of temperatures and concentrations in polymer processing. Larry also developed a micro-reactor technique to study the thermal and oxidative degradation of lubricants under conditions that simulate many engine environments. In the course of his career, he published nearly 200 articles in refereed journals, 45 refereed proceedings, and 18 chapters in books.

Undoubtedly, he most enjoyed working with students. He collaborated with 70 master's degree students, 45 doctoral students, and innumerable undergraduates in the classroom and the research lab. Larry was not the kind of advisor who would send his students off on their own. He worked closely with them, pointing out possibilities, challenging them, and molding their attitudes and approaches to research. The results of his mentoring are apparent in the success of many of his students in industry and academia.

Larry's peers honored him with many awards. In 1981, the American Institute of Chemical Engineers presented the William H. Walker Award to Larry and Jim Vrentas for their outstanding contributions to the chemical engineering literature and in 1989 the Charles M.A. Stine Award in Materials Engineering and Sciences in recognition of their outstanding contributions to the science, technology, and education of materials science and engineering. Also in 1989, Larry was selected the American Society of Engineering Education's Chemical Engineering Lecturer. In 1994, he was made a fellow of the American Institute of Chemical Engineers (AIChE) and was awarded the AIChE Warren K. Lewis Award, which is given in recognition of distinguished and continuing contributions to chemical engineering education.

In 1998, Larry was inducted into the National Academy of Engineering, and in 2006, in his honor, a $2 million endowment, The Dow Chemical Company and Larry Duda Excellence in Chemical Engineering Fund, was presented to the Department of Chemical Engineering at Penn State. Arkema Inc. has also endowed the Larry Duda Award for Outstanding Graduate Student Performance in Chemical Engineering at Penn State.

Larry contributed to his profession in many ways. He served on the Governing Board and Executive Committee of the Council for Chemical Research and was a director of AIChE and the Materials and Science Division of AIChE.

Afflicted with dyslexia, a condition that wasn't diagnosed until he was in his mid-forties, Larry approached his academic and research challenges with determination and good humor. In the classroom, he asked his students to point out his misspellings, inaccuracies, and reversals, and when they did, he laughed along with them.

Everyone who knew Larry soon learned that, although he was a dedicated scientist, he was far from the stereotypical nerd. In fact, he was a true "renaissance man" with interests in all kinds of science, engineering, religion, sports, music, art, travel, family life, nature, and more. He was always a teacher, in and out of the classroom. When asked why he didn't retire and simply pursue his research, his answer was always the same, "I love to teach." An eternal optimist, Larry was always sure a solution could be found to any and all problems.

Larry was also a devoted family man. He and Margaret had four children and seven grandchildren in whom they took great pride. The children are now a pediatrician, a neurologist, a fine-art photographer, and a businessman. Larry was instrumental in starting a Boy Scout troop in State College, Pennsylvania, and all three of his sons achieved the rank of Eagle Scout. There was a special synergy between Larry and Margaret in their professions. Larry was a source of constant support and encouragement to Margaret in her successful career as a professional writer and photographer, and she always supported him wherever his job, eccentricities, or travels took him.

Even when he was close to death, Larry never lost his sense of purpose or stopped searching for insights. His outlook on life and death is summarized in one of his favorite quotes from Rev. Donald Moore of Fordham University: "I see death not only as an opportunity to reflect on the meaning of your own existence, but to offer your life as a gift to others. The end presents us with a time to ponder—and discuss, if possible—what life has meant and might continue to mean for others."

BY MARGARET DUDA
SUBMITTED BY THE NAE HOME SECRETARY

Most of the people who made Larry's acquaintance quickly discovered that he loved to talk and tell stories and his sense of humor is remembered all over the world. He also loved to listen to others and liked nothing more than a good philosophical discussion. Many people were drawn to Larry, but few people knew him the way his family did.

I remember meeting Larry at a lecture on *Dr. Zhivago* when he was taking technical Russian and I was struggling with regular Russian. Larry used to joke that the only thing he got out of Russian was a wife and a name for his daughter, but not many people knew that when he was young, Larry dreamt of being a novelist. That certainly explained the constant encouragement he gave me in my own writing and his lifelong love of reading despite the fact that he was dyslexic. Later in life, Larry limited himself to reading nonfiction, especially in the areas of history and comparative religion. Many of the entries in his now-famous book of quotes came from those late-night forays into the minds of others.

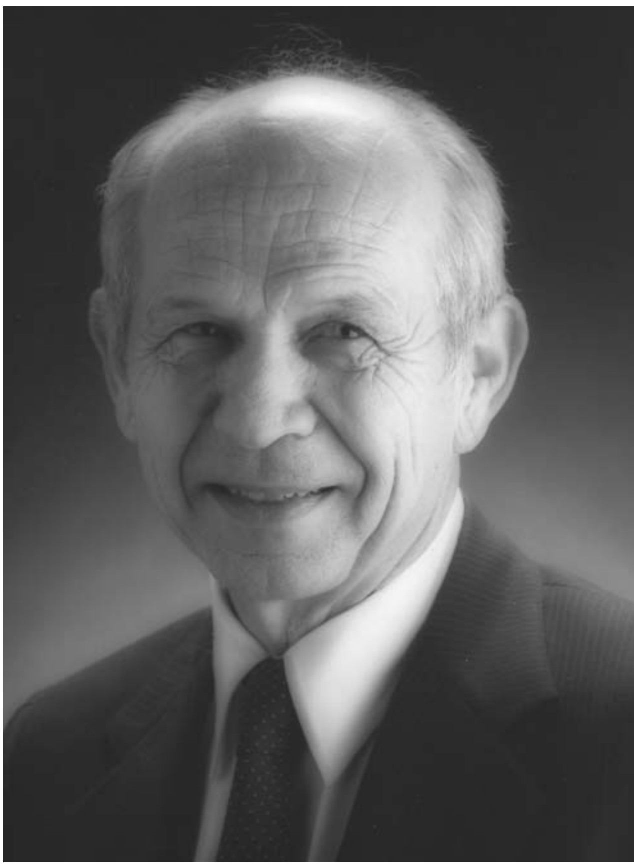
When Larry and I met, I wanted to be an editor and a writer in New York with an apartment overlooking Central Park. Larry wanted to homestead in Alaska. We fell in love despite these differences, and 44 years later, we still shared that love even though neither of us ever lived in those places. Larry did work on the Alaskan pipeline project for Dow and visited Alaska often, and I sold my writings and photographs through agencies in New York, but home was Penn State for 37 years. Together, we traveled to more than 40 countries, exploring sites of scientific discovery and sites of literary merit, food markets and art museums, local customs and native crafts. After each adventure, however, we were always happy to return to Happy Valley.

At home, Larry read in the evenings as he listened to music on his favorite discs. He loved classical, folk, jazz, and even country music if it told a good story. Our four children remember how he often "conducted" some famous classical piece with hair flying and arms flailing at the crescendos. The children, his orchestra, played with equal gusto on the pretend instruments they'd been assigned. When our daughter Laura applied to medical school and was asked for a favorite childhood memory, she mentioned this, and the interviewer said: "How fortunate that all of you children played instruments." She laughed and said: "Well, not exactly."

Long strolls in the woods with the children and grandchildren were always treasured as Larry loved nature and taught as he walked along, taking his lesson plans from nature. A tree growing in an unusual way, a bird call he was sure to recognize, a crawling caterpillar, or a chipmunk rustling in the leaves would all prompt insights. If the grandchildren asked politely, they could often persuade him to show off his almost-perfect crow call, which he once used at an international dinner meeting.

Larry also loved walking to work every day to keep a close eye on the campus trees and plants.

One thing that everyone in our family remembers about Larry was his uncanny ability to look down into a field of grass anywhere in the world and find four leaf clovers. We remembered this when he was dying as he kept reiterating that he felt he was one of the luckiest men to ever walk the face of the earth. But we felt and still feel that we are the fortunate ones to have been able to share his life's journey.



MAXIME A. FAGET

1921–2004

Elected in 1970

"For contributions to the design and engineering of the Mercury and Apollo spacecraft."

BY JOE ALLEN
SUBMITTED BY THE NAE HOME SECRETARY

MAXIME A. FAGET, inventor of the Mercury spacecraft and chief NASA engineer for every manned spaceship developed and flown by NASA, probably until 2010, died on October 9, 2004, at the age of 83. The director of engineering and development at the NASA Johnson Space Center in Houston, Texas, from 1961 until his retirement in the summer of 1981, Faget is widely recognized by his colleagues as the father of the Mercury, Apollo, and Space Shuttle spacecraft.

Max Faget was born in Stann Creek, British Honduras (now Belize), on August 26, 1921. His father, Dr. Guy Faget, was a noted specialist in tropical diseases, and his mother was a health care worker. Both Americans, his parents were employed by the British government to serve in the clinics of this British colony because most British physicians at the time (in the aftermath of World War I) were still serving in England or France.

Max attended San Francisco Junior College in California, but when his parents moved to Louisiana to oversee this country's leprosarium, he enrolled at Louisiana State University (LSU), where he received a bachelor of science degree in mechanical engineering in 1943. After Max died, LSU established a permanent endowed chair in engineering in his honor.

Upon graduation, Max immediately went into the U.S. Navy, where, as a submarine officer, he was in active combat toward the end of World War II. Thus it is not surprising that the first design of the Mercury capsule featured a periscope rather than a window.

After the war, Max was hired by the National Advisory Committee for Aeronautics (NACA, which later became NASA) Division of Pilotless Aircraft Research, an engineering and design team that flew rocket-powered models of airplanes and missiles to supersonic velocities to obtain aerodynamic data. During this time, he was exposed to the idea of space flight and the methods one might use to deal with the high temperatures and dynamic pressures caused by the hypersonic velocities of space vehicles. At NACA, Max became an expert on supersonic inlets, ramjets, and the heating and aerodynamic properties of blunt bodies. He also contributed directly to the design of the X-15, an experimental aircraft that flew at speeds up to Mach 6.

In 1957, shortly after the successful flight of Sputnik, the first artificial satellite to orbit Earth, Max joined a small group of individuals in the NACA Space Task Group investigating ideas to make human space flight possible. By the summer of 1958, he had conceived and proposed the development of a blunt-bodied, one-man spaceship for Project Mercury, the goal of which was to put an American into Earth orbit. The first drawing of this spacecraft, by C.C. Johnson, chief designer of Max's engineering concepts, was completed in June 1958, a full three months before NASA itself was formed.

The complete list of Max Faget's honorary and professional awards takes up two full pages in his biography. A partial list includes NASA medals for outstanding leadership, for distinguished service, and for exceptional engineering achievement; honorary doctorates of engineering from the University of Pittsburgh (1966) and LSU (1972); the Goddard Astronautics Award from the American Institute of Aeronautics and Astronautics; and the Arthur S. Flemming Award. In recognition of his work on the design of the Mercury and Apollo spacecraft and the Space Shuttle, he was inducted into the National Inventors Hall of Fame and National Space Hall of Fame in 2003, the centennial year of the Wright brothers' first manned, powered flight of a heavier-than-air craft. In 1970, he was elected to the National Academy of Engineering. Among Max's patents are the Mercury capsule, the "Aerial Capsule Emergency Separation Device" (the Mercury escape tower designed for use in a launch emergency), and the "Survival Couch" (the device that makes high-g-force reentry of the Mercury capsule safe for the astronaut).

In the early 1970s, he applied for a patent on an early version of a reusable space transportation vehicle (the Space Shuttle), an award that was not pursued to completion because of the many design changes subsequently made to the Space Shuttle to meet additional requirements. This early concept of Faget and Johnson envisioned a one-piece solid rocket booster and an orbiter with short stubby wings. Some years later *Challenger* was lost due to multipiece boosters, and *Columbia* was lost due to its large, delta-shaped wings. Thus, ironically, each accident was caused by a design flaw that would not have existed in Faget's original concepts.

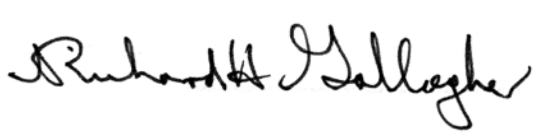
After his retirement from NASA, Max continued to contribute to the U.S. space program. As a visiting professor, he taught graduate-level courses in spacecraft design at Rice University and the University of Houston. In addition, he was a vice president of Eagle Engineering in the early 1980s, and then founder and president of Space Industries Inc. near the Johnson Space Center in Houston. Space Industries was created to engineer and build an inexpensive space station (the Industrial Space Facility, engineered by Max Faget and designed by his long-time colleague, C.C. Johnson), a facility that would remain in Earth orbit and be designed to complement the capabilities of the Space Shuttle fleet being flown by NASA.

Although the project was never completed, in large part because of the loss of *Challenger* in 1986, Max's work ethic, approach to solving tough engineering problems, and overall vision of excellence enabled his colleagues to continue in other lines of business. Max continued to be a senior advisor to the company, which eventually became Veridian, a publicly traded corporation with annual revenues of more than $1 billion and a workforce of about 8,000 engineers, scientists, and technologists. The top technical award given annually in the company was, of course, the Max Faget Award.

Toward the end of his life, Max Faget was asked which of his accomplishments had given him the most satisfaction. Was it true, he was asked, that he was the "chief designer" of American spaceships comparable to Korolyov ("chief designer" of all Soviet space vehicles)? Max answered, "The U.S. is not that kind of country. The king does not appoint a royal spaceship designer." He then pointed to a picture behind his desk of John Paul Jones, often called the father of the American Navy and one of Max's longtime heroes, beside several impressive ships. The caption read: "I wish to have no connection with any ship that does not sail fast, for I intend to go into harm's way."

"I believe I've followed Jones's advice very well," Max said. "I am most proud of contributing to the conception and design of very fast ships indeed, ships which traveled into harm's way with remarkably good success."

Max was preceded in death by his wife Nancy in 1994. He is survived by four children, Ann, Carol, Guy, and Nanette, a daughter-in-law, two sons-in-law and 10 grandchildren.



RICHARD H. GALLAGHER

1927–1997

Elected in 1983

"For outstanding contributions to finite element theory, to its dissemination to engineering practice, to teaching, and to administration of engineering education."

BY RICHARD S. GALLAGHER
SUBMITTED BY THE NAE HOME SECRETARY

RICHARD H. GALLAGHER, a pioneer of the finite-element method (FEM) in industry, who later had a distinguished career as an engineering dean, provost, and university president, died of cancer on September 30, 1997, in Tucson, Arizona, at the age of 69. He received the highest honors for his work not only as an industry expert but also as a teacher, mentor, and academic leader. Internationally known and widely honored for his expertise in engineering mechanics and his pioneering work on FEM, a fundamental mathematical technique used throughout the world in computer simulations of engineering behavior, Gallagher's efforts paved the way for the development of a multibillion dollar industry and thousands of careers and improved millions of lives.

Born on November 17, 1927, in New York City, Gallagher described his early decision to become an engineer as an afterthought. Following his service in the U.S. Navy during World War II, he enrolled at New York University (NYU), where he "checked off civil engineering as a major, thinking that it might be interesting to build bridges." After earning a master's degree from NYU and working for the Federal Aviation Administration and the Texas Company, he moved in the 1960s to the Buffalo area, where he created a premier development group in aerospace structural analysis at Bell Aerosystems; he eventually became assistant chief engineer at Bell.

Gallagher led the development of finite-element analysis methods that took advantage of the capabilities of digital computers to enable the unprecedented design of complex structures. His book, *Finite Element Analysis Fundamentals,* was translated into seven languages. His success in securing grants and funding enabled him to compete successfully with much larger organizations for top talent, and his groups at Bell included top engineers and researchers in matrix analysis, rocket analysis, dynamics, inelastic analysis, optimization, fracture, and composite materials. Under his guidance, Bell researchers pioneered the development of FEM, including inelastic analysis, design optimization, composite materials analysis, linear fracture applications, thermal analysis methods, solid- and shell-element formulations, and the super-element substructuring technique.

While working in industry, Gallagher also published seminal publications, including papers in refereed journals and his first book, *A Correlation Study of Matrix Methods of Structural Analysis* (Pergamon Press, 1964). In his early work, he expanded the practice of finite-element analysis from two-dimensional to three-dimensional analysis, from structural analysis to heat-transfer analysis, from linear analysis to nonlinear analysis, and from aerospace applications to civil engineering applications. During this time, he also made his first presentation at an international conference, in Germany, the first of his invited visits to 78 countries on six continents.

Still working at Bell, Gallagher taught engineering courses and pursued doctoral studies at the State University of New York (SUNY)-Buffalo, where he earned the school's first Ph.D. in engineering in 1966. Shortly thereafter, he became a full professor of civil engineering at Cornell University, where he was soon appointed chairman of the Department of Structural Engineering. Under his leadership, the reputation of the department improved markedly, particularly in the Master of Engineering Program, a fifth-year professional degree that prepared students to become practicing engineers. The department also offered traditional research-oriented graduate degrees. With first-rate faculty, Cornell was soon recognized as one of the top civil engineering schools in the nation.

During his 11 years at Cornell, Gallagher published two key works that established his legacy in the field. *Finite Element Fundamentals* (Prentice-Hall, 1975), a textbook, was eventually published in seven languages and sold more than 40,000 copies. He was also founder and editor of the *International Journal of Numerical Methods in Engineering*, which was recognized as the authoritative professional journal in its field and one of the best-selling journals for its publisher, John Wiley and Sons; his tenure at the journal lasted for 27 years. Gallagher ultimately published 20 books and 120 papers, including *Matrix Structural Analysis*, with W. McGuire (J. Wiley Book Co., 1979) and *Optimum Structural Design* (J. Wiley Ltd., 1973).

In 1978, he embarked on a career as an academic official when he was named dean of the School of Engineering at the University of Arizona. During his tenure there, he pioneered innovative programs, particularly in distance learning for professionals. After he retired in 1995, he remained a professor in residence in the Aerospace and Mechanical Engineering Department for the rest of his life. In 1984, he accepted a position as provost of Worcester Polytechnic Institute in Massachusetts, where he was instrumental in promoting policies that dramatically improved the faculty and reputation of the school.

In 1988, he was named president of Clarkson University in Potsdam, New York, where he guided the school through challenging economic and demographic changes. During his eight-year tenure, several new academic and graduate programs in engineering were introduced, a Center for Advanced Material Processing (CAMP) was constructed, as were a campus center and a 3,000-seat hockey arena. In addition, a major fundraising campaign more than doubled the school's endowment. In 1996, Clarkson dedicated the Richard H. Gallagher Laboratories, a facility with more than 120 laboratories in the CAMP complex, to honor "a man whose vision and leadership in Clarkson's first century laid a strong foundation for a second century of excellence."

Among the many honors Dr. Gallagher received were the Worcester Reed Warner Medal and ASME Medal from the American Society of Mechanical Engineering, the John Von Neumann Medal from the International Association of Computational Mechanics, the Structural Dynamics and Materials Award from the American Institute of Aeronautics and Astronautics, and the Chancellor Furnas Medal from SUNY-Buffalo. The American Society of Engineering Education (ASEE) also awarded him the Lammé Medal, which ASEE considers its highest honor, and elected him to the ASEE Hall of Fame in 1993. He was elected to the National Academy of Engineering (NAE) in 1983 and was the first North American to be awarded an honorary doctorate from Shanghai University of Technology. He also received honorary doctorates and fellowships from the Technical University of Vienna, University College of Swansea, Wales, and Clarkson University. He was a Fulbright Fellow in Australia in 1973 and a visiting professor at universities in Japan, the United Kingdom, and India.

Gallagher's professional career is chronicled in *Early FEM Pioneers,* by John Robinson (published in the United Kingdom), and he is listed in six different editions of *Who's Who.* Despite all of these honors, he considered his greatest legacy to be the development of talent in others. He was always closely involved not only with his professional colleagues but also with his graduate students, who came from all over the world to study with him. He gave unstintingly of his time to those around him, and a great many people in engineering and academia, many of whom became leaders in their fields, owe their careers to his mentoring.

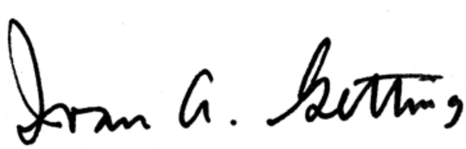
In his personal life, Dr. Gallagher was happily married for 45 years to his wife, Terese (Terry), with whom he had four sons and a daughter. In 1983, when he was inducted into NAE, Dr. Gallagher was singled out in the NAE quarterly, *The Bridge,* as the first member whose five children, all engineering students, went on to pursue graduate work and successful technical and business careers. A memorial symposium and dinner held in early 1998 (and recorded on film) at the University of Arizona was attended by more than 600 people from around the world, including many of his close professional colleagues.

Dick had a terrific sense of humor and insisted that Terry accompany him to 78 countries, six continents, and nine cruises because she shared his wit. They both truly completed each other's personalities and both had a vigorous love of the "arts." Whether it was plays, musicals, or museums, they were in the audience applauding heartily. They were also great sports enthusiasts. As president of Clarkson University, Dick and his wife delighted in having good seats for the hockey games, his all-time favorite sport, and he saw to it that the building of a 3,000-seat hockey arena was a top priority. One of his fondest hobbies was "doing in ink" the *New York Times* crossword puzzle.

His children remember him as the perfect "dad." He took the boys to visit the Baseball Hall of Fame in Cooperstown and to Yankee Stadium in New York City. Always the teacher, they remember viewing the "Bayeux Tapestries" with the headsets strapped to their heads and then visiting the miniature altar in the bedroom of St. Terese in Liseaux, France. He took them on walks on the beaches of Normandy and to view the crosses of those buried at St. Mere Eglise. He took them to Pearl Harbor to look down at the *U.S.S. Arizona* where 1,800 sailors died.

In his memory, publisher John Wiley and Sons commissioned the Richard H. Gallagher Prize for Young Investigators in Numerical Methods in Engineering, a cash award and silver medal featuring Dr. Gallagher's image, to be awarded to talented young engineering faculty at each world congress of the U.S. Association for Computational Mechanics (USACM). Terese Gallagher remains involved in carrying on his legacy, often appearing before audiences of 1,000 or more to present this award. Dr. Gallagher's work also lives on in his professional contributions, his publications, and the many lives he touched.

Dick is survived by his wife, Terry; their five children, Mary Lee, Richard, William, Dennis, and John; and six grandchildren.



IVAN A. GETTING

1912–2003

Elected in 1968

"For development of radar systems and technical weapons; advice to national agencies."

BY GEORGE PAULIKAS
SUBMITTED BY THE NAE HOME SECRETARY

IVAN A. GETTING, founding president of the Aerospace Corporation and inventor of the global positioning system (GPS) satellite navigation concept, died October 11, 2003, at his home in Coronado, California, at the age of 91. Getting was one of a generation of outstanding individuals who held technical leadership positions from the beginning of World War II until the end of the cold war in the 1990s. His autobiography, *All in a Lifetime,* is subtitled "Science in the Defense of Democracy," an apt description of his life and career.

The son of immigrants from Slovakia, Getting was born in New York City on January 18, 1912. He attended grade school and high school in Pittsburgh, Pennsylvania, was an undergraduate at the Massachusetts Institute of Technology (MIT) from 1929 to 1933 as an Edison Scholar, then, as a Rhodes Scholar, attended Oxford, where he received the D. Phil. in astrophysics in 1935. He was a junior fellow at Harvard from 1935 to 1940. A seminal paper written with Arthur Holly Compton in 1935 on possible cosmic-ray anisotropies is still widely cited in the scientific literature for its description of the Compton-Getting effect.

Getting might have had a brilliant academic career, but world events interfered, and he spent the rest of his life working on and advising the government on national defense issues. In 1940, he returned to MIT, where he headed the Division of Fire Control and Army Radar in the Radiation Laboratory. His group developed the SCR 584 automatic-gunfire control radar that, by controlling proximity-fused antiaircraft artillery, has been credited with destroying 95 percent of the V-1 cruise missiles launched by Nazi Germany during World War II.

After a stint as professor of electrical engineering at MIT from 1945 to 1950, Getting left academia to join the Raytheon Company as vice president for research and engineering. In 1960, he resigned from Raytheon to head the newly created Aerospace Corporation.

Throughout his career, indeed throughout his life, Getting not only held positions that entailed heavy administrative responsibilities but also was an advisor to government on many issues, particularly related to national defense. In 1945, with General Hap Arnold and Theodore Von Karman, he was a founding member of the Air Force Scientific Advisory Board, and he later became the chief scientist of the Air Force. He was a member of the President's Scientific Advisory Committee for many years and the National Academy of Sciences Undersea Warfare Committee for 25 years. He was also an advisor to NATO.

Getting participated in, indeed led, many technical advances in national defense, such as the development of air-to-air missiles and radar and electronic systems. He was also instrumental in the founding of Lincoln Laboratory at MIT. His longtime membership on the National Research Council Naval Studies Board and its various panels enabled him to play a leading role in the creation of the Polaris submarine-launched ballistic missile system (SLBM).

Many, many honors, citations, and awards were bestowed on Getting in recognition of his numerous accomplishments. His awards included the Presidential Medal of Merit, presented to him in 1948 by President Truman; the Naval Ordnance Development Award (1945); the Air Force Exceptional Service Award (1960); the IEEE Aerospace and Electronic Systems Pioneer Award (1975); the Los Angeles Chamber of Commerce Kitty Hawk Award (1975); the IEEE Founders' Medal (1989); the

U.S. Department of Defense Medal for Distinguished Public Service (1997); the Navy Superior Public Service Award (1999); the AIAA Goddard Astronautics Award (2001); and, with Bradford Parkinson, the National Academy of Engineering Charles Stark Draper Prize in 2003 for the development of the GPS satellite navigation system. He received honorary degrees from Northeastern University and the University of Southern California.

Getting was a member of the American Academy of Arts and Sciences, a fellow of the American Physical Society and IEEE, an honorary fellow of the American Institute of Aeronautics and Astronautics, and, since 1968, a member of the National Academy of Engineering. He also served on the Board of Directors of the Northrop Corporation and was a trustee of the Environmental Research Institute of Michigan (ERIM) and the University Research Association (URA).

Getting was an avid sailor both in New England and, later, in southern California. When contending with New England fog and heavy weather, he welcomed the sight of lighthouses. Based on a combination of his intuitive knowledge of navigation as a result of his sailing experiences, his work on navigation and positioning systems at Raytheon (such as MOSAIC [mobile system for accurate ICBM control]), which used time-delay-of-arrival [TDOA] principles, the coming of the space age, the availability of high-flying satellites, and his early engineering work on electronic navigation systems, he conceived of a satellite navigation system that would be the equivalent of lighthouses in the sky. Many individuals and organizations subsequently contributed to the realization of GPS, but Getting came up with the fundamental ideas and had the tenacity to see the development of the system through to completion. He always considered GPS to be his proudest achievement.

Based on his long association with the Air Force and the respect of leaders in government and industry for his technical acumen and integrity, his broad vision and experience, and his superb management abilities, Getting was asked to be the first president of the newly created Aerospace Corporation. He headed the company through its early, critical years

(1960 to 1977) as the nation's military space program grew to robust maturity. Aerospace was involved in the development of a family of launch vehicles and satellite systems for communication, navigation, weather, and surveillance, as well as several classified missions. Getting also initiated the planning activities at Aerospace that ultimately led to GPS and was intimately involved in the plans to use Air Force rockets, such as Atlas and Titan, to launch American astronauts into orbit aboard the Mercury and Gemini spacecraft.

As the military space program grew, so did Aerospace Corporation. Getting was always aware of the special role of Aerospace in the planning and development of military space systems, and he made a point of meeting for lunch with every newly hired member of the technical staff to explain the company's mission. He constantly reminded his management team to "hire people at least as smart as you." Now, almost half a century later, the corporation still bears the strong imprint of Ivan Getting.

Getting was a gregarious, compassionate, and outgoing man. Friends tell of a time when he anchored his boat, the *Sirena,* at Catalina Island off the California coast, with quite a few people on board for drinks and dinner. It was a miserable night, cold, rainy, and windy. In the midst of the libations, there was a loud crash and the *Sirena* rolled. A young couple trying to moor their small sailboat, which had no motor, had lost control and run into the *Sirena* in the foul weather. In the middle of the party, Getting donned his rain gear, got into his dingy, and towed them to their mooring—then invited them to join the party!

With his puckish sense of humor, Getting loved to recount his experiences and describe his encounters with the great—and not so great. He was also an excellent pianist. Overwhelmed each year by innumerable Christmas parties, he decided one year to hold the Aerospace management Christmas party in September to ease the crush. Thus, on a warm southern California September afternoon, he appeared, decked out in a Santa Claus hat, playing Christmas carols on the piano. During breaks in the music, he could be seen showing off his prized orchids and having a great time.

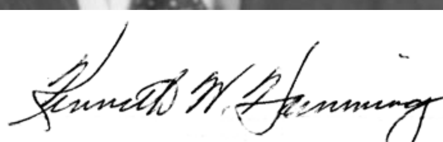
Getting's love for scientific research continued throughout his life, even when he was immersed in pressing management problems, first at Raytheon and later at Aerospace, or serving as a valued advisor to many branches of government. In his honor, the Board of Trustees of Aerospace Corporation named its research complex the Ivan A. Getting Laboratories.

In the face of some skepticism and opposition, Getting had worked tirelessly to make GPS a reality. After his retirement from Aerospace, as a member of an independent review team for many years, he continued to bring his expertise to bear on improving GPS. His efforts were rewarded as the concept grew from an idea to an operational constellation of many spacecraft and became not only an essential military system, but also a global utility serving millions of users throughout the world.

In March 2004, after his death, the Air Force launched a new member of the GPS constellation, with a plaque mounted on the satellite that will remain in orbit for a thousand years. A fitting tribute to his memory, the plaque reads:

Lighthouses in the Sky Serving All Mankind
Dr. Ivan A. Getting
1912–2003

Getting is survived by his wife, Helen; a daughter, Nancy G. Secker of Green Bay, Wisconsin; and two sons, Ivan C. Getting of Boulder, Colorado. Another son, Peter A. Getting of Iowa City, Iowa, died in 2007.



KENNETH W. HAMMING

1918–2005

Elected in 1974

"For leadership in the design of large scale fossil-fuel and nuclear power plants."

BY WILLIAM A. CHITTENDEN

KENNETH W. HAMMING, senior partner of Sargent & Lundy (S&L), one of the leading power plant design engineering firms in the world, an accomplished freshwater sailor, an accomplished musician, and a philanthropist, died on December 21, 2005, at the age of 87.

Born in the Albany Park Community of Chicago on September 22, 1918, Ken's family moved eight years later to the North Park area in time for him to witness the replacement of the Swedish Covenant Church, where he first recalled hearing an organ "speak." This experience may have inspired his lifelong interest in organs and pianos.

In 1935, Ken made the easy choice of attending the college next door to his home, North Park College, which he passed daily when he was growing up. Based on his interest in mechanical engineering, coupled with his strong desire to escape the demands of preparing for piano recitals, he enrolled in the preengineering curriculum. Following his graduation from North Park in 1937, he entered the General Engineering Program at the University of Illinois in Champaign-Urbana, where he received a B.S. in January 1940.

After graduation, Ken joined the Chicago consulting engineering firm of S&L, where he was initially assigned to the mechanical drafting room. Soon, however, he was transferred to the mechanical engineering staff, where he performed theoretical analyses, produced reports, and participated in the design of steam-powered stations for private utilities. During the war years, he was heavily engaged in the design of the power plant at Oak Ridge, Tennessee, which supplied the gaseous-diffusion plant for the Manhattan Project. For a short time during 1944–1945, he left S&L to work as a weight-control engineer for the Consolidated-Vultee Aircraft Corporation in San Diego, California, but he soon returned to S&L, where he worked on the design of numerous steam-powered plants for Commonwealth Edison Company of Chicago.

In 1956, he became a partner in S&L and was made responsible for all of the company's projects for Commonwealth Edison. In 1964, as manager of the Mechanical and Nuclear Department, he became responsible for all of the company's mechanical and nuclear design work. In 1965, he was promoted to director of engineering, in 1966 to senior partner, and then to chief executive officer of the firm until his retirement in 1974, when the firm numbered some 3,400 employees.

During his career at S&L, Ken was directly responsible for the design of 16 Commonwealth Edison Company power plants with a total capacity of more than 5,000 MW. One of those plants, the Ridgeland Station (1948), was one of the first central stations to operate at 1,800 psig and 1050° F with a central control room for multiple units. This plant raised early concerns about the "downwash" of flue gases from short stacks dictated by a nearby airport and had an innovatively designed coal bunker to accommodate the finely crushed coal required for the boiler's cyclone burners. The design of another plant, the Joliet Power Station of 1960, which incorporated one of the first applications of the "unit-train" concept for the delivery of coal, encountered many unusual design problems. In 1964, Ken was instrumental in the development of the "man-made lake" concept for cooling water for the Kincaid Station.

Ken was a member of the American Society of Mechanical Engineers (ASME) Power Test Code Committee No. 6 on Steam Turbines, a member of the ASME Advisory Committee on Nuclear Power, a member of ASA B-3 1 Code for Pressure

Piping, and a member of the ASME Honors and Awards Committee. He was elected a member of the National Academy of Engineering in 1974 and was a member of other professional engineering societies. In recognition of his accomplishments, he was named a fellow of ASME and was a member of the first class of recipients of the Distinguished General Engineering Alumni Award from the University of Illinois. He was a member of the Board of Directors of the Atomic Industrial Forum Incorporated and the Board of Directors of the Chicago Association of Commerce and Industry. During his career, he presented numerous papers and published many articles on power plant design and construction.

Ken had a wide range of interests. He continued to study and develop his musical abilities for the piano and the organ and was the proud owner of two Lowery organs. He played throughout his life for his own pleasure and the entertainment of his family and friends. In the mid-1960s, Ken developed a strong interest in sailing on Lake Michigan and was soon competing in local races. A few years later, in 1966, he entered weekly "offshore" races and then the 333-mile Mackinac Race from the Chicago Yacht Club to Mackinac Island, Michigan. As the seasons passed and Ken and his crew became more competitive, he graduated to larger and more sophisticated boats.

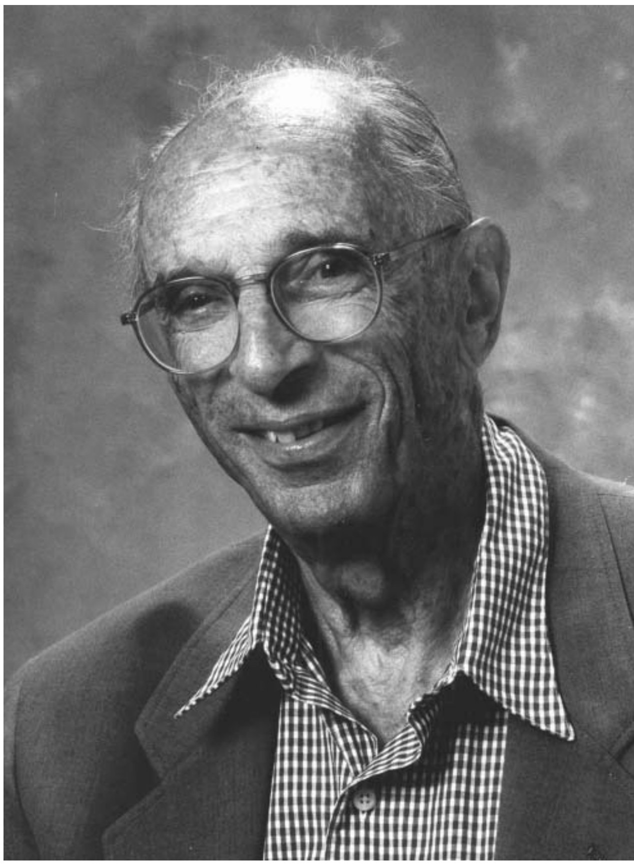
Perhaps the most exciting Mackinac race was in 1970, when severe storms with winds of 70 to 80 mph. severely damaged many of the boats in the 250-boat fleet, two-thirds of which had to drop out of the race. Ken and his crew sailed on to a third-place finish in their class and thirteenth in the overall fleet. In the course of his racing career, Ken developed a Mylar Genoa sail for use in low- or no-wind situations and a ratchet-winch handle to expedite hoisting and trimming sails.

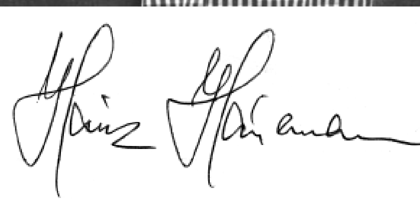
Upon retiring from S&L, Ken turned from racing to cruising, for which he acquired a 57-foot Berger designed for cruising the Great Lakes. After several years, he donated the boat to the U.S. Naval Academy, and an academy crew sailed it from Egg Harbor, Wisconsin, through the Saint Lawrence Seaway to Annapolis, where it was a welcome addition to the academy's fleet.

Ken had a strong sense of responsibility to the organizations that shaped his life and to his family. His notable contributions included the restoration of Viking Hall at North Park University, which renamed the building Hamming Hall in honor of Ken and his wife, Joyce. He also made substantial contributions to the University of Illinois College of Engineering at Champaign-Urbana; the Peninsula Art School in Door County, Wisconsin; the Wisconsin Land Trust in Door County; and other deserving groups.

Last, but surely not least, Ken was a devoted husband of nearly 54 years to his wife, Joyce, a devoted father to their three children, and a devoted grandfather to their eight grandchildren. To his many friends, associates, and family, Ken was truly a Renaissance man.

He is survived by his wife, Joyce; his daughter, Nancy; son, Stephen; and eight grandchildren, Melissa, Onalee, Christopher, Jenny, Julie, Annie, Nicole, and James Kenneth. A son, Greg, predeceased him.





HEINZ HEINEMANN

1913–2005

Elected in 1976

"For conception and development of new petroleum processes and contributions to the advancement of catalysis."

BY JOHN H. SINFELT

HEINZ HEINEMANN, a scientist with a long and distinguished career in industry and academia, died of pneumonia at the age of 92 on November 23, 2005. During the last decade of his life, he was distinguished staff scientist, Lawrence Berkeley National Laboratory (LBNL), University of California, Berkeley, working in the Washington, D.C., office of LBNL. Dr. Heinemann was known for his work on catalytic petroleum refining and petrochemical processes. He also worked on coal gasification and coal liquefaction. Not content to stop working in 1978 after a 40-year career in industry, he spent many more years conducting research and lecturing in a university setting.

