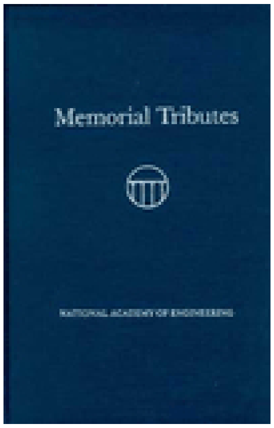

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Memorial Tributes

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Foreword

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

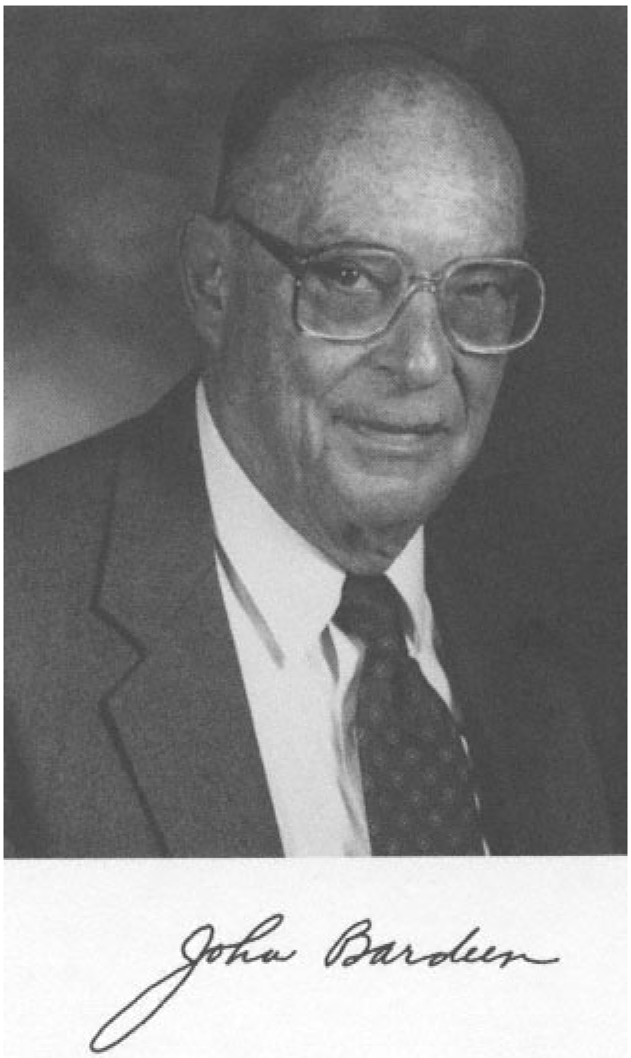
The National Academy of Engineering is a private organization established in 1964 to share in the responsibility given the National Academy of Sciences under its congressional charter signed by President Lincoln in 1863 to examine and report on questions of science and engineering at the request of the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

SIMON OSTRACH

HOME SECRETARY

Memorial Tributes

NATIONAL ACADEMY OF ENGINEERING



John Bardeen

1908-1991

By Nick Holonyak, Jr.

IN JOHN BARDEEN'S own words:

In any field there are golden ages during which advances are made at a rapid pace. In solid-state physics, three stand out. One, the early years of the present century, followed the discoveries of x rays, the electron, Planck's quantum of energy, and the nuclear atom—the discoveries that ushered in the atomic era. The Drude-Lorentz electron theory of metals and Einstein's applications of the quantum principle to lattice vibrations in solids and to the photoelectric effect date from this period. Von Laue's suggestion in 1912 that a crystal lattice should act as a diffraction grating for x rays and research of the W. H. and W. L. Bragg [sic] opened up the vast field of x-ray structure determination.

The foundations of the field were firmly established during a second very active period, from about 1928 until the mid-thirties, which followed the discovery of quantum mechanics. Many of the world's leading theorists were involved in this effort. The Bloch theory, based on the one-electron model, introduced the concept of energy bands and showed why solids, depending on the electronic structure, may be metals, insulators, or semiconductors. The fundamentals of the theory of transport of electricity and of heat in solids were established. In these same years, the importance for many crystal properties of the role of imperfections in the crystal lattice, such as vacant lattice sites, dislocations, and impurity atoms was beginning to be recognized. Some of the names prominent in the developments of solid-state theory during this period are Bloch, Brillouin, Frenkel, Landau, Mott, Peierls, Schottky, Seitz, Slater, A.

> H. Wilson, Wigner, and Van Vleck. The third golden age has been the rapid expansion in the post-World War II years, with not only great advances in understanding but also in technology and new products. (*Physics 50 Years Later* Washington, D.C.: National Academy of Sciences, 1973, pp. 166-167.)

If we look for a specific date for the beginning of the "third golden age" of solid-state physics, the logical choice is when Bardeen identified carrier injection in a semiconductor, that is, when Bardeen and Walter Brattain first demonstrated (December 16, 1947) the transistor and with it a new principle for an amplifying device (*Physical Review* 74 [1948]: 230; U.S. Patent 2,524,035, filed June 17, 1948). Who would have believed that the Ge band structure, which was then unknown, and carrier lifetime would have permitted carrier injection, collection, and signal amplification, even if the idea, the notion of a transistor, existed? The semiconductor suddenly took on new importance, and a revolution in electronics followed. With John Bardeen's death on January 30, 1991, we have passed to another era, maybe now more evolutionary than revolutionary.

John Bardeen was born May 23, 1908, in Madison, Wisconsin, where his father, Dr. Charles R. Bardeen, was dean of the University of Wisconsin medical school. His mother, Althea Harmer Bardeen, was trained as an interior decorator and died in Bardeen's youth, his father later remarrying. Except for his Ph.D., all of John Bardeen's formal education occurred in Wisconsin. He was a true prodigy and at nine years of age skipped from third grade to seventh grade. It is interesting that many years later when he occasionally misspelled a word he attributed this to the drill in spelling he missed in skipping many grades of elementary school. In spite of his obvious talent for mathematics and science, he was given to normal play, mischief, and friendship with his contemporaries, and exhibited a fondness for various sports. He learned golf very early and played the game at a high competitive level all of his life, even into his eighties when his eyesight was failing. Maybe his interest in golf equaled or exceeded his other interests. He had a good sense of humor and admitted that maybe two Nobel Prizes (physics, 1956 and 1972) were better than the hole-in-one he once made. At the University of Wisconsin he was on the swimming team and also played billiards. One of his wartime coworkers at the Naval Ordnance Laboratory (1941-1945) commented many years later that Bardeen was also not to be challenged in bowling. In addition, he apparently was good at cards and was able in his youth to earn spending money playing poker.

After finishing high school at age fifteen, Bardeen entered the University of Wisconsin and, in spite of his interest and ability in mathematics and physics, studied electrical engineering, receiving a B.S. in 1928 and an M.S. in 1929. This is one of the first indications of another side of Bardeen, his considerable appreciation for the practical as well as his ability to invent. It was not possible for him, however, to suppress his talent and interest in mathematics and physics, and at the University of Wisconsin in his first year as a graduate student (1928) he learned quantum mechanics from Van Vleck and later from Dirac, who delivered lectures in Madison based on the famous book published a year later. Instead of finishing his graduate education, Bardeen followed a University of Wisconsin professor to Pittsburgh to work (1930-1933) for Gulf Research and Development Corporation on problems dealing with oil exploration. He became a successful geophysicist, with some of his ideas in oil exploration still kept confidential. Besides his work at Gulf, his golf, and attending seminars on quantum physics at the University of Pittsburgh, he became acquainted with Jane Maxwell, whom he later married (1938), and with whom he raised a family and spent his entire life.

In spite of his success working on geophysical problems, John Bardeen quit his steady employment with Gulf in the heart of the Great Depression to go to graduate school at Princeton University (1933-1935). He had heard that Einstein was coming to Princeton and thought there might be a possibility of working with him. As it turned out, Einstein did not take graduate students, and Bardeen wound up in the Princeton mathematics department (not physics) working for Eugene Wigner, one of the two brilliant young Hungarians (the other was John von Neumann) who had recently arrived in America. Frederick Seitz was Wigner's first research student, Bardeen the second, and

Conyers Herring the third, which was sufficient to identify Princeton as a center of solid-state physics. For his thesis dealing with the calculation of the work function of metals, Bardeen was awarded his Ph.D. in mathematical physics in 1936.

Before his Ph.D. was completed and through the influence of Van Vleck, who had moved from Wisconsin to Harvard University, John Bardeen took a position (1935-1938) as a junior fellow of the Society of Fellows at Harvard, where, incidentally, he overlapped with, among others, James B. Fisk (later of Bell Labs) and Stanislaw Ulam. This was the first time Bardeen was actually in a physics department. At Harvard he worked with Van Vleck and Percy Bridgman, the great high-pressure scientist, and in Cambridge interacted with John Slater and his students at the Massachusetts Institute of Technology. Slater later forgot and referred to John Bardeen as his post-doc. It was Bardeen's Princeton and Harvard years that laid the foundation for his future work. For example, in one of his Urbana seminars in 1970, he mentioned that already at Harvard he had the notion that superconductors possessed an energy gap. Before he became involved in semiconductor research in 1945, he was already deep into the study of metals and superconductors, but had not necessarily decided to pursue solid-state theory as a career.

After Harvard, John Bardeen took a teaching position (assistant professor, 1938-1941) at the University of Minnesota, ironically for a salary much less than he received at Gulf. Before World War II actually began, he went on leave to the Naval Ordnance Laboratory (1941-1945) and worked on problems of ship degaussing and underwater ordnance. At the war's end, and with the need for increased salary for a growing family, he joined the newly formed Bell Telephone Laboratories group that set about acquiring a more fundamental understanding of solids (semiconductors) and launched, at Kelly's urging, the search for a solid-state replacement for the vacuum tube. Because space was short, Bardeen, a theorist, wound up sharing an office with Walter Brattain and Gerald Pearson, experimentalists, and thus began an intensive collaboration of historic consequences.

At Bell Labs Bardeen first checked existing calculations on the operation of a field effect device (an old idea), and agreed the calculations were correct and that the failure of the device was not one of principle. Bardeen made the important suggestion that surface states on Si or Ge, the preferred experimental materials (a consequence of World War II developments), immobilized the carriers and thwarted conduction and field effect amplification. We cannot describe here all of Bardeen's published work, several hundred papers, but wish to mention his famous 1947 paper (*Physical Review* 71 [1947]: 717) on surface states, which, among other features, reveals how thoroughly Bardeen understood the symmetry in electron and hole behavior, that is, the importance of both. This proved later to be of some consequence in permitting recognition of carrier injection. The problem with surface states led to an intensive study of surface effects with Walter Brattain. Bardeen realized that fundamental problems existed with evaporated films then used in field effect experiments, and suggested instead, as a thin conducting channel, the use of inversion layers on bulk crystals of known good properties. The first working field effect device, at first on Si and then Ge, employed Bardeen's inversion layer suggestion. It should be noted that Bardeen's inversion layer idea (U.S. Patent 2,524,033, October 3, 1950, filed February 26, 1948) is the basis for today's CMOS devices, now so critical in integrated circuits. Most individuals are unaware of where this idea originated.

It is a fascinating story to follow how Bardeen and Brattain, by removing the surface electrolyte (a convenient but "slow" mechanism of field modulation) on their field effect device and by substituting a gold field plate on the crystal, realized instead a gold injection electrode (on n-type Ge) and in the process demonstrated an entirely new device. The device, operating on entirely new principles, was the transistor. Several modifications led to the point contact version of the transistor, which was merely an experimental simplification of Bardeen and Brattain's first transistor, the first occurring on December 16, 1947, and a demonstration to the "brass" (Bardeen's word) on December 23, 1947. Not only did Bardeen and Brattain introduce the bipolar transistor—a new idea, a new principle, a new device, a new name—they also introduced a first embodiment, a direct way to convert a crystal into an amplifying or switching device. Bardeen has left an account of all of this work and how it occurred in his June 1990 NHK (Japanese television) interview. The new device demonstrated by Bardeen and Brattain, the transistor, the bipolar device based on carrier injection (which Bardeen identified), served as the prototype for all bipolar and injection devices that followed. A new device principle had been established with carrier injection, and Bardeen and Brattain's transistor and, whether it was realized or not (December 1947), the semiconductor took on then a new level of importance. In fact, semiconductor electronics as known today enjoyed its beginning, and it is proper to say that the "third golden age" of solid-state physics had truly begun.

It was inevitable, since he was in the same office with Brattain and Pearson, that John Bardeen would be drawn into semiconductor work, where indeed, his talents had an immediate and major impact. For various reasons, however, some dealing with Bardeen's broader interests (including superconductivity), some organizational, and some being the opportunities that existed elsewhere, he left Bell Labs in 1951 and came to the University of Illinois (Urbana), where he spent the rest of his life. Illinois was attractive to him because Seitz and others had already established a base in solid-state research and, with a joint appointment in electrical engineering and physics, John Bardeen could expand the solid-state research in Urbana, as he chose, into semiconductor and superconductivity research. In 1951 he began his teaching activities, and in 1952 he founded a semiconductor research activity in electrical engineering and, in physics, began a further push to solve the long mysterious problem of superconductivity.

At Illinois, besides continuing his work on semiconductors and training a new generation of engineers and applied physicists who have themselves made major contributions to semiconductor and solid-state research and its applications to electronics, John Bardeen, with L. N. Cooper and J. R. Schrieffer, constructed (1957) the first successful theory of superconductivity, the so-called pairing theory. This theory, the Bardeen, Cooper, and Schrieffer (BCS) theory, is universally recognized as providing the correct account of the superconductivity of metals, a phenomenon discovered nearly fifty years earlier (1911). From the time of its discovery, superconductivity remained unexplained and was studied by a long list of outstanding physicists, including such great men as Felix Bloch, Niels Bohr, Richard Feynman, Werner Heisenberg, Lev Landau, Fritz London, and Wolfgang Pauli. This gives some idea of the importance attached to this long-unsolved problem and of the genius of John Bardeen in recognizing how to go about attacking it. No one else had a better understanding of the problem and how it might be solved. A solution for the problem of superconductivity ranks as one of the major achievements of physics and technology of this century. Superconductivity, of course, has important practical applications (e.g., high-field magnets) and is perceived as offering even a wider range of important uses now that a new family of so-called high T_c oxide superconductors has been discovered.

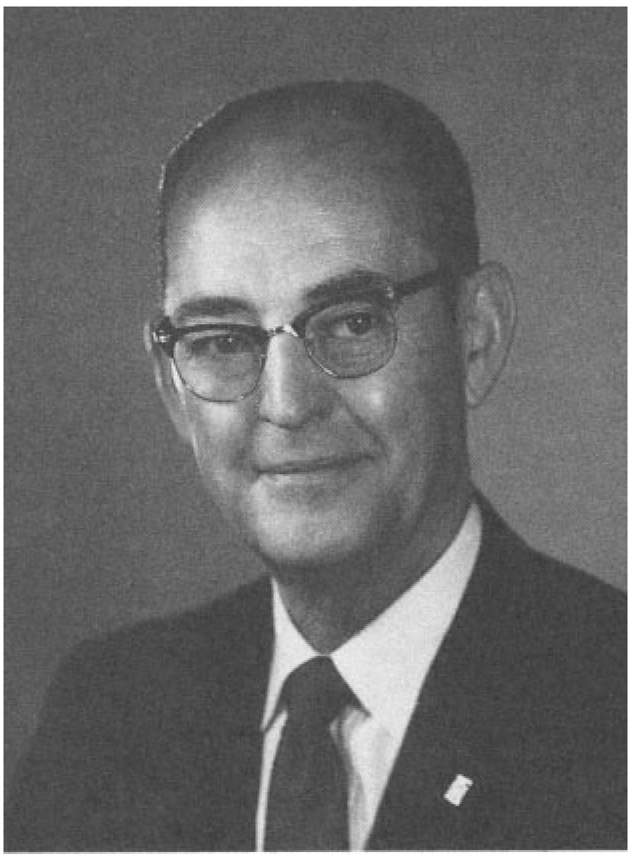
The BCS theory is considered the standard for judging and explaining superconductivity in all of its various manifestations, and has provided also the basis for major advances in related fields. It has been used to explain a number of puzzling facts concerning the structure of nuclei. The "pairing" ideas characteristic of the BCS theory play nearly as basic of a role in theories of nuclear structure as they do in the explanation of the superconductivity of metals. BCS ideas have influenced also the theory of elementary particles and superfluid helium.

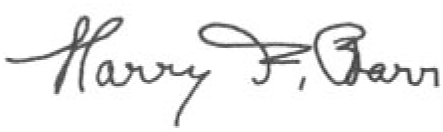
John Bardeen had a unique influence on the technical and scientific life of our time. As already mentioned, he, with Brattain, identified minority carrier injection in semiconductors and invented the transistor. This event started a revolution in electronics and computer technology that is unparalleled and that continues to grow. No other invention of our time has had such a profound effect on society. John Bardeen had an equally profound influence on contemporary physics with the creation of the BCS theory of superconductivity, and its far-reaching influence on superconductivity itself and on various related problems. Bardeen was regarded as one of the world's great solid-state theorists. He was equally renowned as, and was first, an engineer and inventor. His work shed light on nearly every corner of the field of solid-state physics and the conductivity of solids (metals, semiconductors, superconductors, photoconductors, and linear conductors). The foundation of modern electronics rests on much of John Bardeen's work on the conductivity of solids. Even the light emitters and lasers of present-day optoelectronics rely on the mechanism of carrier injection that begins with Bardeen and Brattain's original bipolar transistor.

John Bardeen spoke in a soft voice and at times could be inaudible, particularly when he was tired, deep in thought, or in a long, involved discussion. Some students dubbed him "silent John" or "whispering John," which was a little unfair considering how generously and fairly Bardeen treated students, and similarly colleagues, coworkers, and everyone in general. Everyone sought his advice. In fact, legend held that he was infallible, which, of course, was untrue, but which, of course, had much substance considering his great talent and success as a scientist and engineer. It was known that he didn't say much, but what he said was carefully thought out and important to hear. He was in heavy demand for advice, talks, seminars, committee service, and university, government, and industrial consulting. For example, it was well known that he had no small part in helping the Xerox Corporation in the development of several aspects of the xerographic process. He always gave the best possible advice, and was never intimidated, not even by presidential committees. John Bardeen was a man of the highest integrity and never allowed his name to be used improperly or falsely.

On difficult doctoral examinations he often was the voice of reason that could see where the candidate had ability and was apt to make a contribution. He always looked for the best in others, not the worst. The standards he set for himself, for example, were not what he imposed on others. It was amusing to see him smile when he received a preprint, sometimes wrong, from someone coming into an area of work Bardeen initiated. Problems he worked on quickly drew others. It is hard to estimate the total number of students, post-docs, visitors, and advisees of all sorts that owed their start to John Bardeen. He was a teacher of the highest order, by example and accomplishment, not by popularity vote. It is also hard to estimate how often he was approached to write letters of recommendation for awards, academy memberships, etc., and the burden that this created. John Bardeen was kind and very generous and gave much of himself to others. It seemed his time was never his own. Nevertheless, he somehow managed to be a productive scientist and engineer even as his health was failing. In fact, over the years his publication rate did not change, in spite of his great fame and all the demands on his time. Only a month before his death he published a paper in *Physics Today* (December 1990) on his most recent thoughts and work. Right up to the end of his life, he regularly gave talks and seminars on the "early days of solid-state and transistor research" as well as on superconductivity. Just before his death, he was sorting and assembling material to prepare an account of the history and development of superconductivity, which perhaps no one knew as did John Bardeen.

John Bardeen was a rarely gifted person (cf., *Physics Today,* April 1992) and, of course, received many honors, including the unprecedented award of two Nobel Prizes in physics. His mathematical and analytical skills were of the highest order, and his intuition for "right and wrong physics" incomparable. He was able to untangle and simplify problems—important, difficult (even messy) problems—that stopped the best minds. With the transistor and BCS theory of superconductivity, not to mention his other work, he left science and technology, and indeed, the world, much richer than he found it. He, more than anyone else, can be said to be the "godfather" of modern electronics. We will always be inspired by him and be in his debt.





Harry F. Barr

1904-1990

By Robert A. Frosch

HARRY F. BARR, engineer, inventor, automotive industry leader, and vice-president of General Motors (GM) engineering staff, died on March 5, 1990, at the age of eighty-five.

Elected to the National Academy of Engineering in 1965, Mr. Barr was the first automotive engineer to receive this distinction. He was frequently regarded as "an engineer's engineer." He is known for his innovation, leadership, and contributions to automotive engineering, and for his service to several engineering societies during his forty-year professional career and into his retirement.

A native of Enid, Oklahoma, Mr. Barr was born on August 28, 1904. He studied mechanical engineering at the University of Missouri before enrolling at the University of Detroit in 1926, where he received a bachelor's degree in automotive engineering three years later.

Mr. Barr began his General Motors career in February 1929 as a laboratory technician for Cadillac Motor Car Division. His first assignment was in the development of the V-16 passenger car engine.

For a short time during World War II, Mr. Barr worked on a tank development project and on a lightweight flying bomb. Following his war projects, he was promoted to Cadillac divisional engineer in charge of engines. In 1945 he was named staff engineer and was responsible for the development of the 331 cubic-inch overhead valve engine, introduced on 1949 Cadillacs.

During the Korean War, Mr. Barr became the assistant, and then the chief engineer at Cadillac's Cleveland, Ohio, Ordnance Tank Plant. While there, he assisted in the development and production of the M-41 Walker bulldog tank and the M-42 twin Bofors 40-mm gun carriage.

Following his Cleveland assignment, he moved to Chevrolet Motor Division in 1952 as assistant chief engineer and became chief engineer four years later. Under his direction, Chevrolet introduced a number of new models, including the Corvette and the Corvair, and features, together with important developments in transmissions, engines, and suspensions and an all-new truck line in 1960.

Coinciding with his appointment as chief engineer, Mr. Barr oversaw the development of the engine for the 1960 Corvair. This vehicle was innovative for the current U.S. market because of its rear-mounted engine. The engine was a horizontally mounted, opposed 6-cylinder, air-cooled design. It was the first modern all-aluminum engine in the domestic industry, the first automotive air-cooled engine since the early 1930s, and the only application of the horizontal opposed configuration in the domestic industry.

It was during this time that Mr. Barr became known for his contributions to engine design and development, including the reduction of exhaust emissions. He received nine U.S. patents during his career, more than half in the area of engine structure and lubrication.

Upon Mr. Barr's death, GM Chairman Robert Stempel said, "Harry Barr was both a fine gentleman and an imaginative engineer who was highly respected throughout the industry for his knowledge of automobile engines."

In March 1963 Mr. Barr was elected vice-president of General Motors in charge of the engineering staff, a post he held until his August 1969 retirement. The engineering staff's mission was to explore and develop future vehicles and technologies and to coordinate corporate safety programs.

His responsibilities included chairing the GM Engineering Policy Group and the General Technical Committee, both of which coordinated corporate and divisional engineering and technical matters. Also under his engineering jurisdiction were the GM Proving Grounds in Milford, Michigan, and Mesa, Arizona; GM's test facility in Manitou, Colorado; automotive safety engineering; the new devices section; parts fabrication; technical liaison section; and engineering standards.

During his tenure as vice-president, the federal government began its involvement in automotive safety and emissions. Mr. Barr worked with the government and automotive manufacturers as an engineer and industry spokesperson. A year before his retirement he said, "As responsible engineers, it is our duty to lead and inform administrators in the governmental departments that are charted by law with the task of applying new regulations to our industry. . . . At the same time, we must continue to see that our customers receive the greatest possible value for the cost involved in all these public interest areas, such as safety and air pollution."

New safety features that Mr. Barr supervised included thicker laminate windshield glass, beginning with the 1966 models, to prevent ejection from the vehicle; energy-absorbing steering columns in 1967; and better highway design. This work was based on a research program at the GM Proving Ground, which demonstrated that clearing obstacles from roadsides can reduce the severity of injuries in single-car accidents.

In addition to his election to the National Academy of Engineering, Mr. Barr was a fifty-year member and fellow in the Society of Automotive Engineers (SAE). He held a number of positions in the SAE and was its president in 1970. For ten years he represented the society on the Board of the Coordinating Research Council. He also was a member of the Engineering Society of Detroit and the honorary engineering fraternity Tau Beta Pi.

Throughout his career, Mr. Barr received several honors, including the Alumnus of the Year from the University of Detroit's College of Engineering (1970), the Outstanding Career Achievement Award from *Automotive Industries* magazine (1968), and the Missouri Honor Award for Distinguished Service in Engineering from the University of Missouri (1965).

Based on his many years of observation, Mr. Barr summarized the qualities of successful engineers in a 1964 *GM Engineering Journal* article. According to Mr. Barr, successful engineers have initiative, and they have the ability to make their own decisions and have an open mind. They dare to be different, are enthusiastic team members, effective communicators, and continue to learn about their profession, he said.

"These elements, then, are what I consider to be essential for an engineer in pursuit of success. But possession of them does not assure continual success," Mr. Barr said. "The engineer must expect to encounter failure. In fact, failure is a reality at some stage in most engineering projects. It may, however, be considered as part of the path to success."

There's no doubt among anyone who worked with or knew Harry Barr, that he was one of the successful engineers he described. Mr. Barr's legacy to automotive engineering is still reflected today in GM's cars and trucks.

Gilbert Y. Chin

1934-1991

By Jack H. Wernick

GILBERT CHIN, a physical metallurgist by formal training, made significant contributions to our understanding and applications of crystal plasticity and to the development of new magnetic alloys for telecommunications. Just prior to his death, he was a leader of a productive group doing significant research and development in the areas of optical fibers, electronic ceramics, and materials for high-temperature superconductivity. He died on May 5, 1991, at the age of fifty-six.

Gilbert was elected to the National Academy of Engineering in 1982. At the time of his death, he was director of the Passive Components Research Laboratory at AT&T Bell Laboratories, Murray Hill, New Jersey.

Born in Kwangtung, China, on September 21, 1934, Gilbert received his B.S. and Sc.D. degrees in metallurgy from the Massachusetts Institute of Technology in 1959 and 1963, respectively. He joined the AT&T Bell Laboratories research area in 1962. Among his contributions to metallurgy and materials science, two major contributions stand out; they are in the areas of crystal plasticity and magnetic alloys, which he had coupled with creativity and leadership. In earlier work, he combined the Taylor theory of plastic flow and the Chikazumi theory of directional order to predict the deformation-induced magnetic anistropy of nickel-iron alloys. This basic understanding led Chin and his colleagues to develop a manufacturing process for optimizing the magnetic properties of nickel-iron wires for use in a magnetic memory that became the heart of the nation's first telephone electronic switching system.

Gilbert also pushed forward the frontier of crystal plasticity research by teaming with a colleague mathematician to become the first to use linear programming to solve the Taylor analysis of polycrystalline flow. He also extended the Taylor theory of slip to include twinning, which work Sir G. I. Taylor communicated to the Royal Society. This program continued with more than thirty papers, culminating in a series dealing with the plastic behavior of ionic solids, which won him the prestigious Champion H. Mathewson Gold Medal of the American Institute of Mining, Metallurgical, and Petroleum Engineers as the most significant contribution to metallurgical science during a three-year period. He also used his understanding of crystal plasticity to develop a novel processing technique for achieving the highest combination of strength and ductility in several copper-based alloys.

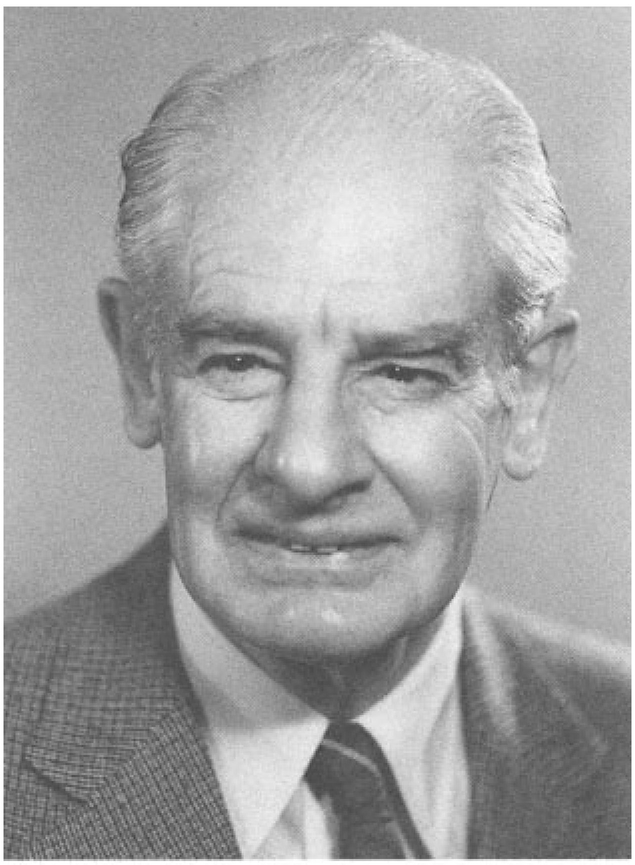
Chin's second contribution was the development with his colleagues of a new family of low-cobalt chromium-cobalt-iron ductile permanent magnet alloys, which can be formed at room temperature, along with the successful transfer of this new technology to production of one of these alloys for use in telephone receivers at an annual cost savings of several million dollars.