Born on August 21, 1913, just before the start of World War I, in Berlin, Germany, Heinz was the son of Felix and Edith Heinemann. He spent his youth in Germany, where he attended the University of Berlin and Technische Hochschule, Berlin, in the early 1930s. The Technische Hochschule refused to accept Heinemann's Ph.D. thesis, because of his Jewish ancestry, according to surviving Heinemann family members, and, therefore, Heinemann left Germany for Basel, Switzerland, where he received a Ph.D. in physical chemistry from the University of Basel in 1937. He then immigrated to the United States in 1938 and became a U.S. citizen in 1944. Several years later, in 1948, he married Elaine Silverman. The marriage was graced by a daughter, Sue, and a son, Peter. After 46 years of marriage, Heinz and Elaine Heinemann were parted by Mrs. Heinemann's death in 1993. Heinz was remarried in 1995 to Dr. Barbara A. Tenenbaum of Washington, D.C.

Heinz arrived in the United States at the tail end of the Great Depression but managed to find work with oil companies in Louisiana and Texas. He was also awarded a postdoctoral fellowship at the Carnegie Institute of Technology, known today as Carnegie Mellon University, where he was involved in research on ethanol produced from sugar cane. According to the Heinemann family, the fellowship was funded by President Rafael Trujillo of the Dominican Republic, where sugar cane was the primary crop. From 1941 to 1948, Heinz worked as a chemist with the Attapulgus Clay Company in Philadelphia, Pennsylvania, where he did research on using bauxite and clays as adsorbents, drying agents, and catalysts.

In 1948, Heinz joined the Houdry Process Corporation in Marcus Hook, Pennsylvania, where he became a key participant in a group at the forefront of research on catalysis in the petroleum industry. Eugene J. Houdry, the man who headed the company, had been the driving force in the 1930s in introducing catalytic cracking in petroleum-refining operations, and the Houdry research group Heinz joined significantly advanced the fundamental understanding of catalytic processes in petroleum refining. In the early 1950s, for example, the group elucidated the bifunctional nature of platinum-on-alumina catalysts, which were being used in the reforming of petroleum naphthas to produce gasoline with improved antiknock properties. Heinz Heinemann was a key figure in this important research, as were several other Houdry scientists, including G.A. Mills, T.H. Milliken, and A.G. Oblad.

The amount of platinum in the reforming catalysts was typically very small, about 0.5 percent by weight, and the surface area of the alumina support was very high, on the order of 200 m^2/g. The alumina surface generally contained chloride ions in an amount roughly comparable to the amount of platinum; this was a consequence of using chloroplatinic acid in the preparation of the catalysts. Additional amounts of halide ions (e.g., chloride or fluoride) were sometimes incorporated into the catalysts. When the catalysts are used in reforming, the platinum provides a source of metal surface sites that are very active in catalyzing hydrogenation or dehydrogenation reactions of hydrocarbon molecules but relatively inactive in catalyzing reactions involving rearrangements of the carbon skeletons of the molecules. By contrast, the surface of the alumina support, with halide ions present, provides a source of acidic sites that are active in catalyzing the latter rearrangement reactions but are relatively inactive in catalyzing hydrogenation and dehydrogenation reactions.

This concept of a reforming catalyst with two distinctly different kinds of active sites capable of catalyzing two distinctly different kinds of chemical steps in a reaction sequence was clearly illustrated by the studies of Heinz Heinemann and his fellow scientists. Thus, for example, in the conversion of methylcyclopentane to benzene, metal sites catalyze the dehydrogenation of methylcyclopentane to methyl-cyclopentenes, which subsequently desorb from these sites and readsorb on acidic sites to undergo a rearrangement to cyclohexene. After desorption from the acidic sites, the cyclohexene then adsorbs on metal sites for the final dehydrogenation to benzene prior to desorption of the latter into the gas phase.

Heinz Heinemann's interests extended beyond catalytic reforming to other processes in petroleum refining. He became known as a key figure in catalysis in the oil industry, as well as in the broader catalysis community. He was a co-founder of the Catalysis Club of Philadelphia, the first of a number of similar groups that appeared across the United States and eventually provided a foundation for the Catalysis Society of North America. Heinz was also instrumental in organizing the International Congress on Catalysis and was president from 1956 to 1960.

From 1957 to 1969, he was director of chemical and engineering research for the M.W. Kellogg Company in New York and from 1969 to 1978 was manager of catalysis research for Mobil Research and Development (R&D) Company in Princeton, New Jersey. During his tenure at Mobil, the company's process for converting methanol to gasoline was developed.

After retiring from Mobil at the then-mandatory age of 65 in 1978, Heinz began a long association with LBNL, University of California, Berkeley, which continued for the remainder of his life. From 1978 to 1994, he conducted research on coal gasification, coal liquefaction, hydrodenitrogenation, oxydehydrogenation, methane-oxidative coupling, Fischer-Tropsch synthesis, and nitrogen oxide-emission control; he was also a lecturer in the Department of Chemical Engineering at Berkeley. Heinz collaborated on research projects with a number of faculty members in the departments of chemistry and chemical engineering and was a consultant to chemical and petroleum companies. In 1995, he left Berkeley to work in the Washington, D.C., office of LBNL, where he brought scientists from LBNL each month to give presentations on their work.

Heinz Heinemann gave freely of his time to many activities on behalf of the catalysis community and the chemistry and chemical engineering communities in general. At technical and scientific symposia, he actively participated in the discussion periods following the formal presentations, and his questions and comments always reflected a keen awareness of the issues.

He founded *Catalysis Reviews* and served as editor of the journal for the first 20 years of its existence. He was also a consulting editor for numerous books in the Chemical Industries Series published by Marcel Dekker Inc. While working at Mobil R&D, he was a member of the Flood Control Commission of Princeton Township and a director of the Princeton Art Association. From 1976 to 1978, he was a member of the New Jersey Governor's Advisory Council on Research.

Heinz received many honors and awards for his contributions to catalysis, petroleum chemistry, and chemical engineering technology. These included his election to the National Academy of Engineering in 1976 and his selection as honoree of the second Advances in Catalysis Chemistry Symposium held in Salt Lake City, Utah, in 1982. He also received the Industrial and Engineering Chemistry Award of the American Chemical

Society in 1972, the Houdry Award in Applied Catalysis of the North American Catalysis Society in 1975, the Philadelphia Catalysis Society Award in 1976, the Distinguished Scientist Award of the U.S. Department of Energy in 1978, and the Homer H. Lowry Award of the U.S. Department of Energy in 1994.

Dr. Heinemann was a distinguished leader in his field for much of the twentieth century and the first years of the twenty-first century. He will be remembered not only for his very significant contributions to industrial catalysis, but also for his effective role as a senior statesman in the field.

STANLEY HILLER JR.

1924–2006

Elected in 1999

"For leadership in helicopter development with great value to human life, safety, and quality."

BY JIM MCCROSKEY

STANLEY HILLER JR., inventor, helicopter pioneer, business leader, and founder of the Hiller Aviation Museum, died April 20, 2006, at the age of 81, from complications of Alzheimer's disease. Mr. Hiller was born November 15, 1924, in San Francisco to the late Opal Perkins Hiller and Stanley Hiller Sr., who was also a businessman, engineer, aviator, and inventor. Stanley grew up in Berkeley, California. On May 25, 1946, he married Carolyn Balsdon, whom he met at the University of California.

In 1944, while he was still a teenager, Stanley Hiller Jr. designed, built, and taught himself to fly an experimental helicopter. He then formed his own design and manufacturing company that produced more than 3,000 helicopters for military and commercial markets worldwide. The company also produced many prototypes of other innovative vertical-flight aircraft. After leading his own company for more than 20 years, Mr. Hiller began a second career in 1966 when he created the Hiller Investment Company, a management consulting firm that specialized in nonhostile takeovers and corporate revivals of faltering U.S. companies to help them become innovative, flexible, and profitable.

Even as a child, Stanley Hiller Jr. had a prodigious talent for invention and innovation. Sitting in his father's lap, he learned to fly before he was 10 years old. At age 12, he started his own business building and marketing miniature gasoline-powered race cars, and within a few years Hiller Industries was producing 350 model cars per month and earning $100,000 per year. During this time, he and his father invented a die-casting machine based on a cooling process that increased the strength of the aluminum castings used in his Comet race car. The invention proved to be so significant that, in 1940, the War Department contracted with Hiller Industries to produce aluminum parts for military aircraft. During World War II, the company had two shifts of employees, seven casting machines, and a payroll of $300,000 per year. Anticipating a postwar decline in the demand for aircraft parts, he conceived ways of using the casting machines to produce aluminum kitchen utensils and briefly manufactured toy water pistols known as the Hiller Atom Ray Gun.

Mr. Hiller's fascination with the challenges and possibilities of helicopters was stimulated by descriptions of Igor Sikorsky's experiments with rotary-wing aircraft. Hiller reasoned that a coaxial rotor design without a tail rotor would overcome some of the complexities and instabilities of Sikorsky's single-rotor configurations. He first built a model, followed by a full-sized helicopter named the XH-44 "Hiller-Copter." This aircraft was constructed mostly of components scrounged or manufactured by his team of engineers and craftsmen and was powered by a civilian aircraft engine supplied by the War Production Board. Hiller conducted the test flight of the XH-44 himself, teaching himself to pilot it in the process, in Memorial Stadium at the University of California at Berkeley in the summer of 1944. On August 30 of that year, he held a public demonstration in San Francisco—the first successful flight of a helicopter in the western United States.

After a brief association with renowned industrialist Henry J. Kaiser, Mr. Hiller and investors formed United Helicopters Inc. in 1945, later renamed Hiller Aircraft Company. The company's goal was to capitalize on the postwar market for low-cost helicopters for the general public by offering an improved version of the XH-44. However, this market failed to materialize, and, after a near-fatal crash, Mr. Hiller developed an alternative single-rotor configuration using stabilizing paddles, called the "rotormatic control system." This new approach was simpler and more reliable, involved significantly fewer parts than conventional rotor systems, and was considerably easier to fly. Subsequently, more than 3,000 of the famed Model 360 light-utility helicopters and numerous variants were sold to commercial and military customers worldwide. Perhaps the most widely recognized version was the U.S. Army H-23, which was used primarily for battlefield medical evacuations in Indochina and Korea and was popularized in the television series "MASH."

Not only a pioneer of practical helicopters, Mr. Hiller remained at the top of his field for two decades. He developed creative designs, manufacturing techniques, and business practices and obtained numerous patents. For example, he introduced all-metal rotor blades; the Rotormatic rotor-control system; helicopters powered by tip-mounted ramjets; and a small, collapsible helicopter that was meant to be parachuted behind enemy lines and reassembled in minutes. He and his team also conceived of and demonstrated a wide range of other vertical-flight vehicles, including a tilt-wing vertical takeoff and landing transport aircraft and vertical-ducted-fan "flying platforms."

After merging Hiller Aircraft into the Fairchild Hiller Corporation, Mr. Hiller left the aviation industry in 1968 to form an entirely new business called the Hiller Investment Company where his creative management skills and techniques helped failing companies turn around and improve their productivity, market share, and profits. Among the many companies he "rescued" were Bekins Company, the moving and storage giant; Levolor Corporation, a producer of window blinds; York International, a large air conditioning firm; and Reed Tool Company, a producer of oil-drilling equipment. When Reed Tool Company was sold to energy giant Baker International, Mr. Hiller helped fashion a merger between Baker and Hughes Tool Company, which became the Baker Hughes Corporation.

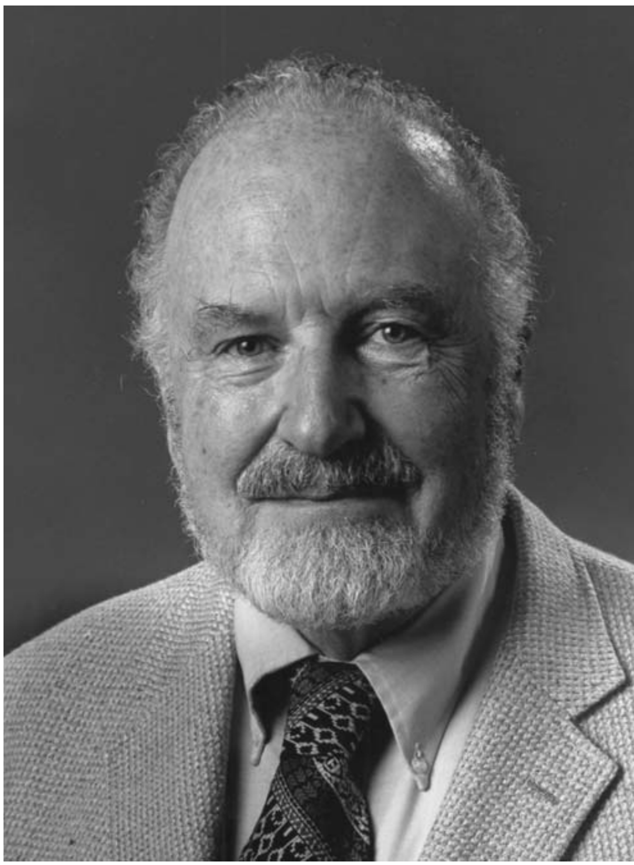
In 1998, he founded the Hiller Aviation Museum at the San Carlos Airport in northern California. Mr. Hiller envisioned a unique education and research museum that would display and explain restored aircraft, replicas, models, and aviation events, with an emphasis on ideas and hardware that originated on the West Coast. Today, the museum highlights the theme of future aircraft and nontraditional challenges and opportunities for young engineers and entrepreneurs. The museum's contribution to the public understanding of the role and value of modern engineering is a fitting climax to Mr. Hiller's long career of leadership and service in the finest tradition of the National Academy of Engineering, to which he was elected in 1999. A memorial service was held at the museum on May 5, 2006.

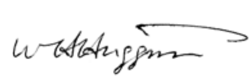
Stanley Hiller Jr. received recognition and awards from a wide range of sources. In 1944, he became the youngest recipient ever of the Fawcett Aviation Award for major contributions to the advancement of aviation. He was a charter member of the American Helicopter Society (AHS), became an honorary fellow of AHS at age 27, and received the prestigious AHS Alexander Klemin Award in 1991. He was awarded the National Transportation Association Award in 1958, the Smithsonian National Air and Space Museum Trophy for Lifetime Achievement in 2002, and the Helicopter Foundation International Heritage Award in 2003. He also served on numerous advisory boards and corporate boards of directors.

His family remembers him as a great father who was devoted to his family. Although Mr. Hillier traveled for work and spent many hours on airplanes, he always managed to spend time with his family. He loved restoring old wooden boats at Lake Tahoe, and he had a passion for boating. The family spent summers cruising from Alaska to Mexico and thru the Panama Canal to Nassau and the Eastern Seaboard. Mr. Hillier loved to find that special place where he could anchor the boat and where the family could spend time together.

His son notes that his dad put together a team and spent over a year working on perpetual motion. He was fascinated with trying to find a way to use magnets to create perpetual energy. Unfortunately, the project was unsuccessful.

Mr. Hiller is survived by his wife, Carolyn Balsdon Hiller; his sons, Jeffrey and Stephen Hiller, and their wives, Mary Hiller and Barbara Hiller; seven granddaughters, Christy Hiller Myronowicz (and husband Cameron) of Hermosa Beach, California, Brooke and Carrie Hiller of Atherton, California, daughters of Stephen and Barbara Hiller; and Maryann, Kristen, Constance, and Samantha Hiller, of Atherton, California, daughters of Jeffrey and Mary Hiller; and a sister, Patricia Hiller Chadwick, of London, England.





WILLIAM HERBERT HUGGINS

1919–2001

Elected in 1970

"Contributions to electrical and biomedical engineering through radar and systems research, publications, and pedagogical innovation."

BY WILSON J. RUGH AND DORIS R. ENTWISLE
SUBMITTED BY THE NAE HOME SECRETARY

WILLIAM HERBERT HUGGINS, a professor of electrical engineering at Johns Hopkins University (JHU) from 1954 to 1984, died August 11, 2001, at the age of 82. Born January 11, 1919, in Rupert, Idaho, he received a B.S. and an M.S. in electrical engineering from Oregon State College in 1941 and 1942, respectively. In 1944, he joined the Radio Research Laboratory at Harvard University, and from 1946 to 1954 he was affiliated with the Air Force Cambridge Research Center. From 1949 to 1954 he was also a research associate at Massachusetts Institute of Technology (MIT); he received an Sc.D. from MIT in 1953. In 1954, he joined the faculty of JHU, where he remained until he retired as Westinghouse Professor Emeritus in 1984.

Huggins received the IEEE Browder J. Thompson Memorial Prize Paper Award in 1948 and the U.S. Air Force Decoration for Exceptional Civilian Service in 1954. He also received several teaching awards, including the IEEE Education Award in 1966, and was elected to the National Academy of Engineering in 1970.

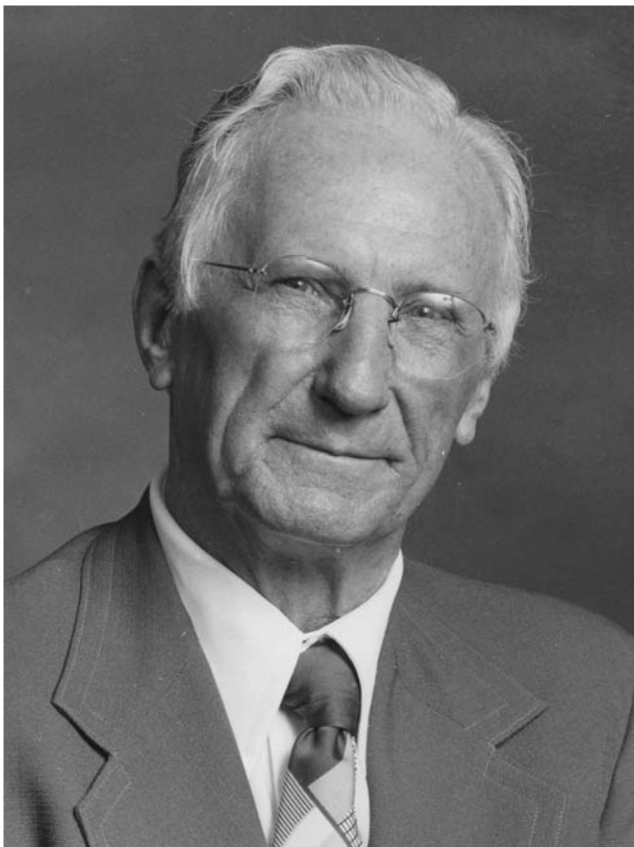
Huggins's early work and publications were on a theory of hearing, electrical-circuit theory, and electronics. His methodical development of an algebraic theory of signal analysis, and a series of technical reports and papers published, with his students, in the 1950s and early 1960s, influenced the generalization of circuit theory into signal and system theory. He was always a strong advocate for using computers in communication, teaching, and research, and later in his career his work was focused on this burgeoning field.

Huggins arrived at JHU with the rank of full professor and quickly demonstrated his unusual qualities as a teacher—enthusiasm and a rare ability to make complex information seem straightforward by changing the way it is encoded. For example, he established a single course for teaching linear models to students in electrical engineering, mechanical engineering, and chemical engineering. His mastery of the subject matter and his zeal for teaching were accompanied by a deep respect for students, and he maintained contact with many of them, both undergraduate and graduate, long after they left the university. Letters from former students continue to arrive at JHU even today.

In 1960, Huggins arranged for the purchase of the first computer at JHU, an LGP-30 made by National Cash Register Company. This device read paper tape and had 1,024 fixed (8-bit) memory spaces, 512 of which were taken up by the compiler. Huggins's fascination with this device and his curiosity about its capabilities spread through the Electrical Engineering Department and to other departments. He and a colleague, James Coleman, who later became one of the most productive sociologists of the twentieth century, collaborated with many students and postdocs to introduce computing to JHU and to the Johns Hopkins Hospital.

Huggins was ahead of his time in introducing computer technology into the engineering curriculum and recognizing its potential for helping students learn design. He even wrote a JOBSHOP program by which students could design devices and then simulate their performance. Nevertheless, he also hedged his bets—in addition to commissioning the preparation of a self-teaching text on FORTRAN I, he invested in a lab equipped with personal-analog computers (one for every four students). His enthusiasm for both hardware and software never waned, however, despite disasters like ending up with just 32 seconds worth of movie film after spending his entire sabbatical year in 1965 trying to generate a computer animation of the mathematical notion of complex phasors. A few years later he endured the frustration of putting a book manuscript on tape (no small achievement at the time) only to have the publisher insist that a paper manuscript be substituted.

No account of Bill Huggins's life would be complete without mentioning his love and talent for music. An accomplished pianist, he played mostly Bach on his nineteenth-century Steinway. He also kept a clavichord in his office that he tuned and played from time to time. He was generally thought to have perfect pitch. Perhaps his research on the human auditory system was a natural consequence of his passion for music.



CHALMER GATLIN KIRKBRIDE

1906–1998

Elected in 1967

"For development of catalytic cracking and petroleum processes."

ADAPTED FROM AN ARTICLE BY SANDY SMITH,
PUBLIC RELATIONS DEPARTMENT, WIDENER UNIVERSITY
SUBMITTED BY THE NAE HOME SECRETARY

CHALMER GATLIN KIRKBRIDE, engineer, teacher, researcher, author, environmentalist, inventor, and major contributor to our understanding of energy, died on June 16, 1998, at the age of 91. Born on December 27, 1906, near Tyrone, Oklahoma Territory, to pioneer parents, he spent his formative years in the southeast Kansas town of Caney. Kirkbride's parents were Zachariah Martin Kirkbride, a frontier judge, and Georgia Ann Gatlin, niece of the inventor of the Gatling gun. He went on to attend the University of Michigan, where he received his B.S and M.S. in chemical engineering in 1930.

Most of Kirkbride's life was devoted to finding efficient ways of extracting and producing fuel to support America's industrial economy. His first job out of college, in 1930, was as a chemical engineer for Standard Oil Company of Indiana (Amoco), now BP. From 1934 to 1942, as assistant director for research at Amoco's Texas City refinery, he ran projects to develop a catalytic cracking process and synthetic rubber for the war effort.

While at Texas City, he met Billie Skains, the Galveston woman who became his wife in April of 1939. The couple remained married for 50 years, until Billie's death, and had one son, Chalmer G. Kirkbride Jr., born in January 1940.

After a brief stint as chief chemical engineer at Mobil Field Research Laboratories, Kirkbride was appointed distinguished professor at Texas A&M University—the first distinguished professorship established by the Texas legislature—where he taught courses in process design in thermal and catalytic processes, fractional distillation, and heat transfer. He also wrote a textbook, *Chemical Engineering Fundamentals* (McGraw-Hill, 1947), which was later translated into Spanish and Russian and was adopted by more than 80 colleges and universities worldwide.

While at Texas A&M, Kirkbride first entered public service. In 1946, he was asked to serve as a science advisor for the atomic bomb tests at Bikini Atoll, which were expected to produce valuable data on the effects of atmospheric and underwater nuclear explosions. The following year he returned to private industry as vice president for research and development (R&D) at Houdry Process Corporation in Marcus Hook, Pennsylvania. As head of the company's R&D unit, he oversaw the development and marketing of catalytic processes for refining and processes for manufacturing polyurethane and butadiene. In 1952, as president and chairman of the board, Kirkbride restored the bankrupt company to fiscal health, collecting a backlog of some $20 million in unpaid royalties and building its licensing business back to the point that its corporate parent, Sun Oil Company, could sell the firm. He also started Houdry's chemical marketing department and established an atomic energy department in its wholly owned subsidiary, Catalytic Construction Company. While at Houdry, he received the first of his more than 22 patents for energy recovery and conversion processes; his last patents were awarded posthumously in 2000 and 2001.

Kirkbride made his most important contributions to the North American energy industry during his 14-year relationship with Sun Oil Company, where he was executive director for the research, engineering, and patent departments from 1956 to 1960 and vice president from 1960 to his retirement in 1970. Under his leadership, research at Sun led to the development of practical ways of recovering oil from Athabascan tar sands in Alberta, Canada, which led to more patents and the development of a major new source of oil. Research at Sun also led to the development of new processes for manufacturing polypropylene plastic, film, and fiber, which are used today in food-storage containers, textiles, automotive parts, and banknotes.

In 1967, he served as president of the Cecil County Anti-Pollution League in Maryland. Through his efforts, the league prevented the B.F. Goodrich Co. from building docking facilities and a chemical plant on the Chesapeake and Delaware Canal, helping to preserve wildlife and avert potential pollution of the air and water in the upper Chesapeake Bay watershed.

Late in his career, Kirkbride's efforts focused on reducing America's dependence on foreign oil. In 1974, he was a member of the Federal Energy Administration's R&D staff, and from 1975 to 1976 he was science advisor to the administrator of the Energy Research and Development Administration. He delivered speeches to industry and civic groups across the country warning of a looming energy crisis that would be worse than the 1973 OPEC oil embargo and urging investment in domestic energy sources that could be developed quickly, including nuclear power and oil from shale deposits in the Colorado Rockies. His last patents were for environmentally friendly processes for producing oil from shale and tar sands. In 1997 Kirkbride founded the Chattanooga Corporation along with his son and a business associate, Jerold Smith, of Bradenton, Florida, to commercialize these processes. In September 2005, the company announced that it had successfully produced synthetic crude oil from shale and tar sands.

Throughout his career, Kirkbride maintained a keen interest in engineering education. In 1953, he became a member of the Board of Trustees of Pennsylvania Military College (PMC), the predecessor institution of Widener University; he was vice chairman of the board from 1954 to 1970, when he became an emeritus trustee. Kirkbride was instrumental in the fundraising and design of a science and engineering laboratory building at PMC, which was named Kirkbride Hall in his honor when it was dedicated in 1965. When the

Kirkbrides moved from Philadelphia to Washington, D.C., in the early 1970s, they donated their nineteenth-century home in Wallingford, Pennsylvania, to Widener College. Today the Billie Kirkbride House, named in honor of Mrs. Kirkbride, is the official residence of the university president. In addition to his involvement with Widener, Kirkbride maintained close ties with his former Texas A&M colleagues, working with them and with Widener faculty on several consulting projects. He was an avid reader who maintained a library of more than 1,000 technical and research books in his home.

Kirkbride served on the boards of several prominent professional and industry groups, including the American Institute of Chemical Engineers (AIChE) from 1946 to 1948 and 1950 to 1955; he was vice president in 1953, president in 1954, and past president in 1955. From 1947 to 1952, he was treasurer of the Petroleum Chemistry Division of the American Chemical Society. From 1958 to 1969, he was a director of the Coordinating Research Council Incorporated, an industry group organized by Walter C. Teagle of Standard Oil Company of New Jersey and Alfred P. Sloan of General Motors to promote technology sharing between the petroleum and automobile industries; in 1967, he was council president. From 1965 to 1969, he was chairman of the National Security Industrial Association's Ocean Science and Technology Advisory Committee.

Kirkbride received numerous honors during his long career. In 1967, he was elected to the National Academy of Engineering. AIChE honored him with the Professional Progress Award in 1951, the Founders Award in 1967, and the Fuels and Petrochemicals Award in 1976; in 1983, on the occasion of the AIChE's Diamond Jubilee, he was named one of "Thirty Eminent Chemical Engineers of America." In 1964, the Delaware County Chapter of the Pennsylvania Society of Professional Engineers named him Engineer of the Year, and in 1971, the Engineers Club of Philadelphia awarded him the George Washington Medal, the club's highest honor. Government honors included service on President Richard M. Nixon's Task Force on Oceanography in 1969 and a Distinguished Public Service Award from the U.S. Navy in 1968.

His academic honors included an honorary Sc.D. from Beaver College in 1959, a D.E. from Drexel University in 1960, and the Engineering Centennial Medal and an honorary D.E. from PMC College (now Widener University) in 1970.

Kirkbride is survived by his son, Chalmer G. Kirkbride Jr.

HENDRICK KRAMERS

1917–2006

Elected in 1978

"For leadership in Dutch industry, education, and professional societies and research on chemical reactor design, separation processes, and process control."

BY R. BYRON BIRD AND BOUDEWIJN VAN NEDERVEEN

HENDRIK KRAMERS (usually called Hans), formerly a member of the Governing Board of Koninklijke Zout Organon, later Akzo, and presently Akzo Nobel, passed away on September 17, 2006, at the age of 89. He became a foreign associate of the National Academy of Engineering in 1980.

Hans was born on January 16, 1917, in Constantinople, Turkey, the son of a celebrated scholar of Islamic studies at the University of Leiden (Prof. J.H. Kramers, 1891-1951) and nephew of the famous theoretical physicist at the same university (Prof. H.A. Kramers). He pursued the science preparatory curriculum at a Gymnasium (high-level high school) in Leiden from 1928 to 1934. Then, from 1934 to 1941, he was a student in engineering physics at the Technische Hogeschool in Delft (Netherlands), where he got his engineer's degree (roughly equivalent to or slightly higher than an M.S. in the United States).

From 1941 to 1944, Hans was employed as a research physicist in the Engineering Physics Section at TNO (Organization for Applied Scientific Research) associated with the Technische Hogeschool in Delft. From 1944 to 1948, he worked at the Bataafsche Petroleum Maatschappij (BPM) (Royal Dutch Shell) in Amsterdam. BPM had given a large sum of money to the Technische Hogeschool (later the Technische Universiteit) in Delft for a research laboratory on the condition that a new professor be appointed. This new professor was Hans Kramers, who at the time was only 30 years old and had but one publication to his name.

Hans readily took up this tremendous challenge. He took upon himself the development of "engineering physics" (applied transport phenomena, chemical-reactor operation, and process control), and the original work he and his students performed resulted in many publications that are still recognized as classics. The experimental set-ups in the laboratory were often homemade and cleverly designed, and the students genuinely enjoyed their work.

Hans was an inspiring teacher who always tried to bring out the best in his students. Although he could be critical and demanding, he knew how to couple his criticisms with a friendly smile and a twinkle in his eye. He supervised 160 students through their engineering degrees and directed the Ph.D. theses of 15 students. Hans and his students published about 70 scholarly papers, mostly in chemical engineering journals. Although the number of publications per year was modest, their quality was high, because Hans was reluctant to publish anything that was not really new.

Besides his contributions to research, Hans's effectiveness as a teacher was demonstrated by the number of prominent positions in research, engineering, and management held by his former students in the Dutch (and very international) chemical industry during the second half of the twentieth century. Ten of his former students became university professors; thus, part of his legacy is the continuing education of outstanding engineers in the Netherlands.

During his Delft period, Hans prepared a set of mimeographed lecture notes called *Physische Transportverschijnselen* (1956), the first attempt to teach the subject of transport phenomena and its applications to chemical engineering. In addition, he coauthored, with K.R. Westerterp, *Elements of Chemical Reactor Design and Operation* (Netherlands University Press, 1963). He also spent the first half of 1955 as a visiting professor at the University of Minnesota.

In the fall of 1957, the University of Wisconsin began teaching transport phenomena to chemical engineering students, which led to the publication of *Notes on Transport Phenomena* (John Wiley, 1958), by R.B. Bird, W.E. Stewart, and E.N. Lightfoot. Bob Bird spent the spring semester of 1958 at Hans Kramers's laboratory in Delft, where he taught transport phenomena and produced a set of class notes, *Transportverschijnselen in Stromende Media* (1958), with the assistance of B. van Nederveen (later CEO of Hoechst Nederland). Hans and Bob engaged in many fruitful discussions and developed a lifelong friendship, and Bob considers his interactions with Hans Kramers very important to his own professional development.

Hans felt very strongly that Europeans should work together across national boundaries to adapt to a rapidly changing world. In 1963, he left the laboratory he had founded and nurtured to take a job as the first scientific director of Euratom, in Ispra, Italy. Fluent in several languages and an international authority in engineering physics, Hans was ideally suited for this job, which required an understanding of the interests of participating countries. Here his talents as an administrator came to the fore.

From 1968 to 1979, Hans was a member of the Governing Board of Koninklijke Zout Organon, later Akzo, and still later Akzo Nobel, located in Arnhem, Netherlands. He was responsible for research and development and engineering during a difficult period of mergers, reorganizations, and the development of new modes of operation. With his leadership style of coaching and encouraging, rather than directing, Hans was a great success. He was a strong believer, both at Akzo and in his many other activities, that people not remain in one job for too long: Board memberships should be limited to two terms; members in scientific and professional organizations should leave five or so years after retirement; and a person starting on a new assignment should consider beforehand how and when to get out.

Hans Kramers served on the following councils and committees in the Netherlands: chairman, Industrial Development Council of the Ministry of Economic Affairs (1979-1986); chairman, Advisory Committee on the Future of the Laboratories for Hydraulics and Soil Mechanics (1981-1983); member of two advisory committees on the future of the Department of Mining and Petroleum Engineering, Technische Universiteit in Delft (1983-1986); consultant to the Ministry of Economic Affairs (1985-1990); member of the General Board of TNO (1975-1985); and committee member of Stichting Toekomst der Techniek (1969-1975).

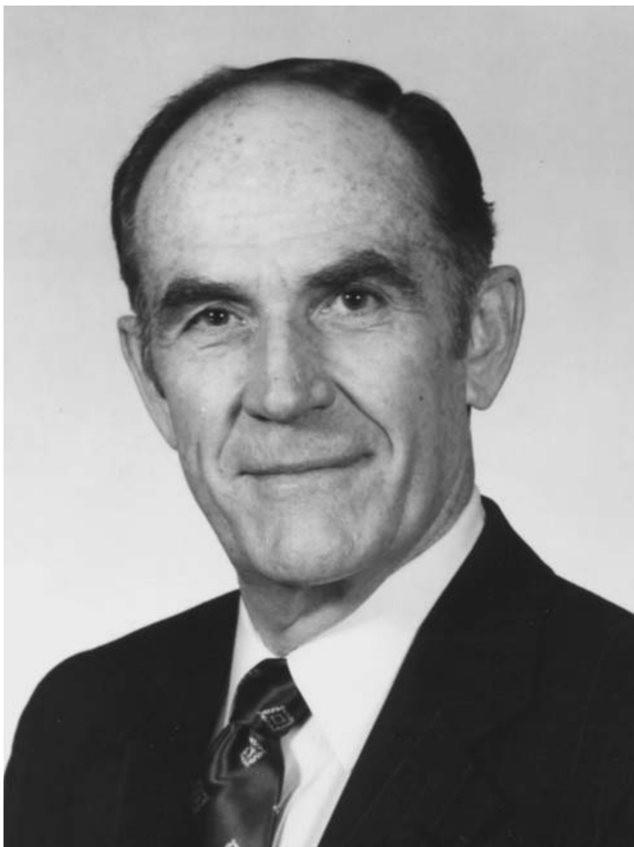
In addition, he was a member of the following organizations: Royal Institution of Engineers (1945); Institution of Chemical Engineers (UK), fellow (1952); Netherlands Physical Society (1945); and Royal Netherlands Chemical Society (1968). He was also one of the founders of the Division of Chemical Engineering and Division of Process Control of the Royal Institution of Engineers in The Hague.

Hans was honored by a number of organizations: Royal Netherlands Academy of Arts and Sciences (1978); Hollandse Maatschappij der Wetenschappen (1958); National Academy of Engineering, foreign associate (1980); Technical Research Medal, Royal Institution of Engineers in the Netherlands (1978); Honorary Doctor, Technische Universiteit in Eindhoven, Netherlands (1976), the first such degree ever granted; honorary member, Royal Institution of Engineers in the Netherlands (1980); honorary member, Netherlands Forum for Engineering and Science (1987); Commendatore nell'Ordine del Merito della Republica Italiana (1970); Knight in the Order of the Lion of the Netherlands (1979); and honorary founding father of the European Federation of Chemical Engineers (1996).

Despite his exalted positions and the many honors bestowed on him, Hans remained quiet and unassuming, amiable, and full of good humor. In his honor, the Technische Universiteit in Delft has named the laboratory he founded the Kramers Laboratorium.

Hans was also a family man. Asked by one of his young sons about his ambitions, he answered that the most important one was to see his children find their way. He and his wife created a trustful home for their children, which was also a common meeting place for the wider family. Hans taught his children and grandchildren to find simple solutions for complex problems, using cheap, effective, and sometimes unorthodox tools. After his retirement, he gradually retreated from the many commitments he was still involved in, and he devoted his time to many issues in the home and the garden, such as woodworking and building compost systems, as well as to the old farm the family had rented in Tuscany for many years. He will always be remembered in his family for his riddles and unexpected funny stories. His and his wife's positive and constructive way of looking at life has been continued by the generations that followed.

Hans was survived for just over one year by his wife Lies, who died on November 20, 2007, and by his five children (Pieter, Jan Dirk, Annelies, Pauline, and Nanette), nine grandchildren, and one great-grandchild.



THOMAS DUANE LARSON

1928–2006

Elected in 1985

"For outstanding contributions in academic leadership, and for creative research and management accomplishments contributing to the advancement of U.S. transportation."

BY PHILIP D. CADY
SUBMITTED BY THE NAE HOME SECRETARY

THOMAS D. LARSON, educator, administrator of transportation agencies at the state and federal levels, leader in transportation associations, and consultant to the transportation industry, died on July 20, 2006, at the age of 77. Larson was born on September 28, 1928, in Philipsburg, Pennsylvania, and grew up on a farm in nearby Grassflat, Pennsylvania. He received his primary education in Philipsburg and earned his B.S. (1952), M.S. (1959), and Ph.D. (1962) from Pennsylvania State University. He also completed postdoctoral studies at Oklahoma State University (1966) and Massachusetts Institute of Technology (1982).

Dr. Larson began his career as a plant engineer at Bethlehem Steel Corporation in Bethlehem and Steelton, Pennsylvania. From 1954 to 1957, he served in the U.S. Navy Civil Engineers Corps, where he was officer-in-charge of construction at Grand Turk and Nantucket, Rhode Island, and public works officer at Camp Lejune, North Carolina. Also, in 1957, he was a designer in the Flood Control Division of the Pennsylvania Department of Forests and Waters.

From 1957 to 1962, while working on his M.S. and Ph.D., he was an instructor in civil engineering at Penn State. By 1979, he had advanced to the rank of full professor, researcher, and administrator. He founded and directed the Pennsylvania Transportation Institute at Penn State, which was a source of significant funding for research, mostly on highways and bridges. As a result of this research, Larson published some 100 reports, technical papers, and journal articles, as well as one textbook.