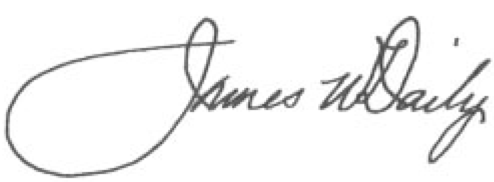
Gilbert was the holder of eleven patents and author or coauthor of more than 140 publications. Among his many awards and honors he was elected a fellow of the Metallurgical Society of AIME, class of 1981, the total number limited to one hundred living members. He was also elected a fellow of the American Society for Metals (ASM) in 1983 and was ASM's Sauver Memorial Lecturer for 1985. He was frequently sought after to organize symposia and to chair important materials science committees.

His service on national committees included work for the National Research Council, as well as the University Materials Council and the National Science Foundation. For the National Research Council, he served from 1980 to 1982 on the Committee on Materials Substitution Methodology, National Materials

Advisory Board; in 1984-1985 on the Committee on New Magnetic Materials, National Materials Advisory Board; and in 1985-1987 on the Committee on Army Basic Scientific Research, Board on Physics and Astronomy. From 1986 to 1989 he served on the Panel on Education in Materials Science and Engineering, a joint activity of the National Materials Advisory Board and the Board on Physics and Astronomy. In addition, from 1986 to 1988 he served on the Policy Committee of the University Materials Council, and from 1986 to 1989 he served on the Materials Research Advisory Committee of the National Science Foundation.

Gilbert's devotion as a son, husband, and father is equally as significant as his contributions to science and technology. He made sure that his family (as well as his younger brothers and sister) became highly educated.





James Wallace Daily

1913-1991

By Donald R. F. Harleman

JAMES WALLACE DAILY, educator and consultant in hydraulic engineering, died on December 27, 1991, at the age of seventy-eight. Jim retired in 1981 as professor of fluid mechanics and hydraulic engineering in the applied mechanics and engineering sciences department of the University of Michigan and spent the last years of his life in Pasadena, California.

Jim was born in Columbia, Missouri, on March 19, 1913. He obtained a B.A. in the school of engineering at Stanford University in 1935 and an M.S. in mechanical engineering from the California Institute of Technology in 1937. Jim remained at Caltech as manager of the Hydraulic Machinery Laboratory and instructor in mechanical engineering. He married Sarah Atwood in 1938, and they had two children, John Wallace and Sarah Anne. After the start of the second world war, Jim began experimental research on underwater ballistics related to submarine warfare. He, together with Robert J. Knapp, designed the first general-purpose water tunnel in America for the study of cavitation phenomena. Jim received a Ph.D. from Caltech in 1945 on the basis of his pioneering research on torpedo-shaped bodies. In 1946 he joined the faculty of the Massachusetts Institute of Technology (MIT) on the urging of his former Caltech colleague, Arthur T. Ippen, who had been given the charge to build up MIT's strength in fluid mechanics and hydraulic engineering.

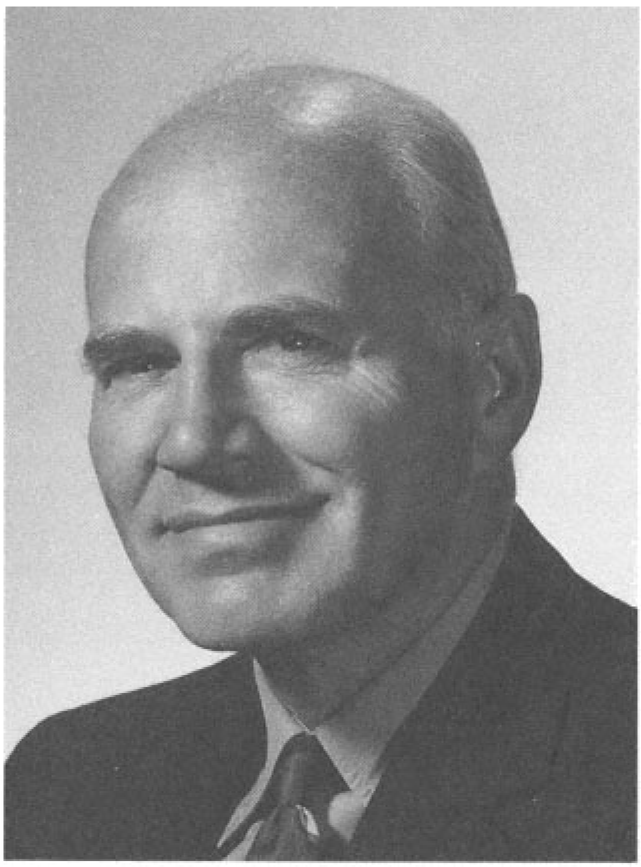
Jim was a major participant in the design and equipping of MIT's Hydrodynamics Laboratory (now called the Ralph M. Parsons Laboratory), which was completed in 1950. He rose through the academic ranks, becoming full professor in 1955. During his period at MIT, Jim made significant contributions to the understanding of flow-induced vibration and the development of criteria to predict the occurrence of hydro-elastic oscillations. He also studied the mechanics of liquid-solid flows of fibrous materials related to the design of high-speed papermaking machinery. In 1966 he coauthored with Donald R. F. Harleman a successful undergraduate fluid mechanics textbook that remained in print for twenty-five years.

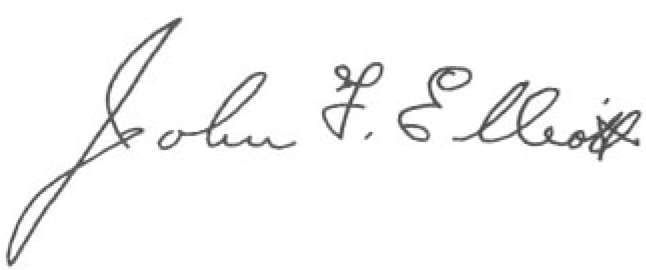
In 1964 Jim was appointed professor and chairman of the engineering mechanics department at the University of Michigan. In addition to administrative duties, he continued teaching advanced and non-Newtonian fluid mechanics. Jim relinquished the chairmanship in 1972 to return to teaching and research until his retirement in 1981.

Jim served four years (1967-1971) as president of the International Association for Hydraulic Research. In 1974 he visited the People's Republic of China as a member of the U.S. Study Tour on hydraulic engineering and water resource systems. He wrote the definitive English-language book on cavitation, and as a consultant to the Tennessee Valley Authority, he helped solve some difficult turbine vibration problems.

Jim was elected to the National Academy of Engineering in 1975. Earlier he had been made a fellow of the American Society of Mechanical Engineers, an honorary member of the Japan Society of Civil Engineers, and an honorary member of the International Association of Hydraulics Research.

Jim was genuinely concerned with improving engineering education by insisting on sound science backgrounds. His dedication and concern nurtured a generation of students, and his engineering expertise contributed to the advancement of the engineering profession in this country and throughout the world.





John Frank Elliott

1920-1991

By Morris Cohen

JOHN F. ELLIOTT, one of the world's foremost authorities in the field of metallurgy, died on April 15, 1991, at the age of seventy. He was the American Iron and Steel Institute Distinguished Professor of Metallurgy and director of the Mining and Mineral Resources Research Institute at the Massachusetts Institute of Technology (MIT). He was elected to the National Academy of Engineering in 1975 as a teacher, engineer, and scientist, who was responsible for major advances in metallurgical education, research, and processing.

John was born on July 31, 1920, in St. Paul, Minnesota, and received his early education in northern Minnesota. He was awarded the S.B. in metallurgical engineering with high distinction at the University of Minnesota in 1942. After becoming a lieutenant commander in the U.S. Navy during World War II, he enrolled as a graduate student at MIT and received the Sc.D. in metallurgy in 1949. He then joined the Fundamental Research Laboratory of the United States Steel Corporation as a physical chemist. Following this experience in industrial research, John joined the Inland Steel Company as a member of the research staff and was later appointed assistant superintendent of quality control of steelmaking. In 1955 he returned to MIT as associate professor of metallurgy and rose to full professorship in 1960.

John's teaching and research at MIT established his intellectual leadership in chemical-process metallurgy. He and his students published well over two hundred papers, covering ferrous process metallurgy, high-temperature chemistry of inorganic materials, and hot corrosion of metals and refractories, as well as the underlying chemical thermodynamics and kinetics. One of his major publications was a comprehensive two-volume compilation, *Thermochemistry for Steelmaking.* He was also involved with technological developments in the metallurgical processing industry and with the conservation of energy and raw materials, including the related environmental implications.

In all these activities, John's achievements were acknowledged by many awards, invited lectureships, and honorary memberships. Among his more than a dozen prizes were the Robert W. Hunt Award of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), the John Simon Guggenheim Memorial Fellowship at Imperial College in London, The Albert Easton White Distinguished Teacher Award of the American Society for Metals, the AIME Legion of Honor, and the Tawara Gold Medal of the Iron and Steel Institute of Japan.

In addition to John's membership in the National Academy of Engineering, his honorary and fellow memberships included the American Academy of Arts and Sciences; the American Institute of Mining, Metallurgical, and Petroleum Engineers; the Metallurgical Society of AIME; the Iron and Steel Society of AIME; the Iron and Steel Institute of Japan; the Japan Institute of Metals; the American Institute of Chemical Engineers; the Sociedad Venezolana de Ingenieros de Minas y Metalurgicos; and the American Association for the Advancement of Science.

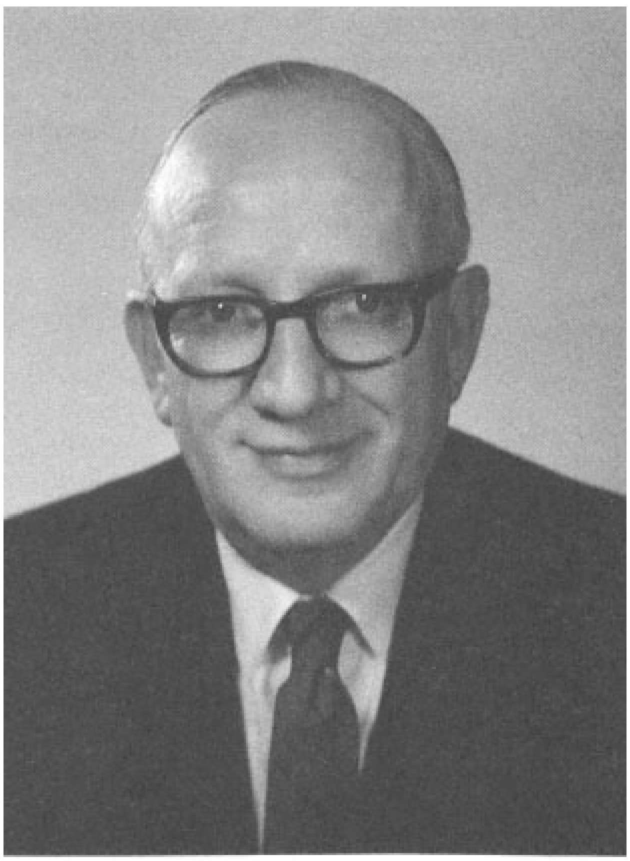
Among the honorary lectures given by John were the Howe Memorial Lecture of AIME, the Carter Memorial Lecture at the University of Strathclyde in Scotland, the Yukawa Lecture of the Iron and Steel Institute in Japan, the Extractive Metallurgy Lecture of AIME, the Zay Jeffries Lecture of ASM, and the Sir Julius Wernher Memorial Lecture of the Institution of Mining and Metallurgy in Great Britain. He also presented invited papers in Sweden, India, and Korea. In 1974 he served as visiting professor at the Tohoku University in Sendai, Japan, and in 1976 at the Simon Bolivar University in Caracas, Venezuela. He co-chaired the First Bilateral USA-China Metallurgical Conference in Beijing in 1978, and coedited the classic proceeding on *Metallurgical Treatises* in 1981.

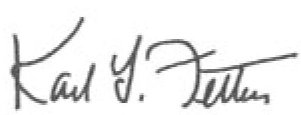
Perhaps the tribute that meant most to John was the Elliott Symposium on Chemical Process Metallurgy, organized by his students and colleagues and held at MIT in June 1990. It was a memorable occasion with featured papers on the future of process metallurgy in Asia, Australia, and Europe, as well as in the America's. John participated actively throughout the symposium and gave the final presentation on "Whither Chemical Metallurgy?" Another highlight of the event was the establishment of an endowed fund by the Iron and Steel Society and the Minerals, Metals, and Materials Society in support of a John F. Elliott Lectureship in Chemical Process Metallurgy, "to honor Professor Elliott for his many accomplishments, and for the leadership he provided over a career spanning more than four decades."

Despite several life-threatening illnesses throughout his career, John demonstrated remarkable resolve to carry on with his way of life after each health crisis. Each time, he managed to resume his research and teaching, together with a vigorous schedule of world travel for conferences, honors, and invited lectures. He also remained ever-devoted to his family, students, and profession, along with his hobbies of gardening, sailing, and music appreciation.

Tragically, however, in December of 1990, fateful symptoms of a brain tumor were detected, and the end came for John in April of 1991. He is survived by his wife, Frances Pendleton Elliott; two children, William Stowe Elliott and Dorothy Elliott Sempolinski; and four grandsons.

John Elliott lived a life of purpose, fullness, and lasting achievement. He has left his indelible mark on the metallurgical profession.





Karl L. Fetters

1909-1990

Written By Robert D. Pehlke

Submitted By The Nae Home Secretary

KARL L. FETTERS, metallurgical engineer and major contributor to the development of science and technology in the iron and steel industry, died on October 3, 1990, at the age of eighty.

Elected to the National Academy of Engineering in 1965, Karl had already achieved recognition for his contribution to the engineering profession on an international basis. He was a dedicated professional who was recognized for the breadth of his views, which extended well beyond his steel industry experience to promotion of the mining, energy, and materials industries and especially to the education of young people by encouraging their association with these industries.

The professional career of Karl Fetters extended over more than six decades, and his involvement and leadership through many dramatic changes are highly commendable. He was involved in steel production as a metallurgist, then was an academic instructor at Carnegie Institute of Technology, and later was involved in steel operations and subsequently became a leader in steel research and research management.

Karl Fetters was born on November 28, 1909, in Alliance, Ohio, where he attended public schools. He received his bachelor's degree in metallurgical engineering from Carnegie Institute of Technology in 1931, and his doctorate in metallurgy from the Massachusetts Institute of Technology (MIT) in 1940. From 1933 to 1936 he was a metallurgical assistant for the

National Tube Company in Lorain, Ohio. From 1936 to 1938 he was a plant metallurgist for Youngstown Sheet and Tube Company. He then attended MIT to achieve a graduate degree. Karl returned to Carnegie Institute of Technology to assume a position with the Office of Scientific Research and Development project on seamless steel gun tubes, while he also served as an assistant professor of metallurgy and a staff member of the Metals Research Laboratory. In 1943 he returned to Youngstown on special assignment as a metallurgical engineer. He was appointed assistant to the vice-president of operations in 1950, became assistant vice-president in 1956, and vice-president of research and development in 1959. In 1970 he became vice-president of planning and technology.

Dr. Fetters was widely known throughout the international steel industry, and received recognition and numerous honors in other areas of the engineering community. He served as chairman of the Iron and Steel Division of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) in 1958-1959, and as president of The Metallurgical Society (TMS) of AIME in 1961-1962. In 1964 he was president of AIME. He was a fellow grade member of both TMS and the American Society for Metals (ASM). He served on several key committees of these societies, including a two-year term as a national trustee of ASM, representing that society at metallurgical conferences in Europe in 1955. He was also a chairman of the Mahoning Valley Chapter of ASM. He served as a member of the General Research Committee of the American Iron and Steel Institute and as a director of the American Standards Association, and was a member of iron and steel professional associations in Great Britain and Germany. He authored or coauthored many technical papers. He visited and interacted with iron and steel industry personnel throughout the Western Hemisphere, Europe, and Asia, particularly in Japan.

Dr. Fetters possessed great personal energy and wide interests. He was an active and skilled yachtsman, and was involved in teaching courses in seamanship, piloting, and boating safety. He was also a ham radio operator with contacts all over the world. Photography was another of his areas of expertise, and one of his most enjoyable hobbies.

A key aspect of the outstanding career of Karl Fetters was his communication skills, and in particular, his ability to express his experience and outlook to those who benefited from his advice. He could share his own experience as well as his perspective on current and future situations when presenting an evaluation of a challenge or opportunity. The incorporation of this skill and ability in working with younger colleagues represented a special quality of Karl Fetters. He was outspoken in his support of corporate research. Even more significant was his encouragement of individuals to extend their limits in contributing to our society. His perspective has had a significant impact in defining the goals of younger people following paths similar to his own.

The career of Karl Fetters can be looked on in terms of his success, for example, his achievements and professional recognition. Indeed, however, one must not only acknowledge the exceptional accomplishments that followed from his own abilities, but also recognize his perception and sensitivity in communicating many of these skills to those associated with him.

His dedication and expertise remain with those who were associated with him, and the many who follow in similar career paths. Karl Fetters was a leader and a pioneer in creating a model role by example, and in defining future goals in his area of the engineering profession.

James C. Fletcher

1919-1991

By Dale D. Myers

JAMES C. FLETCHER—scientist, engineer, corporate executive, educator, and administrator—died on December 22, 1991, at the age of seventy-two. He made important contributions in all of the these fields. For the National Aeronautics and Space Administration (NASA), he was the right man in the right place twice. Twice he was administrator of NASA at times of crisis, and twice he calmly led NASA to focus, balance, and advances in science, space transportation, aeronautics, and long-range plans for exploration.

Jim was born on June 5, 1919, in Millburn, New Jersey. He received an undergraduate degree in physics from Columbia University in 1940. He did research at Harvard's Cruft Laboratory, taught at Princeton, and then received his Ph.D. in physics from the California Institute of Technology.

He started his industrial career at Hughes Aircraft Company in 1948. In 1954 he joined the Ramo-Wooldridge Corporation, where he helped develop the broad systems analysis and oversight practices then being initiated for management of the intercontinental ballistic missile programs. In 1958 his entrepreneurial interests led him to form, with an associate, the Space Electronics Corporation in Glendale, California. Sputnik had led to the expansion of space programs, and with Jim's talent for picking good people and good programs, the company prospered. In 1960 Space Electronics merged with a portion of

Aerojet to form Space General Corporation, and Jim became president, and later chairman.

In 1964 Jim was asked to become president of the University of Utah, and with his enthusiasm for new challenges, he accepted. In the seven years that he was at the university, the enrollment doubled and he brought new emphasis to the science and mathematics curriculum.

While at the university, Jim was elected a member of the National Academy of Engineering (NAE). Over the years, he served as a member of the NAE's Council and Finance Committee; the Governing Board of the National Research Council (NRC); and NRC's Commission on Physical Sciences, Mathematics, and Resources. In 1991 he became a member of the NAE Development Advisory Committee.

His first opportunity to be the right man at the right place with NASA happened in 1971. President Nixon asked him to be the fourth administrator. By that time, NASA had met President Kennedy's challenge to land a man on the moon and bring him home safely. Budgets were tumbling down, but NASA's long-range plans called for such ambitious expansion that budgets would have had to increase unrealistically.

With his usual calm, analytic approach to a difficult problem, he developed an approach that the President, the manned-flight supporters, and the growing science group accepted. Under pressure from the administration to reduce budgets, he chose to fall back from the fully recoverable shuttle design to the partially recoverable configuration we have today. That proposal reduced the development cost by more than 50 percent and was accepted by President Nixon.

He still was a scientist by training and inclination, and he played a key role in developing and implementing the strategy of first flying by the planets, then orbiting them, and finally landing on them. During that period as administrator of NASA, he also encouraged early NASA experiments in communication satellites and studies of the Earth from space. He initiated the multispectral viewing space telescopes, including the Hubble Space Telescope.

After leaving NASA in May 1977, Jim moved to a more flexible position as a consultant and member of several boards. He was appointed to the Whiteford Chair of Technology and Energy Resources at the University of Pittsburgh, and a member of several government committees. During this time, he was particularly active with the National Academy of Engineering. He was on (or led) several classified studies that made substantial contributions to the nation's defense.

In 1986 after the shuttle *Challenger* disaster, President Reagan asked Jim to return to NASA to lead the recovery of the nation's space program from the devastating effect of the accident. He reluctantly agreed to come back for the duration of the Reagan administration. He was confirmed by the Senate in May 1986, four months after the accident. Morale was at its lowest. Jim again took on the challenge. He looked for and found new, good people by his usual thorough technique of calling many, many people that he trusted for recommendations. He traveled to all the centers, talking to large groups. He spoke of the exciting things to come and inspired confidence in the future. This was a case where leadership was rewarded. His strong reputation of "leveling" with people caused them to believe him, and to believe in him. Later, he said in confidence that he had made promises in those early trips that he had to fulfill. He did.

Under his leadership, morale recovered, and steady progress was made in rebuilding the shuttle and in reorganization, communications, and safety. When the organization was functioning again, he initiated forward planning and led NASA in defining a "vision" and a long-range plan. That work led to the major Presidential Directive on Space signed by President Reagan in February 1988. It called for continuing strong science programs, leadership in aeronautics, support of commercial space programs, and the expansion of human presence in the solar system.

Concerned with the ongoing space station definition, Jim felt that it was vital to the future direction of space, but directed a reduction in its size. That action left room in the projected budgets for an ambitious growing space-science and Earth-observation program and a vigorous aeronautics program.

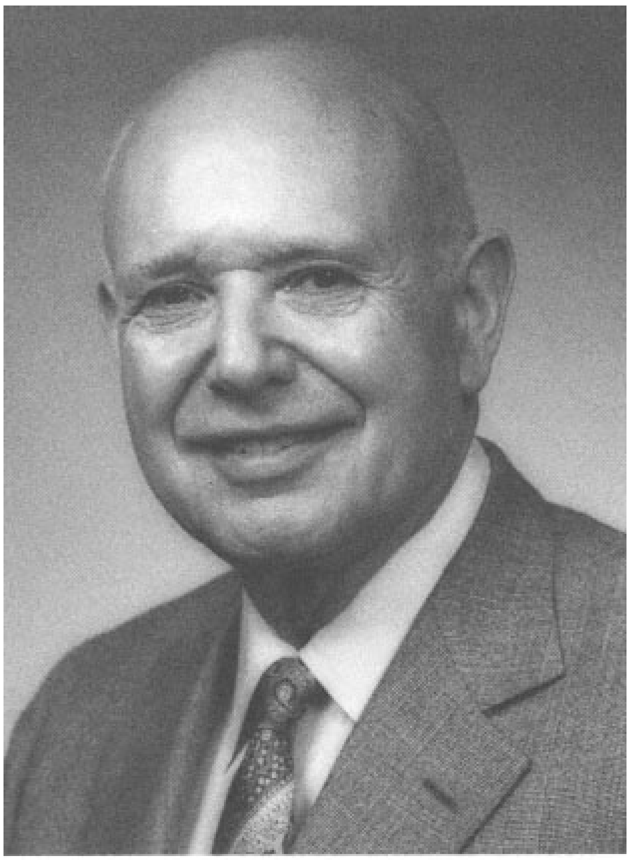
With the shuttle program recovered, and with organizational changes accomplished to improve safety and communications, Jim retired from NASA for the second time in April 1989. He returned to the University of Pittsburgh as Distinguished Public Service Professor and to his continuing service as adviser, board member, and committee member.

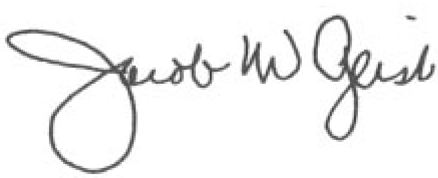
Jim would never admit to being a politician, but throughout his career his careful articulation of his views and his ability to argue logically his position resulted in reaching many important conclusions in the committees, businesses, and government activities in which he was constantly involved. Most of those activities were on the cutting edge of technology and made important contributions to defense or to the civil space program.

In the 1950s, for example, he contributed to the von Neumann committee that addressed the feasibility of intercontinental ballistic missiles. He made expert contributions concerning guidance. More recently, in early 1983 he led a committee doing the original architectural studies for technical evaluations, development planning, and the Space Defense Initiative (SDI) program. That study, initiated at the time President Reagan suggested the SDI, scoped and outlined the system configuration options and the research and development work that was required to move from concept to working system.

Jim Fletcher was a fellow of the Institute of Electrical and Electronics Engineers, the American Society of Arts and Sciences, the American Astronautical Society, and the American Institute of Aeronautics and Astronautics. He was in the first group to receive the Distinguished Alumni Award of the California Institute of Technology, and he held honorary degrees from several colleges and universities. He was awarded the United States Air Force Exceptional Civilian Service Medal, the NASA Distinguished Service Medal, and the American Defense Preparedness Association's Strategic Defense Award. In 1989 he was presented the prestigious Arthur M. Bueche Award for demonstrated statesmanship in the field of technology from the National Academy of Engineering. He was granted patents concerning sonar and missile guidance.

Jim Fletcher distinguished himself in every activity he undertook. He was always a leader, always the cool analyst, always seeking the best advice available, and at all times an aggressive, enthusiastic producer of results. His many contributions to the nation in defense and education, and to the world in civil space, will be permanent reminders of his dedication, intelligence, vision, and patriotism.





Jacob M. Geist

1921-1991

By P. L. Thibaut Brian

JACOB M. GEIST died on March 22, 1991, at the age of sixty-nine. Thus ended the brilliant career of a chemical engineer who made major contributions in the field of cryogenics.

Jack Geist's career included both academic and industrial experience, but his principal contributions were made during his twenty-seven years at Air Products and Chemicals, Inc. Dr. Geist was a prolific contributor to the company's development of processes for the separation of air and the liquefaction of its products, the production of liquid hydrogen and liquid helium, and the liquefaction of natural gas. He played a major role in the design of more than one hundred large-scale process plants embodying these technologies with total installed capital cost exceeding $1 billion. He was also a major contributor to process safety in the cryogenics industry, especially in the storage of liquefied natural gas.

Jack Geist was born on February 2, 1921, in Bridgeport, Connecticut. After attending Newark College of Engineering the first year, he attended Purdue University, graduating in 1940 with a B.S. degree in chemical engineering. He then entered Pennsylvania State University, where he received the M.S. degree in 1942. After spending the next year as an instructor in chemical engineering at Penn State, he took a position with Publicker Alcohol Company in July of 1944. Three months later he entered the U.S. Army as an enlisted man in the infantry and chemical warfare service. After attending Officer Candidate School, he reached the rank of second lieutenant in the chemical warfare service, assigned to Edgewood Arsenal. In February 1946, Jack was discharged from the Army and entered the University of Michigan to pursue his doctorate. It was here that he had the privilege of working intimately with Professor G. G. Brown, an experience that greatly influenced Jack's approach to engineering and engineering professionalism throughout his career. Jack finished up the work for his Ph.D. in chemical engineering at the University of Michigan in 1950 (the degree was granted in 1951) and joined the Chemical Engineering Department at Massachusetts Institute Technology, where he was an instructor and then assistant professor from 1950 to 1952. After spending the next three years as senior lecturer in chemical engineering at the Technion, Israel Institute of Technology, Jack returned to the United States and joined Air Products in November of 1955.

At that time Air Products was a fifteen-year-old start-up company in the industrial gas business, just beginning to experience success in developing its founder's concept of the on-site oxygen plant and to establish a position in the production and distribution of liquid oxygen and liquid nitrogen. Air Products had revenues of approximately $10 million, net income of approximately $800,000 and about 700 employees. During the next twenty-seven years, Air Products grew to become a major international industrial gas company with 1982 revenues of $1.5 billion, net income of $170 million, and almost 19,000 employees. Jack Geist was a major contributor to the technologies that fueled that growth.

Jack participated in all phases of the technology effort at Air Products. He had assignments in research and development, process engineering, plant start-up, and engineering technology development and assessment. Jack's education was in chemical engineering, but he had a flair for mechanical engineering and for equipment manufacturing, and he contributed many key ideas to these areas.

Jack's innovative contributions began almost immediately after his joining Air Products. As head of the technology diversification group in research and development, he used his heat transfer and mechanical engineering skills to develop the world's smallest cryogenic refrigerator. It was less than two inches in length, had a cool-down time of thirty seconds, and delivered 0.2 watts of refrigeration at liquid nitrogen temperatures. About 30,000 of them were sold to enhance the signal quality of infrared sensors, and this became a key product in the new Advanced Products Division of Air Products. Jack was at ease with both the production technicians and the research engineers.

Jack's most important contribution to Air Products was in the field of liquefied natural gas. When a new, proprietary propane precooled MCR™ process with its large coil-wound heat exchanger was developed by Air Products, Jack's contribution covered the range from the fundamental heat and mass transfer correlations used in the design of these heat exchangers to their mechanical integrity and manufacturing simplicity and to optimum plant operation in the field. The exchangers are the world's largest, some weighing in excess of two hundred tons, containing a thousand miles of tubing, and capable of liquefying up to three hundred million cubic feet of natural gas per day.

When one of the early liquefied natural gas (LNG) plants was installed in Brunei, Jack quickly recognized that although the plant met all guarantees, it did not meet its full potential. Working closely with the operators in the field and Ph.D. engineers in Allentown, Jack probed deeply into the process, the fundamental heat transfer and mass transfer, and the mechanical configurations of these exchangers. The result of his efforts was a 20 percent improvement in productivity for that particular plant, a greater insight into multicomponent, multiphase heat and mass transfer in these exchangers, and innovative design changes in the main cryogenic heat exchanger that led to significant cost reduction and simplification. His was a key contribution to Air Products achieving a 90 percent worldwide market share as a process licenser and heat exchanger supplier in the baseload LNG business. Concurrent with his efforts on the LNG process was his contribution to the safety of LNG storage and transportation. In collaboration with colleagues at Air Products, Jack became the definitive expert in LNG storage safety.

During his career at Air Products, the type of contributions that Jack made in LNG were repeated many times over in plants, such as air separation and liquefaction, hydrocarbon reforming, liquid hydrogen and helium production, and specialty gases manufacturing. He worked on innumerable plants in the United States, Western Europe, Latin America, and the Far East.

Jack Geist was an intellectual leader and a mentor. Through him many young engineers and scientists learned about plant and equipment design philosophy, safety philosophy, the importance of both plant experience and engineering fundamentals, and the importance of addressing new technology details right up front instead of after a problem occurs. He recruited and mentored many of the engineers who went on to form the backbone of the company's technology team. This speaks eloquently of Jack's greatest strength—that of a teacher.

In 1982 Jack took early retirement from Air Products and formed his own consulting firm, GeistTec, Geist Technology and Engineering Company. Air Products was one of his major consulting clients, but he also served a number of other companies with his expertise in process design and development and in engineering safety. He continued his active involvement in professional organizations such as the American Institute of Chemical Engineers, the International Institute of Refrigeration, and the international LNG conferences.

Dr. Geist's contributions to the engineering profession have been widely acclaimed. He was elected honorary fellow of the Indian Cryogenics Council in 1975 and was named Institute Laureate of the International Institute of Refrigeration. He received the Award in Chemical Engineering Practice given by the American Institute of Chemical Engineers (AIChE) in 1976, and AIChE also elected him a fellow in 1975. Dr. Geist was elected a member of the National Academy of Engineering in 1980, and he was elected a fellow of the American Association for the Advancement of Science in 1984. He received an Honorary Doctorate of Science from the Technion, Israel Institute of Technology, in 1987.

Jack Geist made a lasting impact on the cryogenics industry and on the chemical engineering profession. He will long be remembered and missed by his many friends and colleagues.

Milton Harris

1906-1991

By Alfred E. Brown

MITON HARRIS, chemist and retired vice-president for research at the Gillette Company, died of cancer on September 12, 1991, at the age of eighty-five.

Dr. Harris was born on March 21, 1906, in Los Angeles, California, but grew up in Portland, Oregon. He received a B.Sc. in 1926 at Oregon State University and then attended Yale University, where he received a Ph.D. in 1929.

The accomplishments of the ebullient Dr. Harris were legion. During his lifetime, he rendered outstanding service in five areas: pure and applied sciences, industrial research and development, professional society activities, government and public service, and academic activities. To these areas, Dr. Harris brought his enviable energy and optimism. In addition, many people sought his counsel.

His career began in 1931 as a research associate at the National Bureau of Standards, where his early work was in basic research. In 1938 as director of research of a textile industry research group, he moved into industrial research. Here, shrink-proof wool was developed for the Army and cited by the Army Quartermaster General as having saved the Army several hundred million dollars during World War II. Dr. Harris was also involved in engineering clothing for extreme climatic conditions, and he modified fabrics to make them selectively water repellent, flameproof, rot proof, radiation-resistant, and resistant to chemical warfare agents.

In 1945, at the end of the war, numerous industrial people who had worked with Dr. Harris suggested that he organize a consulting laboratory. He assembled a small group of scientists and founded Harris Research Laboratories. This was a very successful organization, which was acquired by the Gillette Company in 1956.

During his industrial research and development activities as vice-president for research at Gillette, many innovations took place, such as polymer-coated blades that dramatically reduced the cutting force in shaving and made obsolete all prior shaving systems. He was also involved in improving ballpoint writing products.

During these research years, Dr. Harris was very active in professional society activities. He became a member of the American Chemical Society (ACS) in 1931 and served there in various capacities before being named chairman of the board in 1966, a position he held for six years. He continued to serve the ACS until his death.

Dr. Harris was also active in many other scientific and professional societies, both inside and outside the United States. He was president of the American Institute of Chemists in 1960 and chairman of its board of directors. He served on numerous advisory boards such as those of *Science, Textile Research Journal,* and *the Journal of Polymer Science.* In addition to his government service in active research, Dr. Harris also served as chairman of the White House Committee on Civilian Technology in 1961-1962, as consultant to the White House Office of Science and Technology (1962-1965), and as a member of the President's Panel on the Environment (1968-1972).

Dr. Harris was elected to the National Academy of Engineering in 1976 and was a member of its Finance Committee for a six-year term beginning July 1987. He was active in the Panel of Jojoba and several other National Research Council (NRC) committees. He supported the NRC financially as a major benefactor for the Milton Harris Building at the NRC Georgetown facility.

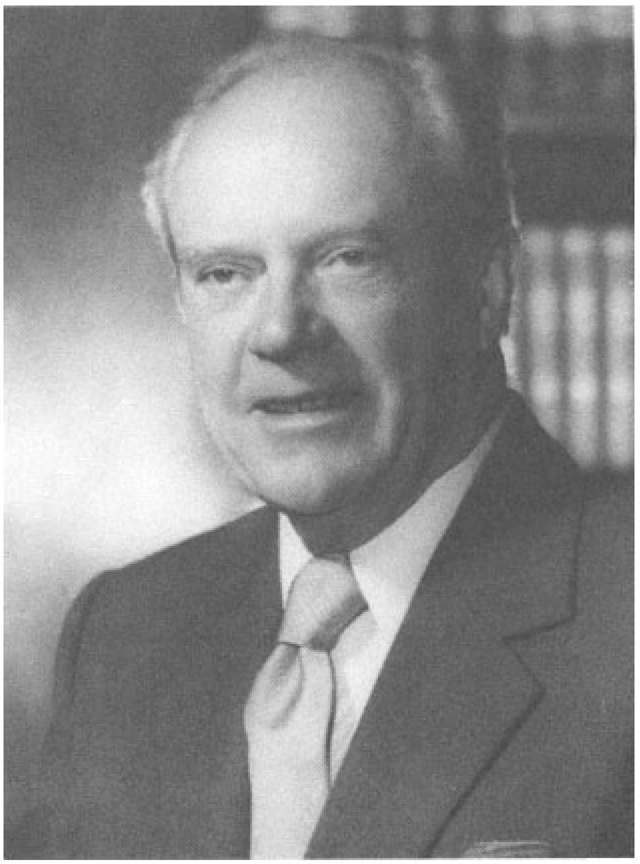
Dr. Harris often spoke of the interrelationship among industry, government, and academia and of his activities in nurturing this relationship. Milton gave his time, expertise, and wisdom to several universities, including his alma maters. In 1967 Oregon State honored him with the Oregon State University Distinguished Service Award. From 1961 to 1967 he was president of Yale Chemists' Association and active in several Yale bodies. For these contributions Yale conferred on him the Yale Medal and the Wilbur Lucius Cross Medal. Dr. Harris established chairs in chemistry at Yale and also the first chair in chemistry at Oregon State. In addition, he provided scholarships at both of these universities as well as at American University where he was active in the chemistry department.

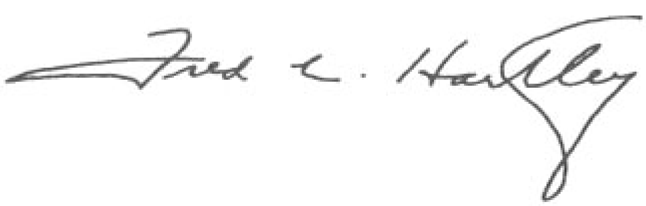
Dr. Harris received numerous awards and other special recognition. He received the Priestley Medal, the highest award given by the American Chemical Society; the Washington Academy of Sciences Award; the Naval Ordnance Development Award; the Perkin Medal; the Honorary Fellow Award of the American Institute of Chemists; the Olney Medal; and the Harold DeWitt Smith Memorial Award.

Dr. Harris was a member of the Cosmos Club and the Chemists Club of New York. He was a prolific author, having published over two hundred scientific publications. He was also issued thirty-five patents.

I had a wonderful relationship with Milton Harris for forty-seven years, and I worked closely with him at Harris Research Laboratories in technical and other activities for twenty-one of those years. He was a most enthusiastic leader and had an unlimited capacity for friendship.

Finally, I do want to mention his great interest in advising and helping people. For career advice, scientific direction, or guidance in financial matters, he was always available. Above all else, Milton remained throughout his busy life a devoted family man. His wife of fifty-seven years, Carolyn, was ever the object of his solicitous concern, and he was a dear father of his two sons.





Fred L. Hartley

1917-1990

By John R. Kiely

WHEN HE DIED in 1990, Fred L. Hartley, chairman emeritus of Unocal Corporation, was praised as a creative engineer, an executive of vision, and a man of great integrity. His passing on October 19 was just two days after the one-hundredth anniversary of the founding of the company he led for a quarter of a century. In that time, he transformed Unocal from a small, regional oil operation to an international energy resources company.

Hartley was born in Vancouver, British Columbia, on January 16, 1917. He attended grade school and high school in Vancouver and then the University of British Columbia. He graduated in 1939 with a degree of bachelor of applied science in chemical engineering.

Fred worked much of his way through college. For the first two summers, he was a dishwasher and then a steward on a Canadian cruise ship running between Vancouver and Skagway, Alaska. He spent a third summer with a five-man survey party in the wilds of the Yukon, and his last summer in college, he worked as a draftsman for Standard Oil Company of California's Canadian subsidiary.

Unocal recruited Fred while he was in college. In 1939, immediately after graduation, he was on his way to the Unocal refinery at Oleum, near San Francisco. Hartley often recounted the surprise on the face of the Union Oil employee assigned to meet the new recruit when he stepped down from the train wearing a suit with a vest and a flat-topped straw hat.

He started at the very bottom. His first few months were spent chipping rock-hard residue from the bottoms of furnace stacks. Within in a few months, he was promoted to junior research engineer at the Los Angeles refinery, and he was on his way.

The next year, 1940, Fred's college sweetheart, Peggy Murphy, graduated with a degree in physics. She came to California in November, and they were married. Their children, Marnie and Jack, were born in 1956 and 1958.

Two things that characterized Hartley's career at Unocal were his enthusiasm for what he was doing and his vision of what technology and hard work could accomplish. In 1990 Unocal published a book celebrating its first one hundred years. The chapter covering Hartley's twenty-four years at the helm is entitled "Fred L. Hartley, Visionary Engineer."

As the war years approached, Fred moved up the corporate ladder. By World War II he was totally involved in working on the design of plants for the manufacture of aviation gasoline and toluene for explosives. Both the American and Canadian armies decided that he could be of most value continuing what he was doing at Unocal.

By the summer of 1942, at the age of twenty-five, Hartley was put in charge of the hydroformer's start-up at the Oleum Refinery. As he told it, "I just sort of fell into the job as the key man doing the initial work on the plant with the contractors. Having operated the pilot plant, I probably was one of the best informed men around to operate the commercial one." In 1944 he moved up to the headquarters office as manufacturing process supervisor in charge of process engineering design for all of Unocal's new plants. In 1950, at age thirty-three, he became general superintendent at the Los Angeles refinery.

In 1953 Hartley was transferred to the research department in Brea, California, where one of his activities was the sale and licensing of Unocal technology to other companies. He was also actively involved in two of Unocal's key developments. The first was called Unifining, where cobalt molybdenum catalysts were extensively tested and found effective as a means of removing poisonous sulfur and nitrogen compounds from naphthas, straight run gas oil, and catalytic gas oils. Several hundred plants were constructed as a result, and licensing income surged. In 1955 he became a corporate vice-president in charge of all of Unocal's research.

In 1958 Unocal initiated the revolutionary development of hydrocracking, called Unicracking, which is in use by refineries around the world. The process made use of new materials called molecular sieves, which as catalysts caused hydrogen to react with petroleum distillate feed stocks to produce gasoline in yields of 115 or 120 volume percent of feed. By 1990 there were sixty-five Unicracking plants around the world, and well over 60 percent of the world's installed hydrocracking facilities were using the Unocal developed technology.

In 1960 he became senior vice-president, marketing, and was elected to the board of directors. Two years later he became senior vice-president both for marketing and for all refining. In 1963 Hartley became executive vice-president. In 1964, at the age of forty-eight, he became president and chief executive officer of Unocal, and in 1974 chairman of the board.

By 1964 Hartley had developed a firm opinion that Unocal needed to grow from a small company in the Western region to a large national company if it was to survive. As soon as he became chief executive officer he moved aggressively to accomplish this growth. Meanwhile the Pure Oil Company, headquartered in the Midwest, had come under attack by raiders and was vulnerable to takeover attempts. In late 1964 Milligan of Pure Oil and Hartley of Unocal developed an outline for a merger. The merger was consummated by mid-1965. Thus, Unocal became twice as big with markets on both sides of the Rockies. This was the biggest oil company merger up to that time.

Six months later, Hartley announced the formation of the Unocal International Oil and Gas Division. Only one year after he became chief executive officer, he had transformed the company from a small regional company to a national company with a growing international presence.

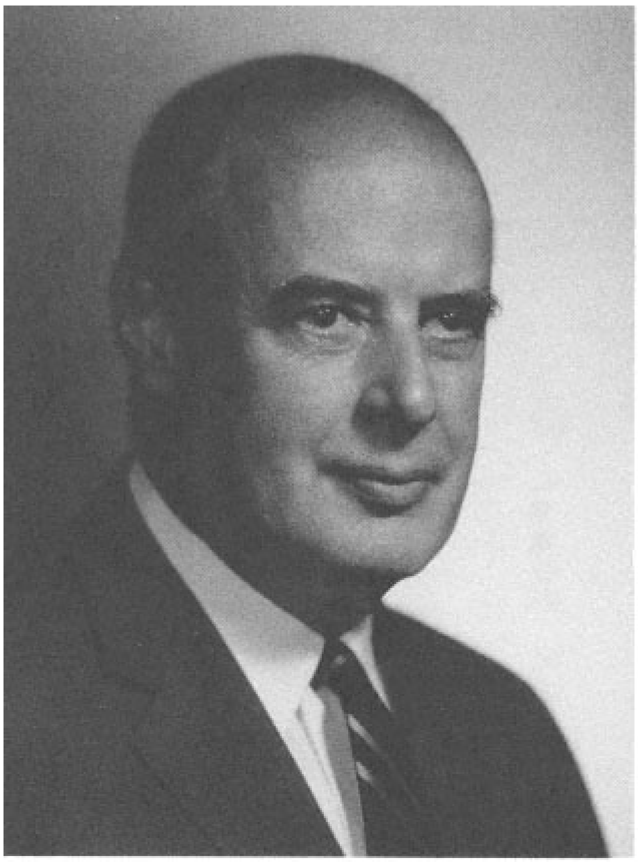
Hartley also took a keen interest in the development of geothermal energy and in oil from shale. His college thesis had been on shale oil. Unocal became the largest producer of geothermal energy in the world. Unocal also built the nation's first commercial shale oil facility, which produced nearly 4.5 million barrels of synthetic crude during its five years of operation. But oil and gas prices would need to rise substantially for oil from shale to be competitive.

Hartley's most difficult time came when T. Boone Pickens, a well-known corporate raider, tried to take control of Unocal using a combination of large debt and junk bonds. Unocal won out, but it did so at a heavy price.

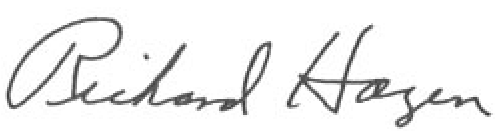
Hartley was an honorary director and former chairman of the American Petroleum Institute. He was a fellow of the American Institute of Chemists and the American Institute of Chemical Engineers. He was a member of the American Chemical Society and the Society of Automotive Engineers. He was also a director and former president of the California Chamber of Commerce, as well as being active in many other civic organizations. He served as a senior trustee of the California Institute of Technology and a trustee of the Committee for Economic Development, and was a member of the Conference Board. He was elected to the National Academy of Engineering in 1980. Hartley was also involved in three patents, and published many articles on the various aspects of the oil business and on civic affairs.

Hartley was active in many cultural affairs. He served as a vice-president and trustee of both the Southwest Museum and the California Museum of Science and Industry, a director of the Los Angeles Philharmonic Association, a life trustee of the board of governors of the Music Center of Los Angeles County, and a member of the board of overseers of the Huntington Library.

On a more personal side, Fred was very fond of music and singing. He could sit down at the piano and play from memory for hours without stopping. He liked nothing more than an evening spent with friends or at company gatherings, playing the piano and singing songs. He had a great sense of humor and was pleasant to spend an evening with. He never hesitated to give his opinion on subjects that he felt strongly about, as all who knew him will agree.



Photograph by Fabian Bachrach.



Richard Hazen

1911-1990

By Daniel A. Okun

RICHARD HAZEN, a consulting engineer involved in the planning and design of water supply and wastewater disposal projects in the United States and around the world, died on February 12, 1990, in Dobbs Ferry, New York, where he had been born.

A son of the distinguished consulting engineer Allen Hazen, a pioneer in the water field, Dick Hazen was cofounder of the New York City environmental engineering consulting firm Hazen and Sawyer in 1951. He had studied at Dartmouth College, where he earned a B.A. in history in 1932. Intending originally to go on to business school at Harvard, he wondered whether he should go into engineering. A Dartmouth trustee advised, "With your name, you surely should!" Dick graduated with a civil engineering degree from Columbia University in 1934 and then went to work for the West Virginia Pulp and Paper Co. He left after two years to study sanitary engineering at Harvard under Professor Gordon Fair, earning an M.S. degree in 1937.

Dick began his consulting career immediately upon leaving Harvard, going to work for Malcolm Pirnie, an engineer who had been with the Hazen and Whipple firm and taken over its responsibilities on Allen Hazen's death. With the onset of World War II, he joined the Civil Engineer Corps of the U.S. Navy, where he was involved in the construction of the Sampson Naval Training Station in New York State and then became responsible for the planning, operation, and maintenance of water-related facilities at naval stations in the southeastern part of the United States. After the war, he rejoined Malcolm Pirnie as a partner. (The author of this memorial served as a neophyte consulting engineer under Richard Hazen at this time.)

In 1951 with another Pirnie engineer, Alfred W. Sawyer, the firm of Hazen and Sawyer was founded. It grew to be one of the most prestigious consulting firms in the United States in water-related consulting and engineering, with a staff of more than 160 in six offices when Dick formally retired in 1981. He remained active in "retirement," and ten years later Hazen and Sawyer had grown to some 500 staff members in twelve offices.

Known throughout the profession as an "engineer's engineer," Dick never gave up his commitment to engineering being involved in the technical aspects of every project with which he was associated. He studied the maps, made the calculations, wrote the reports (or reviewed the writings of others with a heavy hand), and trod the project sites in all kinds of weather to the end of his career. He never succumbed to being only a manager and never perceived his engineering firm to be a "business." He was opposed to competitive bidding for professional engineering services: "The quality of professional services is rarely amenable to specification or contract, especially in the planning and design of facilities; . . . the least expensive engineering often proves to be the most costly."

Dick Hazen's professional impact was widespread. Registered in seventeen states, he was personally responsible for major water supply and sewerage projects in Venezuela, Liberia, Saudia Arabia, Nicaragua, Brazil, Kuwait, Vietnam, and Ecuador. After initially being engaged as an engineer by a client, the quality of his work earned him repeated projects with the same client. An example was Greensboro, North Carolina, where he was first brought in to make a rate study and was thereafter retained to design three dams, two water treatment plants, and two wastewater treatment plants. His projects included a field study for filtration of water from the first major water system for the City of New York, the Croton, which Allen Hazen had recommended be done in 1900; design of the water supply and treatment system for the Detroit Metropolitan region; and water supplies or wastewater treatment projects for Charleston, South Carolina; Washington, D.C.; Philadelphia; Springfield, Massachusetts; and Oneida County, New York, among others. He served as a principal witness for the Great Lakes states in the Chicago-Lake Michigan water diversion case and designed water-related facilities for industry throughout the United States, including those for the New York World's Fair in 1964-1965.

Dick Hazen used his "free" time for studying and writing. He toured Europe, as his father had done, and wrote of European practices for the benefit of American engineers. He wrote journal articles and chapters in handbooks and maintained an interest in the technical developments in his field.

Dick also served the profession directly. Elected to the National Academy of Engineering in 1974, he served the National Research Council from 1977 to 1980 and again in 1982-1984 as a member of the committee appointed to review the Corps of Engineers Metropolitan Washington Area Water Supply Study. The respect in which he was held in the profession is attested to by his election to the presidencies of the American Institute of Consulting Engineers and the Metropolitan (New York) Section of the American Society of Civil Engineers (ASCE), and to honorary membership in the ASCE and the American Water Works Association. He had also served as director and chairman of the Publications Committee of the American Water Works Association.

Education was always been important to Richard Hazen. He gave courses over a three-year period (1938-1940) at Columbia University and took a sabbatical from his office for one semester in 1968 to teach a special graduate course in water supply for engineers from throughout the world at the University of North Carolina at Chapel Hill. (While there, Chapel Hill suffered a severe water shortage, and the university, which then owned the water system, engaged Hazen and Sawyer to address the problem. The dam and Cane Creek reservoir, designed by Hazen and Sawyer, were placed in operation shortly before Dick's death.)

His interest in engineering education was profound but, unfortunately, ahead of his time. He believed strongly that engineers today cannot be expected to be educated in four years, especially if they are to serve in helping make public policy with much better educated lawyers and planners. "The world has become so complex that much more is expected of the engineer, " he wrote. "Engineers must play a larger role in society than previously and be familiar with a wide range of subjects and ideas. That cannot all be accomplished in four years." Liberal arts courses designed for engineers are not enough; much more important in their education is the association with students from other walks of life "even if they do not think like engineers." Engineers need to be educated as well as trained.

Dick appreciated that the quality of education, and the capacity to learn at the university and in life, is heavily dependent on the quality of the experience in grade school and high school. His six years on the Dobbs Ferry school board affected his approach to education generally and to children in particular, the latter leading him to become president of the school board of Children's Village, a home for emotionally disturbed boys in Dobbs Ferry.

Richard Hazen had been the husband of the late Elizabeth Shute; father of daughters Putnam Gorman and Molly Hazen Gillam and son, the late Richard (Chris) Hazen, Jr.; and grandfather of Mary Gorman, Timothy Gillam, Jonathan Gillam, and Richard Hazen III. His name will live on in his works and in his family.

Edward H. Heinemann

1908-1991

Written By Donald Douglas, Jr., And Harry Gann

Submitted By The Nae Home Secretary

THE DISTINGUISHED CAREER of Edward H. Heinemann has provided significant and lasting contributions to the advancement of aircraft and associated equipment design. A high school graduate who became a self-taught engineer, Mr. Heinemann started with the Douglas Aircraft Company in 1926. In 1927, at the age of nineteen, he became the chief draftsman for the International Aircraft Company. In 1928 he joined the Moreland Aircraft Company as the assistant chief engineer, later advancing to the position of chief engineer. In September 1930, he moved to the Northrop Aviation Corporation of Burbank, California. When a new Northrop Corporation was formed in 1932, which was a part of the Douglas Aircraft Company holdings, he became affiliated with that organization, rising to the position of chief engineer in 1936 at the age of twenty-seven. In 1958 he was appointed vice-president, military aircraft engineering. He left the Douglas organization in 1960 to become executive vice-president of Guidance Technology, Inc. In 1962 he joined General Dynamics as corporate vice-president of engineering, retiring from that position in 1973.

More than 20,000 aircraft have been built from Edward Heinemann's designs. He designed the first carrier-based aircraft (the F4D Skyray) to set the world's absolute speed record, for which he received the prestigious Robert J. Collier Trophy in 1954. His D-558-II Skyrocket was the first aircraft to exceed

Mach 2, or twice the speed of sound. This line of aircraft was especially cost-effective in the research programs that contributed to the progress of technology after World War II, pushing aircraft through the so-called sound barrier.

He is especially well known for his line of attack aircraft, beginning with the legendary SBD Dauntless. This dive bomber sank more enemy tonnage in the war in the Pacific than any other weapon and was exceptionally effective at the Battle of Midway, where four aircraft carriers were sent to the bottom of the ocean, thus blunting the eastern drive of the Japanese. The AD Skyraiders, the A3D Skywarriers, and the diminutive A4D Skyhawk were the first-line equipment in the U.S. Navy and Marine Corps for forty-five years—exemplary of Edward Heinemann's intuition of future requirements and his ability to design aircraft to meet these requirements. For example Mr. Heinemann anticipated that the Skywarrier, a carry-based heavy attack bomber, would need to work off a smaller aircraft carrier than was originally intended, and he designed the aircraft to meet this challenge.

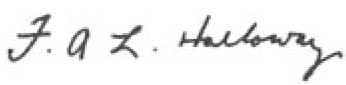
The A-4 Skyhawk is probably his best-known aircraft today and the culmination of his experience in dealing with the special requirements of ship-based aircraft. Also supplied in an advanced trainer version, the Skyhawk has been flown by every current tactical jet fixed-wing pilot in the U.S. Navy and Marine Corps.

Almost 7,500 A-20/DB-7 and 2,500 A-26 twin-engine attack bombers of his design were built for the Allied forces of World War II. The A-20/DB-7s were available to the Allied forces at their entry into World War II and greatly contributed to the holding of the Axis powers before the entry of the United States into the war. Many of the A-26s were converted to high-speed commercial business transports after World War II, whereas the military versions continued to be used in the Vietnam War.

Edward H. Heinemann's ability to design lightweight, innovative, cost-effective aircraft without sacrificing capability has enabled U.S. military forces to more adequately perform their required missions. As a result of the superior basic design, these aircraft have been able to operate over long periods of time and in a diversity of missions, and in some cases, exceeding the life of the aircraft designed to succeed them. Mr. Heinemann also produced associated aircraft equipment, such as inflight refueling stores, ejection seats, streamlined stores, bombracks, and special ordnance, which have become standard items on other manufacturers' aircraft.

Mr. Heinemann's list of awards is long and distinguished. It includes—in addition to the Robert J. Collier Trophy—the National Medal of Science, honorary fellow in the Royal Aeronautical Society, the Guggenheim Medal, the United States Navy Distinguished Public Service Award, and many others. He is also enshrined in several aviation halls of fame established throughout the United States.

Edward Heinemann's illustrious career ended when he died on November 26, 1991, at the age of eighty-three. He will be long remembered for the number of aircraft designed by his team and the crews that operated them.