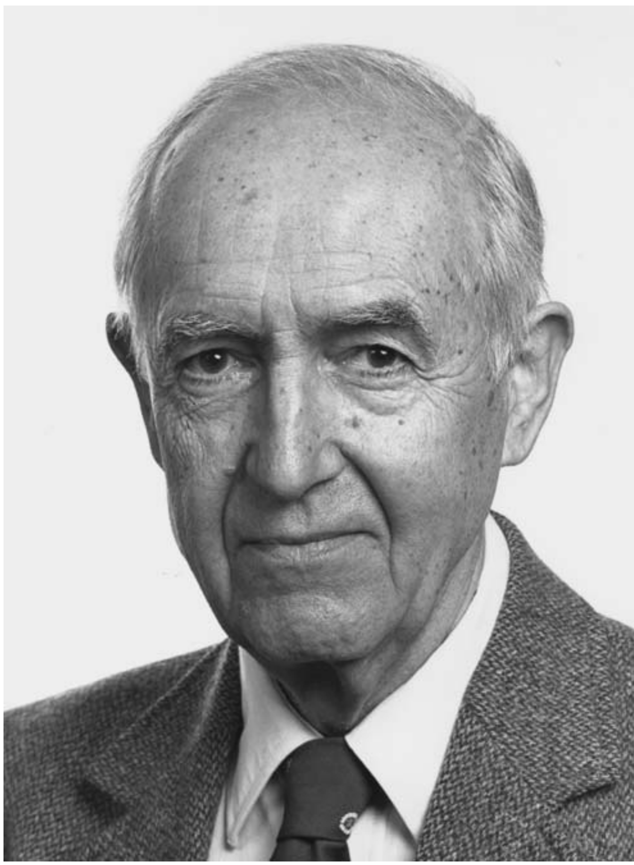
From 1979 to 1987, Dr. Larson was secretary of transportation for the Commonwealth of Pennsylvania under Governor Richard Thornburgh. During that time, he was recognized by the National Governors Association as "Outstanding State Cabinet Official" and was elected a member of the National Academy of Engineering (NAE). He returned to Penn State as a chaired professor in 1987.

In 1989, Dr. Larson retired from Penn State as Pennsylvania Professor Emeritus of government and Management and professor emeritus of civil engineering. On August 10 of that year, he was appointed by President George H.W. Bush as the twelfth administrator of the Federal Highway Administration (FHWA), responsible for the overall management of the organization, including the Federal Highway Aid Program. While at FHWA, he was involved in the development of the Intermodal Surface Transportation Efficiency Act, one of the top items on Bush's domestic agenda. The measure was signed into law in 1991.

Larson was named Construction Man of the Year (1982) by *Engineering News Record;* Man of the Year (1985) by the International Road Federation; Outstanding Pennsylvania Government Official (1985) by the Pennsylvania Chamber of Commerce; recipient of the George S. Bartlett Award for Highway Progress (1989); a fellow of the National Academy of Public Administration (1989); distinguished alumnus of Pennsylvania State University (1990); recipient of the William N. Carey Jr. Distinguished Service Award (1992); and recipient of the American Society of Civil Engineers Medal (1993).

In addition to his regular membership in NAE (1985), he was councillor and a member of the Executive Committee of the NAE Council; a member of the Charles Stark Draper Prize Committee; and a fellow of the National Academies Committee on Science, Engineering, and Public Policy. He was also a member of the National Academy of Public Administration Committee on Management; a member of the Board of Directors, Baker Corporation; president of the American Association of State Highway Transportation Officials (AASHTO); chairman of the National Governors Association Task Force on New Federal Transportation Regulation; chairman of the National Research Council Transportation Research Board; and chairman of the Strategic Highway Research Program Executive Committee. In 1993, when he completed his term at FHWA, he returned to his home in State College, Pennsylvania, where he remained active as a consultant on government and management issues.

Dr. Larson lived his personal life with the same energy he exhibited in his professional life. In October 2004, he was thrown from a horse-drawn cart and hit his head on a tree. He was hospitalized and, initially, showed some improvement, but he never fully recovered. He is survived by Esther, his wife of 50 years, and three daughters, Catherine Bisbee, Suzanne Fetter, and Merilee Peery.



ERASTUS H. LEE

1916–2006

Elected in 1975

"For contributions to advances in mechanics and their application to rocket engine and nuclear power plant design."

BY FREDERICK F. LING

ERASTUS LEE, Rosalind and John Redfem Jr. Chair Emeritus of Engineering, Rensselaer Polytechnic Institute (RPI), died on May 17, 2006, at the age of 90. He was with Rensselaer for 10 very productive years, from 1981 to 1991; prior to that, Ras, as he was known to friends and colleagues, was professor emeritus, Division of Applied Mechanics and Department of Aeronautics and Astronautics, Stanford University, where he had been active for 20 years.

Ras was born on February 2, 1916, in Southport, England, to Herbert J. and Emma Cook Lee. A recipient of several scholarships, Ras graduated in 1937 with 1st Class Honors from the University of Cambridge, where he majored in mechanical sciences and mathematics. He came to the United States for the first time on a two-year fellowship from the Commonwealth Fund of New York to study with Professor S.P. Timoshenko, a renowned professor at Stanford University. Ras earned his Ph.D. in mechanical engineering and mathematics from Stanford in 1940.

Ras remained in the United States during World War II, first as a progress officer in the British Purchasing Commission in New York City and later in the British Air Commission in Washington, D.C. Officer Lee was involved in planning deliveries of aircraft from U.S. companies and keeping records of modifications required to meet British needs.

In 1941, Ras and his bride, Shirley Wilson, whom he met at Stanford, decided to return to England, whereupon he worked at the Ordnance Board and later in the Armament Research Department. In 1944, he was elected a fellow of his College at Cambridge, Gonville and Caius, and in 1945, he received an M.A. from Cambridge. By this time he was contemplating an academic career but decided he should have some experience in engineering practice first. In 1946, he was offered the position of assistant director in charge of the Technical Section, Production Department in the newly established Department of Atomic Energy, where he was involved in the initial designs for the British atomic energy program. However, the next phase—power production—would have taken another five years, so Ras decided it was time to begin his academic career in earnest. He returned to the United State for the second time in 1948 to take up a permanent position as associate professor at Brown University. He remained at Brown until 1962, when he accepted a position at Stanford.

During World War II, the U.S. Navy was keenly interested in impact deformation and the penetration mechanics of projectiles. The Office of Naval Research (ONR) brought a world authority on plasticity, Professor William Prager, to Brown University to conduct research and provided substantial financial support for the establishment of the Graduate Division of Applied Mathematics; Ras was recruited as an associate professor. Soon he was promoted to professor and later elected chairman of the division, a position he held for five years.

In time, several generations of graduate students were brought into the field of plasticity (the study of the consequences of loading materials beyond their elastic range), and these students gradually spread to other leading universities. The year of Ras's retirement from Stanford, his former students and colleagues presented him with a commemorative volume, *Topics in Plasticity*, edited by Wei H. Yang (AM Press, Ann Arbor, Michigan), that includes articles and encomiums describing Ras's path-finding contributions in mechanics and engineering science.

Ras was elected to the National Academy of Engineering in 1975, "for contributions to advances in mechanics and their application to rocket engine and nuclear power plant design." He was a fellow of the American Academy of Mechanics, a life fellow of the American Society of Mechanical Engineers, a John Simon Guggenheim Memorial Fellow, recipient of an Alexander von Humboldt Senior Scientist Award, and a Timoshenko Medalist of the American Society of Mechanical Engineers. This medal, awarded for outstanding contributions in applied mechanics, was named after his professor and mentor of 40 years before!

Despite his brilliance, Ras was always a modest gentleman who willingly served in technical, scientific, or social capacities, but seldom talked about his accomplishments. In fact, he came very close to not having the opportunity to pursue his desires at all. In pre-World War II England, after elementary school, children had to take a scholarship examination for entrance to secondary school, and headmasters had the authority to keep them from taking the examination. Ras's older brother had been denied permission because of the humble status of the family, and the headmaster had suggested that he become a bricklayer. With the future of his three children at stake, Ras's father demanded that his children be allowed to take the examination. As it turned out, all three passed their respective examinations. Ras entered King George V School, the local secondary school, in 1927 and went on from there to the University of Cambridge and a brilliant career.

Ras was predeceased by his wife, Shirley Wilson Lee, and is survived by four children: Michael Lee of Providence, Rhode Island; Martin Lee of Durham, New Hampshire; Margaret Lee of Mill Valley, California; and Susan Greenleaf of Peacham, Vermont. He is also survived by four grandchildren.

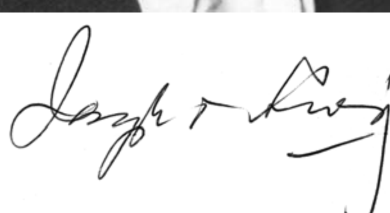
Addition by the Family:

In 1990–1991 Ras (my Dad) began to experience lapses in his memory. Although these were simply puzzling at first, they signaled the onset of Alzheimer's disease. The initial forgetfulness turned into difficulties performing mathematical calculations. He forgot much about his life in America and eventually even lost his ability to clearly recognize family members. After Mum's death in 2002, Dad came to live with my wife and me from January 2003 until February 2006, when he entered a nursing home. Once we learned the art of care giving, these years were the most rewarding of my life. Remarkably, his personality remained essentially unchanged by Alzheimer's disease. He remained gentle, reasonable, optimistic, and helpful, and he always loved to eat.

In spite of the ravages of Alzheimer's, Dad never forgot three early mentors. Edgar Brining "Boss" Hewlett was Dad's scoutmaster, who led his charges on camping expeditions to the Lake District and North Wales, and instilled in Dad a love of hiking, camping, and the outdoors. Boss was also ahead of his time in warning his scouts about the dangers of smoking and drinking. Dad always attributed his longevity to Boss's advice on smoking. George Millward, headmaster of King George V, had been a keen student at Caius College, Cambridge, and he loved mathematics, physics, and science in general. He instilled his passion in a small select group of boys including Dad and one lone girl, who had to suffer the embarrassment of walking over to class from the girls' school. Finally, Stephen "Timmie" Timoshenko was Dad's Ph.D. supervisor during an eventful two years at Stanford when Dad met my mother, shared an apartment with Nick Hoff, skied in the Sierras, drove around the U.S. in the summer of 1939 with another commonwealth fellow, and, according to family legend, in the final month of his stay at Stanford wrote his thesis entitled "The behavior of a mass striking a beam."

In his years with us Dad had lost all his memories of the 43 years as a professor at Brown, Stanford, and Rensselaer. In order to prompt what was left of his memory we constructed a "memory wall" in the dining room with pictures of Dad throughout his life, with fellow scouts, with family, with colleagues, and while lecturing. We always tried to remind him of who he had been: He was a teacher loved by his many graduate students. He was a prized colleague, who was always collegial. He was an outstanding researcher on the behavior of materials under stress. Dad was a caring father, who followed silently 10 feet behind me on my first trip by public bus to school (to make sure I arrived safely), who took his children on hikes, and who coached me on multivariable calculus when I resumed my studies in mathematics and physics after a one-year hiatus at Stanford-in-Germany. He was a devoted husband who supported my Mum's many passions and idealism. He would use a clothespin to replace a lost button on his coat, and his desk at Stanford was piled so high with papers that he had to work on the pullout shelf. But he could always find an important paper in one of the piles. As long as he had clothespins to keep himself together, Dad did not need the material trappings of life such as stylish clothes, fine meals and accommodations, hobbies, or indulgences of any sort. He did not covet awards and prizes, and yet many were bestowed upon him. He found great satisfaction in his profession, his family, and his daily walk, and for him, this was enough.

– Martin Lee



JOSEPH T. LING

1919–2006

Elected in 1976

"For leadership in environmental engineering, specifically in pollution control of air and water."

BY RICHARD A. CONWAY AND LOUIS J. LING

JOSEPH T. LING, a visionary pioneer of pollution prevention and an advocate of sustainable development and growth, died on February 22, 2006, in Minneapolis, Minnesota, at the age of 86. During his 32-year career in engineering, he had a profound influence worldwide on the direction of environmental policy, philosophy, and industrial environmental practices, as well as on government regulation and legislation.

Joe retired in 1984 as vice president, Environmental Engineering and Pollution Control, 3M Company, but continued for another two decades as an advisor and a supporter of myriad academic, industrial, regulatory, and legislative organizations. He was known around the world for his foresight, innovative approaches, and effective implementation of advanced environmental technologies and policies.

Joe was born June 10, 1919, in Beijing, China, into a family with a tradition of public service. At the age of 18, Joe found himself head of the family in Nanking, after his father died and his older brother accompanied the government to Chungking. The Lings survived the bombing and brutal Nanking massacre in November 1937 by hiding in the countryside. Two years later, American Methodist missionaries, Marie Brethorst and Albert Stewart, helped Joe attend Hangchow Christian University in the international sector of Shanghai.

Although schooling became difficult when the Japanese occupied Shanghai on December 7, 1941, Joe still managed to complete his engineering studies in 1943, after only three-and-one-half years. A year later, he married Rose Hsu, a classmate majoring in chemical engineering, who became his lifelong partner. Joe was a district engineer for the Nanking-Shanghai Railroad System from 1944 to 1947. In 1948, he left China to study at the University of Minnesota, where he received the university's first doctorate in sanitary engineering in 1952. In the early 1950s, during the Korean War, the U.S. government refused to allow Chinese nationals with technical expertise to return to China, so Joe joined his wife, a research scientist, at General Mills. Finally, in 1956, the family returned to China, where Joe founded and directed the National Institute of Sanitary Engineering Research in Beijing.

Although the Lings were well treated, they were frustrated by Chinese politics of the era, so they devised an exit plan that got the family out of China to Hong Kong in 1958, where Joe became professor of civil engineering at Baptist University. In 1959, the family moved to the United States, and, in 1960, Joe became 3M's first professionally trained environmental engineer and head of the company's Water and Sanitary Engineering Department. He became a proud citizen of the United States in 1963.

In 1975, Joe established a formal environmental policy for 3M, specifying that 3M would solve its own environmental problems, observe government regulations, and assist the government with environmental regulatory matters. With this policy, 3M moved beyond waste treatment into pollution prevention, natural resources conservation, and a policy of developing products with minimal or no adverse effects on the environment. The policy was based on the idea that pollutants are natural resources that can be reclaimed—and, at the same time, improve operational efficiency through higher production yield.

A highlight of Joe's career at 3M was the Pollution Prevention Pays (3P) Program, established in 1975, which is still a worldwide standard. The 3P Program recognized and rewarded 3M scientists, engineers, and technicians who found ways to eliminate or reduce pollution from products and laboratory or manufacturing processes. The "pays" component of the program—measured in dollar savings—provided essential motivation. After 30 years, the 3P Program is still a key strategy in 3M's Environmental Management Plan. From 1975 to 2005, with some 8,500 pollution prevention activities and programs in 23 countries, the company was able to keep from producing an estimated 2.2 billion pounds of pollutants while saving nearly $1 billion.

Joe realized that government and public awareness was essential to regulatory and legislative acceptance of this new approach, so he "went public" with the idea in 1976. The Economic Commission for Europe held a conference on pollution prevention in Paris that same year, and soon thereafter the United Kingdom, France, Germany, and other countries adopted pollution prevention as an integral part of their national environmental policies.

In 1977, the Environmental Protection Agency (EPA) and U.S. Department of Commerce conducted a series of industry/government seminars on pollution prevention. Joe was a keynote speaker at the conferences in Chicago and Boston; 3M also participated in the conferences in San Francisco and Dallas. These conferences attracted significant attention to the concept of pollution prevention, and, by 1988, 34 states had established pollution prevention programs, and EPA had published a national policy and established the Office of Pollution Prevention. In 1989, the American Institute for Pollution Prevention was founded, sponsored by EPA, with Joe as its chairman. In 1990, Congress passed the Pollution Prevention Act, requiring that pollution prevention be considered the first phase of any environmental enhancement program.

Throughout his life, Joe addressed audiences around the world about the role of pollution prevention in "a conserver society ... that sustains the environment and natural resources, while permitting progress that allows developed nations to maintain a high standard of living and less-developed nations to improve their lifestyles." He stressed the need for cooperation among industry, government, academia, and the general public, because "the environmental issue is emotional ... the decision is political ... but the solution must be technical." His ideas and aspirations encompassed the world, and he called on all "nations of the world to provide for future generations through the achievement of *sustainable patterns of production and consumption.*"

Joe was an advisor to numerous academic, industrial, and governmental organizations worldwide—including the United Nations Environment Program, the Organization for Economic Cooperation and Development, the National Academy of Engineering (NAE), EPA, and the U.S. Chamber of Commerce. He published an impressive number of technical papers, including an influential monograph, *Low- and Non-Pollution Technology Through Pollution Prevention,* prepared with the United Nations Environment Program and circulated worldwide.

In 1974, President Nixon appointed Joe to the President's Air Quality Advisory Board. In 1978, President Carter named him to the Domestic Policy Review of Environmental Policy and Industrial Innovation, and, in 1988, President George H.W. Bush named him to the Jury Committee of the President's Environment and Resources Conservation Award. Joe was elected to NAE in 1976 and was a senior fellow of the Woodrow Wilson National Fellowship Foundation, a diplomate of the American Academy of Environmental Engineers, and a life fellow of the American Society of Civil Engineers.

On June 23, 2005, Joe was awarded the International Air and Waste Management Association Richard Beatty Mellon Environmental Stewardship Award. Among his other awards were induction into the United Nations Global 500 Honor Roll; the first Gold Medal Award of the World Environment Center; and the Queneau Palladium Medal of the National Audubon Society and American Association of Engineering Societies.

A long-time supporter of the University of Minnesota, Joe and his wife, Rose, established the Rose S. and Joseph T. Ling Graduate Fellowship in Environmental Engineering and the Joseph T. and Rose S. Ling Professorship in Civil Engineering.

Joe received the university's Outstanding Achievement Award in 1983.

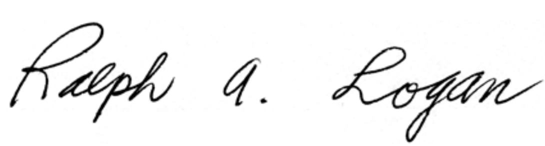
In 1999, *Engineering News Record* selected Joe one of the 125 most significant people of the previous 125 years; all of the individuals on the list were honored for "pioneering, often in uncharted territory, [and] developing new analytical tools, equipment, engineering or architectural designs. Their efforts, singularly and collectively, helped shape this nation and the world." Joe was honored for developing "the total environmental concept, aiming to reduce wastes in the manufacturing process itself."

Joe and Rose raised three daughters born in China and a son born in Minnesota to value education and service. Two became teachers, and two are physicians. He traveled for business and pleasure and enjoyed talking to people all over the world. His hobbies included fishing, walking, eating Chinese food, and giving advice..

Joe is survived by his wife, Rose, and his children, Lois Olson, Rosa Ahlgren, Lorraine Laroy, and Louis Ling and 12 grandchildren, Susan and Sandra Olson; Micah, Aric, Theresa, and Jason Ahlgren; Jennifer, John, and Caroline Laroy; and Eric, Alison, and Amanda Ling. One of the grandchildren has followed in his footsteps to become an environmental engineer. He is also survived by six great-grandchildren

With his vision, tenacity, and diplomacy, Dr. Joseph T. Ling was an irresistible force that moved many an immovable object as he strove for fundamental changes in environmental approaches—from pollution control to pollution prevention to sustainable development and growth. His effect on the environment can best be measured by how many others worldwide have followed in his footsteps.

Although short in stature, Joe was a giant who argued tirelessly and compellingly, in his quiet way, for groundbreaking concepts. Colleagues in the National Academies and elsewhere looked to him as a friend and mentor, and he will be greatly missed.



RALPH A. LOGAN

1926–2006

Elected in 1992

"For contributions to the development of solid-state lasers."

BY MORT PANISH

RALPH LOGAN, retired distinguished member of the technical staff at AT&T Bell Laboratories, played a seminal role in the early development of fundamental semiconductor technologies. He died on December 1, 2006, at the age of 80.

Ralph was born in the very small village of Mille Roches, Ontario, Canada (the village was submerged when the St. Lawrence Seaway was constructed). His mother, Lucy, one of 17 siblings, was an immigrant from Birmingham, England. His father, Joseph Alexander (Alec), from a large close-knit French-speaking farming family in Howick, Quebec, was a Canadian National Railroad agent. For the first few years of his schooling, in Greenfield, Ontario, Ralph attended a one-room schoolhouse. In later years, he liked to claim he was the smartest kid in the class ... and then admit he was also the only kid in his class. When the family moved to Alexandria, Ontario, Ralph thrived in the seventh and eighth grades where he competed with other students and where his aptitude for mathematics became evident. Subsequently, the family moved to Montreal so the children could attend better schools.

Upon graduation from Catholic High School in Montreal in 1943, Ralph won Sir Edward Beatty and Robert Bruce scholarships to McGill University, where he took honors courses in pure and applied mathematics. While at McGill, he won two additional scholarships, the Sir William MacDonald Scholarship and a National Research Council of Canada Bursary. He received a B.Sc. and, after one more year, an M.S., both in applied mathematics.

In 1948, Ralph was offered scholarships to attend graduate school at Rochester University, the University of Illinois, MIT, Cornell University, and Columbia University. He elected to attend Columbia, where he studied under Isidor Rabi and Polykarp Kusch. In 1952, he was awarded a Ph.D. in physics.

After graduation, Sid Millman (a former student of Rabi) was instrumental in bringing Ralph to Bell Labs, where he spent the next 43 years as a researcher. During his career, Ralph made continuous significant contributions to III-V crystal growth, semiconductor physics, and device physics. In several instances, he demonstrated the earliest examples of devices that are now technologically and commercially important. In the late 1950s, he pioneered studies on impurities in silicon (Si) and germanium (Ge) relating the presence of oxygen to defect behavior. One of the earliest workers on III-V compounds, he demonstrated the first high-efficiency red and green light-emitting diodes in gallium phosphide and the first use of such diodes in telephone handsets. His work revealed the promise of light-emitting diodes, which led to their widespread use.

With his co-workers, Ralph demonstrated some of the earliest real optically integrated circuits that incorporated gallium arsenide (e.g., aluminum-gallium-arsenide wave guides, lasers, modulators, and switches). This work laid the groundwork for later studies on shorter wavelengths in the gallium-indium-arsenide-phosphide system.

In the late 1970s and early 1980s, Ralph studied several varieties of buried-heterostructure lasers and demonstrated the first injection lasers with threshold currents of less than 3 mA. He also demonstrated the first low-threshold high-yield crescent laser, which became a major optoelectronic product that stimulated the development of fiber-optic communications. He and his co-workers grew the semiconductor structures for and demonstrated the first low-threshold quantum-well lasers in the gallium-indium-arsenide-phosphide system.

His early distributed-feedback lasers led to the first terabit km/s fiber-optic transmission in 1985. Subsequently, Ralph demonstrated monolithically integrated mode-locked lasers operating at 350 GHz and ultra-low-threshold lasers operating at less than 1 mA at the communications fiber wavelength of 1.55 microns. He continued working on the growth of a variety of semiconductor structures, principally for extending the usefulness of semiconductor lasers, until his retirement in 1994. After retirement, Ralph was a member of the National Research Council Microgravity Committee.

Ralph was the author or coauthor of several hundred papers and the owner of 52 patents. He was a fellow of the Institute of Electrical and Electronics Engineers and the American Physical Society and was designated a distinguished member of the technical staff at Bell Labs in 1982. He was elected to the National Academy of Engineering in 1992.

Ralph's life was not totally consumed with science, however. After he had been at Columbia for about a year, he met Ann Garvey, who had come from Elmira, New York, as a student in a master's program at Teachers College in New York City. They lived within walking distance of each other, enjoyed the city and friends together, including Ralph's large circle of friends and colleagues, and after about two years were married in Corpus Christi Catholic Church on the Columbia University campus.

In January 1953, they moved to Morristown, New Jersey, where they lived for the next 43 years. They had nine children, eight of whom survived Ralph. Ann says that Ralph led the equivalent of two lives. He left early for work at Bell Labs but quit at 5:00 p.m. to come home, help with dinner and shopping, and work on projects with the children. He also loved to cook and was good enough at oil painting for friends to ask for his paintings. In repairing a shell lamp one of the children gave them, Ralph began the craft of seashell lamp shades which then filled their home. Somewhere along the way, he also acquired training in classical piano. He was an all-around handyman for their large home, doing painting, electrical installations, and carpentry, as required.

Ralph was also active in his community. He was president of the Morristown Board of Health in the mid-1950s and chairman of the Democratic Party in Morristown in about 1957. He was also chairman of the Committee of Readers at St. Margaret's Church, and he organized a Jewish-Catholic dialogue; participating couples met monthly at each other's homes for more than 30 years.

Ralph's circle of collaborators was a virtual who's who in the physics and chemistry of semiconductors and semiconductor devices at Bell Labs. His lunch companions might include Chuck Henry, Franz Reinhart, Jan van der Zeil, Dave Lang, Wan Tsang, Barry Levine, John Bean, Anders Olsen, Henryk Temkin, Venky Naryanamurti, Bob Miller, and me. In the field of semiconductor lasers, with apparent ease, he covered the areas of epitaxial growth, device fabrication, and evaluation. Everybody was important enough to him to warrant his time and attention, and, in return, he asked only that his collaborators give him prompt and accurate feedback.

With his creative mind and unique laboratory skills, he was always at the center of the action. However, those of us who were privileged to know him remember him first as a kind man and a good friend who was always willing to reach out and help with a cheerful attitude and confidence that things would work out if we just kept at them.

Ralph is survived by his loving wife of 56 years, Ann (Garvey); eight children, Howard and his wife Mary Ann Logan, Mary Logan, Marguerite Kerscher and her husband Leo, Enid Logan, Alisa Logan and her partner Christine Day, Ruth Catherine Logan, John Logan and his wife Nancy, and Thomas Logan and his wife, Maura; and 10 grandchildren.

ROBERT W. MANN

1924–2006

Elected in 1973

"For contributions to design education and to the advancement of biomedical engineering."

BY THE MIT NEWS OFFICE
SUBMITTED BY THE NAE HOME SECRETARY

ROBERT W. MANN, born in 1924 in Brooklyn, New York, attended Brooklyn Technical High School, after which he entered the U.S. Army and served in the Pacific Theater in World War II. He came to Massachusetts Institute of Technology (MIT) as a student on the GI Bill in 1947 and received his S.B. in 1950, his S.M. in 1951, and his Sc.D. in 1957.

Robert Mann joined the MIT faculty in 1953 and was a professor of mechanical engineering for almost 40 years. During that time, he was also Whitaker Professor of Biomedical Engineering and, from 1974 until his retirement in 1992, director of the MIT Eric P. and Evelyn E. Newman Laboratory for Biomechanics and Human Rehabilitation.

Robert Mann was a leader in the field of design. In fact, he was instrumental in turning design into a discipline. During the 1950s, Professor Mann's research on internal power systems led to the development of the Sparrow I and III and Hawk missiles. But by the mid-1960s, his research was focused primarily on applying technology to human disabilities.

In 1997, during a talk at MIT about his fruitful career, Mann characteristically combined modesty and enthusiasm in describing how he made the switch from "powering rockets to powering people." A fellow veteran who had lost his sight and one arm in the Battle of the Bulge inspired his first applications of technology to helping people with disabilities. In collaboration with John Kenneth Dupress, the blind veteran, and others, Mann inaugurated the Sensory Aids Evaluation and Development Project in 1964. English-to-Braille computer translation systems, the award-winning MIT Braille Embosser, and electronic travel aids for the blind resulted from that project.

Dr. Mann also applied his knowledge of computer-aided design—another area in which he was a pioneer—to his experience with powering rocket systems and his commitment to helping people with disabilities. His Boston Arm was the first artificial limb to be controlled by a combination of biology and technology. Through studies of skeletal joints and osteoarthritis, together with related computer-aided imagery, he explicated the biomechanical role of cartilage and made the only measurements of pressures on and in cartilage in vivo in the human hip. He designed a caliper-like sizing device to ensure that the replacement ball used in hip surgery fit perfectly. While teaching and mentoring graduate students at MIT, Robert Mann, along with Woodie C. Flowers (then a graduate student, now Pappalardo Professor of Mechanical Engineering) was also involved in the development of the MIT Knee.

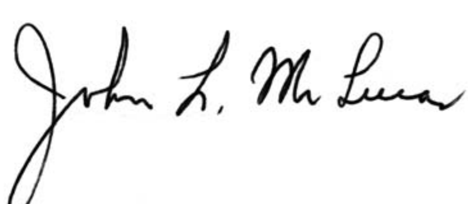
Professor Mann's service to MIT was as innovative as his research on biomechanics. He was a devoted teacher, advisor for more than 300 theses at MIT, and nurturer of MIT's sense of community. He transformed the design curriculum in mechanical engineering in the 1960s when he introduced project-oriented courses that involved students in the entire design process. He was president of the Association of Alumni and Alumnae of MIT from 1983 to1984, only the second faculty member to hold that position in the twentieth century, and he was president of the Class of 1950 for 50 years. In recognition of his contributions to MIT, the institute awarded him two endowed chairs, and in 1983–1984, the James R. Killian Jr. Faculty Achievement Award, which was established to "recognize extraordinary professional accomplishments of full-time members of the MIT faculty." He also received the Bronze

Beaver in 1975, the highest honor awarded by the Association of Alumni and Alumnae.

Beyond MIT, Robert Mann's contributions to other organizations and communities are almost too numerous to mention. He was a member of the Advisory Committee of the National Braille Authority and a member of the National Research Council Committee on the Skeletal System and Prosthetics Research and Development and founder and chair of the Subcommittee on Sensory Aids. He was also director and president of the Carroll Center for the Blind, trustee and president of the National Braille Press, and a consultant on engineering science at Massachusetts General Hospital.

Robert Mann was elected to the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine—one of fewer than 10 people who are members of all three of the National Academies. He was also a fellow of the American Society of Mechanical Engineers, IEEE, American Academy of Arts and Sciences, American Association for the Advancement of Science, and American Institute for Biological and Medical Engineering.

Robert Mann met and married Margaret Florencourt, a researcher at MIT on the Whirlwind Computer Project, in 1950. Margaret died in 2002. He is survived by a son, Robert Jr. (S.B. 1975, S.M. 1977), and daughter-in-law, Susan, of Port Washington, New York; a daughter, Catherine, and son-in-law, Randy Hartnett, of Great Falls, Virginia; two sisters, Virginia Swartz of Pittsburgh, Pennsylvania, and Helene Madigan of St. Paul, Minnesota; a brother, Kenneth, of Burlington, Vermont; and four grandchildren.



JOHN L. MCLUCAS

1920–2002

Elected in 1969

"For conception and development of electronic reconnaissance devices."

BY ALLEN PUCKETT

JOHN LUTHER MCLUCAS—businessman, scientist, administrator, author, and visionary—died of respiratory failure on December 1, 2002, in Alexandria, Virginia. With his death, we lost a distinguished public servant and a good friend. John was exceptional in how he embraced public service. He considered it to be a privilege, a duty, and an opportunity to contribute to the public good.

John was born in North Carolina. After his father died when he was 2, John was raised by various relatives in South Carolina. He worked his way through Davidson College with the assistance of an aunt who sent him $50 a month. He went on to earn a master's degree in physics at Tulane University in 1943 and later a doctorate in physics from Penn State University in 1950.

During World War II, after advanced training at Princeton and MIT, John served as a naval radar officer in the Pacific, where his ship was damaged by a kamikaze attack in the Battle for Okinawa. While attending Penn State after the war, he began working for Haller, Raymond, & Brown Inc., eventually becoming the president of HRB-Singer (now part of Raytheon) and the father of four children. While with HRB, John was awarded 10 patents as he contributed to pioneering developments in infrared aerial photography, radar imaging, telemetry, signals intelligence, and the cable television business.

In 1962 he left this thriving company and moved his family to Washington, D.C., where he became a deputy to Dr. Harold Brown in the Pentagon Directorate of Defense, Research, and Engineering. As John explained to other youthful executives in the Young Presidents Organization, "I believe that a man has an obligation to serve his country through government service if he has that combination of background, education, and personal characteristics which will enable him to be effective." In his Pentagon position, John was responsible for initiating and overseeing many important R&D programs. He and I spent many hours during this period discussing and debating intricate technical issues.

John's next adventure in public service came in 1964, when he went to Paris as NATO's assistant secretary-general for scientific affairs. Two years later he returned to the states to become president of the MITRE Corporation, a Massachusetts-based federal contract research center specializing in communications, command, control, and air defense systems. Under John's leadership, the company provided critical technical support to air operations in southeast Asia and diversified into civilian fields where its systems engineering expertise could be beneficial.

In 1969 John once again answered his country's call, returning to the Pentagon as undersecretary of the Air Force with a covert collateral duty as director of the then totally secret National Reconnaissance Office (NRO). He and Secretary Robert C. Seamans formed a close partnership in leading the Air Force through the last four years of the Vietnam War. In his NRO position, John managed replacement of the Corona reconnaissance satellite and development of a new electro-optical system that would soon revolutionize our nation's intelligence capabilities.

After Bob Seamans's departure in 1973 (to become president of the National Academy of Engineering), McLucas took over as secretary of the Air Force and skillfully managed its transition into the post-Vietnam era. Among the successful programs that John most contributed to were the Airborne Warning and Control System (AWACS) and the F-16 fighter. He also helped modernize the Air Force's culture through his strong support of equal opportunity for minorities and women. For example, he favored opening the Air Force Academy to female cadets and personally made the decision to allow women officers to become pilots.

In 1975, when President Gerald Ford needed a trusted and experienced executive to run the Federal Aviation Administration, he called on John McLucas. While at the FAA, John provided needed leadership on a variety of sensitive issues, including aircraft safety, jet noise, passenger screening, and handling the militant Professional Air Traffic Controllers Union. In 1977 John joined the Commercial Satellite (Comsat) Corporation, where he held three senior executive positions before reaching its mandatory retirement age in 1985.

John, however, never retired from public service. He was always in demand to serve on various boards and study groups and frequently testified as an expert witness for congressional committees. While still at Comsat, he was appointed by President Ronald Reagan to lead a task force that set controversial but badly needed new standards for the number of pilots required on long-distance airliners. In the early 1990s he served on the FAA's Research, Engineering, and Development Advisory Committee and chaired the NASA Advisory Council. He was also a member of the Defense Science Board, the Air Force Scientific Advisory Board, and Boeing's Technical Advisory Committee.

John was very active in professional organizations. A fellow of the Institute of Electrical and Electronics Engineers (IEEE) since 1962, a member of NAE since 1969, and a fellow of the American Institute of Aeronautics and Astronautics (AIAA) since 1971, he served as AIAA president from 1984 to 1985 and on the National Academies' Committee on Science, Engineering, and Public Policy from 1981 to 1984 and again from 1990 to 1993. Among the honorary societies to which he belonged were Sigma Pi Sigma and Sigma Xi.

A great proponent of commercial space and other high-tech enterprises, he served in the late 1980s and 1990s as a director or chairman of the board at the General Space Corporation, External Tanks Corporation, Quest-Tech, Avion Systems, C-COR Electronics, and Orbital Sciences Corporation. He served in similar capacities for scientific and cultural organizations, including the University Corporation for Atmospheric Research, the U.S. Space Foundation, the U.S. Association for the International Space Year, the Wolf Trap Foundation for the Performing Arts, and the Air Force Historical Foundation. He was especially proud of his role as chairman of the Arthur C. Clarke Foundation of the United States from 1983 to 2002 and as member and chairman of the International Space University Board of Trustees from 1990 to 2002.

John enjoyed the variety of his assignments and undertook each job determined to meet his responsibilities and then some. He sometimes commented rather wryly to me that, in all these activities, he hadn't paid much attention to increasing his net worth. But at least he was comfortable and enjoyed working with a wide range of associates and friends. John was generous with what he had, for example, being one of two initial donors to the X-Prize Foundation and giving to many other worthy causes. He is survived by his wife, Harriet, four children, five stepchildren, and nine grandchildren.

The Arthur C. Clarke Foundation, the Space Shuttle Children's Trust Fund, and other organizations and individuals have established a permanent endowment in John's honor dedicated to studying and improving astronaut safety. The endowment was used to create the John McLucas Astronaut Safety Research Fund and sponsors the annual John McLucas Research Prize administered by the University Space Research Association. The prize supports undergraduate student research and new approaches to space flight safety. The Air Force has also memorialized John McLucas with its annual basic research award.

Our country is indeed fortunate to have counted Dr. John McLucas among its citizens. He was a capable and successful businessman, inquisitive scientist, and ingenious engineer who welcomed challenges and sought to solve real-world problems.

Those of us who knew him feel a deep personal loss, but are thankful he left a lasting legacy that includes two major books. The first, *Space Commerce*, was published by Harvard University Press in 2001. The second is an especially informative memoir (completed after his death by Kenneth J. Alnwick and Lawrence R. Benson), *Reflections of a Technocrat: Managing Defense, Air, and Space Programs During the Cold War*. It was published by Air University Press in 2006 and is available for purchase or digital downloading at *http://www.au.af.mil/au/aul/aupress/catalog/books/McLucas_B-101.html.*


Ruben F. Mettler

RUBEN F. METTLER

1924–2006

Elected in 1965

"For outstanding creative missile and systems engineering."

BY TOM EVERHART

RUBEN F. METTLER, a guiding force in the American aerospace industry and former CEO of TRW, died on May 23, 2006, at the age of 82.

Ruben, or Rube as he was generally called, was born in Shafter, California, a small town about 60 miles north of Los Angeles, on February 23, 1924. While doing chores on the farm where he grew up with nine siblings, he first experienced the "hierarchy of duties" in a complex organization, which probably planted the seeds of his future CEO managerial style. "I don't know that a large family directly translates into being comfortable in a corporate setting," he once told a journalist, "but there is no question that a large family is not a likely place to find a highly egocentric person."

A bright, ambitious student who pushed himself to excel, Rube won a scholarship to Stanford and began his undergraduate career there in 1941, intending to study law. However, with the attack on Pearl Harbor that December, he changed his plans. Expecting to be drafted, he enlisted in the Navy at the end of his freshman year. Because he had shown an aptitude for calculus and chemistry at Stanford, the Navy sent him to Caltech, where he studied radar and electronics in the V12 training program and received a bachelor's degree in 1944. He liked the experience so well that, after specializing in radar systems during the war, he abandoned all thoughts of becoming a lawyer and returned to Caltech to earn his M.Sc. (1947) and Ph.D. (1949) in electrical and aeronautical engineering.

When he left Caltech, he was hired as associate director for systems research and development by two earlier graduates, Si Ramo and Dean Woolridge, who were leading the Hughes Aircraft Company. In 1954, he left Hughes for Washington, D.C., where he worked as a consultant to the U.S. Department of Defense and where he met his future wife, Donna. The couple was married in May 1955. Their first son, Matthew, was born in 1958, and their second son, Daniel, came along in 1960.

Returning to California in 1955, he joined Ramo Wooldridge Corporation, later TRW, where he spent the rest of his career. He was a key person in developing the U.S. capability in intercontinental ballistic missiles (ICBMS). From program director of the Thor Program, he subsequently directed the Atlas, Titan, and Minuteman missile programs for Space Technology Laboratories (a corporation owned by TRW). He was named president of the Space Technology Laboratories in 1962, president of the Systems Group in 1963, member of the Board of Directors of TRW in 1965, president and chief operating officer in 1969, and chairman of the board and CEO in 1977. He served in that capacity until he retired at the end of 1988. Among his many accomplishments at TRW, he was responsible for the Pioneer and Orbiting Geophysical Observatory satellites and the lunar module descent engine used for the moon landings.