Frederic A. L. Holloway

1914-1990

By J. F. Mathis

FREDERIC ANCRUM LORD HOLLOWAY, former vice-president of science and technology for Exxon Corporation, died on November 30, 1990, at the age of seventy-six.

Fred was born in 1914, in Lumberton, North Carolina, to Elisha Andrew Holloway and Cammie Anderson (Lord). He graduated from the Georgia Institute of Technology in 1935 with a bachelor of science degree in chemical engineering. In 1939 he completed the doctor of science program in chemical engineering at the Massachusetts Institute of Technology. In 1941 he married May Bolling Cross. They had four children.

He was elected to the National Academy of Engineering (NAE) in 1965 in the Academy's second election, the first after its formation. He believed in being active. In a letter to President Eric A. Walker in 1966 he said, "It has been my feeling for some time that if the NAE is to fulfill its objectives, there must be a serious intent [for a member] to devote some time to service. As a matter of fact, I feel this should be one of the requirements for membership.... As far as my personal position is concerned, I would be happy to devote a reasonable number of days ... each year...

The NAE took him at his word. From 1966 to 1972 he served on the NAE Committee on Public Engineering Policy. Then until 1975 he served on the Committee on Environmental Engineering, which was organized under the NAE and later became part of the Assembly of Engineering, National Research Council (NRC). In 1971 he was elected to the NAE Council, and from 1971 to 1975 and from 1977 to 1986 he served on its Executive Committee. He was elected treasurer in 1977 and served two successive terms. It is clear that Fred made a major, positive impact on the affairs of the Academy. He also served from 1971 to 1985 on the Governing Board of the NRC.

In addition, Fred was vice-chairman and chairman of the American Section of the Society of Chemical Industry (London) in 1970-1971. He belonged to numerous professional societies and was honored by Georgia Tech and Stevens Institute of Technology.

Fred's entire business career was with Exxon, spanning the period from pre-World War II until after the Arab oil crisis in the 1970s. He was an expert in refining petroleum and saw Exxon's refinery operations grow from a small base in the United States to a worldwide operation. This was a very exciting period in the history of the oil business and Exxon, and Fred played a key role throughout it.

Fred joined the Exxon refinery at Baton Rouge, Louisiana, as a process engineer in 1939, just as World War II was breaking out. The United States could see that before long it would be involved, and petroleum production for military purposes would be strained to the utmost. It was also a period in which revolutionary new refining technologies were being introduced. Fred was in the thick of all this. Three key process patents bear his name. Exxon's new fluidized catalytic cracking process was first started up at Baton Rouge in 1941; it eventually became the industry's standard process to convert heavy liquids to gasoline. Fred worked on that. Aviation gasoline components were at a premium; a cold acid dimerization process was quickly thrown into operation in Baton Rouge. Fred worked on that too. It is fair to say that Fred, along with his colleagues in Exxon and other U.S. refineries, had a direct hand in helping the allies win the war.

By 1953 Fred had become general superintendent of the Baton Rouge refinery, a lofty position for a young man of thirty-nine. Two years later he was posted to New Jersey to the head quarters of Esso Standard Oil Company, which owned and operated the Baton Rouge and several other East Coast refineries. When Exxon U.S.A. was formed in 1961 from Esso Standard, Humble Oil, and other companies, Fred moved to Houston to become its first vice-president for manufacturing planning. Just a year later he was sent to the parent Exxon Corporation in New York to serve as deputy refining coordinator for Exxon's refining operations all over the world. In all these assignments Fred honed his considerable management and analytical skills, investing in operations that made sense and cutting out those that did not meet his rigorous standards.

Until 1964 Fred had only peripheral involvement with Exxon's refining research activity, the Exxon Research and Engineering Company (ER&E). Eger V. Merphree was ER&E's charismatic and innovative president through the 1950s. After he died Exxon decided to insert someone with operating experience into the job to build a better bridge between the research and business communities; it was almost inevitable that they eventually chose Fred. The veteran ER&E researchers were considerably concerned over Exxon's bringing in a tough, demanding businessman to run the company. However, before Fred's tenure was over in 1968, he had gained their undying respect. ER&E was prospering as never before. For example, major programs in environmental engineering and computer science were created. But the thing that pleased the researchers most was that Fred started the Corporate Research Laboratories (CRL) to conduct basic science in technical fields of intrinsic interest to Exxon and to market the inventions. He in effect was gambling that the inventions would be used and would pay off. Not all, but many did, and CRL still exists today.

Fred spent the last decade of his career in Exxon's headquarters, dividing his time about evenly between heading the corporate planning department and the science and technology department. This was the period in which the Organization of Petroleum Exporting Countries (OPEC) cartel caused the price of oil to quintuple and long lines to form at America's service stations. It was during the "Energy Crisis" that Fred caused Exxon to invest in massive programs on synthetic fuels and other alternate energy sources. Major research and development efforts were unleashed on coal liquefaction, coal gasification, shale oil production and refining, advanced batteries, solar cells, and so on. While none of these technologies was put to use in his lifetime, it is entirely possible that they or their second-generation variants will return in the years to come.

After his retirement from Exxon, and to no one's surprise, Fred remained active in the NAE and the business community. He was a director of the Gulf States Utilities Company and advisory director of the Construction Specialties Company. He was an enthusiastic golfer and belonged to a number of major country clubs.

More so than most people, Fred had two sides. One was his public side—a tough, demanding, logical, and somewhat aloof side that instilled respect in all and fear in some. The other was a soft, warm, and personal side he rarely exposed to the public because basically he was a shy person. I'll never forget his saying to me in private, "I'd give anything to be able to tell a joke." Well, jokes or not, nearly everyone who knew Fred both respected him and liked him very much. He was a first-rate engineer and businessman, and a fine father and man.

Photograph by Fabian Bachrach.

Marshall G. Holloway

1912-1991

Written By Raemer E. Schreiber

Submitted By The Nae Home Secretary

MARSHALL G. HOLLOWAY, pioneer in nuclear weapon development, died in Winterhaven, Florida, on June 18, 1991, after a lengthy illness. He was seventy-eight years old. His career included academic research at Cornell University, research and program management at the Los Alamos Scientific Laboratory (LASL), and senior management positions in industrial laboratories. He was elected to membership in the National Academy of Engineering in April 1967.

Marshall was born in Oklahoma, but his family moved to Florida a few years later, so Marshall's schooling through college was in Florida. He earned his bachelor's degree from the University of Florida in 1933 and a master's degree in physics two years later. He was then accepted into graduate school at Cornell University and received his Ph.D. in physics in 1938. He remained there as a research associate until 1942, when he was selected to head up a secret project using the cyclotron in the physics department at Purdue University.

The Purdue assignment was the measurement of the cross-section of tritons colliding with deuterons and fusing to form helium—vital data for the study of the feasibility of thermonuclear energy production and thermonuclear explosives. The work was funded by the Manhattan District of the U.S. Army Corps of Engineers and was completed in the early fall of 1943.

The Purdue team was invited to join the Manhattan District laboratory known then as Site Y (somewhere in New Mexico) and later known as the Los Alamos Scientific (now Los Alamos National) Laboratory. Marshall and his colleagues became part of the group that designed and built the "Water Boiler," a miniature nuclear water boiler fueled with U-235, uranium of atomic weight 235, which had been separated from the much more abundant 238 isotope at Oak Ridge. A few hundred grams of this enriched uranium in an aqueous solution achieved a "critical mass" or self-sustaining nuclear reaction and provided experimental data to supplement the theoretical calculation concerning such phenomena. The Water Boiler "went critical" in May 1944 and contained essentially the entire world supply of enriched uranium at that time, although the pipeline was filling up rapidly.

During the remainder of 1944, Marshall was involved in a series of experiments to measure the critical mass of various combinations of enriched uranium and reflector materials and, later, similar measurements with plutonium. This work led him into the design of the nuclear components and the loading techniques of the "Fat Man," the implosion system tested at Trinity Site in July 1945 and dropped on Nagasaki in early August.

In the spring and summer of 1946, the U.S. Navy sponsored an elaborate nuclear bomb effects test, Operation Crossroads, at the Bikini Atoll. An array of ships, submarines, and other armaments was subjected to an air drop and an underwater explosion of the "Fat Man" device. LASL was responsible for providing and preparing the explosives and for providing or specifying much of the nuclear effects instrumentation. Marshall was designated as the LASL field representative and was deputy scientific director of the operation.

During the next several years, Marshall was in charge of the division responsible for implementing and testing improvements in nuclear weapons design, developing stockpiling procedures, and training nuclear military officers. During this period, nuclear testing of experimental devices was initiated at the Pacific Proving Grounds headquartered in Eniwetok Atoll and smaller scale testing at the Nevada Test Site.

The feasibility and advisability of developing a thermonuclear "Super" bomb had been debated intermittently at top national policy levels since the end of World War II. The cold war with the USSR was a powerful stimulant. Finally, in the fall of 1951, LASL was directed by the Atomic Energy Commission (AEC) to proceed as rapidly as possible with the design, fabrication, and testing of a thermonuclear explosive device. This was a formidable assignment involving the design and fabrication of unusual materials on a very large scale. Marshall was placed in charge of the operation by LASL Director Norris Bradbury. Other AEC laboratories and industrial contractors were called on for help, and LASL was placed on an extended work week. The program was started on November 1, 1951, with a target of a full-scale test within a year. On November 1, 1952, "Mike" was detonated and one of the islands of the Eniwetok Atoll disappeared.

"Mike" was not a thermonuclear weapon but was a monstrously over-designed device to show whether an explosive thermonuclear reaction could be achieved. It obviously could be achieved, so the LASL team was kept busy over the next several years designing and testing weaponized versions based on the "Mike" results.

In 1955 Marshall was chosen as the director of the Lincoln Laboratory of MIT and spent the next two years there administering research related to air defense. The focus of work there involved computers, radar, and solid-state physics.

Later, Marshall transferred to ACF Industries to head up the Nuclear Products-Erco Division, a research and development organization that operated an AEC weapons complex and also was engaged in nuclear reactor development.

Marshall's last professional assignment was as vice-president, research, for the Budd Company in Philadelphia. His duties there involved development of new technology and troubleshooting throughout the company. He remained in this position from 1967 to 1969 and then retired to Jupiter, Florida, where he was active in community affairs for a considerable time.

Marshall and his wife, Harriet, later moved to Winter Haven, Florida, to be near their son, Jerry, a retired U.S. Air Force officer. Both Marshall and Harriet are now deceased.

In addition to his membership in the National Academy of Engineering, Marshall was elected a fellow of the American Physical Society and a fellow of the American Nuclear Society. He did little writing for technical journals since most of his professional career involved work classified by the AEC as restricted data or company confidential work for corporations.

Marshall received little public recognition for what was probably his most challenging assignment: project leader for the gigantic task of designing, building, and testing the "Mike" thermonuclear device in a one-year period. He was given unlimited authority and used it wisely. He relied heavily on team leaders from the several laboratories and engineering firms that were involved, but scheduling conflicts and interface problems were his to solve—often on very short notice. In spite of the remarkable success of the "Mike" operation, Marshall remained almost anonymous except to his colleagues.

Grace Murray Hopper

1906-1992

Written By Gordon R. Nagler

Submitted By The Nae Home Secretary

REAR ADMIRAL GRACE MURRAY HOPPER, USNR (retired), a legend in her own time, died January 1, 1992, at the age of eighty-five. She was buried at Arlington National Cemetery with full military honors, as befitted an individual who believed that having the privilege and responsibility to serve her country as a naval officer was the highest possible honor she could receive.

Grace Brewster Murray was born on December 9, 1906, in New York, New York. (She claimed as her second home town, Wolfeboro, New Hampshire, which she first visited in the summer of 1907.) Her parents always encouraged her insatiable curiosity. In 1928, a time when most young women who graduated from college became school teachers, Grace graduated from Vassar College, Phi Beta Kappa, with degrees in mathematics and physics and a Vassar College fellowship. In 1930 she married Vincent Foster Hopper. They had no children and were divorced in 1945.

From Yale University she received an M.A. in 1930 and a Ph.D. in 1934, together with election to Sigma Xi and two Sterling Scholarships. She returned to Vassar as a mathematics assistant in 1931, and she successively became an instructor, assistant professor, and associate professor. She received a Vassar faculty fellowship and studied at New York University in 1941-1942, and the following year became an assistant professor of mathematics at Barnard College.

In 1944 she started her long love affair with the United States Navy when she was commissioned a lieutenant (junior grade) in the U.S. Naval Reserve. She was ordered to the Bureau of Ordnance Computation Project at Harvard University. It was here that she met her "destiny" and commenced work on the first large digital computer, the Mark I. She was very proud of the fact that she was the world's third programmer, or "coder" as they were then called. In 1946 she left active duty in the U.S. Naval Reserve because she was "too old" to apply for the regular Navy, at age forty!

She joined the Harvard faculty as a research fellow in engineering sciences and applied physics in 1946, when the Computation Laboratory was working on the Mark II and Mark III computers.

In 1949 the fledgling corporation of Eckert-Mauchly Computers was involved with building the first UNIVAC, and Grace joined as a senior mathematician. She remained with that corporation and its successors, Remington Rand and Sperry Corporation, until she retired in 1971.

In 1966 Commander Hopper retired from the U.S. Naval Reserve, having reached the age of sixty. Within the year she was recalled from her company to active duty to help impose a standard on the U.S. Navy's many computer languages. Because of her retired reserve status, she was not eligible for promotion, and the chief of the Bureau of Naval Personnel could only extend her active duty one year at a time. On August 2, 1973, through a special act of Congress, she was promoted to captain, USNR (retired). When Admiral Rickover left active duty in 1982, she became the oldest naval officer serving on active duty. She constantly noted this distinction with pride. Through the intervention of John Lehman, then secretary of the navy, President Reagan made a special presidential appointment of Grace to commodore on November 8, 1983. (The rank of commodore was changed back to the title of rear admiral in 1985.) At the age of seventy-nine she retired from active duty for the last time on August 14, 1986, on board the USS *Constitution—the* oldest naval officer on active duty aboard the oldest warship in commission.

During her distinguished navy career she received numerous honors, citations, and awards, including the Navy Distinguished Service Medal and the Legion of Merit.

Immediately upon her retirement from the U.S. Navy, she went to work for Digital Equipment Corporation as a senior consultant and was an active participant until she died.

Grace Hopper was known for many achievements. In fact, Charles H. Doersam, Jr., a member of an early small group of computer people, circa 1950, reported that Grace, the only woman in this group, once caused quite a stir when she rose to a podium and declared, "I've been coming to these meetings for some time now and listening to all of you men tell me about your fine hardware, and I think it's about time I tell you about my 'software."' This was an early use of the term "software," now an integral part of our daily lexicon. This example typifies Grace Hopper—she told you what she believed, whether you were ready to hear it or not.

One of the few areas in which she would accept any credit was the work she did on the development of the first compiler. In May 1953 her paper "Compiling Routines" described some of the fundamental ideas of compiling, as contrasted with interpreting. A computer program known as a compiler translates instructions written in a programming language into machine language that the computer can understand and use. Without this concept computers never would have attained today's broad use.

This led to Grace's involvement with COBOL—Common Business-Oriented Language. As Jean Sammet has documented in her article "Farewell to Grace Hopper—End of an Era!" published in *Communications of the ACM,* April 1992, Grace was one of six people who recommended in April 1959 that the Department of Defense convene a meeting to consider the development of specifications for a common business language. From this meeting came the Committee on Data Systems Languages (CODASYL) executive committee. Grace was one of its two technical advisers. The committee that developed COBOL operated under the aegis of the CODASYL executive committee. Her main contribution, however, is the legacy of her initial work on FLOW-MATIC, which was a major input to COBOL.

An area where she truly excelled, and was most proud of, was her interaction with young people, whether at work or giving speeches at symposia and colleges. Young people referred to her in a reverent way as "Amazing Grace." She was constantly telling them that the phrase she disliked the most was, "We have always done it that way." She would tell young people, "Go ahead and do it. You can always apologize later if need be. " As she often said, the most important thing that she had accomplished in life was the training of young people. Another of her favorite sayings, and she had many, was "We manage things. We lead people." How fortunate we are that she dedicated so much of her time and energies to young people.

There were many things that set Grace apart from the average person. For example, many of us were lucky enough to receive one of her "nanoseconds," a piece of wire 11.38 inches long. In speeches and travels she would explain her early frustrations of not being able to comprehend a milli-, micro-, and nanosecond. Having never "seen one," she would explain that she did not know when it was over. Since electromagnetic radiation travels in space at the speed of light, one thousandth of a second represents just over 186 miles. Grace would then hand out her 11.38 inches of wire so you could "see" a nanosecond, one billionth of a second. Then she would explain the problem we faced in computers was the need to compute and operate faster. She was always effective in reaching her audience.

Most people who worked with Grace were familiar with some of the stories attributed to her. She used to start many of her out-of-town speeches with an account of how someone mistook her for an airport security guard as she walked through the local airport. Another story attributed to her was the origin of the phrase "computer bug." One night in 1945, supposedly, she and several others were having problems with the Mark I computer (which was fifty-one feet long). Someone looked inside and pulled out a two-inch moth that had become wedged inside. After that, whenever there was a problem with the computer, the group would say, "another bug has gotten inside."

Everyone who was ever associated with Grace knew about her famous office clock. To disprove that there was only one way to do things, she had a clock that ran counterclockwise-and kept perfect time.

In 1983 Grace was featured on the television show "60 Minutes." She once again proved that a "computer whiz" could be a normal, bright, interesting person, not a stodgy desk-bound individual who had no other interest than manipulating a computer. In fact, she was so popular on the show that her segment was repeated in 1986 after her navy retirement.

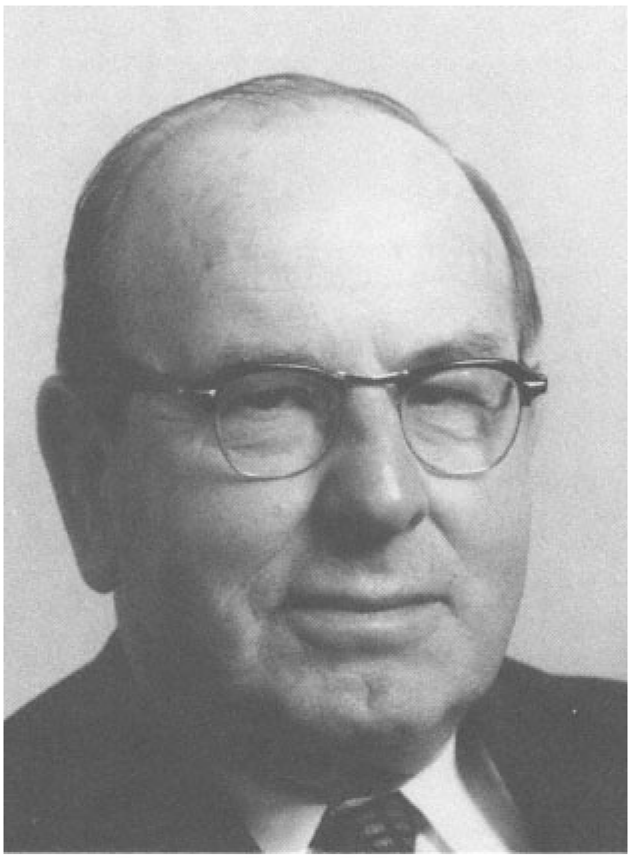
One facet of Grace's life that is not as well known was her generous support of the Navy Relief Society, which is dedicated to helping individuals in the Navy family who are in need. In 1982 the U.S. Navy magazine *All Hands* featured an article on Grace titled "Grace Hopper—A Living Legend." To the best of my knowledge, this article publicized this support for the first time, as follows: "Grace Hopper, an extraordinary woman, seeks no honors or awards for her work. She prefers to give freely of her tremendous energy and talents. As of June 1982, for example, she had contributed more than $34,000 to the Navy Relief Society from honorariums she had received for numerous speaking engagements over the years." (From 1973 until her death, Grace donated $114,295 to the Navy Relief Society.) The above excerpt from the *All Hands* article described Grace as well as anyone can. She was truly a remarkable woman.

Admiral Hopper was elected a member of the National Academy of Engineering in 1973. She also belonged to at least thirty-five other societies and associations. She was the author or coauthor of numerous reports, articles, and a book, *Understanding Computers,* with Steven L. Mandell, West Publishing Company, 1984.

Honors and awards ranged from Phi Beta Kappa in 1928 to the National Medal of Technology awarded to her by President Bush in 1991, the first woman individually recognized with this prestigious award. In between were more than thirty-five honorary doctoral degrees from various universities and numerous awards from organizations worldwide.

Admiral Grace Murray Hopper was truly an individual who will be remembered in history for her many accomplishments in the field of computers. Most important, she touched and influenced many lives. For this we are all thankful.

She managed things. She led people.



Richard Ralston Hough

1917-1992

Written By S. R. Willcoxon

Submitted By The Nae Home Secretary

RICHARD RALSTON HOUGH, whose forty-two-year career at AT&T included more than seventeen years at Bell Laboratories, died July 9, 1992. Mr. Hough, seventy-four, and his wife, Jane, seventy-three, were killed when the family's private plane crashed shortly after taking off from Concord Airport in Concord, New Hampshire. Hough made a number of significant contributions to telephony and to national defense through his work at Bell Laboratories and AT&T.

Richard Hough was a man of many talents, equally comfortable and competent in a laboratory, a boardroom, or a competitive sports setting.

A native of Trenton, New Jersey, he was graduated from Trenton High School in 1935. He received a B.S.E. degree in electrical engineering with highest honors from Princeton University in 1939. The following year he received a master of science degree in electrical engineering from Princeton. He served as a charter trustee of his alma mater for more than twenty years.

During his senior year at Princeton, Mr. Hough set several world swimming records, including two in one week. He was later elected to the Swimming Hall of Fame in Fort Lauderdale, Florida.

Richard Hough's professional affiliations included being named a fellow of the Institute of Electrical and Electronics Engineers (IEEE). He was named Outstanding Young Electrical

Engineer by Eta Kappa Nu in 1947 and was awarded the Alexander Graham Bell Medal in 1980 by the IEEE.

Richard Hough joined Bell Telephone Laboratories in 1940, where he worked primarily on the development of various military weapon systems, including guided missiles. In 1955 he was appointed director of military electronics development and was elected vice-president of the laboratories two years later. His leadership in technology assessment, technical planning, and research helped AT&T and other large organizations respond to the demands of large, complex communications systems in both the civilian and the military government sectors. He also led the implementation of modern technologies, including communications satellites and electronic transmission and switching systems, into the U.S. telecommunications network.

Following his career at Bell Laboratories, Richard Hough moved to AT&T corporate headquarters as assistant chief engineer with broad responsibilities for the application of technology to the nationwide telephone network. In 1959 he was elected vice-president-operations of the Ohio Bell Telephone Company. Two years later he returned to AT&T as vice-president in charge of engineering, where he performed his duties until his appointment in 1966 as president of AT&T Long Lines, which was then the long-distance telephone service arm of the Bell System. He became AT&T executive vice-president in 1978, a position overseeing all Bell System engineering and network activities. He held that post until his retirement.

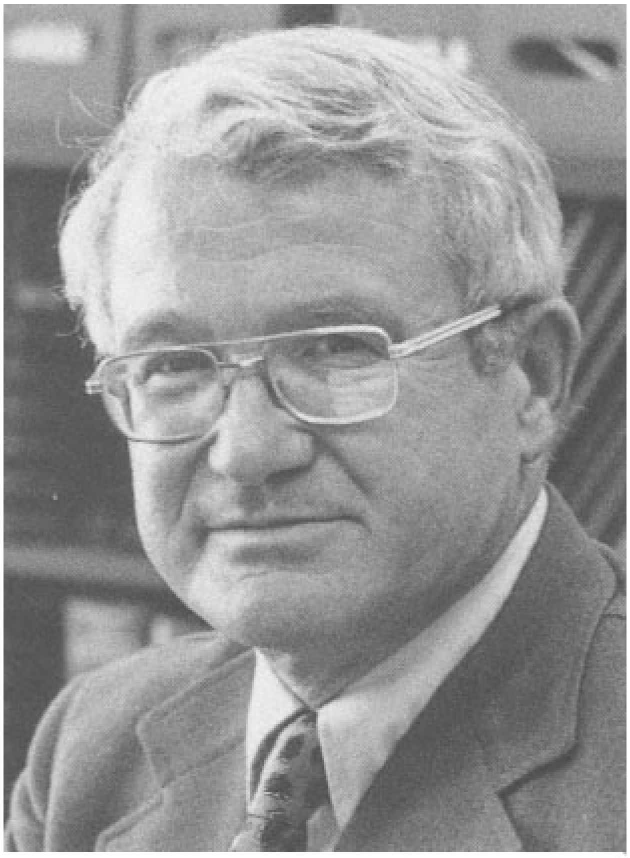
Richard Hough served as a consultant to the U.S. Defense Department, first as a member of the Radar Panel of the Research and Development Board, and later as a member of the Technical Panel on Electronics.

In 1961 President John F. Kennedy appointed him to head Project Beacon, a task force studying safe and efficient use of air space. He served for four years as chairman of the Technical Advisory Board to the Federal Aviation Administration. He also served as a member of the Advisory Board of the U.S. Naval Postgraduate School for nine years and as a member of the Defense Science Board of the Department of Defense for three years.

Richard Hough served as director of the American Can Company (now Primerica Corporation), Alleghany Corporation, Chemical Bank, Midlantic Corporation, and other institutions. He was also past president of the Telephone Pioneers of America, the world's largest volunteer organization. He had also served as a trustee of Morristown Memorial Hospital in Morristown, New Jersey.

The Houghs were married in March 1941. They were devoted parents to six children: Suzanne H. Pedersen of Isaquaha, Washington; Richard R. Hough, Jr. of Roanoke, Virginia; Edith H. Overtree of Houston, Texas; William F. Hough of Basking Ridge, New Jersey; Dr. Jane Hough of Earlville, New York; and Robert M. Hough of Derry, New Hampshire.

During his forty-two years at AT&T, Richard Hough demonstrated the highest level of skill in technology and in business leadership. He accepted any challenge that came his way and got the job done with quiet dignity and class. He was an extremely gifted engineer whose work set standards for world-class telecommunications systems.



Robert I. Jaffee

1917-1991

Written By John Stringer

Submitted By The Nae Home Secretary

ROBERT I. JAFFEE, a metallurgist of remarkable insight, died on November 28, 1991, at the age of seventy-four.

Elected to the National Academy of Engineering in 1969, Bob was engaged in alloy development and physical metallurgy research until his death and made many important contributions in these fields. He was also closely involved for much of his life in professional activities, both in the United States and internationally.

A native of Chicago, Bob graduated from the Armor Institute of Technology (now the Illinois Institute of Technology) in 1939 with a degree in chemical engineering. He then joined the School of Metallurgy at Harvard University, receiving his S.M. in 1940. Following this, he was awarded a U.S. Bureau of Mines fellowship at the University of Maryland, receiving a Ph.D. in 1943. He worked briefly at Battelle Memorial Institute in Columbus, Ohio, from 1942 to 1943, but decided in May of 1943 to go to the University of California, Berkeley, to work on a War Metallurgy project on magnesium alloys. It was there he met his wife, Edna. In 1944 he rejoined Battelle, where he was to spend the next thirty years, eventually becoming chief materials scientist.

In 1974 Bob "retired" from Battelle and joined the then new Electric Power Research Institute (EPRI). There he developed a material support activity, retiring as senior technical adviser in 1989. However, he continued to work with EPRI as a consultant until his death. He was also a consulting professor in the Department of Materials Science and Engineering at Stanford University.

Bob was active in many metallurgical professional societies. He was particularly involved in The Metallurgical Society (TMS) of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). He was a director from 1977 to 1980, and in 1978 he served as the society's president. He was elected a fellow of TMS in 1972 and received the James Douglas Gold Medal of AIME in 1983 for "distinguished achievements in nonferrous metallurgy." Bob was also active in the American Society for Metals (ASM), of which he was elected a fellow in 1970 and an honorary member in 1976. He was selected to present the Edward DeMille Campbell Memorial Lecture of ASM in 1977, and in 1985 he was selected for the TMS/ASM Joint Distinguished Lectureship in Materials and Society. In addition, he received the Bronze Medal of the American Ordnance Association in 1966, and was selected to present the H. W. Gillett Memorial Lecture of the American Society of Testing and Materials in 1976. He was appointed fellow of the Institution of Metallurgists in the United Kingdom in 1967.

He was on the board of governors of *Acta Metallurgica* from 1969 and was chairman in 1976. Immediately before his death, he was selected as the third recipient of the J. Herbert Hollomon Award *of Acta Metallurgica,* which recognizes outstanding contributions to understanding the interactions between materials technology and societal interests. He was a member of numerous committees of the National Academy of Sciences, the National Research Council, the National Aeronautics and Space Administration, and the Advanced Group for Aeronautical Research and Development of the North Atlantic Treaty Organization.

Bob's research activity at Battelle was concerned with nonferrous metals, and in particular, titanium and its alloys. He established a worldwide reputation as perhaps the most distinguished metallurgist in this field. He was the inventor of a large number of commercially important (particularly for aerospace applications) titanium alloys and of fabrication methods for titanium alloys and structures. His interest in titanium metallurgy continued at EPRI, where he was responsible for the development of a thermomechanical fabrication route to make large titanium alloy blades for steam turbines. However, at EPRI he also became an authority on ferrous metallurgy and led an important international program to develop superclean steels for turbine rotors and related applications, demonstrating that the control of minor constituents or impurities in the steel could greatly improve its toughness and stability. Bob was quick in identifying a potential materials problem in an advancing technology, or an opportunity for a useful materials development; and he was tireless in pursuing it to its solution, irrespective of the obstacles. The clean steels work demonstrates this characteristic particularly well; an idea was taken from the laboratory to installation in very large machines over a period of perhaps ten years, involving major technical contributions from England, Germany, and Japan, as well as the United States. Bob held forty-five U.S. patents and was author or coauthor of more than three hundred publications in technical literature.

Bob was also very interested in the communication of knowledge and ideas. While at Battelle he developed the concept of carefully focused, high-level colloquia on specific topics, with a limited number of invited participants. These formed the basis of a series of influential proceedings volumes. The same approach was also used for a number of specialist workshops at EPRI, and has been used as a model elsewhere. Bob was editor of twenty-three books, mostly of this kind.

In addition to his own skills as a researcher, Bob was adept at assembling groups of talented people to work with him. He formed a metals science group at Battelle and used a similar approach to build up a small but effective group of senior professionals at EPRI. He set high standards for all who worked with him, and he expected a level of effort similar to his own. However, he was also extremely supportive of those who passed his demanding criteria. He also assembled a group of researchers from around the world to attack specific technical problems. He had extensive interactions with colleagues in England, France, Germany, Japan, Taiwan, and the former USSR, among others. He was admired, liked, and respected wherever he went. His enthusiasm for materials research and his uncanny insight (the mark of a good metallurgist) remained burning brightly to the end of his life.

Clarence L. "Kelly" Johnson

1910-1990

By Daniel M. Tellep

CLARENCE L. "KELLY" JOHNSON, acknowledged throughout most of the world to have been the best aircraft designer in the history of aviation, died on December 21, 1990, at the age of eighty.

Elected to the National Academy of Engineering in April 1965, Kelly contributed to the design of more than forty Lockheed aircraft—including the P-80, which was the United States' first operational jet fighter, and the world's fastest, highest-flying aircraft, the renowned SR-71 Blackbird. He also was acclaimed for his unique leadership qualities and his distinctive management style and philosophy.

Kelly Johnson was born in Ishpeming, Michigan, on February 27, 1910. He later moved to Flint, graduated from Flint Junior College, and completed his education at the University of Michigan, where he received his bachelor of science degree in 1932 and his master of science degree in aeronautical engineering in 1933.

The seventh of nine children, Kelly said in later years that he learned respect for hard work and for education from his Swedish immigrant parents. From his father, a bricklayer and carpenter, he acquired a love of tools and the knowledge of how to use them. By the age of twelve he knew he wanted to build airplanes.

After joining Lockheed as a tool designer in 1933, Kelly had assignments as flight test engineer, stress analyst, aerodynami cist, weight engineer, and wind tunnel engineer before becoming chief research engineer in 1938. He founded Lockheed's Advanced Development Projects organization—more widely known as the "Skunk Works"—in 1943. Subsequently, while retaining leadership of the Skunk Works, Kelly became chief engineer in 1953 and was appointed corporate vice-president for research and development in 1956. He retired in 1975 as a senior vice-president of Lockheed Corporation, but remained a senior adviser until his death.

This prolific genius has been widely recognized. He was the first two-time recipient of both the Robert J. Collier Trophy, presented by the National Aeronautic Association of the U.S.A., and the Theodore von Karman Award of the Air Force Association. Kelly also received two Sylvanus Albert Reed Aeronautics Awards, given by the American Institute of Aeronautics and Astronautics; the National Aeronautic Association's Wright Brothers Memorial Trophy; and, in 1971, the Founders Medal of the National Academy of Engineering—all among the most prestigious awards in engineering and aviation.

He was elected to the Aviation Hall of Fame in 1974, the Michigan Hall of Fame in 1988, and the National Management Association Hall of Fame in 1991. He received four presidential citations, including the Medal of Freedom—the highest civil honor the president can bestow.

Kelly was an honorary fellow of the American Institute of Aeronautics and Astronautics and a fellow of the Royal Aeronautical Society. In addition to the National Academy of Engineering, he was a member of the National Academy of Sciences, the Society of Automotive Engineers, and the Tau Beta Pi and Sigma Xi engineering fraternities. He received honorary doctorates from the University of Michigan, the University of Southern California, and the University of California at Los Angeles.

He authored or coauthored numerous articles and technical papers on aircraft design and production. His autobiography, *Kelly: More Than My Share of It All,* written with Maggie Smith, was published in 1985.

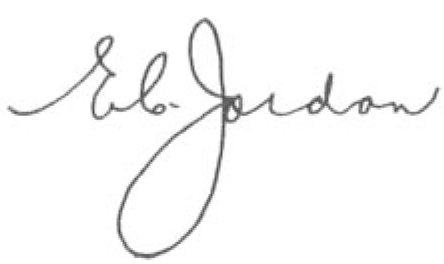
Under Kelly's leadership, Lockheed's Skunk Works built America's first operational jet fighter, the P-80 Shooting Star.

Lockheed's F-104 Starfighter was the first operational jet to fly at twice the speed of sound. Its U-2 first flew more than thirty years ago but is still the highest-flying single-engine aircraft in the world. The incomparable Mach-3 SR-71 Blackbird holds world records for speed and altitude that have yet to be eclipsed a quarter-century after it was built.

Those aircraft were all produced under budget and on time, using an absolute minimum number of people working in an atmosphere of exceptional innovation. Under Kelly's direction and management, the name Skunk Works became synonymous with a unique management style that encourages creativity, responsibility, accountability, and trust. He devised and enforced fourteen basic management rules that have been widely cited in publications such as *A Passion for Excellence.* Kelly supplemented his formal operating principles with memorable axioms such as "if you can't do it with brainpower, you can't do it with manpower or overtime" and "be quick, be quiet, be on time."

The Skunk Works, under Kelly's leadership, was known for continuously advancing the state of the art in engineering and aviation. Typical of the group's achievements was its pioneering use of titanium in aircraft skins and structures, an effort recognized by the American Society of Metals in 1970 with its first annual Engineering Materials Achievement Award.

In summation, perhaps President Lyndon B. Johnson put it best as he was awarding Kelly his second Collier Trophy for the Blackbird series of aircraft: "Kelly Johnson and the products of his famous Skunk Works epitomize the highest and finest goal of our society, the goal of excellence. His record of design achievement in aviation is both incomparable and virtually incredible. Any one of his many airplane designs would have honored any individual's career."



Edward Conrad Jordan

1910-1991

By George W. Swenson, Jr.

EDWARD C. JORDAN, professor emeritus of electrical engineering at the University of Illinois at Urbana-Champaign, died after a short illness on October 18, 1991. He was eighty.

He spent his life from the age of seventeen in the practice of electrical engineering, having served successfully in the gamut of roles from radio broadcast technician through engineering student, industrial engineer, professor, researcher, administrator, author, editor, and consultant to government and industry over a span of six decades. His accomplishments have been recognized by numerous awards and offices.

Born in Edmonton, Alberta, Canada, on December 31, 1910, he attended the public schools of that city and graduated from Victoria High School in 1927. The following year he enrolled in the University of Alberta in the electrical engineering department and obtained a position as control operator in the university's radio broadcasting station, CKUA. He served in that position until 1935, supporting himself while he earned BSEE and MSEE degrees in 1934 and 1936. His first electronic development project was a pioneering automatic gain control system, which provided a 30-decibel compression ratio for the radio station's studio audio system. Upon receiving his master's degree, he sought a position in the electronics industry; however, the depression limited his options, so he accepted a position as an electric power engineer in the nickel mines of Sudbury, Ontario. After one year in this situation, he went to Ohio State University to study for a Ph.D. Although handicapped by impaired hearing, for which he designed and built his own hearing aid, he earned the degree in 1940 for a thesis supervised by Professor William L. Everitt, who became a lifelong colleague and friend.

Dr. Jordan then spent a year teaching at Worcester Polytechnic Institute, after which he returned to Ohio State to join the electrical engineering faculty. In 1943 Everitt was called to war service in Washington, whereupon Jordan assumed the entire burden of electrical communication and electromagnetic theory courses, including the developing field of microwave technology. During this period, he initiated his successful career as a textbook author, collaborating with Everitt and others on *Principles of Radio* (Prentice-Hall, New York, 1942) and starting work on *Electromagnetic Waves and Radiating Systems* (Prentice-Hall, New York, 1950). In addition, he collaborated with George Sinclair on the measurement of aircraft antenna patterns by modeling.

In 1945 Everitt was appointed head of the Department of Electrical Engineering at the University of Illinois (Urbana Champaign campus), and Jordan joined the department as associate professor. As part of Everitt's mandate to develop the department into a leading teaching and research institution, Jordan founded the Radio Direction Finding Research Laboratory. He later assumed leadership of the Antenna Research Laboratory, and he continued with a regular load of classroom teaching and thesis supervision until 1954, when he became head of the electrical engineering department. At that time, he exchanged his career as a classroom teacher and hands-on researcher for that of an academic administrator, leading his department through revolutionary changes over the next twenty five years.

Probably his best-known work was the textbook *Electromagnetic Waves and Radiating Systems,* first published in 1950, which has influenced electrical engineering seniors and graduate students for forty years. It was reprinted many times over the next sixteen years, and in 1968 an extensively revised second edition was published, coauthored with Professor Keith C. Balmain of the University of Toronto. It still has a wide audience, has been translated and published in both Spanish and Chinese (both in Taiwan and Beijing), and has been adopted by universities in more than thirty countries. During his active years on the Illinois faculty, Edward Jordan also edited major symposium volumes for the Institute of Electrical and Electronics Engineers' (IEEE) Antennas and Propagation Society and the Union Radio Scientifique Internationale, and published many review papers on antennas, electromagnetics, electronics, and electrical engineering education.

Edward Jordan was elected a fellow of the Institute of Radio Engineers, later the Institute of Electrical and Electronics Engineers, in 1953. In subsequent years he was awarded honorary life membership by the IEEE Antennas and Propagation Society, and other IEEE awards including the Education Medal (1968) and the Centennial Medal (1984). He served in several IEEE national offices and committees.

In 1974 he was elected an eminent member of Eta Kappa Nu, the North American electrical engineering honor society, and through the years he was honored for his professional accomplishments by the University of Illinois, the Ohio State University, and the University of Alberta.

In 1967 he was elected a member of the National Academy of Engineering (NAE) "For radio direction finding and antenna research." Subsequently he served on the NAE Committee on Telecommunications until 1974, as well as on several other ad hoc committees and panels dealing with telecommunications techniques and policy.

He was in demand as a consultant to industry, government, and universities. Over the years, he served on advisory boards and panels of the Department of Defense, the U.S. Air Force, the National Science Foundation, the Institute of Electrical and Electronics Engineers, the Union Radio Scientifique Internationale, Pennsylvania State University, University of California, Massachusetts Institute of Technology, University of Houston, Purdue University, and, of course, the National Academy of Engineering. In these voluntary public service duties, he was widely traveled throughout the world, reinforcing his stature as a world leader in his profession.

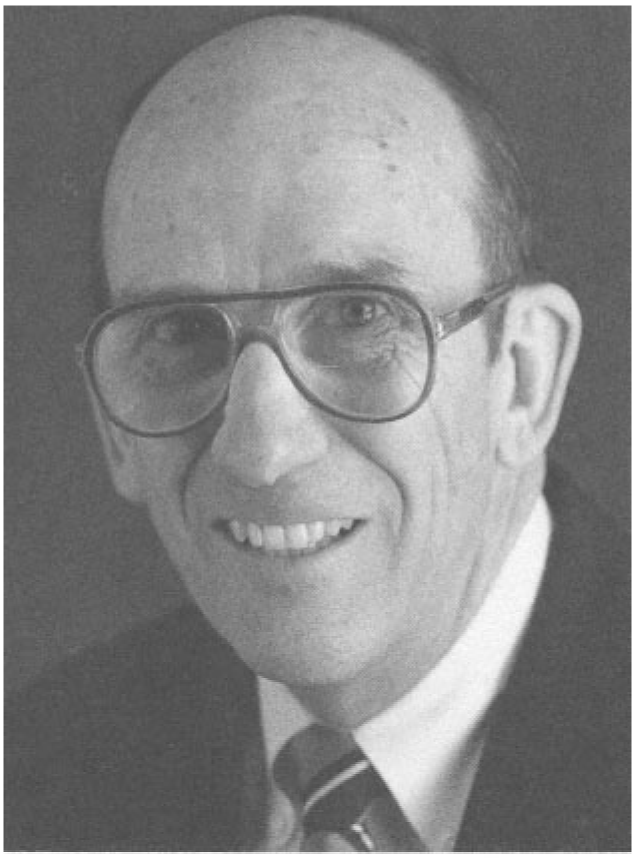
Under Edward Jordan's leadership, the University of Illinois Electrical Engineering Department continued the evolution initiated by William Everitt, from an institution primarily devoted to undergraduate teaching to a major research and graduate teaching organization. The state government of Illinois budgeted few resources for research and graduate study. At the same time, the nation demanded of its universities much greater emphasis on advanced technical education and research, mainly in response to the perceived imperatives of the cold war and the challenge posed by the Soviet Union's launching of the first artificial Earth satellites. Resources were provided mainly in the form of research grants and contracts from federal agencies, which supported salaries for faculty and graduate students, equipment acquisitions, and (through "indirect cost" allowances) infrastructure improvements. Dr. Jordan managed these opportunities skillfully and wisely, recruiting an outstanding faculty and encouraging new initiatives in promising research directions, always with primary emphasis on quality. The result, by the time of his retirement in 1979, was the country's largest department of electrical engineering (one hundred professors, not including computer science), which consistently ranked among the top four in surveys of quality of research and graduate education. At that time, the department was producing annually the country's largest number of combined undergraduate and graduate electrical engineering degrees. During his term as head, Jordan signed over six hundred Ph.D. theses in electrical engineering.

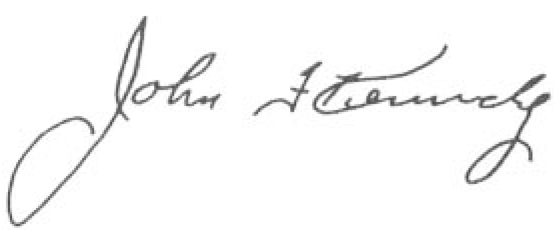
Upon his retirement, he was asked by the Howard Sams Company to act as editor in chief of the seventh edition of the classical IT&T electronics handbook, *Reference Data for Radio* E*ngineers,* a task that occupied much of his time until 1985. The handbook was renamed *Reference Data for Engineers: Radio, Electronics, Computer and Communications* to reflect the rapid evolution of the profession since the sixth edition in 1968. The book contains 48 chapters and 1,360 pages. At the time of his death, he was engaged in preliminary work on the eighth edition.

Edward Jordan was the son of Conrad and Erna Penk Jordan. He married Mary Helen Walker in September 1941, in Edmonton. She died June 1, 1986, in Urbana. He later married Caroline W. Egbert, who survives.

Also surviving are three sons, Robert of Cairo, Egypt; David of Helena, Montana; and Thomas of Eugene, Oregon; three grandchildren; and three stepdaughters, Virginia, Barbara, and Judith.

He was greatly admired and respected throughout radio and electronic engineering circles of the world. To the younger faculty members of his department, he was a father figure; to senior colleagues and fellow Rotarians, a friend and confidant and golfing partner. He will be missed by all.





John Fisher Kennedy

1933-1991

By Vito A. Vanoni And Norman H. Brooks

JOHN F. KENNEDY, Hunter Rouse Professor of Hydraulics, University of Iowa; director emeritus, Iowa Institute of Hydraulic Research; and internationally known hydraulic engineer, died in Iowa City on December 13, 1991, at the age of fifty-seven years. He was born in Farmington, New Mexico, on December 17, 1933.

Dr. Kennedy earned a bachelor's degree in civil engineering at the University of Notre Dame in 1955. He continued his academic education in civil engineering at the California Institute of Technology (Caltech), where he obtained a master's degree in 1956 and a Ph.D. degree in 1960.

The title of his thesis was "Stationary Waves and Antidunes in Alluvial Channels." The results of this research, published in the *Journal of Fluid Mechanics* (1963), clarified the phenomena of antidunes and became a landmark study on the subject. This served as his introduction to river sedimentation, the various aspects of which became the subject of much of his research and engineering work.

Upon completion of his graduate studies at Caltech, Dr. Kennedy immediately entered a long and productive career of academic teaching, research, and professional engineering.

In 1960-1961 he remained at Caltech as a postdoctoral fellow while he continued his work on sedimentation and started his teaching career. In the fall of 1961 he joined the civil engineering faculty of the Massachusetts Institute of Technology (MIT) as assistant professor of hydraulics, and in 1964 he was promoted to associate professor. While at MIT, he taught hydraulics courses and extended his research to include hydraulic resistance in alluvial streams, transport of cohesive sediment, and density-stratified flows.

In 1966 Dr. Kennedy joined the University of Iowa as professor and director of the prestigious Iowa Institute for Hydraulic Research (IIHR), a position held previously by Dr. Hunter Rouse. In 1981 he was named Carver Distinguished Professor. He retired as director in August 1991 after a busy tenure of twenty-five years.

Under Kennedy the program of IIHR continued to work on basic hydraulics but at the same time undertook research on engineering problems that were of interest to him. The engineering problems often resulted from consulting projects that Kennedy undertook at times, and were a welcome factor in maintaining the fiscal viability of the laboratory.

John Kennedy's accomplishments were appreciated by his associates as indicated by the University of Iowa President Hunter R. Rawlings III, who said, "During the distinguished twenty-five-year tenure as director of the Iowa Institute of Hydraulic Research, Professor Kennedy contributed greatly to the institute's position of world leadership. All of us will remember him not only as a great engineer but as a warm and caring human being. We will miss him."

While he was director of IIHR, Kennedy devoted much of his time to research. During this time over two hundred technical papers and reports were published in which he was the sole author or a coauthor. The wide range of subjects of these papers is an indication of the breadth of his interests in hydraulics. A portion of these papers dealt with aspects of alluvial streams, including sediment transport, bedforms, and flow in bends and meanders. These papers mostly were fundamental in nature and tended to advance the understanding of the complicated erosion processes acting in rivers. His paper in the *Annual Review of Fluid Mechanics,* 1968, entitled "Formation of Sediment Ripples, Dunes and Antidunes" summarizes his work on bedforms and is a reference work on the subject.

In addition to river sedimentation, Kennedy's many papers dealt with mechanics of river ice, density currents, density stratified flows, cooling towers and pumping systems for circulating cooling water for power plants, transport of cohesive sediment, and biographies of famous hydraulicians and history of hydraulics.

Kennedy's interest in ice hydraulics dates from the time a colleague called his attention to ripples that form under the ice cover of rivers. He was intrigued immediately with the ice ripples and ice problems and set out to obtain funding for studying these problems. This led to the construction of a refrigerated laboratory to house a flume to study ice problems. This laboratory was the first of its kind in the world. Kennedy was called on to consult for the design of other similar facilities.

Kennedy and his Ph.D. student George D. Ashton developed a theory that explained the formation of ice ripples, and which was confirmed by experiments in the refrigerated laboratory. The results of this work, for which they won the Hilgard Prize, were published in the *ASCE Journal of the Hydraulics Division* in 1972. Kennedy became a leading figure in ice hydraulics research. He was called on frequently to lecture on ice engineering and was instrumental in forming the International Association for Hydraulic Research Section on Ice Research and Engineering. Together with his Ph.D. students, he produced what remains the leading theoretical model of ice jam equilibrium and other papers on ice hydraulics.

As the program on ice engineering grew, Kennedy delegated its coordination to his colleagues, several of whom went on to develop careers in ice research.

Dr. Kennedy traveled widely and gave lectures at a number of foreign laboratories. In September and October 1969 he visited several scientific centers in the USSR under the auspices of the Academy of Science of that country. In the academic year 1972-1973 he was Fulbright Fellow and visiting professor at the University of Karlsruhe, Germany. In the winter of 1976 he was Erskine Fellow and visiting professor at the Canterbury University in Christchurch, New Zealand. In the winter of 1981 he was visiting consultant at the Central Power and Water Research

Station, Poona, India, and in the spring of 1985 he was guest professor at Eidgenössische Technische Hochschule, Zürich, Switzerland.

Dr. Kennedy was the recipient of many honors and awards starting early in his career. The crowning award came when he was elected to the National Academy of Engineering in 1973 at the unusually young age of thirty-nine years. When he was still in the lower academic ranks, he received several awards for his publications in the journals of the American Society of Civil Engineers. In 1980 he was elected president of the International Association for Hydraulic Research and reelected for a second term in 1982, and in 1989 he was elected honorary member of the association. He was invited to give the American Society of Civil Engineers' Hunter Rouse Hydraulics Lecture in 1981, and in 1983 he was awarded the Iowa Governor's Medal.

Through his publications, travel, and other activities, he became known widely and received a number of international honors. In 1983 he was elected honorary member of the Hungarian Hydrological Society. Two years later in 1985 he was named honorary fellow of the Institute of Water Conservancy and Hydroelectric Power Research, Beijing, China, and was appointed honorary professor by the East China Technical University of Water Resources, Nanjing, China. In the next year, 1986, he was named corresponding member of the Chinese Engineering Society.

Kennedy was an active member of the National Academy of Engineering, International Association for Hydraulic Research (honorary member and past president), American Society of Civil Engineers, American Society of Mechanical Engineers, and American Society of Engineering Education. He served on and chaired numerous committees of these organizations.

Kennedy served on the following committees of the National Research Council:

Commission on Engineering and Technical Systems, Committee on Natural Disasters, chairman 1983-1984, member 1980-1991,

Commission on Engineering and Technical Systems, Committee on Computer Analysis of River Sedimentation, chair man 1980-1983,

Commission on Engineering and Technical Systems, Water Technologies Board, 1982-1984,

Commission on Engineering and Technical Systems, Panel on Niagara Ice Boom Investigations, 1983, and

Commission on Engineering and Technical Systems, Advisory Committee for the International Decade of Hazard Reduction, 1987.

He served on the following national consulting boards:

Board of Consultants for the Sacramento River and Tributaries, Bank Protection and Erosion Control Investigation, 1978-1991,

Board of Consultants for St. Lawrence Seaway Navigation Extension Season, 1975-1979, and

Peer Review Group, Alden Research Laboratory Power Reactor Containment Sump Studies, Department of Energy, Nuclear Regulatory Commission and Sandia Corp., 1981-1982.

In addition, he served on the following international consulting boards:

Team of Experts to Review Development of National Water Plan for Saudi Arabia, 1982-1991,

Advisory Panel of International Experts for Three Gorges Dam Project (China), 1986-1988, and

International Commission of Experts to Review Leningrad Storm Surge Barrier, Lenhydroenergospesstroy (USSR), 1990.

Through his activities in teaching, research, professional societies, and international and national committees and consulting boards, John F. (Jack) Kennedy had a major influence on hydraulic engineering. He was an effective speaker, knowledgeable of a broad range of technical subjects, and a sought after leader. Engineers who have worked closely with him admired him for his pleasant personality and his ability to grasp the salient features of an engineering problem and to quickly conceive its solutions.

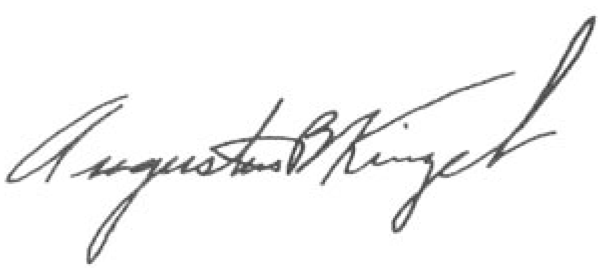
Jack Kennedy was a very personable, articulate, friendly, and caring person. He was devoted to his wife, Nancy, and their four children. He will be missed.

The following poem included in the introduction to his doctoral thesis reflects his personality as well as his skill with words:

SEDIMENT RESEARCH

Sand in my hair,
Sand in my teeth,
Sand overhead,
Sand underneath.
Plugging the pitot,
Abrading the pump,
Clogging the samplers,
Filling the sump.
This was my research,
Exciting and grand.
Very rewarding
Despite all the sand!!

JFK 1960



Augustus B. Kinzel

1900-1987

By Walker L. Cisler And Harvey A. Wagner

AUGUSTUS BRAUN KINZEL, the first president of the National Academy of Engineering (NAE), died on October 23, 1987, at the age of eighty-seven. His distinguished career in research and metallurgy included important contributions in both fields and reflected his dedication to the engineering profession.

He was born on July 26, 1900, in New York City. His father, Otto, was a professional pianist and his mother, Josephine Braun, a mathematics teacher. He received an A.B., cum laude, in mathematics in 1919 from Columbia University; a B.S. in general engineering from the Massachusetts Institute of Technology (MIT) in 1921; and a D. Met. Ing. in 1922, and an Sc.D. in 1933 from the University of Nancy, France. Among other honorary degrees he was awarded were the doctor of engineering from New York University in 1955, doctor of sciences from Clarkson College of Technology in 1957, and doctor honoris causa from the University of Nancy in 1963.

He began his professional career at the General Electric Laboratories in Pittsfield, Massachusetts, in 1919. Dr. Kinzel joined Union Carbide Research Laboratories in 1926 as a research metallurgist. He successively became chief metallurgist in 1931, vice-president in 1945, and president in 1948. In 1954 he was appointed director of research for the Union Carbide Corporation, and in 1955, vice-president of research.

He served as consultant to the Los Alamos, Oak Ridge, Argonne, Knolls, and Brookhaven Laboratories. As a member of the initial Manhattan District Committee for the World Control of Atomic Energy, he helped draft the classified report that was the working basis for the Lilienthal and Baruch plans. During World War II he also held key advisory posts in the ordnance field and was in charge of the metals branch of the Technical Industrial Intelligence Committee in Europe. He was a member of the Defense Science Board and the Naval Research Advisory Committee, of which he was a past chairman (1953-1954). He was president of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) (1958) and of the Engineers Joint Council (1960); chairman of the Division of Engineering and Industrial Research of the National Research Council (1960); and a member of the National Academy of Sciences, the American Philosophical Society, and the MIT Corporation. He was a trustee of the California Institute of Technology, the Jet Propulsion Laboratory, and the Salk Research Institute, and a member of the board of System Development Corporation of General American Investment Company, American Optical Company, and Beckman Instrument Company.

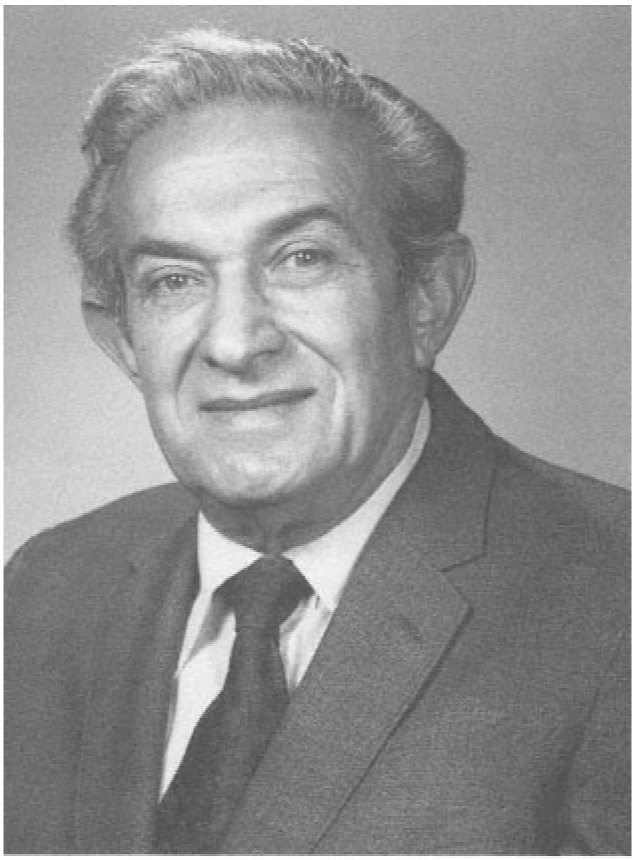
Dr. Kinzel was a founding member of the NAE and was instrumental in the formulation of its objectives on policies and philosophies. Over the years, he has given unstintingly of his time in serving the needs of the growing Academy. He was certainly an important factor in the Academy's success.