Rube Mettler received many honors during his lifetime, starting at an early age. In 1954, he was named the Nation's Most Outstanding Young Electrical Engineer; in 1955, he was one of the U.S. Junior Chamber of Commerce's Ten Outstanding Young Men; in 1964, the Engineering Societies of Southern California elected him Engineer of the Year; and, in 1965, he was elected to the National Academy of Engineering. In 1966, Caltech named him one of 23 alumni to receive the first Distinguished Alumni awards, the institution's highest honor. He was a fellow of the Institute of Electrical Engineers and the American Institute of Aeronautics and Astronautics.

He received the Automotive Hall of Fame Leader of the Year Award in 1989, the National Medal of Honor from the Electronic Industries Association in 1990, the Arthur M. Bueche Award from the National Academy of Engineering in 1992, and the National Engineering Award from the American Association of Engineering Societies in 1993.

Ruben Mettler also had a keen interest in people who were disadvantaged. In 1977, President Carter appointed him to develop a program to promote the hiring of Vietnam War veterans. This program was credited with reducing the unemployment rate from 15 percent a year, double the national average, to less than 8 percent. As chairman of the United Negro College Fund, he was credited with raising $110 million in two years. In recognition of his humanitarian efforts, he received the National Human Relations Award of the National Conference of Christians and Jews in 1979 and the Roy Wilkins Memorial Award in 1981 from the L.A. chapter of the NAACP.

Ruben Mettler not only advised several presidents of the United States on defense matters but also was recognized as a leader by his business associates. He chaired the National Alliance of Business (1978–1979), the Business Roundtable (1982–1984), and the Business Council (1985–1986).

Rube had a long association with Caltech. In addition to his three academic degrees and the Distinguished Alumni Award, he was named a trustee in 1968, chaired the Board of Trustees from 1985 to 1993, and was a life member of the board at his death. He also chaired a presidential search committee in 1986–1987 and mentored the selected candidate for several years. He encouraged a successful campaign for Caltech that raised $376 million and funded the Ruben and Donna Mettler Professorship. He was a life member of the Caltech Associates and President's Circle and a member of the Caltech Alumni Association.

After his retirement from TRW, he remained an active advisor to many organizations. A trustee of St. John's Health Center Foundation from 1992 to 2006, he cochaired a capital campaign that raised $125 million to rebuild St. John's Hospital in Santa Monica after the Northridge earthquake of 1994.

Ruben Mettler was a modest giant who accomplished many things for the good of his country. He continually sought opportunities to serve, listened well, led well, and helped others, both as individuals and through organizations. He is greatly missed.

Rube is survived by his wife, Donna, and two sons, Matthew and Daniel, a grandson Jeffrey, two sisters Elsie and Irene, and many nephews and nieces.

ALAN S. MICHAELS

1922–2000

Elected in 1979

"For pioneering developments in the fields of surface, colloid and polymer chemistry, membrane science and technology, and advanced systems for drug delivery to the human body."

BY ANDREAS ACRIVOS

ALAN S. MICHAELS, a talented, creative, and influential educator, inventor, and entrepreneur in the field of chemical engineering, and one of the pioneers in biomedical engineering and biotechnology, died on January 16, 2000, in his winter home in Pasadena, California, after a prolonged illness. He was 77 years old.

Alan was born in Boston, Massachusetts, on October 29, 1922, the elder of two sons of Harry (who was a lawyer) and Edith Michaels. He grew up in Boston and Newton, Massachusetts, and attended Newton High School, graduating in 1941 prior to entering MIT to study chemical engineering. Like many of his contemporaries who chose to study chemical engineering, he decided on the subject because he liked chemistry but wanted to do practical work. His studies were interrupted in 1942 for military service with the U.S. Army Chemical Warfare Service. He saw combat in Germany as a mortar platoon officer (first lieutenant) and was awarded a Bronze Star. One of the few WWII memories he shared with his two sons was of drinking vodka with the Russians on the Elbe on VE day. Alan returned to MIT in 1945 to complete his B.S. (technically class of '44), S.M. in chemical engineering practice (1947), and Sc.D. (1948). His doctoral thesis, "The Measurement of Interfacial Tension at Elevated Temperatures and Pressures," was directed by Ernst Hauser.

After receiving his Sc.D., Alan joined the MIT chemical engineering faculty for the following two years as an assistant professor and worked closely with his senior colleagues W. K. Lewis and E.A. Hauser in the teaching of colloid chemistry. Following a year in industry where he joined a colleague trying to commercialize a new leather tanning process, he was invited to return to MIT as a co-director of the newly organized Soil Stabilization Laboratory (a collaborative activity of the civil and chemical engineering departments). He was promoted to associate professor of chemical engineering in 1956 and to professor in 1961. In 1962, Alan founded Amicon Corporation and went on part-time leave of absence from MIT to organize and build the new company and serve as its president. In 1966, he resigned from the MIT faculty to devote full time to managing the company.

During his 18 years at MIT, Alan played a major role in the development of an intensive teaching and research program in the synthesis, properties, and applications of colloids and polymers. By 1966, this program encompassed six graduate courses and a research team comprising more than 20 predoctoral and postdoctoral students and postdoctoral fellows, whose studies were supported by industrial and government grants. Between 1960 and 1966, the faculty teaching staff associated with this activity increased from two to six. This program brought the MIT chemical engineering department the distinction of being one of the nation's premier centers of graduate study in polymer science and in the engineering applications of surface and colloidal phenomena.

Alan's research activities in the course of his tenure at MIT were extensive and diversified and brought him international recognition in a variety of fields. Specifically, his early work on chemical methods of solidifying solids for military highways and airstrips attracted broad interest in the civil and chemical engineering communities. His use of phosphoric acid, chemically modified asphalt and cement, and synthetic resins as soil stabilizers was considered useful and economical in both military and civilian applications. This work also stimulated his interest in the surface and colloidal properties of clays and clay-water systems and in the development of techniques for modifying mineral surfaces to make them better fillers and reinforcing agents in plastics. Furthermore, his interest in the problems of wetting and adhesion led him into basic research on the spreading of liquids on solids and, later, into the development of a novel method for improving the efficiency of oil recovery from petroleum reservoirs using a previously unrecognized wetting phenomenon.

In 1958, Alan became interested in the factors influencing the transmission of gases and vapors through polymers. He rapidly expanded his research program on polymer permeability and its dependence on polymer structure. The results of this research, which were described in about a dozen published papers, are regarded as the most significant contributions in the literature of polymer physics and are widely referenced both in the United States and abroad. An important concurrent research program involved the development of techniques for preparing "permselective" polymeric membranes, useful for the separation and purification of gaseous and liquid mixtures, which Alan and his MIT research staff subsequently applied, under the auspices of the U.S. Office of Saline Water, to the important problem of desalting seawater. Out of this research evolved the current great interest of the chemical-process industries in membrane separation as a new unit operation.

Amicon was established by Alan as a unique research and development organization devoted to providing innovative product and process development capabilities to private industry and government in the fields of applied surface, colloid, and polymer chemistry and novel chemical separation technology. It also pioneered the concept of "joint venture" research and development projects, wherein the company and its industrial clients or partners shared the cost of the initial research, subject to retention by Amicon of ownership rights to the developed technology, and the grant of royalty-bearing license rights in limited fields to the partners. These arrangements made it possible for Amicon to develop and exploit commercially its most significant technical developments; thus, in 1965, Amicon entered the important new field of membrane ultrafiltration and, in 1968, the field of high-performance epoxy resin adhesives. Amicon's most outstanding technical accomplishments were the development of a unique family of high-flow, low-pressure, semipermeable ultrafilteration membranes and the associated membrane process equipment for laboratory and industrial uses, as well as the development of a novel class of plastics and polymeric composites as engineering materials, packaging materials, and the like. Before its twentieth birthday, the company had become a well-established and respected producer of membranes and related laboratory products, including industrial-scale membrane process equipment and systems, for the pharmaceutical and biotechnology industries and of high-performance adhesives, encapsulants, and specialty polymeric materials for the automotive, electrical equipment, electronics, and computer industries. Amicon was acquired by W. R. Grace and Company in 1983 and merged with Millipore Corporation in 1997.

In 1970, Alan resigned from the presidency of Amicon in order to found and serve as president of Pharmetrics, Inc. (Palo Alto, California), a venture dedicated to research and development in the field of advanced drug delivery systems and devices. (He continued to serve as one of Amicon's directors until its acquisition by Grace.) In 1972, Pharmetrics was acquired by ALZA Corporation of Palo Alto, and, following this acquisition and until 1977, Alan served as president of Alza Research and senior vice president and technical director of ALZA Corporation, as well as a director of ALZA. During his tenure at ALZA, he also served as visiting scholar and consulting professor of chemical engineering at Stanford University, and as visiting professor of chemical engineering at University of California, Berkeley, where he taught courses in surface and colloid chemistry, polymer science, and chemical thermodynamics.

Under Alan's direction, Alza Research became identified as the first research and development organization in the pharmaceutical industry to involve close collaboration between physical and life scientists and engineers engaged in the development of novel pharmaceutical dosage forms. Between 1970 and 1975, the company perfected and introduced into commerce: (1) an ocular therapeutic system (OCUSERT®) which provided seven days' continuous administration of pilocarpine to the eye for the control of glaucoma; (2) an intrauterine system (PROGESTASERT®) which, for effective contraception, continuously delivers progesterone at low rate to the uterine lumen for one year; (3) a small, topically applied transdermal therapeutic system (TRANSDERM SCOP®) that provided 72 hours of continuous administration of scopolamine for the control of motion-induced nausea; (4) an osmotically driven oral therapeutic system (OROS®) permitting the essentially constant delivery of a variety of drugs to the gastrointestinal tract for periods of 6-24 hours; and (5) a self-contained, self-energized, patient-wearable, disposable, liquid-infusion system providing constant-rate intravenous medication for periods of days or weeks. Today, ALZA's TRANSDERM® and OROS® delivery systems are in widespread use around the world and have provided, for many years, a major share of the company's revenues and profits. Alan played an important technical and managerial role in these developments, widely espoused the contributions of the engineering disciplines to the medical community, and stimulated the awareness by the engineering profession of opportunities for engineers in the field of therapeutics. In 2001, ALZA was acquired by Johnson & Johnson Corporation.

Early in 1977, Alan resigned from ALZA to accept an appointment on the faculty of Stanford University as adjunct professor of chemical engineering and medicine, under a grant from the National Kidney Foundation, for the purpose of conducting a research and instructional program on the artificial kidney, other extracorporeal artificial organs, bioengineering, and biomedicine. During his tenure at Stanford, he established an active graduate research program in membrane transport fundamentals; played an instrumental role in initiating an interdisciplinary research program in bioreactor development and genetic engineering; collaborated with the Division of Nephrology of Stanford University's

Medical School in the development of novel diagnostic techniques for studying kidney disease; and co-directed a program devoted to the study of piezoelectric polymers in the Center of Material Research. During this period, Alan was also a visiting professor of chemical engineering at the University of California, Berkeley. His tenure at Stanford also permitted him to reestablish an extensive industrial consulting practice.

In 1982, Alan resigned from Stanford to devote the majority of his time to industrial consulting. Between 1982 and 1984, he also served as adjunct professor of chemical engineering at both MIT and Lehigh University, in the capacity of faculty and student advisor, research co-supervisor, and lecturer. In 1986, however, Alan accepted an appointment as distinguished university professor in the Department of Chemical Engineering at North Carolina State University, Raleigh, where he resumed his teaching and research activities in membrane and separation technology, surface and colloid chemistry, and biochemical/biomedical engineering. In September of 1989, he retired from his faculty position to return to Boston and devote full time to his industrial consulting practice as president of Alan Sherman Michaels, Sc.D., Inc.

In addition to his consulting service to the food, drug, and chemical industries, he served as scientific advisor to the Bioproducts Group (Pharmaceutical and Biosciences Division) and the Food Processing Systems Division of FMC Corporation; as director and scientific advisor to Membrex, Inc. (Fairfield, New Jersey); as scientific advisor to Reprogenesis, Inc., of Cambridge, Massachusetts; and as scientific advisor to Cyotherpeutics, Inc., of Providence, Rhode Island; and from 1996 until his death, as visiting scholar in chemical engineering at the California Institute of Technology, where he collaborated in the planning and the graduate research activities of the expanding program of bioengineering research.

Alan's advisory service to industry, government, and the scientific and academic communities has been extensive and varied; as a consequence of his visit to West Pakistan in 1959 to survey the irrigation problems of the Indus River basin, he was requested to serve as consultant to the President's Science

Advisory Committee and as a member of the Revelle Committee appointed by President Kennedy to study agricultural problems in Pakistan. Also, in 1959, he served as visiting professor of chemical engineering at University College (London). In 1965, he chaired an advisory committee to the director of the Office of Saline Water (U.S. Department of the Interior) on reverse osmosis desalination and, in 1972, he chaired a similar committee for that agency to review piezodialysis. He also served as a member of an advisory committee to the National Institutes of Health on hemodialysis.

Alan organized and chaired numerous symposia and conferences, including the ACS Symposium on Nucleation Phenomena (1965), the Gordon Research Conference on Separation and Purification (1976), and the Engineering Foundation Conference on Advances in Fermentation Recovery Process Technology (1981). He was chairman of the 1986 Gordon Research Conference on Synthetic Membranes.

Alan was elected to the National Academy of Engineering in 1979. After his election, he was actively involved with academy affairs, where he served on the Research Briefing Panel on Chemical and Process Engineering for Biotechnology, as a member and subcommittee chairman of the Committee on Chemical Engineering Frontiers: Research Needs and Opportunities (the Amundson Committee), and of the Committee for Bioprocessing for the Energy-Efficient Production of Chemicals. In 1988, he served as chairman of a National Research Council Workshop on Manufacturing Issues in the Biotechnology Industry. In 1991–1992, he served as a member and subcommittee chairman of the Committee on Bioprocess Engineering for the Board on Biology of the National Research Council.

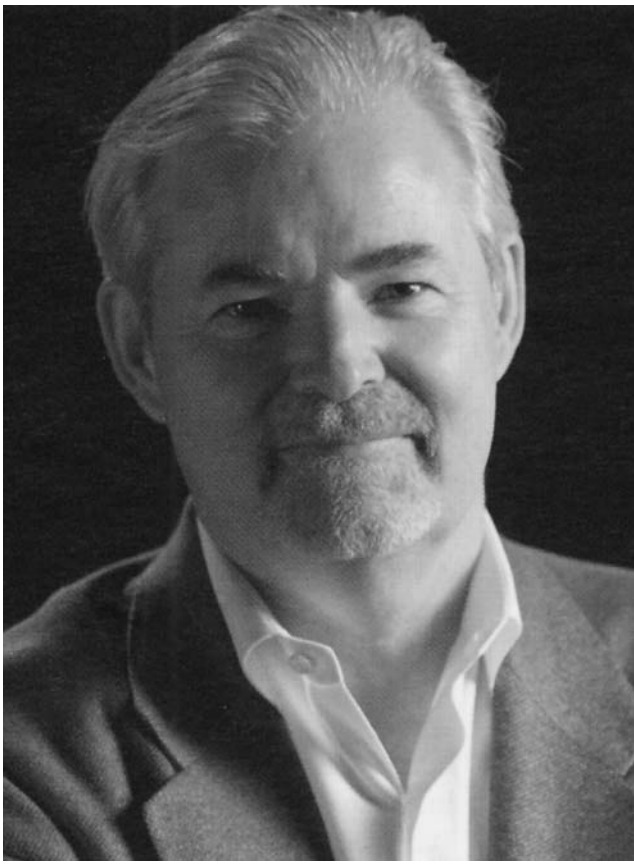
He served as advisory editor of *Separation Science and Technology* (Dekker), *Desalination* (Elsevier), the *Journal of Preparative Chromatography*, and the *Journal of Membrane Science* (Elsevier). During his professional career spanning more than 50 years, Alan authored and coauthored more than 140 technical papers and 58 patents and was a contributing author to eight textbooks.

Alan was a member of Tau Beta Pi, Sigma Xi, the American Institute of Chemical Engineers (fellow), the American Chemical Society, the New York Academy of Sciences (fellow) and AAAS. He received the McGraw-Hill Outstanding Personal Achievement Award in Chemical Engineering in 1974; was designated the 37th Institute Lecturer of AIChE in 1975; received the Food, Pharmaceutical, and Bioengineering Award of the A.I.Ch.E. in 1977; and received the ACS Award in Separation Science and Technology in 1985. In June of 1988, he was honored as one of four Ninth Centennial Lecturers in Chemical Engineering at the 900th Anniversary of the Founding of the University of Bologna (Italy). In 1991, he was elected a founding fellow of the American Institute of Medical and Biological Engineering. In 1992, he was a lecturer at a workshop on "The Biotechnological Production Process" sponsored by the Fondazione per le Biotechnologie, held in Turin, Italy. In 1993, he was plenary lecturer at the Gordon Research Conference on Membranes, Materials, and Processes; an invited lecturer at the International Congress on Membrane and Membrane Processes in Heidelberg, Germany; and an invited lecturer at the 21st Katzir-Katchalsky Conference Workshop on Applications of Membranes in Industry at the Weizmann Institute of Science, Israel. In May 1994, a symposium in his name was organized at the annual meeting of the North American Membrane Society held in Breckenridge, Colorado. He was a director of the North American Membrane Society and was also elected an honorary member of the European Membrane Society.

In 1996, MIT established the Alan Sherman Michaels Endowment Fund in Medical and Biological Engineering in recognition of Alan's contributions to the MIT Department of Chemical Engineering during his tenure as professor in that department and his success in advancing this technology to society's benefit through his service to the medical and pharmaceutical communities. The fund is currently being used to support the Alan S. Michaels Distinguished Lectureship in Medical and Biological Engineering, administered by the Department of Chemical Engineering, whose objective is to bring pioneering contributors in the basic and applied life sciences and bioengineering into constructive interaction with students in engineering and to stimulate cross-disciplinary collaboration in this exciting new area of technology.

Alan is survived by his wife Janet Glotzer Michaels of Pasadena, California, whom he married in 1951; two sons (both chemical engineers), Stephen of Cambridge, Massachusetts; and James of Bedminster, Pennsylvania; and two grandchildren, Aaron and Andrew. A more active, fascinating, and fulfilling life would be difficult to imagine.

*This memorial tribute is a slightly revised version (with help from James Michaels and Allan Hoffman) of a manuscript that Alan Michaels left with his family six months before he passed away.



A. RICHARD NEWTON

1951–2007

Elected in 2004

"For innovations and leadership in electronic design automation and for leadership in engineering education."

BY TERESA MOORE
SUBMITTED BY THE NAE HOME SECRETARY

A. RICHARD NEWTON, professor and dean of the College of Engineering at the University of California, Berkeley, a visionary leader in education and technology and a pioneer in electronic design automation (EDA) and the design of integrated circuits, died on January 2, 2007, at the age of 55, after a short bout with pancreatic cancer. With his eloquence and personal magnetism, he attracted widespread attention to the crucial role of engineers in tackling difficult challenges, particularly challenges facing developing nations.

Born in Melbourne, Australia, on July 1, 1951, Newton was a dedicated educator, researcher, and businessman. Long recognized around the world for his pioneering work in design technology, electronic system architecture, and integrated circuit design, more recently he became known for creating CITRIS (Center for Information Technology Research in the Interest of Society) in 2001, with the goal of bringing together researchers from many disciplines to find technological answers to the social problems plaguing the world. His hope and goal was to educate the next generation of engineers, especially women, to develop those technologies.

Newton was also instrumental in the establishment of the Berkeley Center for Synthetic Biology, which was launched in 2006 with a $16 million grant from the National Science Foundation. He understood the emerging field of synthetic biology as the application of engineering principles to the life sciences.

Newton's interest in engineering was sparked by long hours spent in his father's garage, tinkering with radios and TVs. His formal engineering education began at the University of Melbourne, where he received a B.Eng. and M.Eng.Sci. in 1973 and 1975, respectively. A fortuitous meeting in Melbourne with Donald Pederson, a professor at the University of California (UC), Berkeley, changed his life.

Pederson recognized Newton's skill and ingenuity and invited him to join a team in Berkeley working on a computer program to simulate the operation of integrated circuits. Newton's work on this project kick-started his lifelong interest in EDA. Pederson and Newton worked together to improve SPICE (simulated program with integrated circuit emphasis), a simulation program that enables engineers to analyze and design complex electronic circuitry quickly and accurately. SPICE was then presented to peers for review and improvement, becoming the prototypical example of open-source software. Virtually every electronic chip developed in the world today uses SPICE or one of its derivatives.

After earning his Ph.D. from Berkeley in 1978, Newton spent six months traveling and living in a rural village in India before he began looking for a faculty position. Paul Gray, former executive chancellor and provost of UC Berkeley (and Newton's predecessor as dean of the College of Engineering), was one of the faculty members who decided to hire Newton. As Gray recalls: "We did something we never did. We never hired our own graduate students. We just never did that. It was policy. But in Rich's case, we had to. We knew we could not let such a brilliant individual go to work for an institution we were competing with. He was too good to let go."

Newton went on to become a brilliant teacher and researcher. He helped to found a number of design technology companies, including Cadence Design Systems (formerly SDA Systems), Synopsys, PIE Design Systems, Simplex Solutions (now parts of Cadence), and Crossbow Technology. At Berkeley, he co-founded the Gigascale Silicon Research Center for Design and Test, a nine-university, industry, and government research consortium to address challenges in chip design and testing.

A trusted advisor in the commercialization of emerging technology, Newton served on a number of advisory boards, including the technical Advisory Board of Microsoft Research Laboratories, Lightspeed Semiconductor, Radiata (now a Cisco company), Sonics, Inc., Airgo Networks, Pharmix, and Form Factor. He also served as a member of the board of directors of several companies, including Synopsys and Tensilica. In the venture capital community, he was a venture partner with the Mayfield Fund and Tallwood Venture Capital.

Newton received numerous awards for his research, including the 2003 Kaufmann Award, "the Nobel Prize of EDA." He was a member of ACM, a fellow of IEEE, a member of the National Academy of Engineering, and a member of the American Academy of Arts and Sciences.

Newton's most important legacy, however, was his work for the good of humanity, such as CITRIS, the Berkeley Center for Synthetic Biology, and the many projects he inspired. Richard Blum, a San Francisco financier, philanthropist, and vice chair of the UC Board of Regents, credits Newton with helping develop the concept for the Richard C. Blum Center for Developing Economies, a major multidisciplinary campus initiative launched in April 2006 with a $15 million gift from Blum. "It was his idea that we should use UC's innovative technologies to help developing countries," said Blum. "His death is a huge loss for UC and for society."

"Rich Newton was a man of incomparable vision," said UC Berkeley Chancellor Robert Birgeneau. "Dynamic and entrepreneurial, he understood the power of engineering and technology in entirely new ways, and he connected them to addressing society's toughest problems. The vibrancy of his thinking shaped my own ideas about what engineering is and what it can be. [His death] ... is an enormous loss for us at

UC Berkeley, for California, and indeed for the international engineering community."

Outside of academia and research, Newton was an avid reader and student of spiritual and alternative philosophy. Formative visits to Asia and South America inspired a lifelong interest in Eastern Philosophy and Tibetan Buddhism. He was a poet, writer, and occasional painter. Newton lived in Orinda, California, with his German-born wife, Petra Michel, a theoretical physicist and publisher, and their two children, Neris (13) and Amrita (11).

CHARLES NOBLE

1916–2003

Elected in 1981

"For productive leadership in the control and development of the nation's largest rivers, involving new concepts for effecting optimum utilization."

BY THE CHARLES NOBLE FAMILY
SUBMITTED BY THE NAE HOME SECRETARY

CHARLES "CHUCK" NOBLE was born in Syracuse, New York, to Italian immigrant parents. His father, Anthony, initially worked in the Pennsylvania coal mines, but, after years of self-instruction, he taught himself to be an auto mechanic. Chuck inherited his dad's love of education and excelled in school, where his economics professor at North High School in Syracuse recommended that he pursue an academic career at West Point. At the time Chuck thought West Point was only for rich kids, but months later he saw an advertisement in the newspaper, "Join the Army and go to West Point," and he began actively exploring this opportunity.

After high school graduation, Chuck enrolled in the Army Preparatory School at Fort Totten for the purpose of competing for an appointment to West Point. After serving a year as a private assigned to the 26th Infantry Barracks, Plattsburg, New York, he won appointments to both the military and naval academies. He decided on West Point and enrolled on July 1, 1936, thus achieving his dream.

With World War II looming, Chuck's assignments and responsibilities changed rapidly. His graduation leave was cut short, and he was made platoon and troop commander of A Troop, 8th Engineer Squadron, 1st Cavalry Division, for maneuvers in Louisiana and North Carolina. Next he served as tactical officer, company commander, and battalion commander in the rapidly expanding Officer Candidate Regiment at Fort Belvoir, Virginia. After he was shipped overseas, Chuck commanded the 1271st Engineer Battalion in the Ardennes-Alsace, Rhineland, and Central Europe campaigns. He also commanded the 288th Engineer Battalion with the Occupation Forces.

After the war, Chuck joined the Manhattan Project as the executive officer at Oak Ridge, Tennessee, and liaison officer to the newly established Atomic Energy Commission. In 1948, he earned a master's degree in civil engineering from Massachusetts Institute of Technology and was elected to Sigma Xi. His subsequent assignment was to the War Department General Staff in the Pentagon as plans officer in charge of the atomic desk, which rapidly expanded to a key role in planning the defense of Western Europe. Upon the establishment of the North Atlantic Treaty Organization, Chuck was selected a member of the small American advance party at the new SHAPE headquarters in Paris, France. He served there under General Eisenhower in the Plans and Operations Division and the Office of the Special Assistant to the Chief of Staff, General Cortland Schuyler.

In 1954, Chuck returned to the United States, where he was made deputy district engineer of the New York Engineer District. He subsequently attended the Army War College, after which he took command of the 151st Engineer Combat Group at Fort Benning, with a follow-on assignment as district engineer in Louisville, Kentucky. From 1960 to 1963, he directed the Atlas and Minuteman ICBM Base Construction Program, then was assigned to the National War College, where he earned a master's degree in international affairs from George Washington University.

As a brigadier general, he served as engineer, Eighth Army, in Korea, and later returned to Washington, D.C., as program director for Southeast Asia construction in the Office of the Secretary of Defense. Next he was director of civil works in the Office of the Chief of Engineers at the Pentagon, where he also served as president of the Coastal Engineering Research Board and chief engineer of the Presidential Atlantic-Pacific Interoceanic Sea Level Canal Study Commission.

As a major general, Chuck was chief engineer for the U.S. Army, Europe; in 1970, he became commanding general of the Engineer Command in the Republic of Viet Nam. In 1971, President Nixon appointed him president of the Mississippi River Commission, with additional duties as chairman of the Red River Compact Commission and member of the Board of Engineers for Rivers and Harbors. He retired from active duty in 1974.

Chuck then joined the Charles T. Main Engineering Company in Boston, where he managed engineering projects in Argentina, Uruguay, Canada, Nigeria, Panama, Saudi Arabia, Java, Indonesia, and Kuwait. He retired from the company in 1984 as president and chief executive officer.

Chuck was a registered professional engineer in eight states and the District of Columbia and a recipient of the Wheeler Medal for most outstanding engineer in America. During his tour of service in the U.S. Army, he received three Legions of Merit and three Distinguished Service Medals, among other awards. In 1981, he was elected to the National Academy of Engineering for his lifetime contributions to engineering in the United States. He is also listed in *Engineers of Distinction, Who's Who in Engineering*, and *Who's Who in America*.

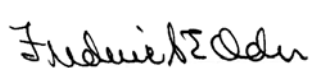
Chuck married Edith Lane just prior to World War II, and the couple had five girls, three boys, 12 grandchildren, and four great grandchildren. Chuck was a devoted father and grandfather who imparted to his family his sense of values, a strong work ethic, and a sense of security. He participated in everything at home, including helping with housework and preparing Thanksgiving and Christmas dinners. Education was his top priority, and he provided college tuition for every grandchild and great-grandchild.

Chuck had a wonderful sense of humor and a caring, optimistic spirit that encouraged everyone to do their best on every project. He treated his subordinates with dignity and respect and was always considerate of others and looked after the little guy.

Family dominated his hobbies and interests. Over a period of 10 years he built and expanded a camp in the Adirondack Mountains, which ultimately had six bedrooms that could accommodate his children and grandchildren, so the family could all vacation together. An early riser all his life, he would always have a roaring fire and homemade waffles ready for the grandchildren when they awoke in the morning. At night he would make spaghetti with his own canned tomato sauce. An avid gardener, he grew his plants from seed and drew detailed sketches of his elaborate gardens. He liked to read in the evening, usually a biography, a medical journal, or a book of ancient history.

Chuck Noble lived out the American dream, rising from modest boyhood circumstances to become one of the most accomplished engineers in the United States. Nevertheless, he remained humble throughout his life. He loved serving his country and was thankful he was able to play a minor role in its development. In his eyes, the door to opportunity opened with his admission to West Point. He loved his alma mater and was steadfastly grateful to the academy for preparing him to face a challenging future with honor, distinction, integrity, and love of country.

His survivors include three daughters, Jeanne Davey, Lynn O'Looney, and Carol Noble and a son, Stephen Noble.



FREDERIC C.E. ODER

1919–2006

Elected in 1980

"For leadership in conceiving and developing civil and military satellites."

BY VANCE COFFMAN

FREDERIC C.E. "FRITZ" ODER, colonel, United States Air Force (retired), and former vice president of Lockheed, died May 11, 2006, in Gloucester, Massachusetts, at the age of 86. He was elected to the National Academy of Engineering in 1980.

In the earliest days of pioneering work on satellite reconnaissance, Fritz Oder was instrumental in transforming what was a theoretical concept of having an "eye in space" into reality. At the time, the United States and Soviet Union were vying politically and militarily, and very little reliable information was available about the USSR's missile and bomber capabilities. Images collected by early satellites gave U.S. presidents photographic evidence of Soviet activities and enabled them to make decisions that had far-reaching implications for America and its allies. In 2000, for this and other contributions to national security—many of which remain classified—Fritz was named a pioneer in national reconnaissance and was inducted into the Air Force Space and Missile Pioneers Hall of Fame.

Fritz was born October 23, 1919, in Los Angeles, California. In an interview late in his life, he said, "I became interested in space at a very young age, long before there was a national space program. I studied and developed an expertise in geophysics and meteorology, which allowed me to get early exposure to developing payloads and putting them on the rudimentary sounding rockets of the post-World War II era."

He attended the California Institute of Technology where he received a B.S. in geology in 1940, then enlisted in the U.S. Army Air Corps as a flying cadet. The Army sent him back to Cal Tech to finish his master's degree in meteorology, which he accomplished in 1941. He was commissioned on July 1 of that year and spent World War II as a weather officer in the Philippines and at numerous locations in the United States. At the end of the war, the Army offered him an opportunity to continue his studies at the University of California-Los Angeles (UCLA), where he received his Ph.D. in meteorology and physics in 1952.

After UCLA, Fritz returned to the Air Weather Service (AWS) and was made director of geophysical research at Cambridge Field Station in Massachusetts, where he managed a staff of about 75 civilians and military personnel. Fritz worked with sounding rockets, such as the "Aerobee" and "V-2/Bumper," which gave him extensive practical experience in putting payloads on rockets.

Following his tour at Cambridge, he was assigned to the Central Intelligence Agency (CIA), where he became the deputy director of the CIA Physics and Electronics Division in the Office of Scientific Intelligence. At the CIA, he developed a close working relationship with the renowned intelligence officer Richard Bissell—a relationship that would prove essential in the eventual development of the Corona Program, the world's first photoreconnaissance satellite system.

In August 1956, Fritz was made the first director of the Air Force Weapons System-117L Advanced Reconnaissance System Program by USAF Major General Bernard A. Schriever. WS-117L was established after several studies conducted by Project RAND (later RAND Corporation) affirmed the technical feasibility and potential of satellite reconnaissance. WS-117L led to the establishment of launch complexes and vehicles, spacecraft, the Satellite Control Center, and tracking stations used in all early National Reconnaissance Office (NRO) satellite programs, including Corona.

Fritz Oder initiated and supervised many of the engineering decisions in the nascent field of satellite design and launching, including the development of the Agena upper-stage booster vehicle, built by Lockheed Missiles & Space Company. He also figured prominently in the development of the Atlas, Thor, Titan, and Minuteman missile systems. He centralized satellite engineering to include payload departments, streamlined program management, and established leading-edge approaches to inertial guidance, passive thermal control, and storable propellants. He also directed research and testing of an imaging read-out satellite reconnaissance system, called Samos, that never became operational but laid the groundwork for NRO's digital satellite systems of the 1970s.

Lockheed Missiles & Space Company, which had a long history of developing classified government programs, was the industry partner for the Corona Program. Lockheed was technical adviser and integrator of all Corona equipment (other than the Thor booster) and centralized the assembly process in facilities in Menlo Park, California. The optics system, which was central to the program, involved a vertical-looking, reciprocating, 70-degree panoramic Itek camera that used special film developed by Eastman Kodak.

The camera was designed to scan at right angles to the line of flight and used image-stabilization processes to improve the visual sharpness of objects on the earth's surface a hundred miles below. Resolution in the early years was in the range of 35 to 40 feet, but eventually it was improved to the point that objects as small as 6 feet across could be identified. The exposed film was ejected by the Corona satellite in a General Electric reentry capsule designed to be captured by a specially modified C-130 aircraft. The cover name "Discover" was used to maintain the secrecy of the program.

Like many development programs, Corona experienced numerous early setbacks, and there was talk of canceling the program altogether. Finally, on August 18, 1960, Discoverer XIV, after ejecting its recovery capsule, which was subsequently recovered in midair, produced Corona's first usable reconnaissance photographs, images covering more than 2 million square miles of Soviet territory. Fritz characterized the reaction of photo interpreters to these photographs as "stupendous."

A reserved and modest man, Fritz Oder was highly regarded by his colleagues in government and industry, but his renown was circumscribed by the veil of secrecy surrounding Corona. He was a dedicated family man, but could not discuss his work with family members or explain the reasons for his frequent absences from home. When he reviewed his travel records at the end of one year, he realized he had been away from home 48 of 52 weeks. Despite the importance of his work, he realized the toll it took on his family, and so, on September 20, 1960, after 20 years in the Air Force, he retired.

He immediately went to work for Eastman Kodak in Rochester, New York, as director of special projects, with a staff of about 1,000 engineers. Once again, now at Kodak, he worked primarily on NRO projects. But he also was involved in the Lunar Orbiter Program, which used electronic photoreconnaissance techniques similar to those used by Samos to identify possible landing sites on the Moon.

In 1966, after more than five years at Eastman Kodak, Fritz and his family moved back to California, where he joined Lockheed Missiles & Space Company as a vice president in the Space Systems Division. In 1970, he became program manager for the NRO program that launched the world's first near-real-time imaging-reconnaissance system.

All told, his career in national reconnaissance spanned 28 years, from 1956 to 1984, the year he retired from Lockheed. During that time, NRO acquired, launched, and operated many of its most sophisticated imaging and signals reconnaissance satellite systems. Fritz's work helped minimize technical risks and hold down costs for these state-of-the-art NRO programs.

After retiring from Lockheed, Fritz became an independent consultant. Under contract to NRO, he coauthored a history of Corona, which was completed in the late 1980s, long before the facts about this revolutionary program were declassified in 1995. He also contributed to classified histories of other space programs and advised the Air Force Space Division on its Titan launch vehicle. He was also the author or coauthor of many other classified and unclassified publications.

Besides being an NAE member, Fritz Oder was a fellow of the American Institute of Aeronautics and Astronautics; a member of the Scientific Research Society of America; a senior member of the American Astronautical Society; a fellow of the Explorers Club; a member of F&AM Lodge 712 (Los Altos, California); and a member of the Commonwealth Club of California.

In addition to being named an NRO pioneer and an inductee to the Air Force Space and Missiles Hall of Fame, his many awards included the Legion of Merit for Accomplishments as program director, First Air Force Space Program (WS-117L). He was affiliated with Sigma Xi, was on the Board of Governors of the National Space Club, and was a member of the Cosmos Club.

In 2000, at the age of 80—after the fall of the Berlin Wall but before the terror attacks of 2001—Fritz Oder gave an extended interview to NRO historians about his life and career. His closing assessment of the risks facing the world was prescient: "The NRO and its leadership are confronted by a world that probably is more dangerous in the 21st century than it was when we were working on our projects during the Cold War. We mainly had the Soviet Union to deal with, whereas in the 21st century there are more numerous threats. The U.S. continues to need accurate, timely information on a range of potential adversaries, yet national reconnaissance alone cannot provide all of the answers. There is a continuing need for high-quality human intelligence in addition to the unique systems and capabilities provided by the NRO."

Fritz's wife Dorothy Oder predeceased him. He is survived by Doris Parrish Oder and his children, Frederic C. Oder, Richard Oder, and Barbara Debes, and five grandchildren.

Dr. Coffman wishes to thank the National Reconnaissance Office for its invaluable help in preparing this tribute.

Widlake, P.D. 2007. In Memoriam: Frederic (Fritz) C. E. Oder, Colonel, USAF (Ret.). *National Reconnaissance: Journal of the Discipline and Practice*, 2007-U (in press).

Interview with Frederic C.E. Oder at the National Reconnaissance Office Headquarters, September 26, 2000.

RONALD SAMUEL RIVLIN

1915–2005

Elected in 1985

"For formulating the large deformation elasticity theory and for verifying and applying the theory extensively to general nonlinear continua in the areas of viscoelasticities, electromagnetics, and thermodynamics."

BY G.I. BARENBLATT AND D.D. JOSEPH

RONALD S. RIVLIN, one of the great applied mechanicians of the twentieth century, died at the age of 90 on October 4, 2005, at his home in Palo Alto, California, where he and his wife, Violet, had recently moved to be near John, his only son, daughter-in-law Susan, and grandson Michael. Ronald Rivlin will be remembered not only for his great scientific work but also for his remarkable personality, his wit, and his dedication to speaking the unvarnished truth.

Born in London on May 6, 1915, Rivlin graduated from St. John's College, University of Cambridge, with a B.A. in physics and mathematics in 1937 and a doctorate (Sc.D.) in 1952. He began his career as a research scientist at the General Electric (GE) Company (1937–1942), where he worked on the first commercial television receiver. From 1942 to 1944, Rivlin worked at Telecommunications Research Establishment.

In 1944, he moved to the British Rubber Producers Research Association (BRPRA), where he pursued his interest in viscoelastic liquids. His decision to move to BRPRA was influenced by L. Treloar, whom he had met while still at GE, and the normal-force-driven rod-climbing experiments of Karl Weissenberg he witnessed at BRPRA.

Rivlin began his career in academia in 1953, when he became a professor of applied mathematics at Brown University, where he taught and conducted research until 1967. In 1963, he co-hosted, with R.S. Marvin, the Fourth International Congress on Rheology, in Providence, Rhode Island. In 1967, Rivlin moved to Lehigh University, where he remained until his retirement in 1980.

Rivlin made crucial contributions to the theories of finite elasticity, stability, constitutive equations for elastic and viscoelastic solids and fluids, internal variables, non-Newtonian fluids, electromagnetism, fracture, waves of linear viscoelastic materials, and crystal physics. Unlike his academic competitors, however, he did not publish books, so his intellectual legacy is distributed among hundreds of papers written over a period of 60 years of exceptional scientific productivity.

His colleagues, concerned that without books his seminal contributions might dissolve into the huge ocean of scientific literature, collected and published his work, together with an extended autobiographical sketch of his personal recollections and amusing comments on the dark side of academic life. As he said, "God created the professor, and the devil created the colleague" (*Collected Papers of R.S. Rivlin:* 2 vol., edited by G.I. Barenblatt and D.D. Joseph).

Rivlin is one of a few giants who created the branch of theoretical physics and engineering now known as nonlinear continuum mechanics. Much of his work deals with fundamental problems that were being investigated by specialists in mechanics, such as William Prager and Daniel Drucker at Brown University; however, Prager and Drucker had little or no influence on Rivlin's work.

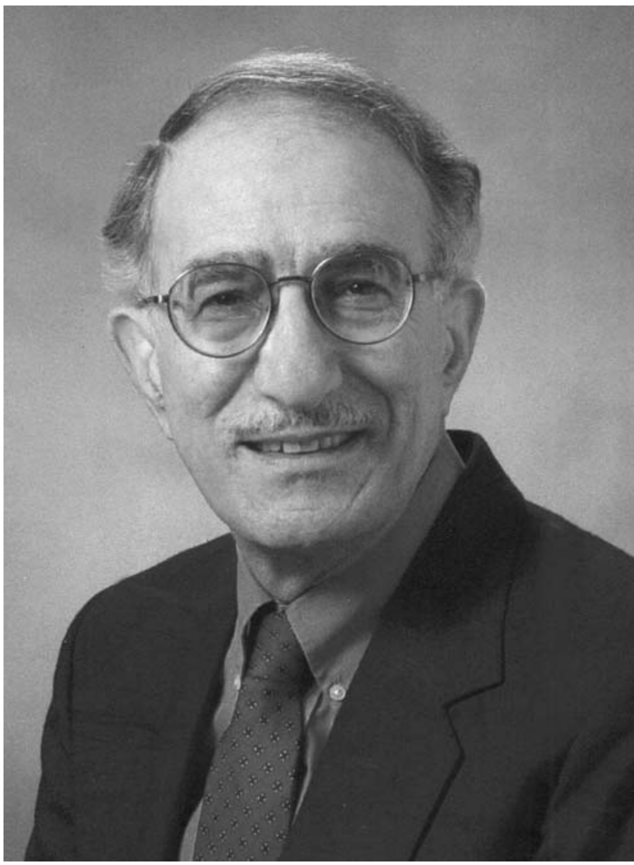
Clifford Truesdell, on the contrary, had a great deal of influence on Rivlin. Truesdell was the leader of a group of talented mechanicians and mathematicians who called their work "rational mechanics." In the early days, Rivlin and Truesdell had cordial relations based on mutual respect. Later, their relationship deteriorated, although many have traced their conflicts back to the 1960s. Truesdell's followers, especially Walter Noll, were encouraged to develop mechanics as an axiomatic subject in the spirit of David Hilbert. Rivlin's approach was to combine deep theoretical analysis with concrete practicality.

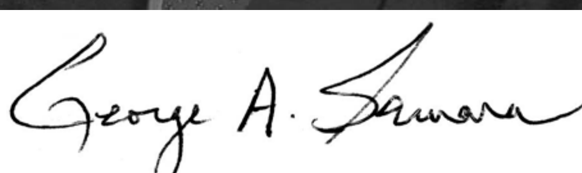
Rivlin was one of the creators of the theory of large elastic deformation, based on the theory of neo-Hookean and Mooney-Rivlin solids. Rivlin's work on the deformations and strengths of rubber and rubber-like materials, which began early on in his career under the influence of Treloar, had tremendous implications for real-world applications. Whereas the classical mechanics approach of applying linear theory of elasticity did not have practical applications, Rivlin, with unsurpassed elegance, overcame the formidable difficulties in understanding the finite deformations characteristic of these materials. His exact solutions are universally recognized as a tipping point that demonstrated to the engineering community that rigorous mathematical results for nonlinear and large deformations could guide engineering design. Today, Rivlin's work provides a mathematical foundation for a wide variety of applications.

In 1953, Rivlin, with A.G. Thomas, published a paper on the rupture of vulcanized rubber in which, by simple but ingenious experiments and by drawing freely on the results of his earlier work on finite-elasticity theory, he established the application of the Griffith criterion for fracture to vulcanized rubber. Griffith's theory requires that the specific energy of crack propagation be a constant, although, under certain assumptions, it can be treated as a function of the rate of crack extension. This essential paper (in a research field now highly developed) showed the interrelations among the rupture, fatigue failure, tensile strength, and other properties of elastomers and other high-polymeric materials and led to the field of fracture-mechanics research on elastomers. The 50th anniversary of this great work was celebrated at a special conference called "Fracture Mechanics and Elastomers: 50 Not Out" held in 2004 at the Rubber Institute in Hertford, U.K.

Rivlin's work figured prominently in the development of constitutive equations for non-Newtonian fluids. The Reiner-Rivlin equation (stress is a quadratic function of the rate-of-strain tensor) was an early, non-Newtonian constitutive equation, perhaps the first that could properly be called "frame-invariant." This had been proposed by Markus Reiner based on phenomenological arguments; Rivlin deduced the same equation as the mathematical form consistent with stress being a function only of the rate-of-deformation tensor and the independence of the calculation from superposed rigid rotation (frame-invariance). Rivlin's name stands with those of Oldroyd, Ericksen, Green, Coleman, and Noll as a fundamental contributor to the development of modern constitutive theories of elastic liquids.

Some of Rivlin's many awards and honors in recognition of his contributions to science and engineering are listed here: Bingham Medal of the Society of Rheology (1958); fellow, American Academy of Arts and Sciences (1958); Guggenheim fellow, University of Rome (1961); Professeur associé, University of Paris (1966–1967); Panetti Prize and Gold Medal, Academy of Science of Turin (1975); Doctor of Science *honoris causus,* National University of Ireland (1980); Doctor of Science *honoris causus,* University of Nottingham (1980); von Humboldt Senior Award (1981–1982); honorary member, Mexican Society of Rheology (1981); Doctor of Science *honoris causus,* Tulane University (1982); foreign member, Accademia Nazzionale dei Lincei (1982); Doctor *honoris causus,* Aristotilian University Thessaloniki (1984); fellow, Institute for Advanced Study, Berlin (1984–1985); member, National Academy of Engineering (1985); Timoshenko Medal, American Society of Mechanical Engineers (1987); honorary member, Royal Irish Academy (1988); and Charles Goodyear Medal, Rubber Division, American Chemical Society (1992).





GEORGE A. SAMARA

1936–2006

Elected in 1986

"For contributions to the understanding of dielectric, ferroelectric, and ferromagnetic materials applications."

BY AL ROMIG

AT THE END of last year, the scientific community lost a dear friend and colleague. George Samara died on December 30, 2006. George was an internationally recognized scientist on the use of high pressure for fundamental studies of electronic and structural properties of solid state materials. There were, however, several other sides to George's life. These involved his scientific contributions to other areas, his administrative skills in management, and finally his personal life. Those of us who had the privilege of working closely with him in any of these endeavors will profoundly miss his quiet leadership, integrity, humility, and willingness to stand up for what he believed in.

Although George was born on December 5, 1936, in the small farming community of Jdeidet Marjayoun in southern Lebanon, his father was a United States citizen. He came to the United States as a 16-year-old, completed high school in Drumright, Oklahoma, and graduated from the University of Oklahoma with a B.S. in chemical engineering in 1958. He earned a doctorate in chemical engineering in 1962 from the University of Illinois at Urbana. This was under the direction of Professor Harry Drickamer, who was a hard task-master. His thesis work as well as continued collaborations with Drickamer covered a wide range of materials. These included pressure effects on the resistance of metalloids, simple fcc and bcc, II-VI, III-V compounds to more exotic fused-ring aromatics. This collaboration with Drickamer continued into the 1970s. Later, other coauthors also enjoyed such long enduring relationships, several extending over two and three decades. Many of these involved research topics resulting from informal questions and/or discussions at scientific meetings. Even though a list of coauthors exceeds 70, George was also the single author of nearly 100 journal papers and topical reviews.

Upon completing his degree at Illinois in 1962, he joined Sandia National Laboratories, but immediately fulfilled his military duty, spending the next two years as an ROTC officer at the Institute of Exploratory Research for the U. S. Army Electronics Laboratory at Fort Monmouth, New Jersey. There, he was able to continue research involving pressure effects on solids, including the pressure homogeneity of the sample in the pressure apparatus, and developed various techniques to measure the physical properties under pressure, such as compressibilities, electrical conductivities, dielectric constants, and Curie points. This effort was with Armando Giardini and others at Fort Monmouth. Also included was a paper in the area of what became of major importance to not only the entire worldwide research field but also his personal research, as well as to Sandia–ferroelectrics. George's contributions to various aspects of ferroelectrics continued throughout his research career.

Returning to Sandia, George began and continued an active personal research effort which spanned 45 years on many areas besides ferroelectrics up to the final days of his life. Among such pending studies when he passed away were promising new ferroelectric materials based on lead lanthanum zirconate titanate and on terpolymers of vinylidene fluoride with other fluoroethylenes. George's numerous scientific papers included pioneering work on structural phase transformations, semiconductor physics, ferroelectrics, ferroelectric polymers, nanosized semiconductor clusters, defects, deep electronic levels, relaxation in crystalline solids and polymers, ionic transport, ceramics, photovoltaics, and MBE and CVD synthesis and processing. Among the invited reviews are three chapters in *Solid State Physics:* "The Study of Soft Mode Transitions at

High Pressure" with Paul Peercy, "High Pressure Studies of Ionic Conductivity in Solids," and "Ferroelectrics Revisited- Advances in Materials and Physics."

Through this research effort, George became perhaps the world's most accomplished scientist in the use of high pressure for fundamental studies of electronic and structural properties of solid state materials. In addition, he was active in national and international organizations involving high pressure science. Among leadership roles he served are vice president and the Executive Committee of the International Association of High Pressure Science and Technology (AIRAPT); chairman of the U.S. Department of Energy (DOE) Panel on High Pressure Science and Technology; chairman, 1974 Gordon Conference on Research at High Pressure; and co-chair and program chairman of the 1993 Joint AIRAPT/American Physical Society Conference on High Pressure Science and Technology.

In 1974, George was awarded the Ipatieff Prize (for scientists under the age of 40) of the American Chemical Society. In 1986, he was elected to the National Academy of Engineering. As an active member of the academy, he served on the Section 9 Peer Committee (2001-2003) and organized the regional meeting in Albuquerque (May 19, 2005) on *Solid State Lighting: The Next Revolution in Lighting*. He was a fellow member of the American Physical Society and the American Association for the Advancement of Science. His activities also included editorial or advisory boards for *Ferroelectrics, Reviews of Scientific Instruments, Journal of Physics and Chemistry of Solids,* and the Materials Research Society's *Journal of Material Research.*

Those of us who were familiar with George's unusually accomplished research career as well as his extraordinary organizational ability to develop a host of national and international materials research activities might also realize he possessed excellent management skills. At Sandia National Laboratory, he was initially promoted in 1967 and served in various management capacities involving oversight of research in condensed-matter physics, electronic materials and phenomena, chemistry research activities, advanced materials and nanoscience.

During George's long and distinguished career at Sandia, he recruited the most promising young scientists in the country, and then nominated them for invited talks, honors, and awards, promoting their career development. His interaction and support of these and other collaborating scientists led to worldwide recognition of excellence for various individuals and groups. He also served as a resource, sounding board, and mentor for generations of Sandians, many of whom came to occupy significant leadership positions both at Sandia or elsewhere. George had a unique combination of deep scientific understanding and insight, foresight, friendliness, and personal and organizational leadership abilities. He was widely recognized for his high professional, ethical, and scientific standards that have inspired all who had contact with him.

In addition to overseeing management of these research activities, George took on additional management responsibilities. During the last 13 years of his career, he served as manager of Sandia Laboratory's Department of Energy (DOE) Basic Energy Sciences core research programs in materials science. He was largely responsible for developing the concept for the DOE Center of Excellence for the Synthesis and Processing of Advanced Materials, a coordinated, cooperative venture among 12 national laboratories and several industrial and university partners, and he served as its director. In recent years, he was instrumental in developing the joint Sandia/Los Alamos Center for Integrated Nanotechnologies (CINT), one of five DOE Nanoscale Science Research Centers. In these efforts, he earned the admiration and respect from his colleagues at the other national laboratories and the materials research community for his unbiased even-handed coordination and leadership. Based on his technical management and leadership, George was awarded the American Chemical Society's Earle B. Barnes Award for Leadership in Chemical Management in 2000.

Finally, a few comments on his personal life, for amazing as his technical accomplishments were, George was much broader—a man for all seasons. In his younger days, he hiked the local New Mexico mountains as well as the midrange of the

Sierra Nevada's in California with various colleagues. He was a respectful opponent in tennis. He visited Lebanon through the years; there he met and married his wife, Helen. Those who lived in or visited Albuquerque enjoyed the Lebanese hospitality and food at their home. Fresh grapes, apricots, and particularly two varieties of figs were provided from his back yard. He enjoyed gardening, the arts, particularly music, and even wrote poetry for his church congregation. A loving and devoted husband and father, George leaves his wife Helen, daughter Victoria, son Michael, brother Emile, and sister Leila. Since George's passing, many have noted that he will not just be remembered for his accomplishments, of which there were many. More importantly, he will be remembered for the way he connected with other people, the generosity of his heart, his willingness to always be open to others, and his constant optimism. He was a brilliant scientist, a good citizen, mentor, and teacher. As Helen said, George was a gift to us all. He will be sorely missed.

REUBEN SAMUELS

1926–2004

Elected in 1994

"For leadership in the practice of heavy and underground construction and for improving contracting practices."

BY JAMES LAMMIE

REUBEN SAMUELS, a principal engineering consultant at Parsons Brinckerhoff and a former executive of Thomas Crimmins Contracting Company, died on February 17, 2004, at the age of 78 at his home in Paramus, New Jersey. His passing marked the end of a distinguished career in civil engineering that spanned more than half a century. An internationally recognized expert in underground engineering and heavy construction, Reuben Samuels oversaw foundation work for some of New York City's most prominent buildings. His commitment to quality engineering was matched by his personal commitment to education, both in his profession and in the community where he lived.

Reuben was born on January 11, 1926, in the village of Suffern, New York. After enlisting in the Navy, he attended the Massachusetts Institute of Technology from 1943 to 1944. He continued his education at Dartmouth College and graduated in 1946 with a BSCE in civil engineering. After serving a year as an ensign in the U.S. Navy Civil Engineering Corps at Port Hueneme in California, Reuben attended the Graduate School of Engineering at Harvard University, where he received an MSCE in soil mechanics in 1948.

For the next two years, he was employed as a soil and foundation engineer at Moran, Proctor, Freeman & Mueser (now Mueser Rutledge Consulting Engineers). Established by foundation engineering pioneer Daniel E. Moran, the firm was an excellent launching pad for Reuben's professional career. From 1951 to 1954, however, he decided to return to the academic environment for studies in the doctoral program at Harvard. During that time, he was a teaching assistant to Professors Karl Terzaghi and Arthur Casagrande.

In 1954, Reuben began a long, intensely productive career at the Thomas Crimmins Contracting Company in New York City, a firm founded in 1848 that specialized in foundations and underground construction. He joined the firm as an engineer and estimator, was soon elected treasurer, and in 1956 became a director. He became chief engineer at Crimmins in 1957, vice president in 1963, president of Crimmins, Samuels & Associates in 1980, and president of Crimmins Constructors in 1987. He became chairman of the board in 1986.

At Crimmins, Reuben oversaw work on a wide range of projects, including foundation engineering and construction for several landmark buildings in New York City, including the MetLife Building on Park Avenue (originally known as the Pan Am Building), the largest commercial office building in the world when it was completed in 1963; the CBS Building on Manhattan's west side, a massive 38-story tower completed in 1965; the Ford Foundation Building on the east side of Manhattan, completed in 1968, with offices arranged around a 12-story atrium; the 53-story office building at 55 Water Street, completed in 1972, which replaced the Pan Am Building as the world's largest commercial office building; the 57-story office tower at One Penn Plaza near Madison Square Garden, also built in 1972 (where Reuben later worked as a senior consultant at Parsons Brinckerhoff); and the 68-story Trump Tower on Fifth Avenue in Manhattan, completed in 1983. Reuben also worked on the development of power plants and utilities, water-treatment facilities, airport terminals, hotels, shopping malls, educational buildings, and entertainment facilities designed for huge audiences.

During his career, Reuben continued to refine the technical skills that eventually made him a recognized expert in foundations, underpinning, soil and rock work, tunneling, and open-cut subway design. He wrote several articles on close-quarter blasting methods for *Civil Engineering* during the 1960s; coauthored the *Construction Rock Work Guide*, published in 1972; and contributed to the chapter "Soil Mechanics and Foundation Engineering" in the *Dictionary of Architecture and Construction*, published in 1975. He also wrote several articles published in *Civil Engineering* and *World Tunneling* and made numerous technical presentations at professional conferences.

Over the many years of his career, Reuben was a guest lecturer at some of the top engineering schools in the country, including Cornell University, Columbia University, Cooper Union, Pratt Institute, New York University, Polytechnic University, and Rutgers University. He was also a licensed professional engineer in seven states and the District of Columbia.

Reuben was active in major professional organizations and devoted considerable energy to promoting the interests of the engineering profession, advancing the state of the art, and supporting academic and professional engineering education. He became a member of the Moles in 1963 and immediately immersed himself in the activities of the Education Committee (over time he also served on special committees and the Executive Committee). He was second vice president and first vice president of the Moles and president in 1973, at the relatively young age of 47. In 1988, he was awarded the organization's highest honor, the Outstanding Achievement in Construction Award, and, in 2003, he became one of 17 life members, the highest level of Moles membership, which requires 40 years of active participation.

Reuben was a fellow of the American Society of Civil Engineers; a fellow of the National Committee on Deep Foundations; chairman of the U.S. National Committee on Tunneling Technology; and a member of the Geotechnical Board of the National Academy of Sciences. He was elected a member of the National Academy of Engineering in 1994.

Reuben's professional activities were not limited to these organizations. As his career expanded, he continued to support effective engineering education, and he took a direct interest in the educational careers of students at his old schools. He was president of the Dartmouth Engineering Society, president of the Harvard Engineering Society, and overseer of the Thayer School of Engineering at Dartmouth. In 1987, he was named a Sylvanus Thayer Fellow at Dartmouth for his contributions to the school.

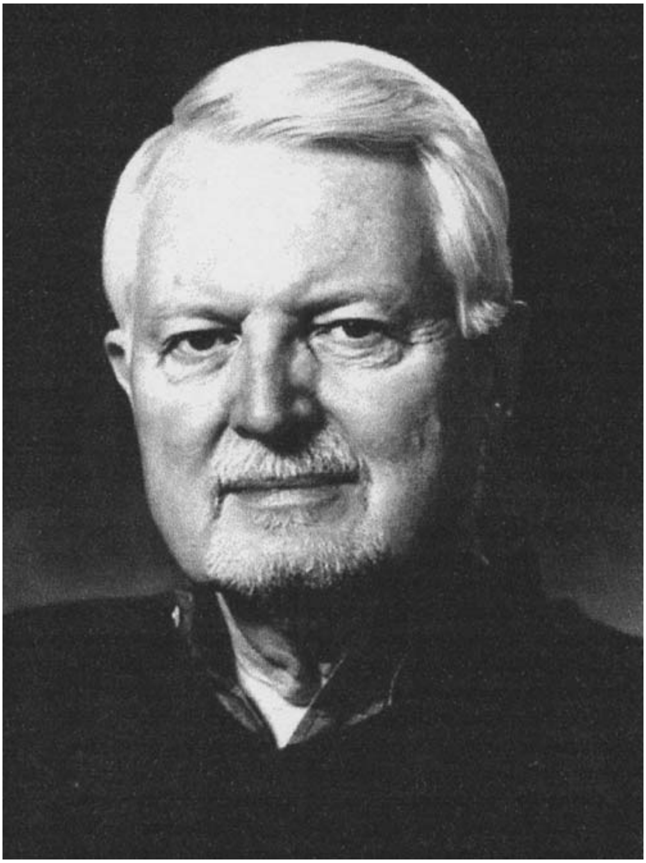
Reuben's support for education was also apparent in his life as a citizen. In New Jersey, where he lived for many years, he was president of the Paramus Board of Education and president of the Bergen County Federated School Boards.

In 1992, he joined Parsons Brinckerhoff, a global engineering and management firm based in New York City, as a principal engineering consultant. True to form, he immediately began work as an advisor on some of the firm's most challenging projects, including the massive Central Artery/Tunnel Project in Boston, the Metropolitan Atlanta Rapid Transit Authority (MARTA), and the Los Angeles Metro Rail system. He was also technical advisor for feasibility studies and cost estimates for the 63rd Street Tunnel Connector in New York City.

Reuben—or "Rube," as he was known to all—had a complex perspective on life and his work that enriched everyone fortunate enough to work with him. He was born at a time when engineering was truly a measure of the strength and progress of a society, not simply a practical way to meet its needs. He witnessed extraordinary growth in one of the world's greatest cities—New York—and helped to make it happen. He devoted a remarkable amount of energy to supporting and strengthening his profession through his active participation in many organizations. And along the way, he found time to reach out as a mentor to those just starting out on the path he had taken—at the schools he had attended, in the community where he lived, and in the companies where he worked.

Rube was passionate about many aspects of life: engineering, mountains (particularly the Matterhorn), opera, rhododendrons, the Yankees—and he pursued his interests fully.

He left behind his beloved wife Diane (who died in 2006), his son Adam and daughter Julie, his son-in-law Barry, and his granddaughters Alyssa and Monica. His many friends and colleagues will greatly miss his insight, his encouragement, and the personal and professional steadfastness that guided him, and others, so well for so long.



DUDLEY A. SAVILLE

1933–2006

Elected in 2003

"For advancing our understanding of electrokinetic and electrohydrodynamic processes and their application to the assembly of colloidal arrays."

BY WILLIAM R. SCHOWALTER

DUDLEY ALBERT SAVILLE, the Stephen C. Macaleer '63 Professor in Engineering and Applied Science and professor of chemical engineering at Princeton University, died on Wednesday, October 4, 2006. In the course of a distinguished 40-year career, Saville established himself as an internationally renowned authority in fluid mechanics and colloid science.

Saville was born in Lincoln, Nebraska, on February 25, 1933. After a precocious childhood, he attended the University of Nebraska and obtained a B.S. in chemical engineering in 1954. Following brief employment with the Union Carbide Corporation as a development engineer, he joined the Air Force as a commissioned 2nd lieutenant in March 1955. He learned to fly T33, T34, T28, and C-47 airplanes at Marana Air Force Base in Tucson, Arizona, and from October 1956 to September 1957, he was a controller at the 314th Air Division at Osan-Ni K-55 Air Base, Korea, and a T33 pilot.

While in Korea, Saville took extension courses in advanced mathematics and tutored several fellow airmen; he served as a radar-intercept instructor at Tyndall Air Force Base, Florida, through January 1958. By the end of his three-year service in the Air Force, he had logged 500 flying hours and had been promoted to the rank of captain. Service in the Air Force was a formative experience that reinforced his self-confidence, and he remained a glider enthusiast for much of his life.

In 1958, Saville enrolled as a graduate student at the University of Nebraska, where he received a master's degree in 1959. He then worked in industrial research at Chevron Oil Company in Richmond, California, from 1959 to 1961, when he entered the University of Michigan, where he studied with Stuart W. Churchill and obtained his Ph.D. in chemical engineering in 1966. His thesis was an analytical and numerical investigation of laminar-free convection in boundary layers near axisymmetric bodies. The journal articles based upon this work stand today as the definitive benchmark of the subject. Upon completion of his Ph.D., he joined an exceptional group of chemical engineering researchers at Shell Development Company in Emeryville, California, where he was strongly influenced by the quality and originality of research by Charles Sternling on mass transfer across interfaces.

In 1968, Saville joined the Department of Chemical Engineering at Princeton. In his letter of application for the position, he wrote prophetically: "If I were to choose one area of interest, it would be electrohydrodynamics." At the time of his death, he was one of the world's most distinguished scholars in that field.

Saville was promoted to associate professor in 1971 and to full professor in 1977. From the very beginning, his interests were centered on the dynamics of electrically conducting fluids. Suspensions of nanometer-to-micron-sized particles in fluids, or colloidal suspensions, also attracted his scientific curiosity. Over the years, his research came to define a vast intellectual territory involving the behavior of colloidal suspensions in the presence of electric fields.

The practical applications of Saville's research ranged from protein crystallization to electrohydrodynamic printing, and from the behavior of fluids in microgravity to enhanced oil recovery. With both theoretical and experimental components, his research was invariably characterized by formal elegance and deep insights. Among his most notable accomplishments were the invention of dielectric spectroscopy for the measurement of the surface charge of colloidal particles and the development of the Dynamic Stern Layer model for the interpretation of electrokinetic measurements. In his 38 years at Princeton, he supervised 25 Ph.D. students and 14 postdoctoral fellows.

In 1992, Saville began a fruitful collaboration with Ilhan Aksay, a Princeton colleague who had complementary skills and expertise. Their exploration of using electrohydrodynamics to assemble and pattern colloidal crystals and other submicron phases resulted in a number of influential papers published in *Science, Nature,* and *Physical Review Letters* on the assembly of colloidal particles, surfactant aggregates, and proteins on surfaces. Theirs was a model scientific collaboration, the results of which were far more important than if the two had worked separately and combined their results.

Saville's research is documented in more than 110 journal articles. With his Princeton colleagues William Russel and William Schowalter, he coauthored the 1989 textbook *Colloidal Dispersions.* In 1992, he coauthored *Dynamics of Electrophoresis* with R.A. Mosher and W. Thormann. Both books are now standards in their respective fields.

In the mid-1970s, as scientific advisor to NASA's Microgravity Sciences Program, Saville was asked to evaluate the role of buoyancy-driven convection in electrophoresis as a possible means of improving the separation of cells and proteins in microgravity. The resulting report, *Fluid Mechanics of Continuous Flow Electrophoresis,* coauthored with Simon Ostrach, was the first attempt to provide a rational framework for assessing the advantages of electrophoretic separations in microgravity.

Subsequently, as a member of the Advisory Committee on Space Science in the Twenty-First Century, he helped to define and implement goals for NASA's Microgravity Sciences Program. His insights were instrumental in dispelling skepticism in the fluid-mechanics community about the objectives and scientific merit of microgravity research.

Saville's involvement with NASA culminated in 1996, when his ALEX liquid-bridges experiment was included in the Life and Microgravity Spacelab mission launched on the shuttle *Columbia.* This experiment tested the predictions of G.I. Taylor's "leaky dielectric" theory on the behavior of fluids under the influence of electric fields.

Saville's preference as a teacher was for foundational, or core, courses, although he also initiated advanced graduate courses in hydrodynamic stability and colloidal dispersions. Whether teaching undergraduate thermodynamics, graduate fluid mechanics, or graduate transport phenomena, his classes were invariably characterized by mathematical rigor, clarity of exposition, and an emphasis on fundamentals. A demanding instructor, he earned the respect of generations of chemical engineering students, many of whom recall his Socratic approach to teaching in advanced courses.

Saville was revered by colleagues for his integrity and his generosity. His economy of thought and expression was legendary, but so was his thoughtfulness. When he spoke, he stripped his arguments of all but the essentials, and, over the years, he offered invaluable insight, advice, and intellectual leadership. He exerted a profound influence on the programs and intellectual environment of Princeton's chemical engineering department and did much to maintain and enhance its reputation as one of the premier chemical engineering departments in the country.

He received many honors for his scientific achievements, including the Alpha Chi Sigma Award from the American Institute of Chemical Engineers (1997) and, in 2003, election to the National Academy of Engineering (NAE). In 2001 he was appointed to the Stephen Macaleer Chair in Chemical Engineering, and, in 2003, the Chemical Engineering Department hosted a symposium honoring him for his distinguished teaching and research career at Princeton and his election to NAE.

No account of Dudley Saville's career can be complete without mentioning his understated, self-effacing manner. Shyness, a strong sense of decorum, and a deep inner confidence in the value of his work combined happily to erase all traces of self-promotion or aggrandizement in his professional demeanor.

Saville is survived by Joy, his wife of 47 years; son and daughter-in-law Dudley Alexander (b. 4/25/64) and Amy Jacob of Highland Park, New Jersey; daughter and son-in-law Andrea (b. 4/14/67) and Stephen White of Princeton, New

Jersey; sister and brother-in-law Harriet Randolph Potter and Thomas Potter of Lincoln, Nebraska; and grandson Aidan, son of Andrea and Steve.

Note: Pablo G. Debenedetti, Ilhan A. Aksay, William B. Russel, and Stuart W. Churchill contributed to this memorial tribute.

His wife Joy, son, Alex, and daughter Andrea wrote that Dudley brought elegance, grace, and a sense of humor to his personal relationships. His appreciation for nature made camping with his young family an exciting and memorable way to see the world. Later in life, he and his wife, Joy, transformed a backyard of brush and trees into a lush garden of perennials surrounding a large fish pond and a bluestone patio built by their son, Alex. His love of flying and Air Force experience translated into 10 years of flying gliders with the Soaring Society of Princeton University. A sport he reluctantly gave up when his increasingly busy schedule did not allow him to fly often enough to meet his safety standards. His impeccably high standards permeated his entire being, but at the same time, his intelligence and compassion filled intimate relationships with love and warmth. For many years he kept fit playing squash, and enjoyed routinely trouncing younger faculty members and students. "If I can't outrun or out-hit them, I outsmart them," he commented to Alex, who was never able to beat him, and who quit trying about the same time Dudley retired from the courts.

In the mid-1970s, he learned to sail, an activity he enjoyed whether it was sailing his *Sunfish* on Lake Carnegie in Princeton, plying the waters of the Sheepscot River in Maine, exploring the estuaries of the Chesapeake Bay, or crewing for a friend on a boat in transit between Bermuda and Connecticut. He was fond of quoting Kenneth Grahame from *The Wind in the Willows:* "There is nothing—absolutely nothing—half so much worth doing as simply messing about in boats." Though he agreed with Grahame wholeheartedly, the quote may actually be more indicative of his undoubtedly favorite pastime, reading. Like most academics, he had an insatiable thirst for knowledge, one that was not quenched by his daytime research alone. His nightstand always had several books neatly stacked on it, and if you were lucky enough to see it, you would find the latest issue of the *New York Review of Books,* a classic text on differential equations, a political best seller, and a novel someone had recommended. Toward the end of his life when he knew his time was likely short, he reread his favorite Hemingway novels and commented with typical dryness that they were better than he remembered.

With most activities in his life, he saw connections to his research and work. His love of boats had as much to do with recreation as it did with his lifelong interest in the behavior of water; he saw and tried to understand the functioning of the natural world around him at every turn. His grandson, Aidan, had barely begun to talk when Dudley began explaining vortices in the bathtub and demonstrating the wonders of surface tension in soap bubbles. And the connections from his life to his work flowed the other direction as well. His daughter, Andrea, remembers when she was learning to read scientific equations in high school how he had her help proofread his papers, an activity that not only put her ahead of her classmates but also gave her a window of understanding into his work.

Very few subjects were of no interest to Dudley, and unexplained and unanswered questions interested him the most. His membership and participation at Nassau Presbyterian Church in Princeton provided him with a place to worship and express his faith in God. Dudley enriched the lives of his family, friends, and colleagues. His life was an example of how to live within, as well as bring together the communities of family, work, and religion. Indeed, he celebrated the wonders of this world each day of his life with everyone in his life. In the end, it was this interconnectivity of all things that fascinated him above all and drove him to examine the details in order to better see the whole.

MILTON CLAYTON SHAW

1915–2006

Elected in 1968

"For contributions to chemical synthesis, lubrication and bearing design, and machine tool design and performance."

BY RANGA KOMANDURI AND BARBARA SHAW ZITZEWITZ
SUBMITTED BY THE NAE HOME SECRETARY

MILTON SHAW, a distinguished and influential educator in manufacturing engineering, died on September 7, 2006, at the age of 91. He was elected to the National Academy of Engineering (NAE) in 1968 for his contributions to chemical synthesis, lubrication and bearing design, and machine tool design and performance.

Shaw was born in Philadelphia, Pennsylvania, on May 27, 1915, to parents who had little formal education but were hard workers and instilled in him a solid sense of values. As a boy, he was active in the Boy Scouts; he became an Eagle Scout and then a Sea Scout. When he finished high school, his parents borrowed against his father's life insurance so he could enter a five-year cooperative program at Drexel University leading to a B.Sc. in mechanical engineering, which he received in 1938. For six months of each of the second, third, and fourth years, he worked in industry; he also joined the Reserve Officers Training Corp. His experiences in these programs were invaluable, and the wages he earned offset his expenses. Upon graduation, he was commissioned a second lieutenant in the U.S. Infantry Reserve.

Shaw graduated during the worst part of the Depression when jobs of any sort were difficult to find. Fortunately, a physicist from the University of Cincinnati came looking for an engineering graduate willing to study chemistry, physics, and mathematics in the College of Liberal Arts while conducting basic research on the development of a new line of cutting fluids. In return for being able to work as a mechanical engineer, Shaw was willing to start over as a liberal arts student, with an emphasis on chemistry. This unique cooperative program was sponsored by the Cincinnati Milling Machine Company (predecessor of Cincinnati Milacron).

In his first year, Shaw studied all of the material required for an undergraduate chemistry major. In the next three years, he took every available graduate course in chemistry and some in physics and mathematics. In 1942, after writing a doctoral thesis on the chemical aspects of cutting-fluid action, he received his Sc.D. As a result of his interdisciplinary studies, a combination of engineering and physical sciences became the foundation for his research.

Late in the fall of 1941, as he was finishing work on his degree, he was offered and accepted an assistant professorship at the Massachusetts Institute of Technology (MIT). However, a few days after the attack on Pearl Harbor, his future boss at MIT called and told him to report immediately to Langley Field, Virginia, to work in the Engine Division of the National Advisory Committee for Aeronautics (NACA), later NASA. In the spring of 1942, he moved to the Lewis Laboratory near Cleveland, where he worked his way up to the position of chief of the Materials Branch at NACA.

Early in 1946, Shaw was finally able to return to his teaching position at MIT, where, with strong support from industry, he established a first-class materials-processing research program. The primary focus of the program was on metal cutting and grinding, and doctoral students working under his supervision produced numerous high-quality research papers on a variety of problems, such as grinding-process temperatures, the temperatures generated ahead of the cutting tool in machining, measurement of forces and the number of cutting points in grinding, the influence of chip thickness on size effects, and the dynamics of chip formation and fracture. Thus Shaw became a world leader in research on metal cutting and grinding, and students from all over the world began to seek positions in his laboratory.

In the fall of 1952, Shaw made his first trip abroad, visiting laboratories and delivering lectures all over Europe. In the spirit of the Organization for European Cooperative Development, he became a founding member (and the first U.S. member) of the College International pour l'Etude Scientifique des Techniques de Production Mechanique (CIRP), an organization in which he remained active and a leader for more than 50 years. CIRP was organized so that large and small countries could participate equally. In English, this international institution is known as the International Academy for Production Engineering Research.

In 1961, Shaw moved to Carnegie Institute of Technology (subsequently Carnegie Mellon University [CMU]) as professor and head of the Department of Mechanical Engineering. During his tenure at CMU, his main areas of focus were form-and-finish grinding (FFG) and stock-removal grinding (SRG), the use of single grains to evaluate grinding performance, and work on high-speed grinding sponsored by the Abrasive Grain Association, the Grinding Wheel Institute, and the National Science Foundation. In addition he worked on lubrication and wear, the fracture of metals and ceramics, hardness testing, and plastic indentation. With a grant from the National Science Foundation, he established the Processing Research Institute, a forerunner of NSF engineering research center where a university interacts extensively with industry. Shaw retired from CMU as university professor in 1978.

He then moved to Arizona State University (ASU) as professor in the Department of Aerospace and Engineering Science. His work at ASU led to more insights into the cutting and grinding of hard materials, ceramics, rubber elasticity, and fracture. In 1985, he became professor emeritus at ASU, but he continued to work with graduate students there until 1998.

Shaw had a unique ability to transfer knowledge from a given field into a new direction or in support of a new application and to develop basic scientific explanations for practical observations. For example, in his Ph.D. dissertation on mechanical activation, he used a metal-cutting setup to initiate chemical reactions that are difficult to initiate and control and are extremely dangerous (known as Grignard reactions). He developed a "mechanical fuse" by applying metal-cutting principles to the bumper of an automobile to absorb energy during slow-speed impact. Similarly, he incorporated an extrusion die near the tool face to draw the metal-cutting chips to form copper wire. He used simple experiments, explanations, and modeling to demonstrate phenomena of concern, and he encouraged his collaborators to rely on their expertise to solve problems instead of developing elaborate proposals for what to do and how to do it. In this way, the researchers who worked with him produced practical results.

Shaw visited and collaborated with many scientists and engineers abroad during his career, particularly in Japan, Europe, and India; he always gave generously of his time and expertise to colleagues overseas. He was a Fulbright Guest Professor at Aachen Technical University (Germany) in 1957; Lucas Professor at the University of Birmingham (United Kingdom) in 1960, 1961, and 1964; guest professor at Munich Technical University (Germany) in 1964; guest professor at Danish Technical University in 1982; and visiting and guest professor at several universities in the United States.

His contributions to research and teaching were widely recognized. He was granted honorary degrees by the University of Louvain (Belgium) and Drexel University. He was a founding member of CIRP, a fellow of the American Academy of Arts and Sciences, a foreign member of the Polish Academy of Sciences and the Japan Society of Mechanical Engineers, an honorary member of the American Society of Mechanical Engineers (ASME), and a member of the Society of Manufacturing Engineers' College of Fellows, among others.