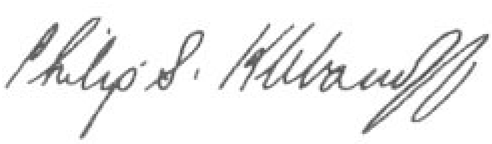
However, his interests were broadened beyond engineering as he became interested in the work of the Salk Institute for Biological Studies and eventually became its president and chief executive officer.

Dr. Kinzel was coauthor of the Engineering Foundation's volumes of *Alloys of Iron and Chromium* and was the author or coauthor of more than one hundred technical papers. He has given many of the honorary memorial lectures in metallurgy, including the Howe Memorial Lecture (AIME), the Comfort A. Adams Lecture (the American Welding Society [AWS]), the Burgess Memorial Lecture (American Society for Metals [ASM]), the Albert Sauveur Achievement Award (ASM), and the Edward DeMille Campbell Memorial Lecture (ASM). He was a recipient of the Samuel Wylie Miller Memorial Medal Award (AWS), a James Turner Morehead medalist (International Acetylene Association [IAA]), and a Powder Metallurgy Medalist (Stevens Institute of Technology). He received the Industrial Research Institute Medal in May 1960 and the James Douglas Gold Medal (AIME) in February 1960. He was also the recipient of many distinguished service awards, is in the Metals Progress Hall of Fame (ASM), and was an honorary member of the Chemists Club and Eurospace.

Dr. Kinzel was a member of the University Club of New York City; the Racquet and Tennis Club of New York City; the Cosmos Club of Washington, D.C.; the Beach and Tennis Club of LaJolla, California; and several art museums and musical associations. He was a director of the Berkshire Farm for Boys and the International Benjamin Franklin Society. He lived in New York City and also had a home in LaJolla, California.

"Gus" Kinzel was a man of wide-ranging interests, but he always approached problems with the engineering system's approach. To quote him, "The scientist is a man of the laboratory, the library, and the land of logic. The engineer is, and should be, a man of affairs in a world of both changing fashions and economic realities. The more he knows about the present, the better engineer he'll be." The engineering profession has benefited much from the life and contributions of Dr. Kinzel. He was truly "A Twentieth Century Man of Affairs."





Philip S. Klebanoff

1918-1992

Written By G. E. Mattingly And L. P. Purtell
Submitted By The Nae Home Secretary

PHILIP S. KLEBANOFF, a prominent researcher in turbulence, died on May 2, 1992, at the age of seventy-three.

Phil was born July 21, 1918, in New York City. He graduated from Brooklyn College, where he studied physics, then joined the National Bureau of Standards in Washington, D.C., in 1942. His early years there were spent participating in the development of rapidly advancing experimental techniques in aerodynamics under the direction and leadership of Galen B. Schubauer. He also pursued advanced studies at George Washington University from 1942 to 1945.

His early projects were pursued in a time of great ferment in experimental turbulence research. In particular, the hot-wire anemometer had been established as a powerful instrument and Phil and his colleagues took full advantage of it to study both transitional and fully turbulent flows. One of the most frequently referenced works in this field is Phil's extensive study of turbulence characteristics in the boundary layer, published as a National Advisory Committee for Aeronautics technical note in 1954. His turbulent boundary layer data are still used to establish validity of current experiments and full numerical simulations in the boundary layer.

Building on his training with Schubauer on the problem of boundary-layer transition from laminar to turbulent flows, Phil later studied the development of waves in the laminar region, far beyond the linear range explored previously. Using the vibrating ribbon technique, he established experimentally the complicated three-dimensional nature of boundary-layer instability. The resulting 1962 publication in the *Journal of Fluid Mechanics* ranks as a stellar classic in the field of boundary-layer transition, and the three-dimensional waves discovered by him are now commonly referred to as Klebanoff modes.

During the early 1960s, Phil began what was to be a long and fruitful collaboration with Francois Frankiel, a theoretician who cofounded the American Physical Society (APS) Division of Fluid Dynamics, and later became editor of the journal *Physics of Fluids.* Together they explored the fundamental statistical description of turbulence, particularly the smaller scales at high Reynolds number. They were among the first to make extensive use of the new power of digitized experimental data, employing it to examine the nature of the probability distribution of small scale turbulence.

In 1979 Phil was invited to visit Hokkaido University, Sapporo, Japan, to lecture, to write a summary paper on transition and turbulence, and thus to receive an earned doctorate in engineering. Phil was honored by election to the National Academy of Engineering and by fellowship in the American Physical Society, the American Institute of Aeronautics and Astronautics, and the Washington Academy of Sciences.

Throughout his career, Phil received numerous awards for his contributions to the study of turbulence. Among these were the Naval Ordnance Development Award received in 1945. In 1968 he received the National Bureau of Standards Certificate of Commendation and in 1975 the Department of Commerce Gold Medal for "his outstanding contributions to the field of fluid mechanics . . . opening up new fields of research in aerospace sciences, air pollution, meteorology, and rocket propulsion ... and leading to important applications in coastal and ocean engineering, oil spill travel, submarine waves, liquid and gases in pipes, high speed atmospheric re-entry, nuclear power, and energy conversion." In 1981 he received the APS Prize in Fluid Dynamics "for his careful experimental studies of the turbulent boundary layer, his fundamental contributions to the understanding of transition to turbulence in boundary layers, and his leadership in the study of turbulence."

There were no aspects of turbulence that were not of interest to Phil. In collaboration with his colleagues at the National Bureau of Standards, he contributed to studies of boundary-layer separation and the influence of roughness on transition, and with his younger colleagues, magnetohydrodynamics, low Reynolds number effects, and anemometry instrumentation. His last paper, an extensive examination of the development and evolution of boundary-layer turbulence induced by a roughness element, was published in the *Journal of Fluid Mechanics* just before his death. This paper, like its predecessors, exemplifies the care, thoroughness, and integrity Phil always practiced and also inspired in those who worked with him. He will be missed.

Alan G. Loofbourrow

1912-1990

By Rupert L. Atkin

ALAN G. LOOFBOURROW, retired vice-president, engineering, Chrysler Corporation, died on December 1, 1990, at the age of seventy-eight.

Alan was born in Columbus, Ohio, on June 9, 1912. He earned a B.S. in mechanical engineering at Ohio State University in 1934, a master of automotive engineering at the University of Michigan in 1935, and an M.S. in engineering at Chrysler Institute of Engineering in 1937.

The Chrysler Corporation has prided itself over the years for its engineering excellence. Because of his outstanding engineering capabilities, the Loofbourrow name has been synonymous with Chrysler during his career with the company, which spanned more than forty years. He has been more than an outstanding engineer. He also has been one of the industry's foremost spokesmen for the engineering profession.

Throughout his career, he either invented, administered, or provided engineering support that fostered many successful innovations in Chrysler cars, as well as the engineering development in various car models themselves. These included the generation of compact cars, the 1976 Dodge Aspen and Plymouth Volare models, with their uniquely designed torsion bar suspension system. He was a prime mover in development programs resulting in advances that have been introduced into the automobile, including electronics, advanced suspension systems, and safety, emissions control, and fuel economy features. Examples are the introduction of electronic ignition in 1972 and electronic lean burn in 1976.

Loofbourrow's involvement in all phases of automotive and engine design is reflected in fourteen patents registered in his name. His inventions in power steering, automatic transmissions, energy-absorbing steering columns, and a gas turbine car transmission are examples of the significance of his contributions to automotive engineering.

Alan was known as an articulate spokesman on behalf of the auto industry, and he earned a reputation for his firm and knowledgeable positions on controversial technical issues. He appeared as an expert witness before congressional committees and other forums to give engineering analyses of complex emissions and safety issues and alternative power plants. For example, at a time when many auto engineers and industry analysts were touting the Wankel rotary engine as a replacement within the decade for the conventional engine, he is quoted in the July 6, 1972, *Detroit News* as saying the rotary would turn out to be a "fantasy."

During World War II Alan was chief engineer of Chrysler's program in the development of the atomic bomb. He later served on the U.S. Department of Commerce's Panel on Electrically Powered Vehicles and the Munitions Board's Industry Advisory Committee on Internal Combustion Engines.

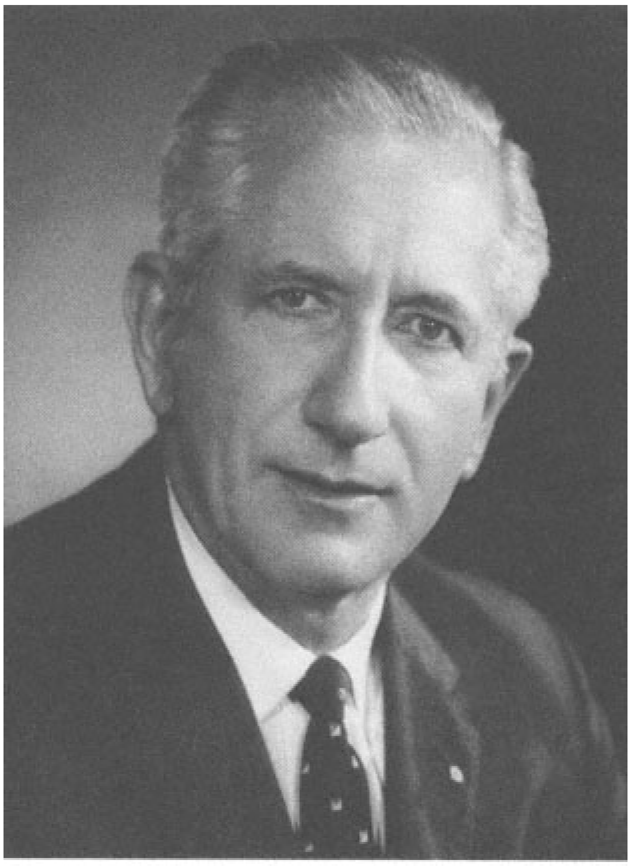
In March 1977 Alan was elected to the National Academy of Engineering. Other honors and recognition included the following from Ohio State University: in 1960 the Benjamin G. Lamme Medal "for meritorious achievement in engineering," in 1970 a Centennial Achievement Award, and in 1972 an honorary doctor of science degree. In 1965 he was given the Gold Knight Award of the National Management Association.

Alan was a fellow of the Society of Automotive Engineers, and a member of the Detroit Board of Commerce, the Automotive Organization Team, the board of the Michigan Opera Theatre, the Oakland University Library Board, the Ohio State University Development Fund Board, and the Ohio State University Indus trial Advisory Committee for the Department of Mechanical Engineering.

Of Alan's 1934 college graduating class of nearly two hundred, he was the only one to be hired by the auto industry that year. He never regretted his choice of Chrysler where he made a lasting career. In his words: "Competing automakers had two or three times the head-count in engineering, yet we've managed to cover 95 to 98 percent of their market offerings and still be innovative. That shows we've had a pretty good bunch of engineers. We have to be selective. We can't test every possibility or approach. If you can try every alternative leading to a solution it's not very difficult to pick the right one. We have not been able to afford that extravagance."

A deep interest in the operation of mechanisms was one of Alan's major characteristics. His home workshop was complete and well-used to develop personal projects and ideas. As an ardent golfer, he developed and patented a device for improving the swing. In "retirement," he continued engineering work as a consultant, but he also became involved in real estate development, banking, and the glamorous field of treasure hunting. Thanks to his scientific perception, he recognized the leading-edge technology developed by a group of oceanography engineers engaged in searching out sunken treasure, and he helped back them financially. This program led to a discovery valued at a billion dollars.

During his later years, he encountered extensive medical problems that required many operations over a two-year period and resulted in the loss of both legs. Typical of his determination, he became involved in development of a van and other devices that allowed him to operate in many of his fields of interest with the humor, enthusiasm, and thoroughness for which he will be remembered by his many friends and associates.



Gerald T. Mccarthy

1909-1990

By Wilson V. Binger

GERALD T. McCARTHY, retired senior partner and chairman of the engineering, architectural, and planning firm of Tippetts-Abbett-McCarthy-Stratton (TAMS) in New York, died on November 21, 1990, at the age of eighty-one. He had Parkinson's disease for many years.

McCarthy was born in Dover, New Jersey, in 1909 and graduated from Pennsylvania State University in 1930 with a B.S. in civil engineering, magna cum laude. He joined the U.S. Army Corps of Engineers as a junior engineer and spent eight years with the Corps in several offices working on various flood control, navigation, and power projects reaching the grade of senior engineer. During his government service he developed many methods and techniques in hydrology and water resources planning that are still used today.

McCarthy left the Corps in 1938 to join what was then Parsons, Klapp, Brinckerhoff, and Douglas of New York and spent the next nine years working in Latin America; much of this time he was a special partner in charge of the firm's work in Venezuela and Colombia.

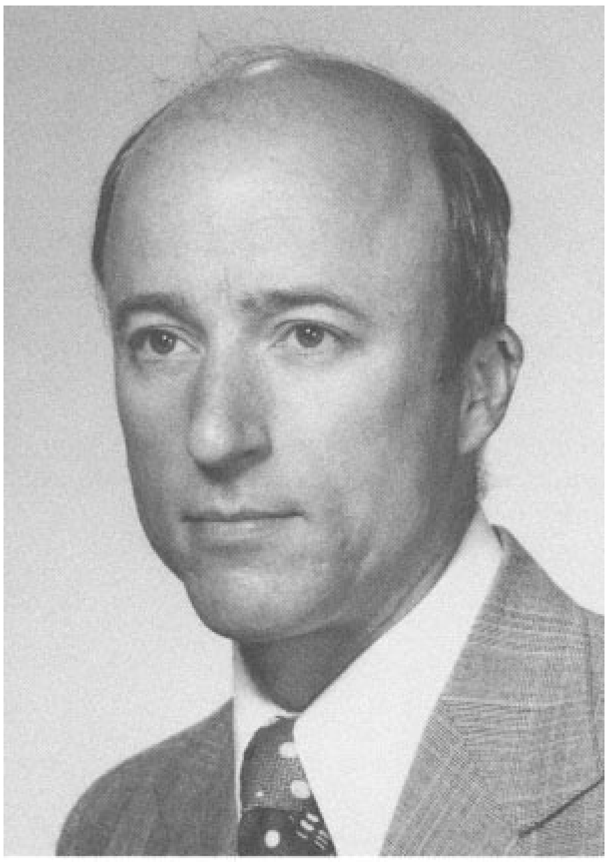
After moving back to the United States, he joined TAMS (then known as the Knappen Engineering Company) in 1947, and his name was added to the firm's partnership that same year. Largely through his efforts the firm became engaged in water resources development activities throughout much of the world. Among many notable projects, he oversaw a countrywide technical and economic survey of Burma in the mid-1950s. He was also much involved in major works in Greece, Morocco, the Philippines, Taiwan, and Turkey. McCarthy retired from TAMS in December 1974 after twenty-seven years of service; during most of that time, he was the acknowledged leader of the firm. He had the vision and imagination that brought the firm to be one of the foremost consulting firms in the United States and the world. He recruited many capable and expert engineers within the firm, some of whom later became partners themselves. He was always quick to recognize and promote talented people.

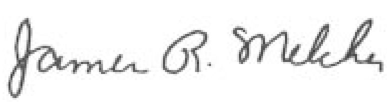
However, McCarthy's energies were not applied only to his firm. He also found time to provide leadership to the engineering profession, both nationally and internationally. He was president of the International Commission on Large Dams from 1964 to 1967, after having served as vice-president for three years. He had earlier been chairman of the United States Committee on Large Dams. He was president of the American Institute of Consulting Engineers in 1961. He served as a director and as a member of the Executive Committee of the International Road Federation, the presidency of which he declined because of other commitments. He was named an honorary member of the American Society of Civil Engineers and chairman of the National Water Policy Committee. He was a registered professional engineer in seven states, the District of Columbia, and the Panama Canal Zone.

McCarthy was elected to the National Academy of Engineering in 1973. His other memberships included the National Society of Professional Engineers, the Society of American Military Engineers, the American Geophysical Union, the American Geographical Society, the Moles, the American Water Works Association, the U.S. National Committee of International Commission on Irrigation and Drainage (member and cofounder), Tau Beta Phi, Chi Epsilon, Phi Mu Alpha, Kappa Gamma Pi, and Phi Kappa Theta. In addition to his professional memberships, McCarthy was a member of the Equestrian Order of the Knights of the Holy Sepulchre in New York and a member of Saint Teresa of Avila Church in Summit, New Jersey. He had also been a member of the board of trustees of Canoe Brook Country Club. He received the Distinguished Alumnus of Pennsylvania State University Award.

Much of McCarthy's success, and there was a lot of success, was in my opinion the result of his personality. It was not only dynamic—he always appeared to be the outstanding person in any group—but also represented a real interest in people. He knew all his key employees, a hundred or more, on a first name or nickname basis, and he also knew their hobbies, the names of their wives and children, and so on, which was all made possible by a wonderful memory. He was always ready to interrupt his work to receive visitors to the office, including overseas employees or former associates who might come by. He was an enthusiastic golfer, an amateur photographer, and a very occasional violinist.

McCarthy was married to Grace Baskerville McCarthy, who predeceased him. He is survived by a daughter, Susan M. Relyea of New York City; a son, George of Florham Park, New Jersey; and two grandchildren.





James R. Melcher

1936-1991

By Thomas H. Lee And Markus Zahn

JAMES R. MELCHER, an engineer and scientist widely respected r his practical applications of the principles of continuum electromechanics and a member of the faculty of the Massachusetts Institute of Technology (MIT) since 1962, died on January 5, 1991, at the age of fifty-four.

Professor Melcher was elected to the National Academy of Engineering in February 1982. At the time of his death, he was the director of the Laboratory for Electromagnetic and Electronic Systems at MIT and was the Julius A. Stratton Professor of Electrical Engineering and Physics. He was a member of the Department of Electrical Engineering and Computer Science (EECS).

Professor Melcher was noted for work that defined the field of continuum electromechanics and for leading in its engineering and scientific applications to human needs. He was inventor or coinventor of twelve patents.

As a broadly interdisciplinary engineering science, continuum electromechanics draws upon electromagnetics, fluid and solid mechanics, heat transfer, and physical chemistry. Professor Melcher was a leader in its application in a variety of ways, including air-pollution control, energy conversion, plasma physics, the measurement of fluid flows, the control of the thickness of sheet glass, the generation of electricity by means of the flow of fluids in electric and magnetic fields, electric power apparatus, and physiology.

A native of Giard, Iowa, where he was born July 5, 1936, Professor Melcher came to MIT from Iowa State University, where he had received his B.S. in electrical engineering in 1957 and M.S. in nuclear engineering in 1958. He received his Ph.D. at MIT in 1962. His 1971-1972 sabbatical at Churchill College, Cambridge, England, was with Sir Geoffrey I. Taylor at the Cavendish.

Considered an outstanding educator—he received the Outstanding Teacher Award from the New England Section of the American Society for Engineering Education in 1969 and the MIT Graduate Student Teaching Award in 1978—Professor Melcher was noted for his dynamic lectures and as a leader in teaching electromagnetic field theory. He was a critical judge of the quality of his students' work, but he did not spare effort and concern in helping his students reach the high standards that he set for himself and them. He deeply affected his students' lives, careers, and values.

His first book, *Field-Coupled Surface Waves,* an outgrowth of his doctoral thesis, was published in 1963. In the 1960s he coauthored a series of three books titled *Electromechanical Dynamics,* accompanied by films. His book titled *Continuum Electromechanics,* a graduate text and encyclopedic research reference, was published in 1981 and remains the definitive text in the field. In 1989 he was coauthor of another text, *Electromagnetic Fields and Energy,* which includes a set of videotapes of lecture demonstrations. His films, tapes, and texts are in wide use at universities throughout the world.

He was a fellow of the Institute of Electrical and Electronics Engineers and a member of the American Physical Society, the American Chemical Society, and the American Society of Mechanical Engineers.

Professor Melcher's work was recognized with many awards throughout his career, starting with the First Mark Mills Award of the American Nuclear Society (1958), given for his master's thesis; a Guggenheim Fellowship (1971); Young Alumnus Award (1971) and Professional Achievement Citation in Engineering (1981), both from Iowa State University; and numerous best-paper awards.

He was the son of a minister and had a high sense of commitment to important social issues in both his professional and personal life. He felt strongly that MIT in general and the EECS department in particular should make a greater effort to obtain research funding from industrial sources rather than the Department of Defense. Jim was an activist trying to make MIT a leader in addressing national problems, and he educated his students for their wider responsibility to the nation. Unlike many academics, Jim tried to understand the real-life problems of the industrial world (and he taught his students to do the same). He had two simultaneous objectives in his industrial research: solving near-term pressing technical problems for the industrial sponsors while at the same time advancing engineering science. He was one of the founders of the MIT *Faculty Newsletter* and often spoke out if he felt that insufficient attention was paid to matters of principle and integrity. There are many examples of his commitment to be a spokesman for his strongly held beliefs: his work with the Southern New England Conference of the United Methodist Church on a resolution condemning militarism and calling for the conversion of industry from weapons manufacture to peaceful uses, his discussion with engineering colleagues at MIT about the implications of Strategic Defense Initiative (SDI) funding, his support for and work on the MIT committees on Lincoln Laboratory, and his concern about the impact of military funding on education and research.

In 1986 Professor Melcher was one of four university researchers who made public at a Washington, D.C., news conference a petition signed by more than thirty-seven hundred senior faculty members across the nation, who pledged to do no research for the SDI program. Even during his last days, it was important to him to complete an article entitled "America's Perestroika" that compared his own personal deteriorating health to the poor health of the country due to the unwillingness of our leaders to honestly define and address the problems of our present way of life. The paper discussed such topics as the need for a national energy policy and examined the role of the U.S. military in our budgetary and competitiveness problems. An edited version of this paper was published in the April 1991 *Technology Review* alumni pages. Jim followed the NAE studies on "National Interests in an Age of Global Technology" closely. One of us (T. H. Lee), as chairman of that study, had numerous discussions with Jim. He made significant contributions on the subject at the Irvine, California, conference.

One cannot know Jim Melcher without mentioning his commuting nine miles each way by bicycle from Lexington to MIT every working day of the year, rain or snow. He experimented with all kinds of means to make a bike navigable in snow and on ice. He biked in part because it helped him in his fight with diabetes, but it was also a personal way for him to demonstrate the need for a national energy policy of nonpolluting energy self-sufficiency. It had the secondary benefit of attracting to his laboratory kindred-spirited students who had similar values, resulting in a bicycle as the laboratory symbol on their sweatshirts.

Jim Melcher profoundly affected the careers of his colleagues and students. He lived a life of purpose and scope and faced his painful illness with courage. His wisdom on technical and human matters will be missed by all.

Photograph by Fabian Bachrach.

Frank R. Milliken

1914-1991

By Nathaniel Arbiter

FRANK R. MILLIKEN, who had retired as chief executive officer of the Kennecott Copper Corporation in 1979 and had been elected to the National Academy of Engineering (NAE) in 1975, died at his winter home in Tucson, Arizona, on December 4, 1991, of coronary failure.

Frank was born on January 25, 1914, in Malden, Massachusetts, where he received his early education. Entering Massachusetts Institute of Technology (MIT) in 1931, he received the B.S. degree in mining engineering in 1934.

From that year on, he began his lifelong association with the mining industry, which was to bring him to eventual leadership of one of this country's major copper producers—the Kennecott Corporation. Starting his career during the depression of the 1930s, he worked briefly for the Peru Mining Company in Deming, New Mexico, as a metallurgist, before occupying the post of chief metallurgist for the General Engineering Company in Salt Lake City, Utah, from 1936 to 1941. He then worked briefly as test engineer at the Utah Copper Company's Magna Concentrator during 1941, foreshadowing his eventual long-term association with Kennecott, its parent company. Joining the National Lead Company's Titanium Division in 1941, his first position was as superintendent of its concentrator in Tahawus, New York, making this operation a model of technical efficiency. This resulted in his becoming assistant manager of the titanium division in 1949, a post he occupied until 1952.

In that year he rejoined Kennecott as the vice-president of mining, becoming executive vice-president and director in 1958, president and chief executive officer in 1961, and finally chairman and chief executive officer in 1978 prior to his retirement in 1979. During the hectic times for the copper industry in the 1960s and 1970s, Frank received national attention through his astute and aggressive management policies, as well as for his involvement in public affairs. That period, in addition to intensified promulgation of strikes by organized labor, saw the nationalization of the copper mines held by Kennecott and Anaconda in Chile and the beginnings of enforcement of new environmental protection regulations under the Environmental Protection Agency. These enforcements were to drastically alter copper smelting practice and, through the increased availability of sulfuric acid, provide new sources of copper through the leaching of low-grade ores. Kennecott, under Frank's leadership and through his support of its research department, was to play an important role in these developments.

Another area on which Frank focused was the expansion of Kennecott's activities into other mineral-related fields, some successful, others not. His predecessor at Kennecott's helm, Charles R. Cox, had started this endeavor with the attempted acquisition of the Okonite Company, a copper fabricator; the Quebec Iron and Titanium Company; and several South African gold mining ventures. The first ran afoul of antitrust regulations, and the others had technical and financial problems. Under Milliken, the major diversification from copper was the acquisition of Peabody Coal in 1966, whose sales and assets then totaled one-third of Kennecott's. However, the Federal Trade Commission detected antitrust implications and started legal actions, which it eventually won in 1977. This forced Milliken to sell Peabody for a price near one billion dollars, instead of spinning off the shares, a move described by *Fortune* magazine as brilliant.

The next and the most dramatic of any of Frank's actions was the acquisition of the Carborundum Company in late November 1977. Because of the depression in the copper industry, Kennecott's directors had advised avoiding any expansion of copper capacity, with Carborundum an attractive alternative.

However, this led to a classic proxy battle, as well as a court battle, pitting Kennecott against T. R. Berner, a veteran of such wars, who was chief executive of Curtiss-Wright Corporation. With no holds barred by Berner, including personal attacks against Frank, both the proxy and legal battles were joined in the spring of 1978, with Kennecott the winner in both. Peter Grace, a Kennecott director, said that Frank's campaign resembled his earlier aggressive tactics in the 1930s as an all-American goalie on MIT's hockey team and as a winning substitute varsity wrestler.

His election to the National Academy of Engineering in 1975 was not only a tribute to his leadership in a major industry, but to Frank's manifold activities in the public interest as well. These activities included his service as deputy chairman of the Federal Reserve Bank of New York, chairman of the Federal Reserve Board of New York, director and vice-chairman of the American Mining Congress, a member of the Business Council, and head of the United Fund of Greater New York. In addition, he headed the International Copper Research Association and the United States Copper Association. He received the U.S. Treasury Department's Distinguished Service Award in 1965 for help in selling government bonds. His memberships in professional societies included Tau Beta Pi fraternity; the Mining and Metallurgical Society of America; and the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), in which he was designated a distinguished member of its Society of Mining Engineers. Other honors he received were the Robert H. Richards Award of AIME, the Copper Man of the Year Award from the Copper Club, and the Distinguished Service Award from the American Mining Congress.

One of Frank's most enduring and dedicated associations was with MIT, which began in 1954 when he became a member of the visiting committee for geology and geophysics. He was elected a member of the Corporation in 1962; he became a life member in 1977 and life member emeritus in 1986. During these years he served on numerous committees, both administrative and educational. The latter included the visiting committees for the departments of chemistry, earth sciences, nuclear engineering, and metallurgy and material sciences. A former president of the institute called him "a devoted and generous alumnus, and a trustee of extraordinary dedication ... a valued counselor to its president's and chairmen." In token of this he received MIT's Corporate Leadership Award in 1976. He also received honorary degrees from the Colorado School of Mines and the University of Utah.