The walls of his study were covered with awards, including the John Simon Guggenheim Fellowship (1956); George Westinghouse Award of the American Society of Engineering Education (ASEE) (1956); Fulbright-Hays Professorship (1957); American Society of Tool and Manufacturing Engineers (ASTME) (now SME or the Society of Manufacturing Engineers)

Gold Medal (1958); Society of Tribology and Lubrication Engineers National Award (1964); ASME Mayo D. Hersey Award (1967); American Abrasive Society Award (1969); American Society of Metals Wilson Award (1971); ASME Thurston Lecture (1971); SME International Education Award (1980); MIT Ralph Cross Award (1982); ASME Medal (1985); Tribology Gold Medal from the British Tribology Trust (1985); and Georg Schlesinger Award (1997).

Shaw published more than 300 technical papers and four books and edited the proceedings of several conferences. He held 19 U.S. and foreign patents and was a consultant for some 150 companies in the United States and abroad. His classic book, *Metal Cutting Principles*, was originally published in 1953 by MIT Press and was republished by Oxford University Press (OUP) in 1984; a revised second edition was published by OUP in 2005. Shaw was coauthor, with Fred Macks, of *The Analysis and Lubrication of Bearings* (McGraw-Hill Book Company, 1949) and author of *Principles of Abrasive Processing* (Oxford University Press, 1966) and *Engineering Problem Solving: A Classical Perspective* (Noyes Publications, 2001). The latter is an introduction to engineering for students trying to decide which branch of engineering to pursue.

Toward the end of his life, Shaw was still investigating questions he had not fully answered, such as the role of micro-cracks in machining, size effect, and thermoplastic shear instability versus brittle fracture in the machining of hard materials. His last paper, published in 2003, was an investigation of the size effect in metal cutting.

Milton Shaw's 60 plus years of pioneering research led to improvements in the productivity, quality, and cost of material-removal processes that benefited industry and society in general. His research results led to many important technological developments, and his scholarship was an inspiration to countless engineers and educators. A role model and mentor to researchers in the United States and abroad, he brought dignity and respect to manufacturing-engineering research and education.

Mary Jane Shaw, his wife of 67 years, a college graduate in romance languages, typed and proofread all of his manuscripts. The Shaw home was always open to students from all over the world, on a personal and professional level. The Shaws helped rebuild bridges between the United States and Germany and Japan following World War II and opened doors for many students from India. They also traveled widely and made friends all over the world.

Professor Shaw is survived by his wife, Mary Jane; daughter, Barbara Zitzewitz; two grandchildren; and four great-grandchildren. His son, Milton Stanley Shaw, died in 1992.

Shaw was as active at home as he was at the university. In the early years, he undertook several home improvement projects: designing and constructing an underground garage, adding two bedrooms and a bath to the house, and building a garage for his parents. He was an avid gardener and always kept the yard in beautiful condition. He involved both family and students in boating, water skiing, and snow skiing. He took an active role in guiding his children's and grandchildren's education and ensured that they had the resources to pursue their interests at the best colleges and universities. He also encouraged them to travel abroad, to become familiar with other cultures and ways of life. Shaw loved children and, in his later years, he enjoyed playing with his great-grandchildren. He saw in them and their exuberance confirmation this new generation would continue on the course he had set, just as the previous ones had. He would have loved to witness that.

A few years ago, reflecting on the fullness of his life, Shaw wrote: "In looking back, there is little I would change. I have found it stimulating to work closely with young people and to see them mature and go on to take an important place in society. I believe this is the most satisfying aspect of my entire career."

SHAN-FU SHEN

1921–2006

Elected in 1985

"For fundamental contributions to aerodynamics and non-Newtonian fluid mechanics."

BY F. K. MOORE

SHAN-FU SHEN, professor emeritus of mechanical and aerospace engineering at Cornell University, passed away after a short illness in Ithaca, New York, on December 22, 2006. He was 85 years old.

Born in Shanghai, China, in 1921, Professor Shen received the bachelor of science degree in 1941 from the National Central University in Chunking. After achieving the rare distinction of placing first in the two most presitigious nationwide scholarship competitions for pursuing graduate studies abroad, he elected to come to the U.S., where he completed, brilliantly, at Massachusetts Institute of Technology (MIT), his Sc.D. in 1949. His thesis advisors were C.C. Lin and H.S. Tsien.

Following two years as a research associate at MIT, Dr. Shen joined the faculty of the Aeronautical Engineering Department of the University of Maryland, where he soon became a full professor. In 1961, after 11 years at Maryland, he was convinced by W.R. Sears to become a professor in what was then the Graduate School of Aeronautical Engineering at Cornell University, where he remained for the rest of his professional career. A distinguished scholar in aerodynamics, fluid dynamics, and heat transfer, Shan-Fu Shen taught and advised Cornell undergraduates and graduate students, conducted his own research, and guided others until his retirement in 1991 as the John Edson Sweet Professor Emeritus.

During his career, a number of special appointments attest to his international interests and distinction. He was a Guggenheim Fellow at the Eidgenössiche Technische Hochschule, Zürich, in 1957. He served as a visiting professor at more than 10 international academic institutions, including the University of Paris (1964 and 1969), the Technical University of Vienna in 1977, the Institute of Space Sciences at the University of Tokyo in 1984–1985, and three universities in China. He was also an honorary professor at his alma mater, the Southeast University (formerly National Central University) in Nanjing, China. Dr. Shen was a consultant to the David Taylor Ship Research and Development Center of the U.S. Navy on matters concerning the seaworthiness of marine vessels in rough seas, the dynamics of giant helicopters with circulation-controlled rotors, and design modifications of aircraft for carrier landing.

Professor Shen's work over the years is striking for its diversity. He made important contributions in transonic and hypersonic aerodynamics; aeroelasticity; finite-element methods for aerodynamics; hydrodynamic stability (including a notable review of the subject in the Princeton Series in High Speed Aerodynamics and Jet Propulsion); the kinetic theory of gases; non-Newtonian flows, including modeling of polymer flows with heat transfer; rarefied gas dynamics; and most recently, the theory and computation of boundary-layer separation, especially in unsteady flow over maneuvering bodies.

From 1974 to 1988, with Professor K.K. Wang (NAE, 1989), he was co-principal investigator of the Cornell Injection Molding Program (CIMP), a pioneering research project supported by the National Science Foundation. This program, conceived and led by Professor Wang, was established to help manufacturers solve problems related to the production of plastic parts. In 1979, an industrial consortium was established enabling more than 50 major corporations throughout the world to benefit from the results of CIMP.

The goal of CIMP was to establish a scientific basis for solving practical problems of injection molding, and Shan-Fu Shen contributed the theoretical understanding of relevant fluid mechanics and heat-transfer issues. His research with colleagues and graduate students on transient and nonisothermal flow and solidification in polymeric materials contributed significantly to the success of the program. With C.A. Hieber, he published an article in the *Journal of Non-Newtonian Fluid Mechanics* in 1980, showing that their predictions of flow-front positions and cavity pressure distributions agreed very well with experimental results. The efficient numerical scheme they developed paved the way for further advances in the analysis of flow and solidification of polymer melt in realistic mold cavities. Shan-Fu Shen's studies of non-Newtonian flow and properties of polymer melts are widely recognized for enabling the efficient design and manufacture of countless plastic parts in modern electronics and consumer products.

In recognition of his wide-ranging contributions to engineering science, Shan-Fu Shen was elected to the National Academy of Engineering in 1985. He also received many other awards: Achievement Award and fellow of the Washington Academy of Sciences in 1958; corresponding member of the International Academy of Astronautics in 1969; in Germany, the Alexander von Humboldt Senior Award in 1975; and a member of the Academia Sinica (Republic of China) in 1972.

Over the course of his career, Dr. Shen authored 75 refereed and invited articles that were published in prestigious journals, including *Annual Reviews of Fluid Mechanics, Advances in Applied Mechanics,* Vol. 4 of the Princeton Series in High Speed Aerodynamics and Jet Propulsion, *Journal of Fluid Mechanics, Journal of Math and Physics, Journal of the Aeronautical Sciences and AIAA Journal, Journal of Statistical Physics, Journal of Computational Physics, Journal of Non-Newtonian Fluid Mechanics, Israel Journal of Technology,* and *Rheologica Acta.* He also supervised many graduate students and postdoctoral fellows who now dot the map of universities and companies across North America and Europe.

Professor Shen always showed a great sense of responsibility for the fortunes of his graduate students, and they attest that they were inspired by his integrity, decency, and imagination, as well as his scientific insights, rigorous standards, and occasional severity. W.G. Habashi, now of McGill University, especially remembers his final oral Ph.D. exam and the difficult and uncompromising questions posed by Professor Shen. He also remembers Dr. Shen's friendly concern for his subsequent career and his urging that he be independent, move beyond his thesis subject, and try new things.

Shan-Fu Shen's faculty colleagues at Cornell remember him as a serious-minded but warm and helpful friend. K.K. Wang, recalling his association with him in the injection-molding program, says that at a critical time when he needed a partner to initiate interdisciplinary research on injection molding of plastics, Shan-Fu stepped in, and, for the next 14 years, generously contributed his vital expertise in fluid mechanics and heat transfer. During that time, he was always a sincere and constructive critic, a reliable advisor, and a major contributor in matters of computational fluid mechanics. Shen-Fu was highly regarded not only by students and research staff in CIMP, but also by program participants from industry and other institutions. Professor Wang adds, "He will be remembered fondly by all of us who worked closely with him for so many years."

Shan-Fu Shen was devoted to China and Chinese culture. At the age of 11, he lost his father, a University of Michigan graduate in civil engineering. Shan-Fu grew up as a self-reliant and exemplary eldest son, constantly striving for excellence. A classic Confucian scholar, his interests were also diverse and wide ranging, and included a great affinity for music, history, calligraphy, photography, and even horticulture and culinary arts.

He was devoted to his family—his wife Ming-Ming and their son Hsueh-Yung and daughter Hsueh-Lang, who all survive him. He was very proud of the musical talents and accomplishments of Ming-Ming and both his children. He was also a proud host of many dinners at his home, at which Ming-Ming showed her mastery of classical Chinese cuisine, to the delight of their privileged guests!

So we must say farewell to Shan-Fu Shen, distinguished scholar, engineering scientist, faithful teacher, colleague, and friend.

ALAN F. SHUGART

1930–2006

Elected in 1997

"For contributions to disc memory devices and interfaces for personal computers."

BY GORDON F. HUGHES
SUBMITTED BY THE NAE HOME SECRETARY

ALAN F. SHUGART, pioneer of the multibillion-dollar computer hard-drive industry and co-founder of Seagate Technology, died December 12, 2006, at the age of 76, of complications from heart surgery six weeks earlier. Shugart was one of the most influential and admired figures in the industry.

After graduating from the University of Redlands in 1951 with a degree in engineering physics, Al began his career at IBM, where he worked on RAMAC, the world's first disk drive, which could store 5 million characters of data, weighed a ton, and took more than a second to access stored data. He continued at IBM for 18 years, working on or leading many significant disk-drive development programs, including the groundbreaking 1311 removable disk-pack drive. By the time he left the company, in 1969, he was director of engineering.

From 1969 to 1972, Al was vice president of product development at Memorex, which became IBM's primary competitor in drive sales. When he left Memorex, he launched Shugart Associates with several loyal followers. The company designed a smaller-diameter floppy-disk drive that was used in the 1979 Apple II, which became the first mass-market PC thanks largely to Al's floppy disk, which eliminated the laborious chore of reentering data and programs every time the computer was turned on.

In 1979, Al and Finis Conner founded Seagate Technology, which designed and manufactured the first hard-disk drive for the personal-computer market. Al realized that "open-source" technology was essential for the PC hard-drive business to grow quickly into a mass market and that Seagate would have many more customers if they could buy hard drives from other companies as well. Betting that he could make better products at lower prices, he pioneered today's standardized, open specifications for computer disk drives. Al made Seagate's disk drive electronic and mechanical specifications publicly available and freely usable by his competitors.

Seagate's first commercial product was a 5.25-inch, 5-megabyte hard-disk drive that became a major enabling technology for the PC industry. The company's success was driven by Al's culture of honesty and open information. Al, who was honest to a fault, ran his companies by his own strict ethical standards. He once said, "I decided that I couldn't lie about anything, even though lying would make things better." His ethics had the virtue of being very simple and perfectly clear to his employees. In an ambiguous situation, they only had to ask themselves, "What would Al say?"

He led Seagate into the design and manufacture of its own critical drive components, becoming the first high-volume manufacturer of thin-film cobalt recording disks. In 1989, Seagate acquired Imprimis Technology in Minneapolis from the Control Data computer company, giving Seagate research and manufacturing capability for recording heads and high-end drives. He diversified Seagate into different aspects of the data-storage business, including data backup and removable flash memory. Seagate ultimately spun off the data backup component as Veritas.

Under Al's leadership, Seagate became the world's largest producer of disk drives, and it remains so today. He insisted that all company employees worldwide share in the company's success. He was a staunch believer in stock options in high-tech start-up companies to ensure fairness to employees. Thus all Seagate employees received stock options. Al also founded the Seagate Institute of Technology to spread Silicon Valley engineering and manufacturing skills worldwide.

As the data-storage industry matured, Al foresaw that research would become increasingly critical. He was a founder of the Center for Magnetic Recording Research at the University of California at San Diego and a major research and education center at Carnegie Mellon University in Pittsburgh.

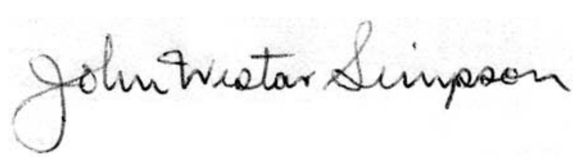
He left Seagate in July 1998 to run his own company, Al Shugart International, an incubator for start-up companies.

Al campaigned for the Private Securities Litigation Reform Act of 1995, which outlawed frivolous lawsuits and limited securities-fraud class actions against corporate executives.

In his long career, Al won many awards. He was elected a member of the National Academy of Engineering in 1997. Also in 1997, IEEE honored him with the Rey Johnson Award for the advancement of information storage technology. In 2005, he became a fellow of IEEE for his lifelong contributions to the disk-drive industry. In 2005, he was also made a fellow of the Computer History Museum. Al was a popular speaker at storage-industry conferences. He received the CEO of the Year Award from *Financial World Magazine* and was Data Storage's Most Admired Executive from 1993 to 1997.

Al was an outstanding leader who inspired great loyalty in his team members. When asked about his leadership model, he often said, "I find a parade, and get in front of it!" Al didn't invent disk-drive technology—neither RAMAC nor the first floppy drive nor the first hard drive for personal computers. Al made high-performance, low-cost drives available to the world. Early drives had been built a few at a time, like airliners. Al built them by the millions.

Al is survived by his wife Rita, daughter Teri, son Chris, and his stepdaughters, Jill Bambace, Mia Peterson, and Dana Bambace.


John Wistar Simpson

JOHN WISTAR SIMPSON

1914–2007

Elected in 1966

"For nuclear power"

BY WILLIAM HOWARD ARNOLD

JOHN SIMPSON, a pioneer in the application of nuclear energy to naval propulsion, electric-power generation, and space propulsion, died on January 4, 2007, at the age of 92. He was elected to NAE in 1966, just two years after its creation. He joined Westinghouse Electric Corporation as a junior engineer in 1937 and retired as executive vice president and president of the Power Systems Company, one of its four main groups, in 1977. He remained active in business, professional, and community affairs until his death.

John Wistar Simpson was born in Glenn Springs, South Carolina, on September 25, 1914, to Richard and Mary Randolph Spotswood Berkeley Simpson. As a boy and young man he was fascinated with both science and the military. In 1932, he attended Wofford College in Spartanburg, South Carolina. At the same time, he applied for an appointment to the U.S. Naval Academy. In 1933, he enlisted in the Marines and had just completed basic training when he was accepted to Annapolis. He graduated from the Naval Academy in 1937, but was denied a commission because of poor eyesight.

In that same year, John joined Westinghouse Electric Corporation at its East Pittsburgh plant and worked in the switch-gear division. He also began studies at the University of Pittsburgh, which led to an M.S. in electrical engineering in 1941. In the naval buildup leading to U.S. participation in World War

II, he was assigned to switchboards and other electrical gear for U.S. Navy ships; he became the manager of this unit in 1944.

In 1939, he had started to work with Cmdr. (later Adm. in 1953) Rickover (USNA 1922), who was in charge of electrical procurement for the U.S. Navy, Bureau of Ships. Their challenge was to design and manufacture electrical gear that could withstand battle shocks and damages in a wartime environment. At one point, John was so eager to join the fray that he enlisted in the U.S. Army, but Rickover blocked his application, telling him that the United States needed to win the war at sea more than it needed one more hero. The proof was in the pudding. Days after the war ended, John was sent to Japan as a member of the Navy Technical Mission, to assess the Japanese war effort.

In 1946, when then Capt. Rickover was assigned to Oak Ridge National Laboratory in Tennessee to study the application of nuclear energy, Westinghouse granted Simpson a two-year leave of absence to join Monsanto and Rickover's group. After pursuit of the Daniels pile, a gas-cooled reactor, ended in a blind alley, Rickover seized on the concept of pressurized water and established industrial efforts at General Electric (GE) and Westinghouse to support Argonne National Laboratory, which was to develop the reactor.

The Atomic Power Division at Westinghouse was formed at the end of 1948, and John was named assistant manager of engineering in 1949. The division was located at the former Bettis Airfield, just south of Pittsburgh. John became technical director in 1952 and laboratory director in 1955.

Under his leadership, the group at Bettis developed the first pressurized-water reactor (PWR), which was installed in the *Nautilus* submarine that went to sea in 1955. The group also designed PWRs for use in surface ships, including aircraft carriers, cruisers, and destroyers. After Adm. Rickover had convinced the Atomic Energy Commission (AEC) to support development of a large reactor, the PWR was adapted for use in a commercial power station.

John was project manager for the Shippingport Power Station, just north of Pittsburgh, which was built as a joint project with Duquesne Light. Shippingport, the first full-scale commercial nuclear-power station in the world, began operation in 1957 and was decommissioned in 1982. President Eisenhower broke ground for the facility in 1954 by remote control.

In 1952, Westinghouse established its Commercial Atomic Power Activity (CAPA) in Pittsburgh. Adm. Rickover worked hard to retain his technical staff at Bettis, and Westinghouse began with just a few Bettis alumni, supplementing where they could with outside hires. In 1959, against Rickover's wishes, John moved within Westinghouse to pursue the use of nuclear power in space. As a result of his departure, Bettis transferred some of its operations to GE at Knolls Atomic Power Laboratory, near Schenectady. Eventually, GE developed the boiling-water reactor, which became the chief competitor of the Westinghouse PWR in the commercial market.

When Simpson took up the challenge of space propulsion, it appeared to be as promising as naval nuclear power. Westinghouse established the Astronuclear Laboratory in Pittsburgh under Dr. Sidney Krasik and several who had worked at Bettis. Their big opportunity came in 1961, when the AEC and NASA announced an industrial competition to design and build a nuclear-propulsion device powered by a reactor based on the Los Alamos KIWI design (NERVA, a nuclear engine for rocket vehicle applications).

Westinghouse, a dark horse, split the contract with Aerojet General. The project soon involved several thousand people and tests of six live reactors, including a breadboard engine, in the Nevada desert. Despite its technical success, however, NERVA was canceled in 1972 for lack of a compelling mission, when near-Earth missions were abandoned for fear of nuclear contamination.

When John left Bettis, he was made vice president in charge of both the Astronuclear Laboratory and the fledgling Commercial Atomic Power Activity. The latter, which was completely outside Admiral Rickover's aegis, had won several small contracts—one for a small PWR (11MWe), to be located in Brussels, to power the World's Fair in 1959. After objections were raised to an urban location, the reactor was built in a rural area, where it operated successfully for many years.

The first truly commercial Westinghouse PWR was Yankee Rowe (185MWe), which followed closely on the 1954 revised Atomic Energy Act (signed by President Eisenhower as the Atoms for Peace Act). The contract was signed in 1956, and the plant went into operation in 1960, essentially on schedule and within budget. In many ways, Yankee Rowe was a prototype of the majority of the 435 nuclear-power reactors operating in the world today.

CAPA was licensor to FIAT in Italy, Schneider in France, Siemens in Germany, ACEC in Belgium, and Mitsubishi in Japan. Thus Westinghouse technology became widely dispersed. In France, Framatome, the company set up by Schneider and Westinghouse, eventually built the 53 reactors that supply 90 percent of France's electricity. Framatome's successor, Areva, is a major factor in the world market today.

When John took charge of CAPA and Astronuclear in July 1959, the former faced enormous technical and managerial challenges. It was John's leadership and drive that made the remarkable surge in nuclear power during the 1960s and 1970s possible. In 1962, he put in a brief stint as corporate vice president for engineering and research, before being appointed vice president for the Electric Utility Group (EUG). From this time until his retirement in 1977, as head of EUG and later as president of the Power Systems Company of Westinghouse, he oversaw the sale of 53 large Westinghouse nuclear plants in the United States and 42 overseas. In addition, licensees sold 83 plants, which brought in substantial royalties until 1992.

Known as a hands-on manager, John personally conducted technical and business reviews. He believed in personal relationships with key customers, government officials, and licensee managers and their customers and governments. For example, the negotiations that transformed the program in France were excruciating. Some parties in France wanted to develop their own design, many wanted to split the business between the Westinghouse PWR and GE's boiling-water reactor, and no one wanted Westinghouse to retain its 45 percent ownership of Framatome or to pay the billion dollars in royalties. John presided over the negotiations, which resulted in an all PWR program, as well as a cooperative R&D program between Westinghouse and the interested technical operations in France. Westinghouse sacrificed it ownership share but retained the royalties. Westinghouse engineers are still proud of their role in helping the French assume the position they hold today in nuclear energy.

During this time, John was a leader in the liquid-metal fast-breeder reactor program, winning contracts for both the Fast Flux Test Facility at Hanford (1968) and the Clinch River Breeder Reactor (1972). The former operated successfully from 1982 to 1993; the latter was canceled during the Reagan administration after design was completed and site preparation had begun. However, as of 2007, the U.S. Department of Energy began funding studies for reviving some of these programs under its Global Nuclear Energy Program.

Westinghouse had a "step-down" program for senior executives beginning at age 60, which John reached in 1974. Against his better instincts, he became a corporate consultant, but this did not allow him to pursue his many other interests. He retired from Westinghouse in 1977 but remained active in the field as a principal in International Energy Associates.

John's leadership in the field of applications of nuclear energy brought him many honors. He was president of the American Nuclear Society (1973–1974) and chairman of the Atomic Industrial Forum, now the Nuclear Energy Institute (1974–1976); recipient of a Certificate of Merit from the U.S. Navy during World War II; a fellow of IEEE and a recipient of the IEEE Edison Gold Medal; a fellow of ASME and a recipient of the ASME Westinghouse Gold Medal; a recipient of the Gold Medal for Advancement of Research from the American Society for Metals; and a recipient of the Newcomen Gold Medal from the Franklin Institute. He was also a trustee at various times for Wofford College, Seton Hall College, and Point Park College, and he served on numerous advisory committees for a number of organizations.

After retirement, Simpson and his wife, Esther, whom he met when both were working at Oak Ridge and married in

1948, retired to Hilton Head Island, South Carolina. They had acquired a beach-front home in 1966 and the family spent many happy years vacationing there before he and Esther became full-time residents of the Sea Pines development in 1980. In the mid-1980s he became a founding director of Sea Pines Associates and he's credited with organizing the homeowners in Sea Pines to purchase the resort and save it from failing and going into bankruptcy.

Simpson remained active throughout the next 20+ years, traveling extensively with Esther and entertaining friends and family in Hilton Head. He was deeply involved in the First Presbyterian Church both in Pittsburgh and on Hilton Head. In addition to his affiliations with many educational institutions and professional organizations, Simpson served on the board of the National Council of Churches. He maintained close ties with Pittsburgh too, keeping memberships at various clubs there, such as the Duquesne Club, the University Club, Laurel Valley Country Club, Rolling Rock Club, and others. He also belonged to Farmington Country Club in Charlottesville, Virginia, and Bear Creek Golf Club on Hilton Head. He loved golf, bridge, snow skiing, hunting, deep-sea fishing, fine wines, good friends, and debating on a myriad of topics.

Never one to rest and relax, he authored two books and continued to consult on nuclear matters with a number of different colleagues. "My father was especially proud of his membership in the National Academy of Engineering," said his daughter, Patricia Deely. "Even at 92, he dressed in a shirt and tie and always wore his NAE lapel pin on his jacket."

Simpson's wife, Esther Slattery Simpson, passed away on August 6, 2004. John is survived by his four children—John Simpson Jr., Carter Berkeley Simpson, Patricia Deely, and Barbara Wilkinson—and five grandchildren—Christina and Carter Berkeley Simpson Jr., Savannah Wilkinson, Sean and Emily Deely—and two step-grandchildren—Dan and Matt Deely.

ROBERT M. SNEIDER

1929–2005

Elected in 2000

"For teaching and demonstrating the importance of synergistic geological, geophysical, and engineering efforts in the exploration and development of hydrocarbon accumulations."

BY MICHAEL PRATS

ROBERT M. SNEIDER, founder of Robert M. Sneider Exploration Inc., died in Houston on October 29, 2005, at the age of 76. Elected to the National Academy of Engineering (NAE) in 2000, he was in the middle of his third year as liaison member between the NAE Earth Resources Engineering Section and the National Research Council when he passed away.

Bob was born in Long Branch, New Jersey, on March 2, 1929; grew up in Asbury Park, New Jersey; and attended Rutgers University, where he received a B.S. in geology (with honors) in 1951. He served in Korea as a combat engineering officer in the U.S. Army Corps of Engineers until 1952. Following his military service, he entered graduate school at the University of Wisconsin and received his Ph.D. in geology and mining engineering in 1956.

Greatly influenced by his mentor Gus Archie, of Shell Oil, who shaped Bob's career and the way he came to think about the subsurface, Bob joined Shell Oil in 1957. He spent the next 18 years, from 1957 to 1974, with Shell Oil or Shell Development Company, primarily as a reservoir geologist working on the application of well logs and reservoir geophysics to sandstone and carbonate reservoirs in the United States and Canada. He also trained geologists, geophysicists, and engineers to work together, the so-called "multidisciplinary team" approach, which reshaped how Shell, and eventually the entire industry, conducted business.

In 1974, Bob co-founded a small consulting firm, Sneider and Meckel Associates Inc., which assembled a technical team of geologists, a geophysicist, a log analyst, and a reservoir engineer. For the next seven years, they took on exciting and challenging projects, some of which resulted in the discovery of more than a dozen new fields, including Canadian Hunter's huge Elmworth Field in the Alberta Basin, and significant redevelopment opportunities in older fields in the Anadarko Basin.

Bob was never one to shy away from forming a new group to accomplish tasks that required unusual combinations of talent. In 1981, he founded Robert M. Sneider Exploration Inc., a move that simultaneously opened new international areas and took him back to his roots, the detailed evaluation of the new potential of old fields. The new company acquired marginally producing properties and significantly increased production by improving reservoir recovery methods, using sound geologic principles, and calibrating well logs to rock types. He was also a partner and co-founder of Richardson, Sangree, and Sneider, a geosciences and engineering consulting group, and a partner and co-founder of PetroTech Associates, a company that specialized in the characterization of reservoir and seal rocks.

Bob pioneered the integration of information from geology, petrophysics, and engineering to solve geologic problems. Based on this approach, his organizations helped build two financially successful oil and gas companies—Canadian Hunter Exploration Limited and Greenhill Petroleum Company. He personally organized and led multidisciplinary teams that led to the discovery of several billion barrels of oil (equivalent) in new fields and in "hidden" reserves in existing fields throughout the world.

In addition, he sought, acquired, and rejuvenated 46 economically marginal fields in the United States in partnership with various companies. He recognized that these fields still had large reserves just waiting to be identified. Using his multidisciplinary approach, more than 600 million barrels of new reserves were acquired from these fields.

By nature, Bob was an outstanding teacher. He felt it was his responsibility to share his observations and insights with others, and he did so with unbounded enthusiasm. He taught more than 20 different courses and trained several thousand professionals. He taught a wide range of subjects, including the exploration and development of sandstone and carbonate reservoirs; application of petrophysics in finding new reserves in dry holes and old fields; the value of integrating concepts and methods from geology, geophysics, petrophysics, and engineering; and methods of organizing and managing multidisciplinary teams.

Bob was active in several professional societies, especially the American Association of Petroleum Geologists (AAPG), for which he chaired several committees. He was also Distinguished Lecturer for the AAPG (1988), in Australia (1992), and the Middle East (1996), and ESSO Distinguished Lecturer for Australia (1997). On behalf of AAPG and three other societies, he convened the first annual Archie Conference on Reservoir Delineation, Description, and Management, an internationally recognized series that continues today. AAPG honored him with the Distinguished Service Award (1991), named him Honorary Member (1994), and granted him its highest honor, the Sidney Powers Memorial Award (2001), in recognition of his outstanding contributions to and achievements in petroleum geology.

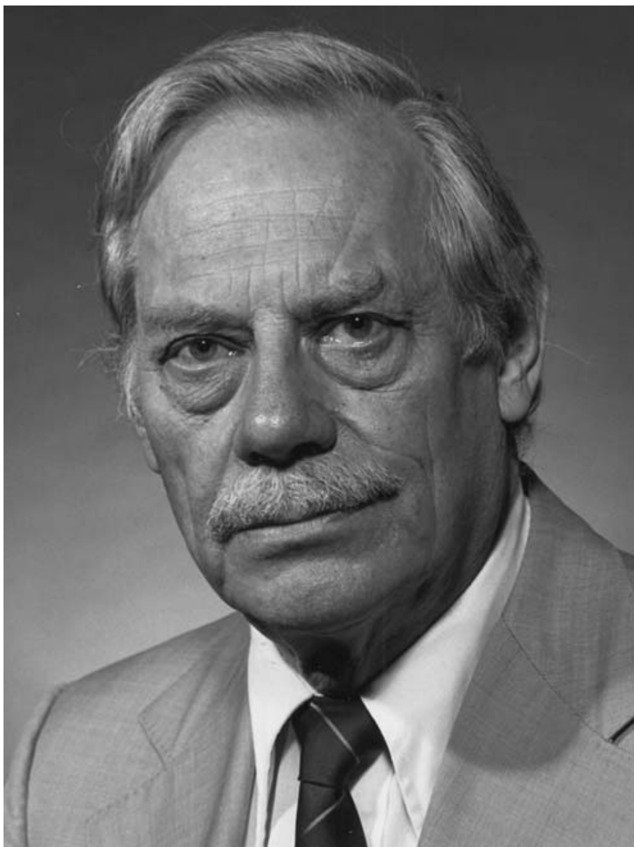
A man of integrity, Bob always knew exactly where he stood on an issue and why. His recommendations were logical, practical, and valued, although they were not always what his listeners wanted to hear. He served on the advisory boards of AAPG, the Colorado School of Mines Department of Geology, University of Wisconsin Department of Geology and Geophysics, and Strike Oil and Strike Energy Ltd. of Australia. He was a trustee associate of the AAPG Foundation and was instrumental in establishing the Gustavus E. Archie Memorial Grant and Gustavus E. Archie Memorial International Grant, which, together, provide four grants a year to graduate students in petrophysics and development geology.

Although Bob's parents weren't thrilled initially about his passion for geology (they didn't know what a geologist was or how on earth he could make a living), when Bob's career took off, they decided it was okay. Bob loved being out in the field, whether he was studying modern depositional processes or outcrops. When most kids and their families went to the beach, the Sneiders went on field trips to study coastal processes. Annual vacations, especially through the mountains of California, Colorado, Wyoming, and the Canadian Rockies, were occasions to take pictures of outcrops and explain the geology, whether or not anyone was listening.

Bob eagerly and generously gave of his time and money, especially to further the development of young professionals and students. Having received financial aid in his youth that enabled him to go to college, he became a mentor for literally hundreds of people. His true strength was the way he shared his knowledge and experience. He treated everyone with respect, from top executives to trainees.

One of those whom Bob mentored said this upon his death: "This is the passing of the greatest mentor that I have ever had in the field of geology. Bob's talents are known worldwide, and on top of his science skill set, he was a true gentleman. He will be missed by many. He once wrote about his own mentor, Gus Archie, 'the mediocre mentor tells, the good mentor teaches, the superior mentor demonstrates, and the great mentor INSPIRES!' Bob was inspirational." Those of us who experienced the breadth and keenness of his knowledge of petroleum geology were indeed fortunate. He was the preeminent, complete subsurface geologist.

Bob is survived by his daughter, Linda A. Reid, and husband, Charles, of Katy, Texas; son, Timothy J. Sneider, and wife, June, of Clear Lake Shores, Texas; son, John S. Sneider, and his wife, Dorothy Ballentine, of Kemah, Texas; grandson, C.C. "Chris" Reid; granddaughter, A.C. "Catie" Reid; sister, Lois S. Tarshes, of Indianapolis, Indiana; sister, Lee S. Sager, of Miami Beach, Florida; sister-in-law, Elayne Donahue, of St. Paul, Minnesota; sister-in-law, Ethel Ann Marshall, and husband, Paul, of Woodbury, Minnesota; brother-in-law, Raymond N. Meyer, and wife, Sheila, of St. Paul, Minnesota; and numerous nieces and nephews.



Vivian T. Stannett

VIVIAN T. STANNETT

1917–2002

Elected in 1995

"For contributions to the understanding of transport processes and polymer radiation chemistry in polymers."

BY DONALD R. PAUL

VIVIAN THOMAS STANNETT, Camille Dreyfus Professor Emeritus of Chemical Engineering and dean emeritus of the Graduate School at North Carolina State University, died October 1, 2002, at the age of 85. He was elected to the National Academy of Engineering in 1995 for his original contributions to the understanding of transport processes and radiation chemistry in polymers.

An internationally renowned polymer scientist/engineer, Vivian pioneered the use of high-energy radiation to form new polymers or alter existing ones through cross-linking, grafting, and degradation. A recognized leader in the study and application of membrane science and technology, his work contributed to the development of a wide range of beneficial products, including super-absorbent paper towels and diapers and flame-resistant textiles. He also worked extensively on chemical modifications of cellulose and applications of polymers to pulp, paper, and textiles.

Vivian was born on September 1, 1917, to a farming family in Langley, England. Much to his father's distress, he had no desire to take up farming. Interested in chemistry from an early age, he carried out experiments on his own in an abandoned railway carriage on the family's property. In 1936, he took another step toward fulfilling his dream of becoming a scientist by enrolling in the London Polytechnic to study chemistry; he graduated with a B.S. in 1939.

After obtaining his degree, Vivian worked for the British government from 1939 to 1947, first as a shift manager of the cellulose-acetate film plant at the British Celanese Corporation. Cellulose-acetate films were in great demand during the war for gas masks and other military uses. In 1941, he was assigned to the Army laboratories at Woolwich Arsenal, where he worked on detonator inspection and research. When the arsenal was severely damaged by bombs, Vivian was moved to a large ordnance plant and laboratories in Liverpool. Later, he was moved back to Woolwich, only to have his laboratory destroyed by a V2 rocket. He then moved to another cellulose-acetate plant.

When the war ended, Vivian applied to study with Professor Herman Mark at Polytechnic Institute in Brooklyn (now Polytechnic University) for a Ph.D. in chemistry. He was accepted in 1947 as a graduate student under Professor Mark, without a fellowship, but he was promised one if he did well the first semester. He received his fellowship the following January, and in 1950, he received his Ph.D. in physical chemistry. Afterward, he returned to London.

On May 30, 1946, Vivian Stannett had married Flora Susanne Sulzbacher, who holds an honors degree in textile chemistry from Queens University in Belfast. Vivian and Susanne had one daughter, Rosemary Anthia (now Royce), and three grandsons. In 1951, Vivian accepted a position as research chemist at the Koppers Company and became a research associate at the Mellon Institute in Pittsburgh. At that time, he and Susanne moved permanently to the United States; they became U.S. citizens in 1957.

In 1952, Vivian accepted an appointment as assistant professor of forest chemistry in the College of Forestry in Syracuse, New York; in 1957, he became a full professor. In 1958, he took a sabbatical leave at the University of Paris, where he became associated with Professors Michel Magat and Adolphe Chapiro, leaders in the field of radiation grafting and the radiation chemistry of polymers. When he returned to the United States, he continued this work in Syracuse and later, in 1961, as associate director of the newly formed Camille

Dreyfus Laboratory for Polymer Research at the Research Triangle Institute in North Carolina. The laboratory director was Professor Anton Peterlin.

While working at the Dreyfus Laboratory, Vivian kept up his academic credentials by becoming adjunct professor of chemistry at Duke University; later he also became adjunct professor at North Carolina State University (NCSU). In early 1967, he left the Dreyfus Laboratory and joined NCSU full time as professor in the Chemical Engineering Department; he was later named Camille Dreyfus Professor. Vivian officially retired in 1988 when he reached the mandatory retirement age of 70. However, he continued working with graduate students until 1992.

During his scientific and academic career, Vivian published more than 400 papers and reviews on polymer science and technology. He also served on the editorial boards of seven prestigious journals. It comes as no surprise that he also received many honors. He was a fellow of the Royal Institute of Chemistry (1948), New York Academy of Sciences (1960), TAPPI (1968), and the Royal Society of Chemistry (1980). He received the Silver Medal from TAPPI (1967), the American Chemical Society (ACS) Award for Polymer Chemistry (1987), the Borden Award from the ACS (1974), the ACS Anselm Payen Medal (1974), the International Award and Gold Medal of the Society of Plastics Engineers (1978), the Olney Medal of the American Association of Textile Chemists and Colorists (1995) and the Distinguished Speaker Award (1983), the Alcoa Foundation Distinguished Research Award from the NSCU School of Engineering (1981), the North Carolina Science Award and Gold Medal (1981), the University of North Carolina Board of Governors O. Max Gardner Award (1984), the North Carolina Distinguished Chemistry Award from the North Carolina Institute of Chemists (1989), and the Holladay Medal from North Carolina State University (1992).

Vivian was active in many professional groups and organizations. He was chairman of the North Carolina Section of ACS (1970), chairman of the ACS Division of Polymer Chemistry (1977), and general secretary of the Macromolecular

Secretariat (1979). He was also involved with TAPPI, the Society of Chemical Industry, Phi Kappa Phi, and Phi Lambda Upsilon. He was chairman for the Gordon Conferences on Polymers (1972) and on Chemistry and Physics of Paper (1967).

Vivian had a unique sense of humor, which made life easier at times and was appreciated by all. He had few hobbies but liked hiking and bicycle riding. His wife recalls that when he finished high school he spent the summer before university cycling all over Europe by himself and got as far as the Alps. He finally ran out of money on his return trip and found an old friend in Holland who lent him enough to return home. He was also an avid reader, and not only of books about science.

Vivian was a true English gentleman who was able to find diplomatic and considerate solutions to problems and was liked by everyone who knew him. He devoted much of his life to mentoring younger colleagues who benefited greatly from his advice and example. He had an uncanny knack of making progress and contributions with grace and dignity. His colleagues from all over the world paid tribute to him at a symposium in his memory at an ACS meeting in New York in September 2003.

Vivian is survived by Susanne, his wife of 56 years; his daughter Rosemary Royce and son-in-law Christopher Royce; and grandchildren Julian, Trevor, and Liam Royce. Julian, the oldest, graduated last year from the University of North Carolina with honors, in religious studies. Trevor, the older twin, graduated this year from the University of Virginia, with honors, in biochemical engineering; he now hopes to go on to medical school. Liam, the younger twin, is in a five year program in pulp and paper and chemical engineering, at NCSU. As Vivian's daughter notes, engineering is still in the Stannett family. Vivian's sister-in-law, Ellen Strauss of London, also survives him.

I wish to thank Vivian's wife, Susanne, and his friend, Otto Vogel, for their help in preparing this tribute.

David Tabor

DAVID TABOR

1913–2005

Elected in 1995

"For contributions to the theory of tribology, hardness, and surface physics."

BY IAN M. HUTCHINGS AND BRIAN J. BRISCOE
SUBMITTED BY THE NAE HOME SECRETARY

WE WERE SADDENED to learn of the death, on November 26, 2005, of David Tabor FRS. He died in Cambridge, England, at the age of 92 after a long illness. One of the foremost tribologists of his generation, he was also a major figure in physics and a remarkable person. He was the author of the first paper published in the first issue of *Wear,* in 1957, and he maintained remarkable ties to that journal, where this obituary was first published.

David Tabor (later known as DT) was born on October 23, 1913, in London, England, to parents who had emigrated from Russia; his father had been an armorer in the Russian imperial army. After undergraduate study at the Regent Street Polytechnic and the University of London (in Imperial College), he moved to Cambridge in 1936 to undertake research in the Department of Chemistry under the supervision of Frank Philip Bowden, a collaboration that lasted until Bowden's death in 1968. Their first joint publication in 1939 on the area of contact between surfaces established the crucial point that the real area was generally much smaller than the apparent area. This basic principle was fundamental to much of their subsequent work.

At the outbreak of World War II, Bowden, who was Australian and was visiting his home country at the time, was persuaded by the Australian government to set up a research group at Melbourne University to work on the practical problems of lubricants and bearings. DT joined the new laboratory in 1940 and was its head for a short time (1945–1946), when Bowden returned to Cambridge. At that point, at Bowden's behest, DT suggested the name "tribophysics" to describe their activities, and the Tribophysics Section, which became the CSIRO Division of Tribophysics in 1948, thrived until 1978, when its name was changed to the Division of Materials Science.

While in Australia, David met and married his wife, Hanna. The Tabors rejoined Bowden in Cambridge in 1946 and remained there for the rest of David's life. The research group at the University of Cambridge, founded by Bowden and led by DT from 1968 until his official retirement in 1981, moved eventually from the Department of Physical Chemistry to the Department of Physics (the Cavendish Laboratory) and changed names several times. For much of its existence, however, it has been the Physics and Chemistry of Solids, and for those fortunate enough to have worked there, it will always be PCS, and David Tabor will always be DT. Despite changes of name, the subject and approach to research pursued by DT and his research group remained constant—to generate a deeper understanding of the physical sciences relevant to problems related to solid surfaces and their interfaces, and especially the science of solids in moving contact now known as tribology,

The laboratory was a carefully managed, almost self-contained research institute with a remarkable reputation complemented by a "family-like" atmosphere. Visitors came from all over the world for long or short periods, and DT, who had a gift for languages, took pride in welcoming each of them in his or her mother tongue. He could probably have done this in at least 17 languages.

DT's monograph, *The Hardness of Metals* (1951 and now reissued), based on his early studies of the area of contact between metal surfaces and his wartime research, is still a readable and authoritative account of the scientific basis of indentation hardness and one of very few books on this important topic. In two classic volumes, published with Bowden, *The Friction and Lubrication of Solids* (1950) and *The Friction and Lubrication of Solids, Part II* (1964), the authors summarized, in elegant prose and with scrupulous acknowledgments of contributions from other research groups, the work done in PCS over two decades on subjects that are now considered the cornerstones of tribology—contact between solids; friction of metals and nonmetals; frictional temperature rise; boundary lubrication and other chemical effects; adhesion; sliding wear; and hardness.

For three decades, DT and his research group continued to make seminal contributions in these areas, characterized by careful, often highly innovative experimentation, thoughtful analysis, and comparisons with theoretical models. DT went on to work on innovative studies of organic polymers, colloid forces, ultra-high-vacuum manipulation, vacuum spectroscopy, the surface of diamonds, and adhesion between solids, especially by van der Waals forces, and other topics. This wide range of interests provided a basis for DT's unique contributions to tribology.

DT retired almost exactly 25 years ago but kept an office in the Cavendish Laboratory, which hosts the polymers and colloids group, two subjects DT pioneered, and has been renamed in his honor. DT also held a visiting post at Imperial College for several years. With a keen sense of the applicability of his research, he recognized, well before the concept became fashionable, that an interdisciplinary approach was essential to the study of tribology. Forty years ago he wrote, "The contribution that the physicist can make to tribology will be greatly increased by effective and enlightened collaboration with the chemist, metallurgist, and engineer."

In his characteristically modest and unassuming way, DT played a leading role in developing and promoting tribology in the U.K. scientific community and in founding and chairing the Tribology Group of the Institute of Physics in 1981. The Institute of Physics has just established the Tabor Medal in his memory, to be awarded for distinguished research in surface or nanoscale physics. Tabor's achievements were recognized by his fellowship of the Royal Society (1963), the first Tribology Gold Medal awarded by the Tribology Trust (1972), the Guthrie Medal from the Institute of Physics (1975), and the Royal Medal awarded by the Royal Society (1992). DT was also well known and highly regarded outside the U.K., where his wide-ranging interest in other cultures and languages had facilitated contacts with tribologists worldwide. He was elected a foreign associate of the National Academy of Engineering in the United States in 1995.

DT's son remembers him as deeply attached to traditional Judaism, which shaped and guided his exemplary conduct toward others, whatever their background or beliefs. He had a deep love of Hebrew literature and a wide range of intellectual and cultural interests. He was a devoted son, husband, and father; a loyal friend; and a wonderful role model for his sons.

He is survived by his wife, Hanna, and their two sons, Daniel and Michael.

Everyone who had the privilege of knowing David Tabor will remember him with affection as a humane, gentle, and intelligent man who inspired many generations of tribologists.

Chen To Tai

CHEN-TO TAI

1915–2004

Elected in 1987

"For basic contributions to the advancement of electromagnetic theory and its application to antenna design."

BY DIPAK L. SENGUPTA AND THOMAS B.A. SENIOR
SUBMITTED BY THE NAE HOME SECRETARY

CHEN-TO TAI, emeritus professor of electrical engineering and computer science at the University of Michigan (UM) and one of the most respected and influential scientists in electromagnetics and antenna theory, passed away peacefully at his home in Ann Arbor on July 30, 2004.

He was born December 30, 1915, to a family of scholars who were also wealthy landowners in Luzhi Township on the outskirts of Soochow, China. In 1937, he received his bachelor's degree in physics from Tsing-Hua University, China's premier institute of higher learning in science and engineering as well as the humanities. He stayed on there as an assistant and also served two years as a communications officer in the Chinese army with the rank of major. In 1943, having obtained a scholarship from Harvard University, he left Kumming and flew to Calcutta (now Kolkata), then traveled across the Indian subcontinent to reach Bombay (now Mumbai); from there he sailed to the United States on a ship called the *Cape of Good Hope,* which eventually reached New York by way of that same cape. The voyage took 49 days.

For the next six years, Harvard was his home. He received his M.S. in communication engineering in 1944 and the doctor of science degree in 1947; his thesis was entitled "Theory of Coupled Antennas and Its Application." He was the second doctoral student of Professor R.W.P. King, with whom he remained close friends throughout his life. He continued at the Cruft Laboratory at Harvard as a research fellow until 1949, when he moved west to take a position as research physicist at the Stanford Research Institute in Palo Alto. Some of the technical reports he wrote during this period are still important reference documents.

In 1954, he was appointed associate professor of electrical engineering at Ohio State University (OSU) in Columbus. Two years later, he left to take a faculty position at the Technical Institute of Aeronautics in São José dos Campos, Brazil, where he became proficient in Portuguese. He returned to OSU in 1961 and then, in 1964, joined the faculty of UM as professor of electrical and computer engineering; he also became a member of the Radiation Laboratory at UM. Except for a few years (1967–1969) when he took a reduced appointment to work part time for KMS Industries, he remained at Michigan for the rest of his career. He was made emeritus professor in 1986 and was honored by his colleagues and former Ph.D. students in a special session at the 1985 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting held in Vancouver, Canada.

Professor Tai is recognized throughout the world for his research on antenna theory, electromagnetic theory, and applied mathematics. His extension of Hallén's pioneering work on antennas to coupled cylindrical antennas established the foundation of multielement array antennas, which are used extensively in a variety of radio systems. His refinement of Schelkunoff's biconical antenna theory provided a much-needed understanding of how antennas can be designed to operate over a wide band of frequencies. His book, *Dyadic Green's Functions in Electromagnetic Theory*, published in 1971, popularized the use of Green's functions for the solution of diffraction-dependent antenna problems.

He also conducted significant work on the electromagnetics of moving media, introduced logical notation for vectors, and rigorously examined the vector calculus, which led to his second book (*Generalized Vector and Dyadic Analysis,* 1991). In collaboration with Dr. J.H. Bryant, he also showed how physical insights gained from Hertz's theory of electromagnetism provide an alternative method to obtain Maxwell's equations.

The years immediately following his retirement were very productive. He refined his prior work on the vector and dyadic calculus and produced a second edition of *Generalized Vector and Dyadic Analysis* in 1997. In this book, and in several technical articles written about this time, he introduced a logically correct notation and interpretation for the divergence and curl operations. A revision of his earlier book on dyadic Green's functions was published as a new edition by the IEEE Press in 1996.

In spite of his formal retirement, he continued to be an active member of the Radiation Laboratory at UM. He was always available to students and faculty for technical advice and discussions, and he always left them with a better and deeper understanding of the subject. As a token of his undiminished love for teaching and education, his family and friends created the annual IEEE AP-S Chen-To Tai Distinguished Educator Award in 2000. The first recipient was Professor R.W.P. King.

Throughout his career, Professor Tai received many honors and awards for teaching and research. He was elected a fellow of IEEE in 1962 and was president of the AP-S Administrative Committee in 1971. He received the AP-S Distinguished Achievement Award in 1986 and the IEEE Centennial Medal in 1984, when he was made a life fellow of IEEE. He also received outstanding faculty and teaching awards from OSU and UM and was awarded honorary professorships by Shanghai Normal University, Chengdu Institute of Radio Engineering, and Nanjing Institute of Post and Communication in 1980, 1986, and 1987, respectively. He was elected a member of the National Academy of Engineering in 1987 and received the IEEE Heinrich Hertz Medal in 1998.

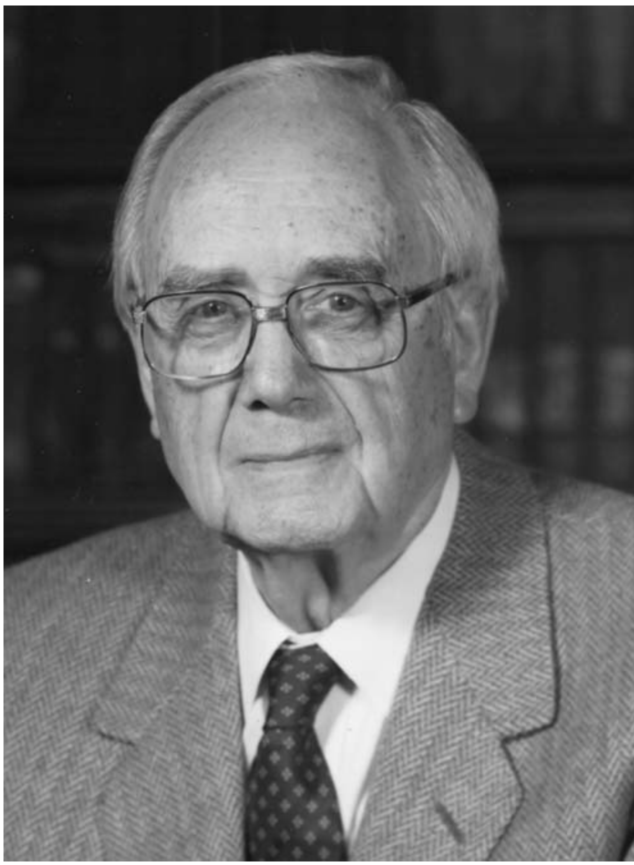
Professor Tai was a visiting professor and researcher at many national and international universities and research institutes, including Harvard University, 1973, and the University of Washington (Walker-Ames Professorship), 1973, in the United States; University of Lund, Royal Technical Institute, and Chalmers Institute of Technology, 1972, in Sweden; Shanghai Normal University, 1979 and 1982, Shanghai University of Technology, 1986 and 1987, and Tsing-Hua University, 1979, in China; Tohoku University, 1979, in Japan; and National Institute of Space Research (Fulbright Senior Lecturer), 1985, in Brazil.

As everyone who attended technical meetings with Professor Tai knows, he had a passion for tennis, and his tennis racquet was part of his travel gear. When the Tais came to Ann Arbor in 1964, they bought a house in the country where there was room for a tennis court, which was soon added. In spite of a heart attack (and subsequent quintuple bypass operation) in 1997, Chen-To continued to play tennis until two years before his death.

When the Tais moved into the city, he set up a woodworking shop in the basement of his home, where he made useful wooden household accessories, which were frequently given to friends as gifts. He was also interested in Chinese literature, painting, calligraphy, and music (both Chinese and Western classical). His first book, published in 1971, may be one of the few technical works with a Chinese painting (done by the author) as a frontispiece. He was extremely proud of his Chinese heritage, and in keeping with his Buddhist faith, he was a man of peace.

Everyone who knew Chen-To Tai will remember him as a kind gentleman and scholar who made magnificent contributions to science and engineering and gave generously of himself. He was a dedicated teacher known for the clarity of his lectures and was loved and respected by his students and colleagues. Most important, he was a decent and compassionate human being.

He is survived by his wife Ming, five children, and 10 grandchildren, to whom we send our condolences.



GORDON K. TEAL

1907–2003

Elected in 1969

"In recognition of his pioneering research on single crystals of germanium and silicon and his co-invention and reduction to practice of the single crystal grown junction transistor, contributions which must be ranked among the most critical and essential to the development of the semiconductor industry and electronics."

BY DON W. SHAW

GORDON K. TEAL, a key participant in the development of the transistor, died on January 7, 2003, at the age of 95. The first transistors, fabricated in polycrystalline germanium at Bell Labs, were unstable and exhibited erratic behavior. Gordon recognized that grain boundaries and other defects characteristic of polycrystalline materials were the likely reasons for this poor performance. He managed to prepare small single crystals and, with remarkable perseverance, convinced his colleagues at Bell Telephone Laboratories to test transistors fabricated from them. The results were dramatic improvements in transistor stability and reproducibility.

Gordon Teal was born January 10, 1907, in Dallas, Texas. He graduated from high school with the highest scholastic average in Dallas and went on to earn a bachelor's degree in physics and chemistry from Baylor University and a doctorate in physical chemistry from Brown University. While a student at Brown, Gordon studied germanium, an exotic material that fascinated him, partly because of its "uselessness."

In 1930, he joined Bell Telephone Laboratories, where his early assignment involved materials for television components, and, during World War II, high-performance rectifiers for radar systems. Working near the transistor development group at Bell Labs, Gordon soon recognized the significance of the transistor, which would also give him an opportunity to work with his favorite element, germanium. Initially his appeals for using single crystals of germanium for transistor fabrication were met with little interest. Eventually, however, he convinced his supervisors to allow him to work on the growth of single crystals, but only after normal working hours. Because of a shortage of laboratory space, Gordon and his colleague, John Little, had to mount their crystal-growing equipment on wheels so it could be rolled into a closet when they finished their experiments each night.

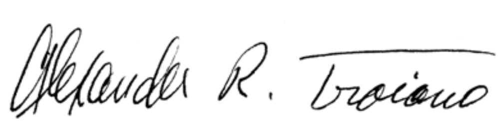
Crystals grown in the Teal-Little “puller” dramatically improved electronic properties in comparison with conventional polycrystalline crystals. The absence of grain boundaries decreased the trapping of charge carriers, and the single-crystal growth process itself further purified the germanium. After the demonstration of enhanced performance and reproducibility in transistors fabricated from single crystals, Bell Labs established an entire group devoted to growing semiconductor crystals. Gordon and another colleague, Morgan Sparks, later developed the double-doping technique that led to the creation of the junction transistor.

In 1952, Gordon returned to Texas as director of the first research department at Texas Instruments (TI), where he assembled a group of talented scientists and engineers to work toward the development of silicon transistors. At the time it was generally recognized throughout the infant semiconductor industry that silicon would be a superior material to germanium for transistors. Unfortunately, silicon crystals were difficult to grow, but Gordon’s perseverance paid off again, and the group succeeded in producing them. Gordon announced the breakthrough at the 1954 meeting of the Institute of Radio Engineers in Dayton, Ohio, where he demonstrated the superior temperature tolerance of silicon transistors by dunking the amplifier of a record player in hot oil. The commercial silicon transistor was a milestone in the growth of TI and the semiconductor industry.

In 1965 Gordon took a two-year leave of absence from TI to become the first director of the Institute of Materials Research in the National Bureau of Standards. Afterwards he returned to TI and served as vice president and chief scientist for corporate development until his retirement in 1972.

Gordon received many awards and honors for his accomplishments. The Patent, Trademark, and Copyright Institute named him Inventor of the Year for 1966. Two years later, he received the IEEE Medal of Honor, and a year after that, in 1969, he was elected to the National Academy of Engineering "For essential contributions to the development of the semiconductor and electronic industries." The American Chemical Society honored him with its Award for Creative Invention in 1970, and in 1984, he received the IEEE Centennial Award.

Gordon met his future wife, Lyda Louise Smith, while he was an undergraduate at Baylor, and they were married in New York in 1931. Gordon and Lyda had three sons, Robert, Donald, and Stephen. The Teals were active in civic and cultural organizations. Gordon was on the board of directors of the Dallas Museum of Contemporary Art and the Texas Fine Arts Association. His family remembers him for his devotion to them, his loyalty to friends, and his kindness and sense of humor. The world of electronics will remember him for his pioneering contributions to the growth of the semiconductor industry.



ALEXANDER ROBERT TROIANO

1908–2002

Elected in 1986

"For distinguished contributions to understanding the mechanical behavior of metals, and to the education of metallurgists."

BY ARTHUR H. HEUER AND GARY M. MICHAL

ALEXANDER ROBERT TROIANO, Republic Steel Professor Emeritus of Case Western University, died June 12, 2002. Born in Boston, Massachusetts, on September 5, 1908, Troiano attended Boston public schools, then Harvard University, where he received an A.B. in physics and mathematics in 1931. After four years as an instructor of physics at Middlesex College, he returned to Harvard for graduate study. He received his M.S. in 1937 in metallurgical engineering through a cooperative program with the Massachusetts Institute of Technology.

From 1937 to 1939, he was Gordon McKay Fellow and instructor in physical metallurgy at Harvard, and, in 1939, he received an Sc.D. from the Harvard Graduate School of Engineering. His thesis, under the aegis of A.B. Greninger, was a pioneering investigation of the crystallography of the martensite transformation in steels.

At a time when a fierce controversy was raging about the decomposition of austenite at low temperatures, Troiano and Greninger established unequivocally the essential and distinct kinetic behavior of the martensite transformation. They also provided new information on, and insight into, the crystallography and mechanism of the martensite reaction.

In 1939, Dr. Troiano accepted a position as assistant professor in the Department of Metallurgy at Notre Dame University; he was promoted to associate professor in 1941 and professor in 1945. He was department head from 1947 to 1949. During his years at Notre Dame, he continued to pursue his interest in phase transformations and made significant advances in our understanding of grain-size effects on the martensite transformation, produced a series of time-temperature-transformation diagrams in the iron-chromium-carbon system that advanced the concept of the incomplete reaction associated with the decomposition of austenite to bainite, and studied the martensite transformation in cobalt and the sigma phase in stainless steels.

During World War II, as an inspection engineer for munitions production, he was involved directly in manufacturing for the war effort. He was instrumental in revising standards and procedures to ensure the quality of components being shipped to the field, and, at the same time, he learned a great deal about the quenching techniques used to impart residual stresses into cannon barrels. This direct exposure to manufacturing influenced the rest of his career.

After the war, Professor Troiano, by now well established in the metallurgical community, joined the Department of Metallurgy at Case Institute of Technology as professor in 1949 and department head from 1953 to 1967, when he was awarded the Republic Steel Corporation distinguished professorship. Upon retirement from the Republic Steel chair in 1979, he remained active in research at Case Western Reserve University as senior research scientist and Republic Steel professor emeritus until his death on June 12, 2002.

While at Case, he initiated programs in mechanical properties, with a focus on the metallurgical aspects of embrittlement, which led to programs in slack quenching and the end-quench test, 500°F embrittlement of quenched and tempered steels, the mechanical properties of carburized steels, hydrogen embrittlement and delayed failure, and eventually stress-corrosion phenomena. He also continued to pursue his interest in phase transformations, with an emphasis on the bainite transformation and decomposition reactions, including early studies of the omega transformation in titanium-based alloys.

As department head, he was an insightful guide to the development of the metallurgy and materials science programs at Case. Among the many talented faculty he hired were NAE members Al Cooper (in 1965) and Art Heuer (in 1967), who initiated a graduate project in ceramics, which, in the ensuing decades, played an important role in the evolution of ceramic science and technology in the United States.

Professor Troiano published extensively on heat treatment and phase transformations of ferrous and nonferrous alloys, engineering applications of materials, and environmental degradation of materials, including hydrogen embrittlement and stress-corrosion cracking. He gave numerous keynote and honorary lectures throughout the world and was an active consultant to industry and government. As a member of the American Society for Metals (ASM), the American Institute of Mining (AIME), Metallurgical and Petroleum Engineers, the American Society for Testing and Materials, the National Association of Corrosion Engineers, and Sigma Xi, he served on and chaired many committees and helped organize many conferences.

Among his many awards were the Robert W. Hunt Medal, AIME (1941); the Henry Marion Howe Medal, ASM (1956); the Edward DeMille Campbell Memorial Lecturer, ASM (1959); the Albert Sauveur Achievement Award (1968) and Honorary Membership in ASM (1978); the LeChatlier Medal of the French Metallurgical Society (1980); and fellow of the Minerals, Metals and Materials Society (1984).

A summary of an academic career does not always convey the impact of an individual on his field or the institutions and people who represent it. Al Troiano devoted his entire professional career to education and research on many facets of physical metallurgy. His research interests ranged from dental alloys (which led to the identification of the g-brass structure in these materials); the kinetics, crystallography, and mechanism of martensitic transformations; systematic evaluations of alloying effects on the kinetics and mechanisms of austenite decomposition and transformations in titanium-based alloys; the mechanical behavior of high-strength steels as related to slack-quenched structures and embrittlement during tempering; and the effects of hydrogen on the mechanical behavior of both ferrous and nonferrous alloys. The latter studies led to his interest, in the autumn of his career, in stress-corrosion cracking in a wide range of commercially important alloys.

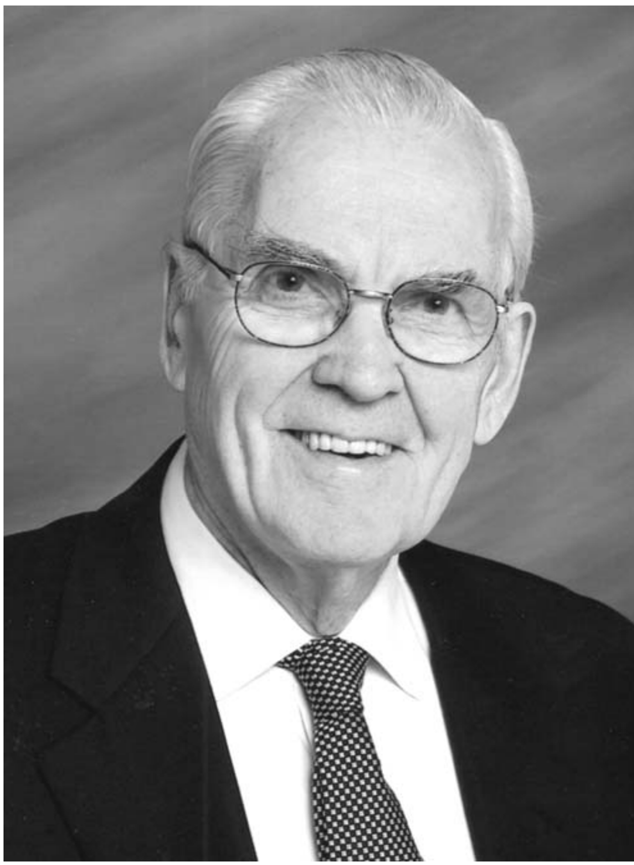
The many honors he received and keynote lectures he presented at national and international conferences attest to his esteem in the metallurgical community. However, the many ways his contributions provided a conceptual framework for the evolution of the field is a more representative measure of the true value of his work. The list of his publications reveals his wide range of interests but gives no indication of the in-depth consultations, critical analyses, and probing discussions with colleagues, friends, and students that resulted in clarifications and the subsequent evolution of new concepts.

Throughout much of his career, Troiano's immersion in research was paralleled by his attention to teaching and academic administration. His leadership, insight, and unselfish devotion were instrumental in the development of both strong research and curricular programs and the academic and professional development of aspiring young faculty. An entire generation of students, first at Notre Dame and then Case Institute of Technology and Case Western Reserve University, benefited from his guidance, his wise counsel, and his sympathetic concern.

Students who worked with Professor Troiano soon realized that his motivation for research was based on a deep-seated interest in industrial problems. In an era when many academic researchers were turning away from problems of interest to industry, he continued to devise and carry out research programs that clarified the basic metallurgical variables that controlled complex industrial processes and applications. His interest in industrial problems lasted throughout his career, from his early work on phase transformations in steel to his later work on stress corrosion.

Professor Troiano enjoyed interacting with his students outside of the classroom and laboratory. An avid golfer, he encouraged his graduate students to pursue the game, and he greatly enjoyed afternoon rounds of golf with them, department staff, and fellow faculty members. He also maintained his connection to the New England area throughout his life. He owned a cottage on the ocean side of Cape Cod, where he loved to go fishing in his boat, and he relished the family's summer vacations there. Upon attaining emeritus status, he and Anne (who was an accomplished artist of Cape Cod seascapes) began spending entire summers on the Cape.

The multifaceted contributions of Professor Troiano to research, teaching, and service advanced the field of materials science and engineering in innumerable ways. His achievements spanned the gamut from insights into the atomistic mechanisms of martensitic transformations and stress corrosion to applied industrial problems involving residual stresses. Being both a teacher and mentor to students and faculty, he cultivated critical thinking combined with a sense of practicality to the many people whose lives he influenced.



ALAN MANNERS VOORHEES

1922–2005

Elected in 2000

"For the discovery and application of the quantitative relationships between urban land uses and traffic flows."

BY THOMAS B. DEEN

ALAN M. VOORHEES, engineer, planner, entrepreneur, and philanthropist, died unexpectedly on December 18, 2005, in Richmond, Virginia. He had just returned to his hotel room after attending a party for his 83^{rd} birthday.

As an urban transportation planner early in his career, Alan developed novel techniques for planning large portions of the interstate highway system in large urban areas. He established an engineering firm that worked on transit and highway plans in scores of cities around the world, later served in leadership positions in academia, and then helped to establish a number of private firms in land development, transportation, software development, business machines, space exploration, and information systems.

Alan was born in 1922 in New Brunswick, New Jersey. His father, a stockbroker, died when he was 7 years old, and his mother raised him alone until she remarried when he was a teenager. As fate would have it, his stepfather was the father of Al's best friend, Fred Zimmerli, who then became his half-brother.

After a brief stint at Rensselaer Polytechnic Institute, Al enlisted in the Navy during World War II and trained as a U.S. Navy frog man (now called Navy Seals) with the rank of Lt.(JG). He was part of an elite Navy unit called UDT-11 (Underwater Demolition Team 11), a unit featured in an exhibit at the

Navy UDT-Seal Museum in Fort Pierce, Florida. Al was in the vanguard of several amphibious Allied invasions of Japanese-held islands in the Pacific. His team swam ashore, often under heavy fire, to clear mines, map enemy defenses, and scout enemy positions in advance of landings by the Marines. His maps helped guide the Allied invasions of Okinawa and Borneo. Just days after the nuclear blast in Nagasaki, Japan, he was among the first American troops who cleared the port for Allied use. Al was awarded the Silver Star, Bronze Star, and Presidential Unit Citation.

After the war, Al returned to Rensselaer, where he earned his degree in civil engineering in 1947; he then moved to Massachusetts Institute of Technology, where he earned his master's degree in city planning. He also renewed his courtship of Nathalie Potter, a tall attractive linguist who was then working for U.S. Senator Styles Bridges of New Hampshire, her home state. Nathalie and Al were married in 1949.

In 1952, Al completed the Yale University traffic program. While at Yale, he also developed the "gravity model," the first successful technique for forecasting urban travel patterns based on future land-development patterns. He published this groundbreaking work, "A General Theory of Traffic Movement," in the *Proceedings of the Institute of Traffic Engineers* in 1955.

In 1949, he began his working career as the first city-planning engineer for Colorado Springs, Colorado, for which he developed a master plan for land use and transportation. He was also a member of a committee that put together a proposal for bringing the Air Force Academy to Colorado Springs.

In 1952, he became planning engineer for the Automotive Safety Foundation, a nonprofit corporation in Washington, D.C., where he further developed and applied his novel methodology of forecasting urban travel and assisted the federal government in developing computer programs for American cities that needed metropolitan-transportation plans, which were required by law before federal funds could be used for construction of urban portions of interstate highways. Al's gravity model and its later derivatives were soon in standard use by transportation engineers and planners throughout the world for planning and designing highway, mass-transit, and other systems. During these early years in Washington, Al moved his wife Nathalie and their three young children into a house he designed and built (with his own hands).

In 1961, he organized Alan M. Voorhees and Associates (AMV), a transportation-planning and engineering firm that became one of the largest firms of its kind in the country, with branches in 10 U.S. cities and six foreign countries. During the next two decades, AMV prepared transportation plans for new national capitals, including Canberra, Australia, and Abuja, Nigeria. The company was also responsible for transportation networks around the New York World Trade Center, which was then in the planning stage.

AMV assisted in the development of new rail-transit systems in Washington, D.C., Caracas, Venezuela, Sao Paulo, Brazil, Hong Kong, Atlanta, Georgia, Calgary, Canada, and Newcastle, England, and prepared transportation plans for a number of new towns, including Reston, Virginia, and Columbia, Maryland. Other projects included comprehensive transportation plans for Boston, Detroit, Miami, Minneapolis, St. Louis, Pittsburgh, Adelaide, Seattle, and San Jose, Costa Rica, and financial and operating plans for the conversion of private bus companies to pubic operation in many cities, including Washington and Boston.

In 1967, AMV was bought by Planning Research Corporation, although AMV remained an independent subsidiary, and, in 1977, Al became dean, College of Art, Architecture and Urban Sciences at the University of Illinois, Chicago Circle, where he was responsible for coordinating education in the various disciplines of the college and the School of Engineering.

In 1979, Al left academia and returned to Washington as an entrepreneur. He had earlier invested in and led Data Terminal Systems Inc., a firm that developed the bar code system used in retailing today. He then launched Atlantic Southeast Airlines (ASA), which was one of the most successful commuter airlines in the country. ASA carried more than 4 million passengers annually and served 56 markets. Al was chairman of the ASA

Board of Directors, and the company eventually became part of the Delta Airlines network. Later he and a partner led Microsystems Inc., a small company that provided point-of-sale systems for hotels (e.g., reservations, room management, etc.); the company grew to become a $700 million enterprise. Al also invested in and provided leadership for other small firms that grew into major companies, such as Ideas Inc. (provider of hi-tech hardware to the U.S. Department of Defense and NASA) and Autometrics Inc., a company that made mapping and software for satellite reconnaissance and was finally sold to Boeing.

He then turned his hand to real-estate development and built Hamilton Court, a mixed-use development in the Georgetown section of the District of Columbia, and properties in a historic district in Richmond, Virginia. He bought a farm, now a popular fruit and berry farm, in Westmoreland County on Virginia's Northern Neck and donated 750 acres for use as a nature preserve. He also established a space satellite launching enterprise and organized a firm, Summit Enterprises in Woodbridge, Virginia, to oversee and coordinate his extensive business interests.

Al's investment prowess was legendary, and his assets grew exponentially. He was frequently listed as one of the wealthiest individuals in the Washington area. He gave generously to numerous civic, environmental, and educational causes, funded new buildings at Rensselaer Polytechnic Institute, and established the Voorhees Transportation Center at Rutgers University. He also organized the Nathalie P. Voorhees Center for Neighborhood and Community Improvement at the University of Illinois in Chicago and helped establish the Council for Excellence in Government, a nonprofit organization dedicated to results-oriented leadership and innovations in government institutions at all levels. He was a member of the board of Voorhees College, a historically black institution in Denmark, South Carolina, and provided significant financial support for its operation.

In later years, Al became interested in historical conservation, and he began collecting antique maps and books. Experts have called his collection of more than 300 maps the "best in private hands." When an important map came up for sale in London, he flew across the Atlantic on the Concorde, without telling his wife where he was going, bought the map, and returned home the same day. He divided his collection, worth several million dollars, among the Library of Congress, Library of Virginia, and Virginia Historical Society. He organized a campaign to have the map collection of the Library of Congress photographed and digitally preserved.

At the time of his death, Al was on the steering committee of "Jamestown 2007," a group planning the 400th anniversary celebration of the settlement of Jamestown, Virginia, and had contributed to archeological explorations that have resulted in important discoveries related to the founding of Jamestown. He was also known for his expertise and extensive collection of fine wines.

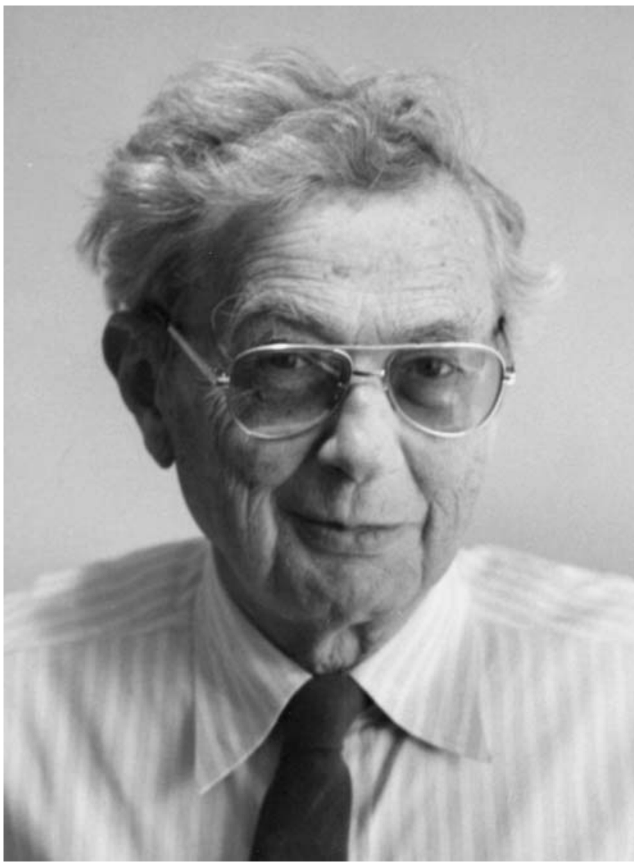
Al received many honors. He was chairman of the Executive Committee of the National Research Council Transportation Research Board and president of the American Institute of Planners. He was elected to membership in the National Academy of Engineering in 2000, and he received honorary doctorates from Rensselaer Polytechnic Institute and Voorhees College. He received the Institute of Transportation Engineers Past Presidents Award in 1955, the first American Society of Civil Engineers Harland Bartholomew Award, and, in 1982, was selected honorary member of the Institute of Transportation Engineers. He was the first chairman of the Center for Geographic Information at the Library of Congress and was a member of several boards devoted to the history of Virginia.

People who knew Al well frequently commented on his modesty and willingness to stay out of the limelight. The *Washington Post* noted in his obituary that, "His work quietly affected the lives of countless people, yet Voorhees maintained such a low public profile that he was all but unknown in Washington, where he had lived since 1952. He moved below the Beltway radar, staying out of politics and the local party scene." His name made headlines only when he made a generous gift to a major educational institution or conservation group.

Even his family and close friends were not aware of his diverse contributions until his death when friends and associates from many different fields came forward with stories of his generosity.

"Al made a huge difference in the way our society is today, and he did it behind the scenes," said Gary L. Fitzpatrick, former senior specialist for digital programs at the Library of Congress, who knew Voorhees as a map collector. Everyone who knew Al, whether as a map collector, businessman, academic, engineer, planner, or philanthropist, recognized that he made a profound and significant difference.

Al is survived by his three children, Susan, Scott, and Nancy, six grandchildren, and two brothers. Nathalie predeceased him in 2000. His daughter remembers that Al and Natalie especially enjoyed spending time on their farm with their children and grandchildren.



PAUL WEIDLINGER

1914–1999

Elected in 1982

"For innovative contributions to structural engineering and outstanding contributions in the design of steel and reinforced concrete structures."

BY MATTHYS P. LEVY

PAUL WEIDLINGER, principal of Weidlinger Associates Inc., died on September 5, 1999. Paul was born in Budapest, Hungary, on December 22, 1914, and educated at the Technical Institute in Brno, Czechoslovakia, and later at the Swiss Polytechnic Institute, where he completed his studies in 1937. After graduation, pursuing his interest in architecture and design, he apprenticed with both Moholy-Nagy and Le Corbusier. At the start of World War II in Europe, he left to take a position as professor at San Andres University in La Paz, Bolivia, where he remained for four years, teaching and designing dams, before he was able to immigrate to the United States.