Survived by his devoted wife of fifty-six years, Barbara Kingsbury Milliken, and by their two sons, Frank and David, Frank's later years were devoted to his family, and until his health deteriorated, to his favorite sports, golf and fishing. He will be long remembered as a public servant and as an engineer who fought successfully for his company's survival, during a period when many other mining companies succumbed to declining resources, to domestic and foreign economic and political pressures, and to corporate wars.

Kiyoshi Muto

1903-1989

By Joseph Penzien And George W. Housner

KIYOSHI MUTO, professor emeritus of the University of Tokyo, world-renowned teacher, researcher, and practitioner in the field of architectural engineering, died on March 12, 1989, at the age of eighty-six.

In recognition of his leadership role and many unique contributions in the field of earthquake engineering, he was elected foreign associate of the National Academy of Engineering in 1978.

Professor Muto was born on January 29, 1903, in Ibaraki Prefecture, Japan. Upon graduation from the Tokyo Imperial University (former name of the University of Tokyo) in 1925, he joined its faculty in the Department of Architecture, where he advanced rapidly to the rank of professor at the age of thirty-two. Having been greatly influenced by Japan's Great Kanto earthquake of 1923, he devoted thirty-eight years (from 1925 to 1963) as a member of the faculty developing and teaching the principles and procedures of earthquake resistant design, including the internationally known D-method used by engineers in many seismic regions of the world. Recognizing the importance of experimental verification of structural performance, he was instrumental in the development of a two-thousand-ton testing machine in 1958; and, to advance dynamic analysis capability, he developed a seismic response analyzer in 1960. Professor Muto served in various administrative roles while at the university, including trustee of the University Senate (1958-1960) and dean of the Faculty of Engineering (1960-1962). His former students, in turn, became eminent engineers and professors of engineering, so his influence has extended to the third and fourth generations.

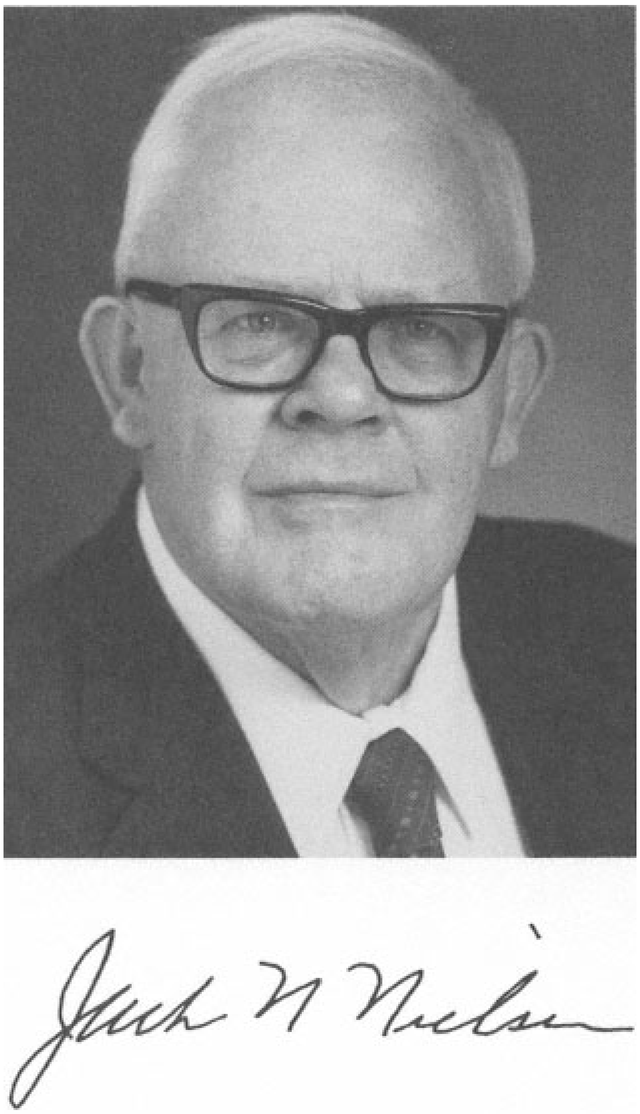
Upon his retirement from the University of Tokyo in 1963, Professor Muto became executive vice-president of the Kajima Corporation, a position he held until 1977; and, in 1965, he established the Muto Institute of Structural Mechanics, Inc., serving as its president until his death in 1989. While affiliated with these firms, he continued his earlier leadership role in the development of seismic resistant designs. His special studies on the nonlinear seismic response of high-rise buildings in the early 1960s led to the acceptance and construction of many such structures in Japan, the first of which was the Kasumigaseki Building in downtown Tokyo. With his continuing guidance during this period of development, Japan's building standards on structural design and analysis were rapidly modernized; and, with his invention and introduction of the reinforced concrete slitted-shear-wall construction, the seismic performance of such structures was greatly enhanced. In addition to his many outstanding contributions to the development of seismic-resistant high-rise building construction in Japan, Professor Muto made similar contributions to the development of its nuclear power plant construction through improving design and analysis methodologies and verifying performance by experimental means. Today the citizens of Japan are quite confident that such structures of modern design will perform satisfactorily during future earthquakes. Much of this confidence is the result of Professor Muto's many contributions in earthquake engineering.

During his entire career, Professor Muto contributed greatly to the advancement of architectural and civil engineering through his participation in professional society activities, including technical committees, seminars, symposia, and national and international conferences. As a leader of such activities, he served as a member of the Science Council of Japan and as president of the Architectural Institute of Japan, 1955-1957, Japanese Society of Soil Mechanics and Foundation Engineer ing, 1956-1958, Japan Concrete Institute, 1965-1967, International Association for Earthquake Engineering, 1963-1965, and the Japan Federation of Engineering Societies, 1975-1977. He also made major contributions through his numerous publications, including his five-book series entitled *The Aseismic Design of Structures,* Maruzen Co., Ltd. and through the U.S. patents Composites Building Structure and Walls, 3,736,712, June 5, 1974; Supporting Structure for Pressure Vessel for Nuclear Reactors, 3,841,593, October 15, 1974; and Process for Reinforcing Reinforced Concrete Post, 4,071,966, February 7, 1978.

His awards and honors include his membership in the Japan Academy; Imperial Prize from the Japan Academy, 1964; Commendation by the Minister of State for Science and Technology, 1968; Medal with Purple Ribbon, 1968; International Award of Merit in Structural Engineering from the International Association of Bridge and Structural Engineering, 1976; Order of Culture, 1983; and Grand Cordon of the Order of Sacred Treasure.

In the conduct of research and development work at the Muto Institute of Structural Mechanics, Inc., Professor Muto gave major responsibility to very talented young engineers who considered it an honor to work for him. He personally supervised their work, demanding and receiving the highest levels of performance. Whenever they prepared papers and slides for conference presentations, he would closely check every detail, requiring modifications until totally satisfied. Preconference rehearsals would then be carried out and, at the conferences, he would usually sit in the center front row to observe their final performances; thus, they were more worried about satisfying Professor Muto than the attendees in general. He, of course, awarded them for their fine performances; they, in return, revered him for his guidance.

Although Professor Muto was extremely busy with his professional activities, he found time for a variety of hobbies that he enjoyed immensely. In his early years as a university student, he developed a strong interest in sports, playing catcher on the baseball team and skiing on skis designed and made by himself. Later, golf became his favorite sport, playing until the age of seventy-eight on many courses around the world, including Pebble Beach and Spy Glass Hills in the United States. During these years, he also loved to watch professional baseball games and Sumo wrestling at the stadiums and on television. His other hobbies included growing his own orchids, which he did until his hothouse burned down, and working with the inner mechanisms of cameras.



Jack N. Nielsen

1918-1990

By Dean R. Chapman

JACK N. NIELSEN, a pioneering developer of engineering methods for analyzing the aerodynamic characteristics and interference effects of various aerospace configurations, died in his sleep on October 31, 1990, at age approaching seventy-two.

During his forty-nine-year professional career, Jack contributed extensively to both government service and the aerospace industry. Early in his career he served for thirteen years as a research engineer with the National Advisory Committee for Aeronautics (NACA), and near the end of his career served for six years as chief scientist at the Ames Research Center of the National Aeronautics and Space Administration (NASA). In the private sector, he was first a cofounder and director of research of Vidya, Inc., and later the president and founder of Nielsen Engineering and Research, Inc. In his professional activities, in both government and private industry, Jack's main technical contributions were to research and development of advanced methods for the aerodynamic engineering of aerospace vehicles.

Jack was born on November 21, 1918, in Carnarvon, Wales, the son of a captain of a merchant marine ship. Although born in Great Britain, Jack's family moved to the United States when he was young, enabling him to become a naturalized U.S. citizen at age twelve. He graduated from the University of California, Berkeley, in 1941 with a B.S. in mechanical engineering, but soon thereafter served with the U.S. Army Engineers during World War II. Following military service, Jack studied aeronautics and mathematics at the California Institute of Technology, receiving an M.S. in 1949, and two years later his Ph.D.

Jack Nielsen is internationally renowned in aerospace engineering, especially for his highly original contributions to missile aerodynamics. These began with his Ph.D. thesis research wherein he developed a special set of transcendental mathematical functions that could be applied to analyze the effects of wing-body-tail interference. In the 1950s relatively little was known about missile aerodynamics except that the then existing body of knowledge about aircraft aerodynamics could not be applied to the greatly different shapes of missiles. Jack conducted many aerodynamic research investigations during his years with the NACA Ames Aeronautical Laboratory, leading to publication of his book *Missile Aerodynamics* in 1960. Although published decades ago, this book is still used regularly and is deemed a classic. It has been translated into foreign languages, including Russian, and has become a standard in the field.

During his years in private industry, Jack's research contributions continued and extended to a variety of other areas of supersonic and subsonic aerodynamics. He made fundamental contributions in the 1960s to methods of computing separated flows on aircraft and missiles, and in the 1970s to methods of computing vortex flows behind bodies and aircraft. He then developed new methods for computing trajectories of store separation from their carrier aircraft. Beginning in the 1970s before the subject became popular, Jack pioneered in developing engineering methods for analyzing the nonlinear aerodynamics of vehicles such as modern fighter aircraft that must operate at very high angles of attack. He also contributed several key papers on orbital mechanics and atmosphere entry. Altogether, Jack published nearly two hundred technical papers between 1943 and 1984, some on quite different subjects including parawings, sail rotors, dispersion in estuaries, and wake turbulence.

In recognition of his many fundamental contributions to aerodynamics engineering, and to his status as the leading authority on missile aerodynamics in the United States, Jack was selected in 1979 to present the distinguished Wright Brothers Lecture of the American Institute of Aeronautics and Astronautics. His subject was missile aerodynamics. Jack was a fellow of the Royal Aeronautical Society and of the American Institute of Aeronautics and Astronautics. He was elected to the National Academy of Engineering in 1985.

Jack did not confine his work to research accomplishments or corporate entrepreneurship. The breadth of his professional work is reflected in the various national committees he served on: AIAA technical committees of fluid dynamics, of atmosphere flight mechanics, and of missile systems; NASA committees for aerodynamics stability and control, and for configurations and aerodynamics; and U.S. Navy panels for gas dynamics and for missile stability and performance.

In personal character, Jack Nielsen was a man very tolerant of those whose life-styles and beliefs were far from his own. He was always sympathetic to people less fortunate than most, and invariably exhibited professional integrity without facade or pretense. Very direct and forthright in his demeanor Jack would state clearly if something appeared good, and would not hesitate to exclaim even more clearly, sometimes in deep stentorian voice, if it did not.

His integrity and strong feelings about what he believed was right were revealed early. United States participation in World War II started shortly after his professional career began as a young graduate mechanical engineer engaged in research at NACA's Langley Field, Virginia. Jack felt strongly about his country's war effort. Believing that he could contribute more directly and effectively by being in the military service, Jack resigned his comfortably secure research position with NACA, and enlisted as a private in the U.S. Army. It was while serving with the armed forces in Germany that he met Gisele, who became his wife of more than four decades.

Individuals of the personal character, integrity, and professional capability of Jack Nielsen are not common. He is indeed missed by his family, friends, professional colleagues, and employees of the company he founded.

Zenji Nishiyama

1901-1991

By M. Meshii And Morris Fine

ZENJI NISHIYAMA, the world's foremost researcher in martensitic transformations, died on March 12, 1991. He was eighty-nine. His research studies on the martensite transformation, which served as the basis for heat treatment of steels, revolutionized understanding of this important crystallographic structure in steels. The spectacular success of the Japanese steel industries in developing dual-phase, high-strength low-alloy (HSIA) steels is greatly due to Professor Nishiyama. His research and that of his students directly contributed to the development of the steels, and his former students are in practically every major academic department, research institution, and research laboratory of steel companies. His legacy is the immeasurable contribution of his leadership in organizing and mobilizing physical metallurgists in Japan in research on thermomechanical treatments of steels and other alloys in Japan as well as in other countries.

Professor Nishiyama was born in Nagasaki, Japan, in 1901 and received his B.S. and D.Sc. degrees, both in physics, from Tohoku University (Tohoku Imperial University then) in 1927 and 1934, respectively. From 1927 to 1936 he was a research assistant in the Research Institute for Iron, Steel, and Other Metals at Tohoku University, and it was then that he served as a research associate with Kotaro Honda. From 1936 to 1939 he was an assistant professor at Tohoku University, and then from 1939 to 1941 an assistant professor at the Institute of Scientific and

Industrial Research at Osaka University. In 1941 he was promoted to full professor there, where he stayed until 1965. He then took a position as special staff member, Fundamental Research Labs, with Nippon Steel Corporation, where he stayed until 1978.

Early in his career, shortly after he began working on analysis of crystal structure of martensites, he discovered the carbon concentration dependence of the c/a ratio in tetragonal martensite. The report (*Kinzoku-no-Kenkyu* 10 [1932]: 1) coauthored with Professor Honda is still cited regularly in the literature published in this field. The most well-known discovery by Professor Nishiyama is the Nishiyama relations that established the crystallographic relation between matrix crystals and martensite crystals (*Science Reports Tohoku University* 23 [1934]: 637). For this discovery and various other contributions, he is called Mr. Martensite along with Georgy V. Kurdjumov, the discoverer of another martensite crystallographic relation, the Kurdjumov-Sachs relation.

His research of martensite was started with steels and developed further with various nonferrous alloys. Professor Nishiyama led the research on martensite in this new area, determining crystal structure and substructure of various martensite phases. His comprehensive text, *Martensitic Transformations,* was translated into English and is still a much-used source book. Many important and interesting phenomena such as the shape memory effect (SME) were found in direct connection with the thermoelastic martensite transformation. The SME alloys were in the limelight because of their functional abilities: they were used as fasteners, couplings, thermoelastic devices, and heat engines, among other applications.

The impacts of Professor Nishiyama's accomplishments over the span of his career were felt particularly in three very important and dramatic technological advances in metallurgy following World War II. These were thermomechanical treatment of steel (ausforming, TRIP steels, controlled-rolled HSLA steels, etc.), dual-phase steels (a key factor in the present technological superiority of Japanese automobiles), and shape-memory alloys.

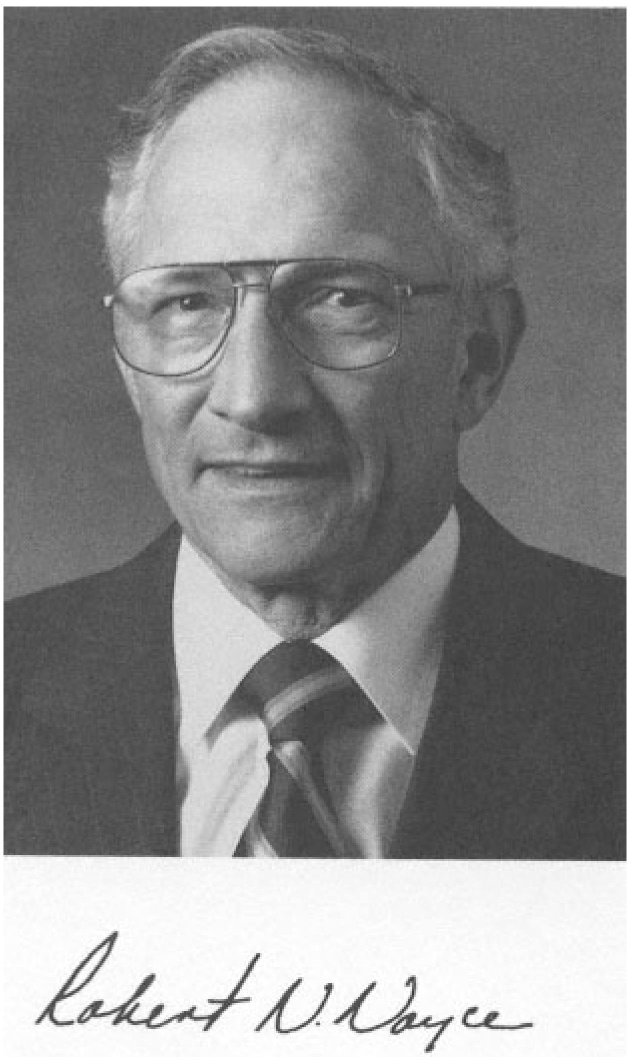
For his unprecedented contributions to the field of metal lurgy, Professor Nishiyama was recognized with numerous awards and honors. These included the Meritorious Honor, Best Paper Awards, and Society Medal of the Japan Institute of Metals; the Hattori Prize from the Iron and Steel Institute of Japan, 1936; the Seto Award from the Japan Society of Electron Microscopy, 1962; the Toyo Rayon Science and Technology Award, Toray Science Foundation, 1965; the Gold Medal of the Japan Institute of Metals; the Honda Medal of the Honda Memorial Foundation, 1972; the Japan Academy Prize (Nippon Gakushiin Sho) from the Japan Academy, 1973; and the Science and Technology Prize from the Toray Science Foundation. He is a recipient of the Third Order of Merit with the Cordon of the Rising Sun from the Japanese government. Commemorating his eminent past performance, the first International Symposium on "New Aspects of Martensitic Transformation" was held under the auspices of the Japan Institute of Metals in 1976.

He was elected a foreign associate of the National Academy of Engineering in 1982, and he was also a member of the Japan Academy of Engineers. Nishiyama was an honorary member of the Japan Institute of Metals and served as its vice-president in 1962 and also on its Governing Board and Board of Trustees. He was a life member of the Physical Society of Japan and a member of the Governing Board and the Board of Trustees of the Crystallographical Society of Japan. He also served on the Governing Board of the Honda Memorial Foundation. He was the author or coauthor of more than two hundred publications.

He retired from professorship at Osaka University in 1965 and worked for Nippon Steel as a special staff member until 1978. He enthusiastically attended scientific conferences in his field and was vigorously involved in discussion even up to a few months before his death.

Nishiyama was unquestionably the leading and most respected metallurgist in Japan. Not only was he well known around the world, but his research contributions on martensitic transformation became a part of the educational core of physical metallurgy. Starting from his very early work of orientation relationships, he contributed continually to the detailed examination of this area. The development of the electron microscope made it possible for him to extend these studies not only in steels but also in other materials. He was, in the true sense of the word, a scholar who could not rest until he felt completely comfortable with his understanding of the problem.

It should also be recognized that Nishiyama's students and their students were, in considerable measure, responsible for much of the modern intellectual approach to Japanese metallurgy, particularly in the iron and steel industry. It was a remarkable tradition that he fostered. While this great metallurgist has gone from the scene, he lives on in his publications and in the generation of students he trained.



Robert N. Noyce

1927-1990

By Gordon E. Moore

ROBERT NOYCE died suddenly on June 3, 1990, at his home in Austin, Texas, where he had been living since becoming president of SEMATECH two years earlier. His career as a physicist, inventor, and entrepreneur was closely tied to the development of the semiconductor industry.

Born in Burlington, Iowa, he received his undergraduate education at Grinnell College before going on to Massachusetts Institute of Technology for his Ph.D. in physical electronics under Professor Wayne Nottingham. Upon graduation he worked on germanium transistors at the Philco Corporation. One of his early contributions was a technique for controlled etching of very thin regions in a germanium crystal that facilitated making the first commercially available high frequency transistors.

In 1956 he joined the fledgling Shockley Semiconductor Laboratory, a subsidiary of Beckman Instruments. There he tackled the physics of silicon devices and the development of technology for their production. His paper (with William Shockley and Chih-Tang Sah) on space-charge generated currents in silicon *p-n* junctions explained the observed voltage current characteristics. This discovery was an important foundation for subsequent development of silicon transistors and other semiconductor devices.

Bob left Shockley Laboratory in 1957 to become one of eight founders of Fairchild Semiconductor Corporation. This com pany later became the Semiconductor Division of Fairchild Camera and Instrument Corporation. In 1959, while director of research and development at Fairchild, he saw how a complete circuit containing interconnected transistors, diodes, and resistors could be built in a small chip of silicon—the integrated circuit. By adding extra junctions in the silicon wafers the individual circuit elements could be isolated electrically from each other, and a metal film insulated from the silicon by a silicon dioxide layer then could be used to form interconnections. Shortly after Noyce's invention, Texas Instruments Inc. announced that Jack Kilby had built a circuit consisting of several elements in a germanium crystal. Noyce and Kilby are generally credited as coinventors of the integrated circuit. In fact, the first Charles Stark Draper Prize awarded by the National Academy of Engineering was shared by Noyce and Kilby, recognizing the unique importance that their inventions have had on society. It is worth noting, however, that their contributions were developed independently and were very different in their execution.

In 1959 Bob became general manager of Fairchild Semiconductor giving him the opportunity to guide the commercialization of his invention. Fairchild was the first to market with integrated circuits and was the world's leading producer for much of the 1960s. Under Bob's management Fairchild continued to make key contributions, both technical and in the development and evolution of the semiconductor business. Fairchild scientists developed an understanding of the silicon-oxide interface, enabling the corporation to make stable metal-oxide semiconductor (MOS) transistors. This continues to be the dominant element in today's integrated circuits. They invented complementary MOS (CMOS) circuitry, the basic circuit form still commonly used today. They also came up with the idea of using gate arrays and standard cells as low-cost design approaches, making possible the economical production of small quantities of logic functions. Based on these discoveries, the company designed and sold a host of digital and analog circuits.

The early market for integrated circuits was slow to develop. So Noyce, who appreciated the potential price elasticity of integrated circuits, announced that Fairchild would sell the chips at a price lower than the sum of the costs of the individual components necessary to make the equivalent circuit. This decision helped trigger the explosion of the integrated circuit market.

In 1968 Noyce left Fairchild and cofounded Intel Corporation to pursue opportunities in large-scale integration. He was Intel's president and chief executive officer until 1975. Over this time frame, Intel introduced the first principal semiconductor memory types—DRAM, SRAM, and EPROM—as well as the microprocessor.

Once Noyce turned over the day-to-day management of Intel, his broader interests in the electronics industry and its relation to government and society consumed the majority of his time. By offering his technical and business advice, he nurtured a number of technology-based companies in Silicon Valley. He was among the first to appreciate the increasing importance of foreign competition in electronics and the weaknesses of American companies. He dedicated much of the last dozen years of his career trying to improve the competitiveness of U.S.-based industry. Noyce was a familiar and effective figure in Washington, D.C.; a founder of the Semiconductor Industry Association; and a tireless advocate of change—in education, capital formation, the tort system, and other areas—aimed at removing impediments to U.S. competitiveness.

He was on the board of trustees of Grinnell College from 1962 until his death and served as its chairman from 1966 to 1970. He was also a regent of the University of California.

Noyce played a prominent role in the formation of SEMATECH, which represented a unique attempt to foster cooperation among semiconductor companies and the U.S. government in an effort to increase U.S. competitiveness in manufacturing. When the search committee (of which Noyce was chairman) could not identify someone to be SEMATECH's first chief executive officer, Noyce responded to the urging of his colleagues in the industry and agreed to take on the responsibility himself. As he put it, "It was just too important a job to leave to others."

He was elected to the National Academy of Engineering in

1969 and to the National Academy of Sciences in 1980. He received both the National Medal of Technology and the National Medal of Science, the Stuart Ballantine Medal of the Franklin Institute, the IEEE Medal of Honor from the Institute of Electrical and Electronics Engineers (IEEE), the Faraday Medal from the Institute of Electrical Engineers (United Kingdom), the Cledo Brunetti Award from the IEEE, and the Harry Goode Memorial Award from the American Federation of Information Processing Societies.

Although Noyce's technical contributions in the development of the integrated circuit are what earned him his long list of prizes and fellowships, his many friends best remember him as someone who was always approachable, always interested in their problems and ideas, and always ready with suggestions—often involving innovative and unusual approaches at odds with conventional wisdom. In my thirty-four years of association with Bob, many of his suggestions proved invaluable in the progress of my work.

Noyce was totally involved in living. He was a good athlete—a champion diver in college and an excellent skier—and he loved scuba diving, hang gliding, and piloting his airplanes, which ranged from an ancient Seabee to a private jet. In fact, he was scheduled to leave Austin to pick up his new jet the very day he died. It was a plane in which he could fly nonstop from Austin to either Washington, D.C., or Silicon Valley.

Thomas O. Paine

1921-1992

By Edward E. Hood, Jr.

THOMAS 0. PAINE, a former administrator of the National Aeronautics and Space Administration (NASA), a long-time General Electric (GE) research scientist and executive, and later president and chief operating officer of the Northrop Corporation, died of cancer on May 4, 1992, at the age of seventy.

Dr. Paine's greatest accomplishment came in his nearly three years with NASA, first as deputy administrator beginning in January 1968 and then as administrator from March 1969 to September 1970. These were among the most historic and heroic years in the history of the space program. The first seven Apollo missions were launched, twenty astronauts orbited the earth, fourteen flew to the moon, and four men walked on the lunar surface. Dr. Paine will be best remembered as the man who directed these feats of science, engineering, and exploration.

Tom was born in Berkeley, California, on November 9, 1921. He earned an A.B. degree in engineering from Brown University in 1942. Tom served as a naval officer aboard combat submarines in the Pacific during World War II and, after the war, married Barbara Helen Taunton Pearse of Perth, Western Australia.

Tom earned an M.S. and Ph.D. in physical metallurgy from Stanford University, where he initiated research on liquid metal heat transfer systems for advanced submarine reactors. From Stanford, Dr. Paine joined the General Electric Laboratory in Schenectady, New York, where he conducted studies on mag netic and composite materials. This work led to the first demonstration of the shape anisotropy effect in single-domain magnetic particles, and to worldwide basic patents of "Lodex" permanent magnets.

Tom moved to Lynn, Massachusetts, where he managed materials development at the GE Meter and Instruments Department. Later, as laboratory manager, his projects ranged from development of photo cells and non-arc-tracking organic insulation to solid-state nuclear reactor control systems and aircraft instrumentation. For the successful fine-particle magnetic development program, Tom's laboratory received the 1956 award for "outstanding contributions to industrial science" from the American Association for the Advancement of Science.

He returned to the GE Research and Development Center in Schenectady in 1959 as manager of technical analysis before becoming manager of engineering applications. In the latter capacity, he organized and managed a new laboratory component engaged in development programs in fields ranging from medical electronics and electric vehicles to power sources in villages in developing nations.

In 1963 Tom moved to Santa Barbara, California, to manage GE's Center for Advanced Studies, an innovative four hundred-man "think-tank" conducting nondisciplinary planning research for government and industry in the United States and abroad. These programs ranged from developing criteria for selecting "model cities" to logistic support systems for Polaris submarines, and from designing computerized management systems to economic development projects in Africa.

On January 31, 1969, President Johnson appointed Tom Paine deputy administrator of the National Aeronautics and Space Administration. Upon the retirement of James E. Webb on October 8, 1968, President Johnson named Tom to be acting administrator of NASA. His nomination as administrator was announced by President Nixon on March 5, 1969, and confirmed by the Senate on March 20, 1969. It was during his tenure that the first seven Apollo manned missions were flown, including the historic Apollo 11 mission, which first landed men on the moon in August 1969. Many automated scientific and applications spacecraft were also flown in Earth orbit and out as far as Mars. He organized a number of successful international programs through which other nations participated in U.S. space operations.

Tom returned to GE in late 1970, becoming vice-president and group executive of GE's Power Generation Group (Worldwide Nuclear Power and Steam and Gas Turbines). Tom capped his distinguished twenty-five-year GE career as senior vice-president for science and technology before becoming president and chief operating officer, and a director, of the Northrop Corporation in 1976.