Paul worked for aircraft companies and housing agencies, which led to a growing interest in industrialized construction, and, in 1948, he established his own consulting firm. Through contacts with fellow Hungarian émigrés, he was able to obtain positions as visiting lecturer at both the Massachusetts Institute of Technology and Harvard University. Meanwhile, as his consulting practice grew and his keen intellect and talent as a designer became known, he attracted the attention of many of the twentieth century's major architects. For example, with Antonin Raymond, he produced a unique antiseismic design for the Reader's Digest building in Tokyo.

He also developed a close professional and personal association with Gordon Bunshaft. Paul, cigarette in hand, and Gordon, puffing on a pipe, would discuss, argue, and negotiate the subtleties of particular designs, each pushing the other to the limit. Gordon would take a fat pencil in hand, saying, "Now, don't lose your lunch," as he sketched a perfectly proportioned structure. "The column is too slender," Paul would say, grab his own pencil, and overwrite Bunshaft's sketch, saying, "The beam could be shaped like this." Together they produced the iconic design for the Banque Lambert in Brussels with its delicate precast concrete façade joined by stainless steel hinges. This was followed by the One Liberty Place tower in Manhattan with the first-ever exposed-steel structure.

With Marcel Breuer, he designed the hyperbolic concrete faces of the St. Francis de Sales Church in Michigan. Following the precepts of Le Corbusier, he designed a number of structures with Jose Lluis Sert, and with Walter Gropius, he prepared the design for the University of Baghdad. When asked why he would undertake risky architectural commissions rather than more lucrative and less restrictive government research projects, Weidlinger said simply that he loved architecture and, "if a building is good and appropriate for its purpose, then I like to get involved." His growing reputation also brought him into contact with Picasso, Dubuffet, and Noguchi, with whom he designed the structures for the large environmental sculptures that grace plazas in Chicago, New York, and Paris.

Ultimately, Paul's deep interest in mathematics and physics led him in a different direction that was to engage him for 40 years. Using his structural expertise, he developed concepts to determine how close a structure could be to a nuclear explosion at ground zero and still survive. Together with Mario Salvadori, he showed that the answer is 50 times closer than was previously believed. From that early study in 1955, he established a practice that specialized in developing protective designs against the effects first of nuclear weapons and, more recently, conventional weapons and terrorist attacks. He was a major figure in this arena in his later years.

Weidlinger's interest in the possibilities of engineering led him to develop advanced concepts for structures, some of which have yet to be built. To cover an oil refinery, he proposed an air-supported fabric roof spanning more than 2 kilometers. For an airport to be built offshore in the ocean, he proposed an assembly of floating units consisting of prefabricated concrete cylinders that could be built in a dry dock, floated out to an assembly point, and attached with tension cables to anchors on the ocean floor. For a 120-meter-diameter radio antenna, he proposed a steel-trussed structure with active deformation-compensating cable ties that would permit the antenna's surface to retain its shape to within 2 mm during the complex movement of the dish. For a long-span bridge for the Great Belt in Denmark, he developed the concept of a tubular, self-anchored, prestressed concrete suspension bridge that would protect users from the harsh environment.

Paul was honored with membership in the National Academy of Engineering and was the recipient of numerous awards, including the Frank P. Brown Medal of the Franklin Institute, the Ernest E. Howard Award, Moissieff Award, the J. James R. Croes Medal of the American Society of Civil Engineers, and the *Engineering News Record* Construction Industry Award. He also published extensively on structural engineering, the effects of nuclear and conventional weapons on structures, and applied mechanics.

Weidlinger's leisure hours were taken up with literature, music, and an appreciation of the fine arts. As a humanist, he struggled to arrive at a working philosophy to counterbalance the realities of defense commissions, and he was also concerned with the social impact of political decisions. Paul was an intensely private person who internalized the tragedies in his life, such as the dissolution of his first marriage and the loss of a child. With his second wife, Solveig, he raised two daughters, Jody and Lina, and he loved romping with his twin grandchildren. He was also intensely proud of his oldest son, Tom, a documentary filmmaker.

Up to the time of his death on September 5, 1999, he was still exploring the frontiers of engineering, looking into "super-strength" concrete, and solving mathematical problems. The firm he founded has grown to more than 300 people who are still exploring structural challenges. This is his legacy.

ALVIN M. WEINBERG

1915–2006

Elected in 1975

"For contributions in reactor design, development, safety, and understanding of how nuclear power must help meet world energy demands."

BY JEFFREY WADSWORTH

ALVIN WEINBERG, a leading figure in the development of nuclear energy, died at his home in Oak Ridge, Tennessee, on October 18, 2006. Born in Chicago in 1915, Alvin received his B.S., M.S., and Ph.D. from the University of Chicago. He completed his doctorate in mathematical biophysics in 1939 and was soon drawn into the Manhattan Project, working with Eugene Wigner at the Metallurgical Laboratory to design the Hanford plutonium-production reactors. The two became friends as well as colleagues and later collaborated on a classic text, *The Physical Theory of Neutron Chain Reactors.* Although Alvin cited this book as his major accomplishment as a practicing scientist, he also deserves credit for stimulating the development of several innovative reactor designs, including the pressurized light-water reactor adopted for the U.S. Navy's nuclear submarines. But he made his mark chiefly in scientific administration and science policy.

Alvin moved to Oak Ridge in May 1945 to work at the Manhattan Project X-10 site, where the Clinton Pile, a pilot plant for producing plutonium, had been constructed. Wigner had drawn up a plan for expanding X-10 into a laboratory for nuclear research with an associated school of reactor technologies, and he persuaded Alvin to join him there as chief of physics. As things turned out, Wigner led the work at Oak Ridge for only a year, while Alvin devoted the next 25 years to building and nurturing a world-class research institution in the hills of Tennessee.

It was an uphill battle, especially at first. When the Atomic Energy Commission (AEC) decided to centralize reactor development at Argonne and focus the work at Oak Ridge on chemical technology and isotope production, it was Alvin who made the case for continuing work on reactors at what officially became Oak Ridge National Laboratory (ORNL) in 1948. Asked to serve as ORNL director in December 1948, he declined, citing his youth and lack of experience, but he agreed to become research director. In this role, Alvin found a variety of ways to sustain the laboratory. The most audacious may have been building a mock-up of the Materials Testing Reactor that would be constructed in Idaho and then convincing the AEC to allow ORNL to operate it as the Low-Intensity Test Reactor, which Alvin christened "the poor man's pile."

ORNL staff also worked on the Aircraft Nuclear Propulsion Project, which Alvin cheerfully admitted was a thoroughly impractical idea. Through work on this project, however, the laboratory acquired new capabilities, such as three reactors, a critical-experiments facility for testing reactor fuels, and a physics laboratory for studying the effects of radiation on solid materials, as well as support for its efforts to acquire its first particle accelerators and digital computers. ORNL also pioneered the production of radioisotopes for scientific research and medical treatment, which Alvin later identified as perhaps the laboratory's most important contribution, and the study of the biological effects and hazards of radiation.

In 1955, Alvin became director of ORNL, a position he called "one of the best scientific-administrative jobs in America." Although he claimed that his real job was to keep the money coming in, he was committed to maintaining standards—he insisted that ORNL establish a scholarly tradition—and to showing that management cared. He was well known for sitting in the front row at division information meetings and asking the first question after each scientific talk. Indeed, some staff members attended these meetings primarily to hear Alvin's questions and comments. His presence at a lecture, even in his last years, was a signal to the speaker to be prepared for at least one penetrating question.

Alvin also enjoyed his contacts with what he called "the best (or at least the most important) people." When Senator and Mrs. John F. Kennedy visited ORNL in 1959, he turned the senator over to his deputy and claimed for himself the privilege of accompanying Jackie Kennedy. His many contacts in government and the scientific community led to appointments to the President's Science Advisory Committee during the Eisenhower administration and to President Kennedy's Panel of Science Information. Based on these experiences, he began to formulate a philosophy of scientific administration, which led him to establish criteria for scientific choice that continue to influence the political debate on priorities for funding science.

Alvin's first priority, however, was assuring the laboratory's future, which to him meant putting it to work on what he called "the important things." As early as 1955, he began exploring opportunities for solving problems beyond the AEC mission. This push to diversify was driven partly by the commercialization of nuclear power, but Alvin firmly believed that national laboratories were uniquely qualified to do "big science" (a term he coined) through coherent attacks on large-scale, long-term, high-risk problems of national importance. Under his leadership, ORNL worked on nuclear desalination, large-scale biology, civil defense, and environmental research, becoming one of the first national laboratories to build a substantial portfolio for non-AEC customers. Thus ORNL acquired skills and flexibility that proved to be valuable assets during the early 1970s, when nuclear power fell into disfavor and environmental issues came to the fore, dramatically changing the research environment.

By this time, however, Alvin's views on nuclear energy, especially his growing concerns about reactor safety, had placed him at odds with the AEC. In 1972, the management of Union Carbide, which operated ORNL for the AEC, informed Alvin that he was being fired. After taking a one-year leave of absence, Alvin officially resigned as director of ORNL in December 1973.

This was a painful transition for Alvin, though he later said that leaving ORNL was one of the best things that ever happened to him. When the Arab oil crisis of 1973 brought the issue of energy to the fore, he turned to "think tankery," creating the Institute for Energy Analysis (IEA) as part of Oak Ridge Associated Universities (ORAU). In January 1974, just as IEA was about to begin operation, he was called to Washington to serve as director of the U.S. Office of Energy Research and Development. In this capacity, he contributed to the establishment of the Solar Energy Research Institute (now the National Renewable Energy Laboratory) and the conversion of the AEC into the Energy Research and Development Administration, which later became the U.S. Department of Energy (DOE).

In 1975, Alvin returned to Oak Ridge as director of IEA, one of the first research institutions to investigate the greenhouse effect and to propose nuclear energy as an antidote to global warming. IEA researchers also explored alternative energy sources, conservation, and (looking beyond what Alvin called the "technological fix") the social, political, and economic factors that influence energy choices. In his view, the accident at Three Mile Island in 1979 brought an end to the first nuclear era. One of IEA's principal goals was to find a safe, economical path to a second nuclear era.

In 1985, Alvin retired as IEA director and was named an ORAU distinguished fellow by the ORAU Board of Directors. He continued to write and lecture, compiling a publications list that included eight books and 541 journal articles, and he remained a vigorous proponent of nuclear energy. He pointed out in 2002 that both he and the reactors built in the 1960s had exceeded their initial life expectancy, using this observation to argue for the economics of nuclear power.

But Alvin was also deeply concerned about the dangers of nuclear weapons. He commented that the nuclear people had made a "Faustian bargain" (another term he coined that is now in general use), and he led a campaign to bring a huge Japanese friendship bell to Oak Ridge as a lasting reminder of the need for a "tradition of non-use."

Alvin was a founding member of the American Nuclear Society, which established the Alvin M. Weinberg Award in 1995 "in recognition of outstanding international technical and policy leadership in nuclear science and technology, and for consistently and effectively illuminating the human dimensions of the nuclear enterprise." Alvin was the first recipient. He also received dozens of other awards from a host of organizations; among the most prestigious were the Atoms for Peace Award in 1960 and DOE's Enrico Fermi Award in 1980. Alvin was also proud of having been named one of the Ten Outstanding Young Men in America in 1950 by the U.S. Jaycees. He held honorary degrees from 28 universities and was elected to both the National Academy of Sciences (1961) and the National Academy of Engineering (1975).

Despite his many honors, Alvin was modest about his achievements. At ORNL and ORAU, his telephone was answered simply, "Mr. Weinberg's office." As he grew older, he was widely accorded a respect approaching reverence. Somewhat bemused by his status as an "icon," he remarked after a tribute presented at a celebration of his ninetieth birthday, "I was just a guy trying to make a buck." This, of course, was not what motivated him—rather, he was driven by a passionate concern for the survival of humanity—but Alvin never considered himself one of "the most important" people. He played tennis until he was well into his eighties and was an accomplished pianist whose repertoire included not only Bach, Mozart, and Chopin, but also popular songs and Christmas carols.

Alvin's first wife, Margaret Despres, died in 1969. His son David died in 2003, and his second wife, Gene Kellerman DePersio, died in 2004. He is survived by a son, Richard; a sister, Fay Goleman; and three grandchildren.

Alvin occupied—in fact, he created—a unique niche at the intersection of science, technology, and society. He thought deeply about the complex issues that arise at this intersection, and he saw clearly the challenges that they present. His insight and foresight in this critical area, and his passionate belief in human ingenuity, will be a continuing source of guidance and inspiration as we continue to wrestle with these issues.


James W. Westwater

JAMES WILLIAM WESTWATER

1919–2006

Elected in 1974

"For contributions to boiling heat transfer by high-speed photography at great magnification."

BY RICHARD ALKIRE AND THOMAS HANRATTY

JAMES W. WESTWATER, emeritus professor of chemical engineering and a pioneer in the field of heat transfer, died on March 31, 2006, at the age of 86.

Born in 1919 in Danville, Illinois, he attended primary and secondary schools in Danville and, in 1937, matriculated from the University of Illinois. After receiving his B.S. in chemical engineering in 1941, he entered graduate school at the University of Delaware, where he studied under Allan P. Colburn. In 1948, he received the first Ph.D. granted in any discipline at Delaware. The same year he joined the faculty at the University of Illinois as an assistant professor. He became an associate professor in 1955 and a professor in 1959.

The central focus of Westwater's research was heat transfer accompanying a phase change. His work was characterized by innovative experimentation, careful analysis, and a clear vision of the relationship between fundamental principles and practical applications. He pioneered the use of high-speed photography, and his remarkably precise images facilitated an understanding of the dynamics of bubble formation and growth and led to the development of realistic theories for boiling heat transfer. Westwater's first film, made in 1954, had 80 showings at companies, universities, technical societies, and on television.

Westwater developed techniques for high- and low-speed photography through a microscope. In subsequent years, he expanded upon these techniques to study nucleate, transition, and flow boiling, flow and drop-wise condensation, freezing, the formation of Bernard cells, and the nature of nucleation sites for boiling and condensation.

These experiments are widely considered to be engineering classics that provided a fundamental understanding of the physical processes governing both boiling and condensation and formed a basis for mathematical development. His work is recognized worldwide as both fundamentally significant and vital to many commercial and other applications.

In 1965, Westwater published the first in a series of papers showing how properly designed fins could greatly increase heat-transfer rates during boiling. This led to experiments showing that remarkable heat duties, as high as 120,000 kw/m^3, could be obtained in miniature fins. Westwater's study of two-phase flow patterns in small passages pioneered the current interest in compact heat exchangers. With his 41 doctoral students, he authored more than 110 publications and produced 19 research motion pictures.

Jim was elected to the National Academy of Engineering in 1974. He also received much well-deserved recognition, including the 1971 Max Jakob Memorial Award jointly from the American Institute of Chemical Engineers (AIChE) and American Society of Mechanical Engineers, the 1966 William H. Walker Award of the AIChE, and the 1974 Vincent Bendix Award of the American Society for Engineering Education. He was selected as one of 30 distinguished chemical engineers who were recognized on the 75th anniversary of the AIChE.

Westwater's impact at the local, national, and international levels was not just a reflection of his research activities. He was also chairman of the Heat Transfer and Energy Conversion Division of the AIChE in 1963 and chair of the 3rd International Heat Transfer Conference in 1966. From 1968 to 1970, he was a director of AIChE, and he was awarded the 1984 Founders Award from that organization for the advancement of chemical engineering.

From 1962 to 1980, Westwater was head of the Department of Chemical Engineering at Illinois. During that time there was a substantial increase in scholarly contributions and significant expansion of the undergraduate and graduate programs. He was known on the Illinois campus as a skillful administrator and a dedicated teacher who had great empathy for the needs and desires of undergraduates. He impressed upon his many students the importance of a sound understanding of the physical fundamentals of chemical engineering processes as a basis for the development and application of those processes. A professorship in his honor was established by friends and admirers in 1986. He retired in 1988.

James traveled extensively as an invited lecturer and consultant to many foreign countries, including Communist Russia, China, India, and Japan. He and his wife traveled, for business and pleasure, to every continent. Other interests included gardening, reading, swimming, and handball.

His wife, Elizabeth Keener Westwater, died on July 17, 2007. He is survived by four children, Barbara Westwater, David Westwater, Judith White, and Beverly Moore; seven grandchildren; seven great-grandchildren; and a brother, Robert Westwater.

J. E. White

J. EDWARD WHITE

1918–2003

Elected in 1989

"For significant and outstanding advances in several fields of geophysics, as well as his clear transmission of these advances to students and colleagues."

BY ROBERT J. WEIMER

JAMES EDWARD (ED) WHITE, a highly respected and accomplished geophysicist, died peacefully on January 30, 2003. Dr. White was appointed in 1976 as the first recipient of the Charles Henry Green Endowed Chair in Exploration Geophysics at the Colorado School of Mines (CSM), a position he held until his retirement in 1988.

Prior to his appointment at CSM, Ed gained international recognition in academic circles as the Lloyd Nelson Professor at the University of Texas (UT)-El Paso (1973–1976), and as a visiting professor at the University of Texas-Austin, Massachusetts Institute of Technology (MIT), University of Sydney, Australia (ESSO Professor), and Macquarie University in Sydney. He also taught short courses in Buenos Aires, Argentina, and Bucaramanga, Colombia.

Ed was known for his ability to communicate difficult concepts in lucid, polished prose for his students, many of whom became renowned geophysicists around the world. He was justly proud to receive the Halliburton Award for outstanding teaching and scholarship at CSM, and he remained active as an emeritus professor, despite the ravages of 20 years of affliction with Parkinson's disease.

Ed was born in Cherokee, Texas, May 10, 1918, but was raised and attended schools in Fredericksburg, a German community in the hill country 60 miles west of Austin. After graduation as valedictorian from Fredericksburg High School, he attended UT-Austin, where he received a B.A. in physics in 1940 (with honors and membership in Phi Beta Kappa). On February 1, 1941, while working on a master's degree, Ed married UT art student Courtenay Brumby, from Houston. When he decided to accept a defense position at MIT in Boston, the completion of his master's degree in physics and mathematics had to be delayed. He completed his degrees in 1946, when the couple returned to Austin.

During World War II, Ed was director of the Underwater Sound Laboratory of the U.S. Naval Research Center at MIT. He received his Ph.D. in physics and electrical engineering from MIT in 1949. He then spent more than two decades working in industry, first for Magnolia Mobil Laboratories, Dallas, Texas (1949–1955), then as one of the founders of Marathon Research Center, Littleton, Colorado (1955–1969), and subsequently as vice president of Global Universal Sciences (1969–1973), first in Midland and then El Paso, Texas.

Ed's research in industry resulted in seminal contributions to four areas of seismic prospecting that are increasingly used and valued today: shear-wave prospecting, vertical seismic profiling, full-waveform acoustic logging, and attenuation of seismic waves. Ed's impressive list of publications in these areas is complemented by three widely used books: *Seismic Waves* (1965); *Underground Sound* (1983 and translated into Russian and Chinese); and *Production Seismology*, coauthored with Ray Sengbush (1986). More than 20 patents were issued to Ed and his associates, and, in 2000, the Society of Exploration Geophysicists (SEG) published *Seismic Waves: Collected Works of J.E. White.*

Ed's prolific career did not keep him from contributing his time and energy to many technical societies and government agencies. He was vice president of SEG in 1964, served as president in 1967, received honorary membership in 1976, and was awarded the Maurice Ewing Gold Medal in 1986.

His other honors included the Piotr L. Kapitsa Gold Medal from the Russian Academy of Sciences in 1996 and honorary membership in the Chinese Geophysical Society in 2002. Ed was also a fellow of the Acoustical Society of America and a member of the American Geophysical Union, European Association of Exploration Geophysicists, American Association for the Advancement of Science, and American Geological Institute.

Because he and Courtenay loved to travel and to learn about other cultures, Ed participated in a number of international scientific programs, which he promoted and implemented. He was one of the first American geophysicists to visit postwar Russia, where he established close and enduring ties with the Russian geophysical community. In 1965, Ed was a member of a six-man delegation, sponsored by the U.S. Department of State, that surveyed the status of geophysical exploration in the Soviet Union. Ed and Courtney paid another visit in 1971 and spent an academic year there (1973–1974) as part of an exchange program between the National Academy of Sciences and the Soviet Academy of Sciences (plus one month in Zagreb, Yugoslavia). While in Moscow at the Institute of Physics of the Earth, Ed was able to visit centers of applied geophysical research throughout the Soviet Union.

As SEG president, Ed encouraged collaborations between SEG and other scientific societies. In 1981, geophysicists from the United States and China jointly chaired a conference in Beijing. Ed was one of 40 geophysicists who spent three weeks visiting geophysicists across China, and he made a point of asking to see those who had not been heard from during the difficult years of the Cultural Revolution. He was honored to acknowledge those individuals and their contributions.

In 1987, Ed was selected by the National Academy of Engineering (NAE), supported by the World Bank, to conduct a month-long evaluation of the academic program of Changchun College of Geology in Jilin Province, Manchuria. Ed taught two intensive courses there in geophysics and mathematics. These and other collaborations led to many exchanges of faculty and students between the United States and China.

Ed regarded his election to NAE in 1989 as his highest honor. His NAE citation reads: "For significant and outstanding advances in several fields of geophysics, as well as his clear transmission of these advances to students and colleagues." Ed always appreciated the support of his colleagues, but he was especially grateful for the encouragement and understanding of Courtenay, his wife and companion for 63 years. Ed took great pride in his four children: Becky Vanderslice, Marie Jamieson, Coco Forte, and Duffie White, and his seven grandchildren.

Dean E. Wooldridge

DEAN E. WOOLDRIDGE

1913–2006

Elected in 1977

"For contributions to physical electronics, analog computers and the management of research and development."

BY JOHN P. STENBIT

DEAN EVERETT WOOLDRIDGE, co-founder of the Ramo-Wooldridge Corporation, later TRW, and a leader of applications of electronics to support the military, died on September 20, 2006, at the age of 93. Wooldridge was elected to both the National Academy of Sciences (1969) and the National Academy of Engineering (1977).

Wooldridge and his long-time business partner, Simon Ramo (NAE and NAS), founded Ramo-Wooldridge Corporation with two administrative employees and two telephones. Within a week of its formation, the company was chosen to lead the development of the intercontinental ballistic missile (ICBM) programs for the U.S. Air Force. That initial contract led to several major divisions of Northrop Grumman that employ tens of thousands of engineers, who are still working on applications of advanced technology to address military needs.

Dean Wooldridge was born in Chickasha, Oklahoma, on May 30, 1913. His brilliance was apparent early on, and he graduated from high school at the age of 14. After waiting to reach the minimum age requirement, he attended the University of Oklahoma, where he received his B.S. and M.S. in physics in

1932 and 1933. From there he went to the California Institute of Technology, where he earned his Ph.D. in physics in 1936 *summa cum laude.*

Wooldridge was always a "quick study." Simon Ramo commented that when he saw Wooldridge perform in their first class at Caltech, he was no longer surprised at how young Dean was when he received his M.S., but rather wondered what had taken him so long. He supposed it was because Wooldridge had toyed with several majors, including law, before he settled on physics. Wooldridge was not slow socially either. He married Helene Detweiler when he graduated Caltech in 1936.

Beginning with their meeting in that first class at Caltech, Wooldridge and Ramo began a friendship, and later a partnership, that delivered much to our national defense. However, after graduation from Caltech, their friendship remained personal, rather than professional. Wooldridge went to Bell Labs, where he became an acknowledged expert in electromagnetic theory, essential to the enormous surge in new technologies during World War II. He led a group at Bell Labs that developed the first airborne computers. At the same time, Ramo went to work for General Electric (GE) in New York, where he too contributed significantly to technological advances that supported the military during the war.

During the war, Woodridge went to Europe to instruct bombardiers on how to use the computers. He traveled via South America and Africa to avoid the possibility of anti-aircraft from ships in the North Atlantic. The family at home traced his trip on a National Geographic map of the world.

When the war ended, most of the country was ready to get back to normal as quickly as possible. Both GE and AT&T wanted to get back to their commercial customers, who had been sidetracked first by the Depression and then the war. However, Ramo saw a future in the defense establishment, which was facing new problems, even during demobilization. The Soviet Union had already begun to pursue its interests, with the help of the still large Red Army. More important, Ramo foresaw that the Soviet Union would develop an atomic bomb sooner rather than later and that the defense of the United

States would depend on radars, aircraft, and guided missiles to keep Soviet aircraft from delivering those weapons.

These were all new challenges for the United States, and Ramo and Wooldridge decided to address them rather than devote their energies to commercial pursuits. Ramo joined the Hughes Aircraft Company in the spring of 1946, and Wooldridge followed that fall, to work on early contracts and continue to gather new ones. Within five years they had built what became Hughes Electronics, the largest concentration of engineers and scientists in the United States working exclusively on defense programs. As predicted, the programs were focused on airborne radar, computers, and guided missiles for fighter aircraft that could intercept long-range bombers. Every U.S. interceptor aircraft was filled with products developed and produced by Hughes Electronics.

Several factors contributed to the buildup of Hughes, including that the military had large balances of funds that had been appropriated by Congress when it was anticipated that the war would last longer. Reluctant to give money back, the military pushed to fund new programs before the fiscal year ended in June 1946. Thus proposals for R&D in new areas were readily funded.

Gathering talented scientists and engineers was also facilitated by the many California-trained professionals who had been uprooted during the war and wanted to come home. That influx, coupled with the notion that engineers could work in offices instead of the large “bull pens” common in aircraft companies, made it relatively easy to attract new workers. Many of them had good ideas for proposals of their own, and the company grew rapidly.

About three years later, just as the partners had foreseen, President Truman announced that the Soviet Union had tested an atomic bomb. Like today, however, the media were focused more on celebrities than defense, at least on that day. The headlines on that historic day were about Rita Hayworth’s elopement with Aga Khan. The announcement of the Soviet atomic bomb had a strong impact on Hughes Electronics, however, which grew even faster after that.

Many stories have been written about working for Howard Hughes and his personality quirks. Although Wooldridge and Ramo did not see him often (almost never during the first years of the growth of this unique new business), their relationship with him was affected by one of his quirks, namely that he was hard of hearing. Hughes had trouble understanding the soft-spoken Wooldridge unless he shouted, which caused him to make facial movements that led Hughes to believe he was angry. To avoid problems, Ramo did most of the talking when they were with Hughes.

After about seven years of increasing conflict between the rapidly growing electronics division of his empire and the traditional Hughes Company, the partners decided to leave Hughes. The decision was triggered when Hughes wanted the electronics enterprise to move to Las Vegas, where he had just made very large investments in land. The difficult discussions about leaving led to one major benefit. Ramo succeeded in convincing Hughes that the electronics enterprise had to be independent of other Hughes holdings. As a result Hughes created the Hughes Medical Foundation earlier than he had planned and donated all of the stock of the Hughes Aircraft Company, which was in effect the electronics company, to the foundation. The Hughes Medical Foundation continues to invest these large funds in promising areas of medical research.

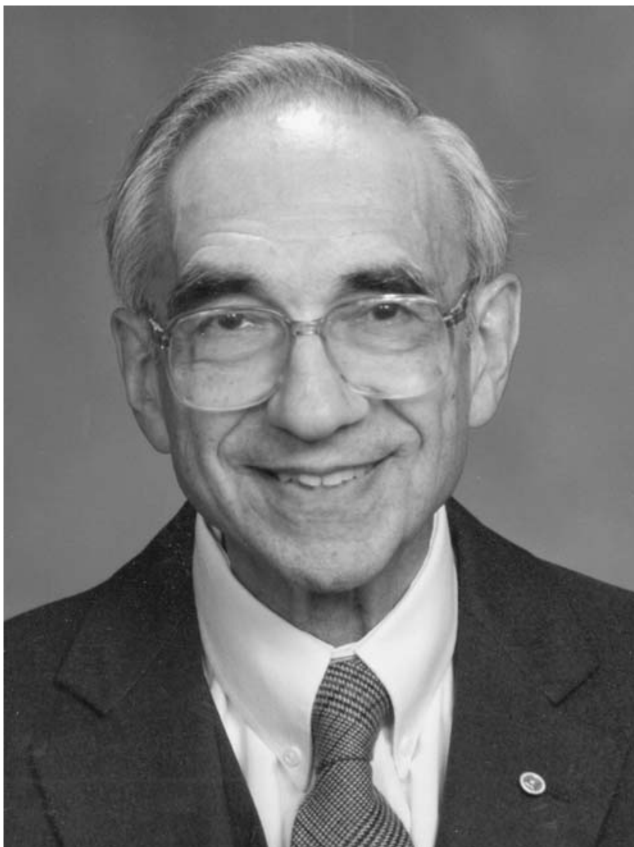
After a final meeting with Hughes on a Saturday, the partners formed the Ramo-Wooldridge Corporation on Monday. Their office in an old barber shop included two assistants and two telephones. The telephones were very busy that Monday, and in the afternoon an Air Force officer, who had been unable to get through by phone, arrived to tell them the secretary of the Air Force was anxious to speak with them. That contact led to an immediate trip, first to New York to complete the formation of the company and obtain initial financial backing from the Thompson Products Company, and later in the week to meetings in Washington where the Air Force selected the new firm to perform the analysis and then the management of a high-priority presidential program to develop ICBMs.

Obviously government contracting was more flexible in those days than it is today. That contract quickly grew, and many engineers wanted to join the new enterprise, so hiring was not a problem.

For the rest of the decade, the company grew rapidly, until three major changes were made starting in 1958—Thompson took advantage of an opportunity to merge with the new company, which became TRW; Wooldridge became president of TRW; and the company spun off the resources doing advanced planning for the Air Force into a new company, Aerospace Corporation. This change allowed TRW to compete for programs to develop and build satellites for the Air Force without a conflict of interest. In fact, in 1958 TRW became the first corporation to build and launch a spacecraft, *Pioneer 1.* A later spacecraft, *Pioneer 10,* which was the first to leave the solar system, transmitted data back to Earth for more than 30 years.

Wooldridge continued as top executive of TRW for about three years, but in 1962 he retired and moved to Santa Barbara. He continued a relationship with Caltech, including engaging in research on brain function and neurology. He wrote two books on those subjects that are widely used in postgraduate courses. He and his wife also traveled extensively. In 1982, he retired from Caltech.

Wooldridge's wife, Helene Detweiler Wooldridge, passed away in 2001. He is survived by three children, Dean E. Wooldridge Jr., Anna Lou Eklof, and James A Wooldridge, and three grandchildren, Michael Andrew, Jonathan David, and Lisa Michelle Wooldridge.know for sure they owned the house there in 1964.



LEO YOUNG

1926–2006

Elected in 1999

"For contributions to microwave technology and to the management of national security research."

BY ARYE ROSEN

LEO YOUNG, a scholar, leader, and gentleman and retired director of research at the U.S. Department of Defense, died on September 14, 2006, at the age of 80.

When I was asked by the National Academy of Engineering to write a memorial tribute to Leo Young, my eyes teared up. I had my doubts about whether I could do justice to this giant whom I had initially come to know through his reputation as a scholar. After having had the privilege of meeting, knowing, and befriending Leo, I came to appreciate his gifts as a visionary and a wonderful human being.

I had the opportunity to visit Leo and his wife Jo-Ellen at their home in Baltimore a few months before Leo's passing. Jo-Ellen, an accomplished and renowned educator in her own right, prepared lunch, and the three of us reminisced together. Leo then gave me a copy of a book he had just completed, *Letters to My Grandchildren,* from which I learned even more about this remarkable man. As he said in his memoirs, he had four separate careers that encompassed industry, academia, government, and consulting. I would add that he excelled in all of them.

Leo was born in Austria in August 1926. His father was a successful physician, and his mother valued education above all. In 1938, to escape the Nazis, the family moved to England, where Leo received a B.A. in mathematics in 1945, a B.A. in physics in

1947, and an M.A. in physics in 1950, all three from Cambridge University. He then began working as a radar engineer.

In 1959, while doing research on radar at Westinghouse, he obtained a Ph.D. from Johns Hopkins University, thereby beginning his long-standing relationship with Johns Hopkins. He received an honorary degree of doctor ofhuman letters from the university in 1989 and was presented the Woodrow Wilson Award for Distinguished Government Service in 2001. He also served on several advisory committees of the Whiting School of Engineering, including the Dean's Advisory Committee, for many years.

From 1960 to 1973, Leo led a group of researchers at the Stanford Research Institute in California, while teaching courses at Stanford University and at the Technion, the Israel Institute of Technology. In 1974, he joined the Naval Research Laboratories in Washington, D.C., then moved to the Office of the Secretary of Defense (OSO) as director of research, which included oversight of the Army/Navy/Air Force/DARPA basic research programs. In addition, he led the University Research Initiative, which promoted multidisciplinary research. Leo was also a supporter of the establishment of the Small Business Innovation Research (SBIR) Program.

In 1969, Leo became president of the Microwave Theory and Techniques Society (IEEE MTT-S). He was presented an MTT-S Prestigious Microwave Prize in 1963 and a Microwave Career Award in 1988. In 1982, he became an honorary life member, and in January of 1980 he became president of IEEE.

Leo retired from his government position in 1994, but he continued working as a consultant and a member of the board of Filtronic. In 1997, Leo became a foreign member of the Royal Academy of Engineering (U.K), and in 1999, he was elected a member of the National Academy of Engineering (NAE). In 2005, NAE presented him with the Arthur M. Bueche Award "for leadership in sponsoring collaborative research programs among academic, industrial, and government engineers and scientists."

Leo held 20 patents, published numerous scholarly papers, and authored, coauthored, or edited 14 books, including *Microwave Filters, Impedance-Matching Networks, and Coupling Structures,* coauthored with G.L. Metthaei and E.M.T. Jones, a 1,100-page book that still sells well after 40 years, has been translated into Russian and Chinese, and is referred to as "the Bible" by microwave engineers. As Leo often said, microwave filters were among his primary interests, along with wireless communications and basic research policy and conduct as applied to national defense.

I knew and respected Leo Young long before I had the privilege of meeting him. Undoubtedly, many engineers and scientists are also familiar with his name and his work, although they may never have met him.

As reflected in the title of his memoirs, *Letters to My Grandchildren,* Leo had a deep passion and devotion to his large extended family. His first wife, Fay Young, the mother of his three biological children, died in 1981. She was a school psychologist. He gained three stepchildren from his second marriage to Ruth Breslow-Young, a social worker and director of the Jewish Council for the Aging in Washington. Ruth died in 1996. Finally, three more stepchildren were added when he married Jo-Ellen Turner, a college English professor. As a result, he could proudly proclaim that 19 grandchildren honored him by calling him grandpa. His entire family was present for his 80^{th} birthday celebration.

APPENDIX

Members	Elected	Born	Deceased
Willis Alfred Adcock	1974	November 25, 1922	December 16, 2003
Robert Adler	1967	December 04, 1913	February 15, 2007
Rutherford Aris	1975	September 15, 1929	November 02, 2005
Stanley Backer	1992	February 09, 1920	January 18, 2003
William Oliver Baker	1975	July 15, 1915	October 31, 2005
Howard C. Barnes	1974	May 28, 1912	May 16, 2003
Robert R. Berg	1988	May 28, 1924	June 13, 2006
Frederick Stucky Billig	1995	February 28, 1933	June 01, 2006
Richard Henry Bolt	1978	April 22, 1911	January 13, 2002
Leon E. Borgman	1999	February 16, 1928	February 05, 2007
Sol Burstein	1985	December 25, 1922	January 28, 2002
Melvin W. Carter	1999	November 05, 1926	August 15, 2007
Harold Chestnut	1974	November 15, 1917	August 29, 2001
Edgar F. Codd	1981	August 19, 1923	April 18, 2003
Morris Cohen	1972	November 27, 1911	May 27, 2005
Ralph Cross	1968	June 03, 1910	June 26, 2003
George B. Dantzig	1985	November 08, 1914	May 13, 2005
John Larry Duda	1998	May 11, 1936	September 24, 2006
Maxime A. Faget	1970	August 26, 1921	October 09, 2004
Richard H. Gallagher	1983	November 17, 1927	September 30, 1997
Ivan A. Getting	1968	January 18, 1912	October 11, 2003
Kenneth W. Hamming	1974	September 22, 1918	December 21, 2005
Heinz Heinemann	1976	August 21, 1913	November 23, 2005
Stanley Hiller Jr.	1999	November 15, 1924	April 20, 2006
William Herbert Huggins	1970	January 11, 1919	August 11, 2001
Chalmer Gatlin Kirkbride	1967	December 27, 1906	June 16, 1998
Hendrick Kramers	1978	January 16, 1917	September 17, 2006
Thomas Duane Larson	1985	September 28, 1928	July 20, 2006
Erastus H. Lee	1975	February 02, 1916	May 17, 2006
Joseph T. Ling	1976	June 10, 1919	February 22, 2006
Ralph A. Logan	1992	September 22, 1926	December 01, 2006
Robert W. Mann	1973	October 06, 1924	June 16, 2006
John L. McLucas	1969	August 22, 1920	December 01, 2002
Ruben F. Mettler	1965	February 23, 1924	May 23, 2006
Alan S. Michaels	1979	October 29, 1922	January 16, 2000
A. Richard Newton	2004	July 01, 1951	January 02, 2007
Charles Noble	1981	May 18, 1916	August 16, 2003
Frederick C.E. Oder	1980	October 23, 1919	May 11, 2006
Ronald Samuel Rivlin	1985	May 06, 1915	October 04, 2005
George A. Samara	1986	December 05, 1936	December 30, 2006

continued on next page

Members	Elected	Born	Deceased
Ruben Samuels	1994	January 11, 1926	February 17, 2004
Dudley A. Saville	2003	February 25, 1933	October 04, 2006
Milton Clayton Shaw	1968	May 27, 1915	September 07, 2006
Shan-Fu Shen	1985	August 31, 1921	December 22, 2006
Alan F. Shugart	1997	September 27, 1930	December 12, 2006
John Wistar Simpson	1966	September 25, 1914	January 04, 2007
Robert M. Sneider	2000	March 02, 1929	October 29, 2005
Vivian T. Stannett	1995	September 01, 1917	October 01, 2002
David Tabor	1995	October 23, 1913	November 26, 2005
Chen-To Tai	1987	December 30, 1915	July 30, 2004
Gordon K. Teal	1969	January 10, 1907	January 07, 2003
Alexander Robert Troiano	1986	September 05, 1908	June 12, 2002
Alan Manners Voorhees	2000	December 17, 1922	December 18, 2005
Paul Weidlinger	1982	December 22, 1914	September 05, 1999
Alvin M. Weinberg	1975	April 20, 1915	October 18, 2006
James William Westwater	1974	November 24, 1919	March 31, 2006
J. Edward White	1989	May 10, 1918	January 30, 2003
Dean E. Wooldridge	1977	May 30, 1913	September 20, 2006
Leo Young	1999	August 18, 1926	September 14, 2006