Tom retired from Northrop in 1982 to become chairman of Thomas Paine Associates, consultants in high-technology enterprises. Tom served as a director of Eastern Airlines, RCA, NBC, Arthur D. Little, NIKE, Quotron Systems, SatScan, and Orbital Sciences Corp. He also served as chairman of the Pacific Forum; a trustee of the Committee for Economic Development, the Asian Institute of Technology (Bangkok), and Occidental College; and a member of the Visiting Committee of the East-West Center of the University of Hawaii.

In recognition of his outstanding career in both private industry and public service, Tom Paine was elected to the National Academy of Engineering in 1973.

Tom was the author or coauthor of more than thirty-five published technical papers and held several patents. He was a fellow of the American Institute of Aeronautics and Astronautics and the American Astronautical Society, and a member of the American Physical Society, the American Institute of Electrical and Electronics Engineers, and other scientific and engineering societies. He held honorary degrees from various universities in the United States and overseas and was awarded the U.S. Navy Commendation Medal and Submarine Combat Insignia with stars, the NASA Apollo Achievement Award and its Distinguished Service Medal, the Order Al Merito Della Repubblica Italiana, the Washington Award from the American Society of Civil Engineers, the John Fritz Medal of the United Engineering

Trustees, the Humanitarian Award of the National Conference of Christians and Jews, and the Faraday Medal of the Institution of Electrical Engineers (London).

Tom is survived by his wife, Barbara, and their four children, Marguerite, George, Judith, and Frank.

Tom Paine was an engineer who applied his science in both the private and public sectors, for the benefit of both the United States and the world. His life and work made history.

Alan J. Perlis

1922-1990

By Fernando J. Corbató

ALAN J. PERLIS, one of the leading figures in the development of modern computer science, died of a heart attack on February 7, 1990, in New Haven, Connecticut, at the age of sixty-seven.

Perlis was elected to the National Academy of Engineering in 1977. As one of the pioneers in establishing the fledgling discipline of computer science, Perlis made several seminal contributions. He played a major role in establishing the preeminent computer science department at the Carnegie Institute of Technology (now Carnegie Mellon University). He was a leader in the development of early algebraic languages and was a forceful member of the international committee that formulated the influential ALGOL-60 language. He helped establish the Association for Computing Machinery (ACM) as an effective professional society while he served as an early president from 1962 to 1964. He also served as the founding editor of the *Communications of the ACM* (CACM). The common themes throughout all these activities were his great personal impact, his verve in articulating the core of an argument, the pithiness of his remarks, and the courage of his convictions.

Perlis was born in Pittsburgh, Pennsylvania, on April 1, 1922. He received a B.S. in chemistry in 1942 from the Carnegie Institute of Technology. From 1942 to 1945 he served in the U.S. Army Air Force. He received an M.S. and a Ph.D. from the Massachusetts Institute of Technology (MIT) in 1949 and 1950, respectively. In 1948-1949 he was a research mathematician with Project Whirlwind at MIT. He was a mathematical adviser with the multimachine computing laboratory of the Aberdeen Proving Grounds, Maryland, in 1951-1952. In 1952 he returned again to Project Whirlwind at MIT where he remained until becoming an assistant professor at Purdue University in September 1952.

At Purdue, Perlis formed and headed the institution's first digital computer laboratory. In 1955 he organized the pioneering development of the IT (Internal Translator) language compiler, initially on the Datatron 205.

In 1956 Perlis became an associate professor of mathematics at the Carnegie Institute of Technology and director of the computation center. By November 1956 a version of the IT compiler was operating on the IBM 650, and Perlis with his coworkers went on to develop a succession of algebraic language compilers and assemblers.

In 1960 Perlis was appointed as professor and chairman of the mathematics department at Carnegie Tech while continuing as director of the computation center. By 1962 he became codirector of a graduate program in systems and communication, and in 1965 he became the first head of a graduate department of computer science at Carnegie Tech. During the academic year 1965-1966, Perlis was a visiting professor at the Mathematische Centrum at Amsterdam, Holland. By the late 1960s the computer science department at Carnegie Tech was viewed as one of the top departments in the country.

In 1971 Perlis was persuaded to join the newly established (1969) computer science department at Yale University and become the Eugene Higgins Professor of Computer Science. He played a leading role in building the department and developing innovative computer science courses. He took major responsibility for teaching both at the undergraduate introductory level and at the graduate level. He was department chairman in 1976-1977 and 1978-1979, and acting chairman in 1987. In 1977-1978 Perlis spent the academic year as the Gordon and Betty Moore Professor of Computer Science at the California Institute of Technology.

Although Perlis's interests in computer science were extraordinarily broad, he maintained throughout his career a focus on programming languages. In 1958 Perlis with K. Samelson coauthored the ALGOL-58 report, a first international attempt to develop an algebraic programming language. He was a member of the subsequent committee that published the widely studied and influential ALGOL-60 report. During the 1960s, Perlis was involved in the definition of extensions to ALGOL, such as Formula ALGOL for manipulating formal mathematical expressions, and LCC, a form of ALGOL for interactive incremental programming.

Throughout his career Perlis was a frequent invited lecturer around the globe. He wrote dozens of papers and two books, some individually, some with others, on a variety of topics ranging from the virtues of particular programming languages, and the process of software engineering, to addressing basic questions such as "What is Computer Science?" His publications always got the attention of his peers for he never failed to make an interesting point and expressed himself with vigor.

Perlis was not content to be a builder of two important computer science departments and a leader in the design and study of new computer languages; as mentioned previously, he also played a major role in the formation of the ACM and was the founding editor of the *Communications of the ACM*. In 1966, in recognition of his research and scholarship in computer science, Perlis was the first recipient of the A. M. Turing Award, the highest award of the ACM.

Perlis had great impact on the discipline of modern computer science as it emerged. He received honorary doctor of science degrees from Davis and Elkins College, Purdue University, Waterloo University, and Sacred Heart University. In 1974 he was elected to the American Academy of Arts and Sciences, and in 1984 he received the AFIPS Education Award of the American Federation of Information Processing Societies (AFIPS).

In his work for the National Research Council, Perlis served on the Assembly (1979-1981) and Computational Mechanics Committee (1981-1985) of the Assembly of Engineering, on the Commission (1982-1984) and the Board on Telecommunica tions/Computer Applications (1987-1989) of the Commission on Engineering and Technical Systems, and on the National Research Network Review Committee (1988-1989) of the Commission of Physical Sciences, Mathematics, and Resources.

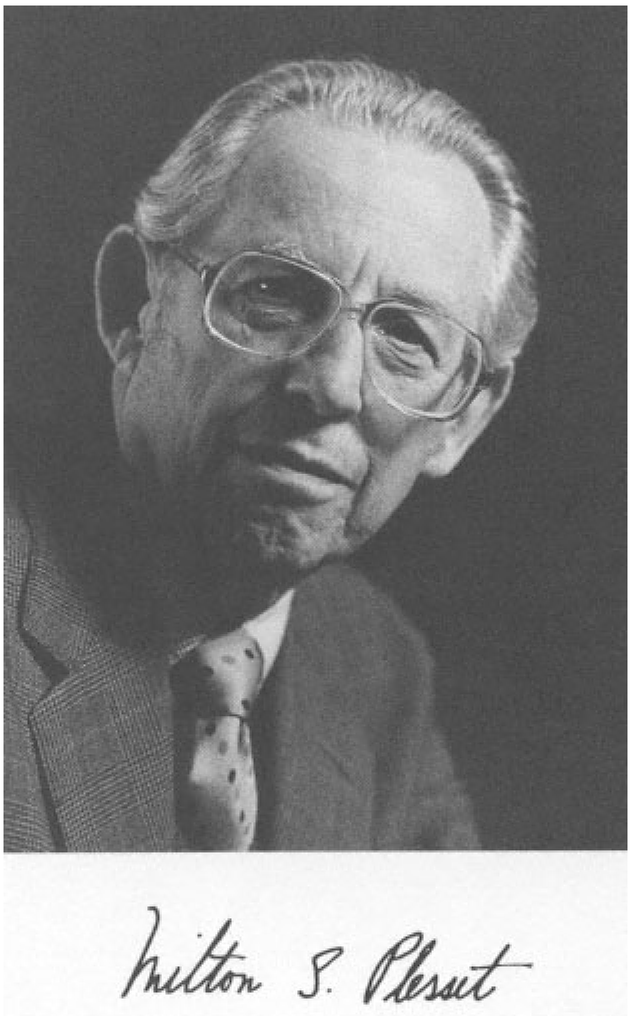
Everyone who knew Perlis will realize that the above formal recounting of his career leaves out a crucial aspect. He was a warm and enthusiastic man, with a quick wit and a wonderful ability to turn a phrase or capture the core of an idea. It was a rare committee where he did not make his presence felt by all. He could both persuade and inspire others about the wisdom of following technical paths, and he did it not only by his forcefulness and rational analysis but also by his shrewd use of humor. He was famous for his "one-liners" that epigrammatically made a technical point. His friends used to argue about which one they liked best and compile lists to circulate. For example, he noted the wide disparity of talent among programmers and the near-genius of the elite:

Everyone can be taught to sculpt; Michelangelo would have had to be taught how not to. So it is with great programmers.

Similarly, while acknowledging the value of the research process, he gently mocked the limited accomplishments of contemporary programs that emulate learning:

When we write programs that 'learn,' it turns out we do and they don't.

Perlis in his later years was confined to a wheelchair. He brooked no concern for his condition and, with the help of his devoted wife, Sydelle, maintained an active career at Yale University during the academic years and at Xerox Palo Alto Research Center each summer. He will be remembered for his courage and zest for life as much as for his technical and leadership accomplishments.



Milton S. Plesset

1908-1991

By Theodore Y. Wu

MILTON SPINOZA PLESSET, professor emeritus of engineering science at the California Institute of Technology and a world authority in the physics of fluids and nuclear energy, died on February 19, 1991, at the age of eighty-three.

Elected to the National Academy of Engineering in 1979, Milton was recognized as a leader in the fields of engineering science, nuclear engineering, and fluid mechanics. His milestone contributions to bubble dynamics, multiphase flow, theoretical physics, and nuclear reactor safeguards set new directions for research, which led to advances in these fields and promoted international cooperation.

Born on February 7, 1908, in Pittsburgh, Pennsylvania, Plesset graduated from the University of Pittsburgh in 1929 and earned his Ph.D. degree in physics at Yale University in 1932. He won a National Research Council fellowship and for its tenure was attracted to Caltech, where research on cosmic rays was making exciting advances under the leadership of Robert Millikan, and the positron was just in the process of being discovered by Carl Anderson. The great success of finding the positron was followed by a theoretical study by Milton Plesset and Robert Oppenheimer employing the Dirac equation in quantum electrodynamics to show how electron-positron pairs were produced.

These scientific activities led Plesset to spend a period of time at the Niels Bohr Institute for Theoretical Physics, 1933-1934.

Interacting with the world's leading physicists at the Bohr Institute, Plesset worked at the frontiers of fundamental physical theory and made contributions of great significance. Of particular merit were the interesting papers he wrote with Christian Moller on electon-electron interaction theory, with John Archibald Wheeler on the theory of scattering quanta, and with E. J. Williams on cosmic ray theory. These papers have greatly benefited scientists decades later because of their fundamental value.

Following this period, he was awarded a C. B. R. Traveling Fellowship, which enabled him to visit eminent leading scientists of the time in many parts of Europe, traveling with his bride Isabel and gaining valuable experience that was later passed on, through teaching and joint studies, to his peers and students.

After teaching at the University of Rochester for five years, Plesset returned to Caltech in 1940 and then left in 1942 to head the Analytical Group of the Douglas Aircraft Company where he devoted his talents to airplane design and the development of new technology. Following a round of visits to the post-war European theater as a scientific representative of the U.S. Air Force, Plesset returned to Caltech permanently as associate professor in 1948, was made a full professor in 1951, was appointed in 1963 as professor in engineering science, and became professor emeritus in 1978. He was also adjunct professor of nuclear engineering at the University of California, Los Angeles, from 1977 to 1988.

In research, Plesset made significant contributions along the frontier where science and engineering meet, leaving the profession with more than one hundred publications of lasting value. The Rayleigh-Plesset equation continues to play a basic role in bubble dynamics, whether used in cavitating flows or in the sack model for atomic nuclei theory. His inspiring teaching, marked with clarity and elegance in treating basic principles, was much appreciated by his students.

An authority on multiphase fluid dynamics and nuclear physics, Plesset served on the U.S. Nuclear Regulatory Commission's Advisory Committee for Reactor Safeguards, first as a consultant, then as a member from 1975 to 1982, and as chairman of the panel in 1980. In these capacities Milton provided assistance and guidance to the development of effective numerical codes to simulate day-to-day operations of a nuclear reactor and to monitor any emergency situation. He played a leading role in spearheading international cooperation with Japan and Germany on joint programs for model tests of the operation of nuclear reactors and establishing the overall rules for their safeguards.

Throughout his career, Plesset served as a consultant to the RAND Corporation, various industrial companies, and the government. He was active in several professional societies. He was a fellow of the American Physical Society; a fellow of the American Society of Mechanical Engineers (ASME); and chairman of the Executive Committee, Fluid Engineering Division of ASME, 1971-1972. He received many awards and honors, including the 1968 ASME Outstanding Research Paper Award and the 1980 ASME Thurston Lectureship.

Milton Plesset is survived by his wife, Janet Jenks; four children, Jean, Michael, Marjorie, and Judith from his previous marriage to Isabel Rosanoff (a writer, who died in 1985); and five grandchildren.

Robert F. Rocheleau

1920-1991

By Edwin A. Gee

ROBERT ROCHELEAU, a foremost authority on wastewater treatment and industrial water pollution, died on February 24, 1991, at the age of seventy. After spending essentially all of his adult life working in the fields of his expertise, Bob retired from the E. I. du Pont de Nemours and Company as a highly valued principal division consultant.

Bob was clearly an expert on industrial waste treatment before the vast majority of his fellow engineers were aware of its national significance. Fortunately the entire field of chemical engineering was responsive to his pioneering. Under Bob's leadership, first DuPont, then the entire organic chemical industry was guided to reduce toxins and other wastes with emphasis on biological treatment. Benefits to society have been notable especially in the restoration of lakes and streams for recreational use.

Born in Penacock, New Hampshire, on December 28, 1920, he received his degree in chemical engineering from the University of New Hampshire in 1942. By that time the world was engaged in its second great war and Bob served his country as a captain in chemical warfare. He began his distinguished career with the New Hampshire Water Pollution Control Board as a senior engineer in 1946 and subsequently served as executive secretary of the West Virginia State Water Commission from 1949 to 1954 at which time he joined the Engineering Depart ment of the DuPont Company. It was during his stay in West Virginia that he received his professional engineering license.

Bob's talents were quickly recognized by DuPont, and he moved rapidly to progressively senior assignments until he became a principal design consultant in 1971, one of only two engineers to reach this unique position at the pinnacle of DuPont's consulting organization. As such he was publicly recognized as an exceptionally qualified senior engineer, distinguished in his field. This expertise was further recognized in 1981 when he was elected a member of the National Academy of Engineering.

Throughout his career Bob was active in assisting government agencies in formulating sound regulations for attaining water purity. Adding to his early service in New Hampshire and West Virginia, he was an advisory member of the Ohio River Valley Water Sanitation Commission and a member of the Engineering Committee to the Interstate Commission on the Potomac River Basin. He was a member of several ad hoc committees of the Manufacturing Chemists Association working with the Environmental Protection Agency (EPA) in the development of guidelines associated with the Clean Water Act. As a member of the National Water Quality Commission, Bob was an invaluable adviser to the EPA staff. His contributions figured prominently in the final report, which provided a basis for the revision of the Clean Water Act.

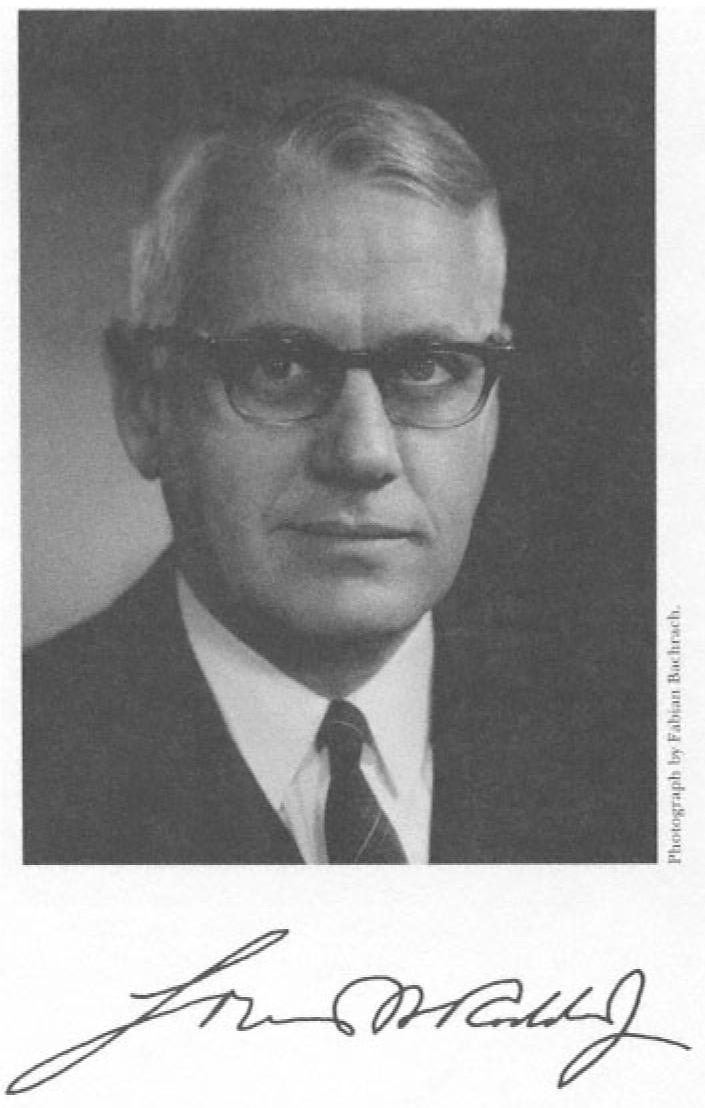
Industrially he is responsible for having developed process design criteria for the first complete mix biological treatment plant in the United States and the first industrial waste biological treatment plant at DuPont. He coauthored a paper on this accomplishment, "Systems for Handling Wastes from the Manufacture of Orlon® Acrylic *Fiber," Journal Water Pollution Control Federation,* 1961. During his career he was responsible for developing process design criteria for about twenty plants in the United States, Canada, and Europe. For ten years he was chairman of the DuPont Environmental Forum.

In 1965 Bob shared the Water Pollution Control Federation's (WPCF) Willem Rudolfs Medal for the outstanding published contribution on industrial waste control. His paper "An Industry

Approach to Pollution Abatement" was published by WPCF in its October 1964 journal. He was selected for this prestigious award a second time for another coauthored paper, "Waste Treatment at a Complex Plastics Manufacturing Plant," in 1974. Although he was not an extensive writer, it is noteworthy that two of his three publications won awards.

Bob gracefully shared his hard-won expertise not only with associates but with competitors and governments. He is an example of how one engineer can favorably affect national welfare.

After a career centered on protecting the water, Bob and his wife retired on an island waterway near Rehoboth Beach, Delaware, where they enjoyed boating, fishing, music, and travel.


Photograph by Fabian Bachrach.

Louis Harry Roddis, Jr.

1918-1991

By John W. Simpson

LOUIS H. RODDIS, JR., naval officer, engineer, and business executive died on September 15, 1991, in Charleston, South Carolina, at the age of seventy-three. At the time of his death he was a private energy consultant and was a director of the Detroit Edison Company, Hammermill Paper Company, Gould Inc., and Research Cottrell Inc.

Roddis was elected to the National Academy of Engineering in 1967 after a distinguished career in the U.S. Navy, the Atomic Energy Commission (AEC), and private industry.

Lou, the son of Louis Harry and Winifred Emily (Stiles) Roddis, was born in Charleston, South Carolina. He graduated from the U.S. Naval Academy in 1939, having the distinction of standing number one in his class each of the four years. Upon graduating he saw sea duty with the U.S. Navy in the Pacific and was in action at Pearl Harbor on December 7, 1941. In 1942 he was directed to take graduate studies at the Massachusetts Institute of Technology. After receiving his master of science degree in engineering, he was assigned to the Philadelphia Naval Shipyard.

After serving on Joint Task Force I, which was conducting atomic weapons tests in the Bikini Atoll, he joined the group of naval officers that included Admiral (then Captain) Rickover at the Clinton Laboratories of the Manhattan Engineer District (later the Oak Ridge National Laboratory).

He served directly under Rickover as project officer during the development, design, and construction of the nuclear powered submarines *Nautilus* and *Sea Wolf.* He played a major role in the development of those submarines as well as in the first U.S. central station nuclear plant at Shippingport, Pennsylvania. His was often a voice of calm and reason in a frequently frenetic atmosphere during the development of the nuclear engines for the *Nautilus.*

In 1955 he resigned as an officer in the U.S. Navy to become deputy director of the Reactor Development Division of the AEC. In this capacity he had responsibilities for both the naval and civilian reactor development programs. He helped originate the nuclear rocket project, the nuclear ship *Savannah,* the nuclear safety program, and the civilian power demonstration program.

In July 1958 he left the AEC to become president of Pennsylvania Electric Company, a subsidiary of General Public Utilities Corporation (GPU). In that capacity he directed the construction of the world's first 500-kilovolt transmission line, an achievement that resulted in the company receiving the Edison Award of the Edison Electric Institute in 1962.

In 1967 Lou became chairman of the board of Pennsylvania Electric Company and a member of the CPU corporate staff. As director of nuclear activities, he was responsible for the development of the Oyster Creek Nuclear Plant of the Jersey Central Power and Light Company, the Three Mile Island Nuclear Plant of the Metropolitan Edison Company, the first breeder reactor plant of Pennsylvania Electric, and the Saxton Nuclear Experimental Corporation plant.

Roddis next became vice-chairman of the Board of Trustees, Consolidated Edison and then president of Consolidated Edison, a position that he held until August 1973. After leaving Consolidated Edison he became president and chief executive officer of John J. McMullen Associates, Inc., a company engaged in naval architecture and marine engineering.

After 1976 Roddis was a private energy consultant with a large and varied list of clients, including many major corporations, U.S. national laboratories, the National Security Council, the

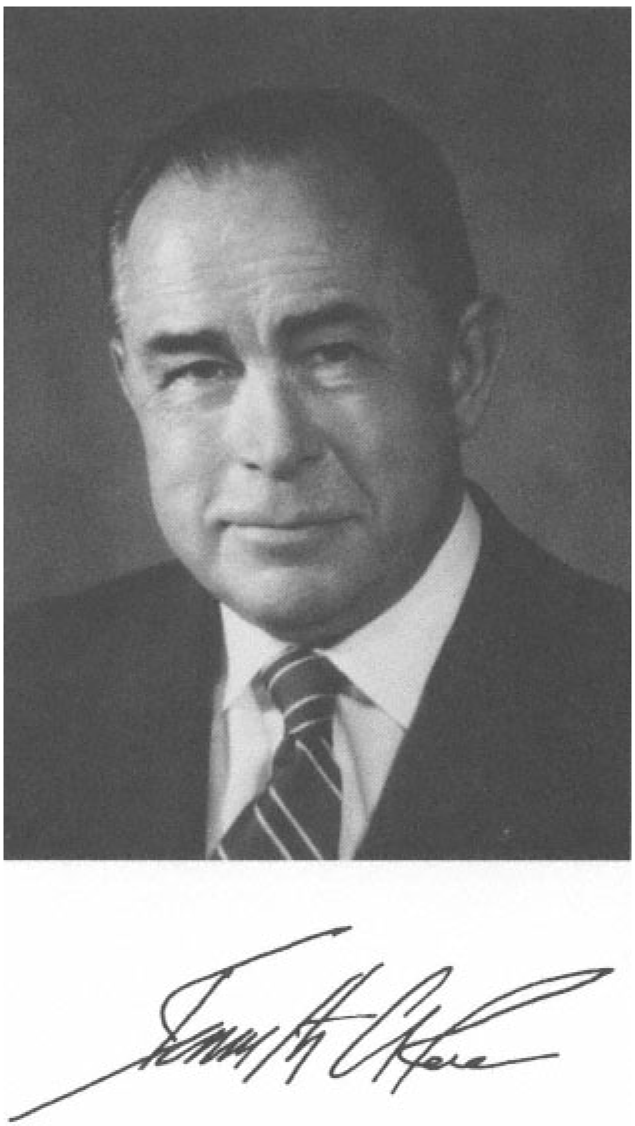
National Science Foundation, the President's Advisory Council on Energy Research and Development, and many other federal government agencies, as well as serving on the corporate boards mentioned earlier.

Lou was a fellow of the American Association for the Advancement of Science, the Royal Institute of Naval Architects, the American Society of Mechanical Engineers, and the American Nuclear Society. He also was a director of the Edison Electric Institute and the American Gas Association. He was a registered professional engineer in South Carolina, New York, Pennsylvania, New Jersey, and the District of Columbia and a chartered engineer in the United Kingdom.

He was president of the Atomic Industrial Forum from 1962 to 1964 and was elected president of the American Nuclear Society in 1969. He also was a member of the Department of Energy's Energy Research Advisory Board and its chairman for several years and chairman of the Maritime Research Advisory Board of the U.S. Department of Commerce.

In 1958 he received the Arthur S. Fleming Award in the scientific and technical field for outstanding men in government, the U.S. Atomic Energy Commission Outstanding Service Award in 1957, and the Department of Energy's Exceptional Service Award in 1984.

Lou also was a board member of a large number of civic, educational, philanthropic, environmental, and religious organizations.



Kenneth A. Roe

1916-1991

By Robert Plunkett

KENNETH A. ROE, chairman of the board, Burns and Roe Enterprises, Inc., died on June 3, 1991, at the age of seventy-five.

He was a man of wide interests and boundless energy, but his activities as an engineer and his services to his profession were of particular interest to the engineering community. These contributions have been recognized in many ways. He was elected to the National Academy of Engineering in 1978. He was awarded honorary membership in the American Society of Mechanical Engineers (ASME) and the American Society for Engineering Education and was a fellow of the American Association for the Advancement of Science, the American Institute of Chemical Engineers, the Institute of Engineers of Australia, and the Institute of Mechanical Engineers of Great Britain. He received honorary doctorates from Manhattan College and Stevens Institute of Technology. In addition to many awards and medals from a wide spectrum of engineering societies and universities, his achievements were particularly recognized by two important intersociety awards, the John Fritz Medal, given for notable scientific or industrial achievement, and the Hoover Medal, given for great, unselfish, nontechnical services by an engineer.

Ken Roe was born in Perry, New York, on January 31, 1916. He received a B.A. from Columbia College in 1938 and a B.S. in chemical engineering from the Massachusetts Institute of Technology in 1941. He was then employed as a mechanical engineer by Burns and Roe, an architect-engineering company that his father cofounded in 1932. He joined the Navy at the outbreak of the war, worked as a naval architect after receiving a certificate in naval architecture from the postgraduate school of the U.S. Naval Academy, and was promoted to the rank of lieutenant commander for his work as officer in charge of building gun turrets on battleships and cruisers at the Philadelphia Navy Yard. In addition, he was responsible for the construction of diving tanks used to train Navy divers, and he supervised the conversion of an Italian liner into a U.S. Navy troopship. He continued his studies while in the Navy and received an M.S. in mechanical engineering from the University of Pennsylvania in 1946.

In 1945 Ken rejoined Burns and Roe and spent the rest of his professional career there employed successively as an engineer, project engineer, vice-president, and executive vice-president. He became president in 1963 and chairman of the board in 1971.

Ken Roe was particularly interested in power generation and was always in the forefront of developing technologies. Under his direction, Burns and Roe has been responsible for the design, engineering, and construction of some of the world's largest and most innovative power generating plants, both fossil-fueled and nuclear. He was personally involved in building the first demonstration nuclear power plant at Shippingport, Pennsylvania, and his company had a major role in the design and construction of the Oyster Creek Nuclear Power Station for Jersey Central Power and Light as well as the Clinch River liquid-metal fast breeder reactor demonstration plant in Oak Ridge, Tennessee. Burns and Roe is actively involved in developing the practical applications of advanced energy technology such as synthetic fuels, magnetohydrodynamics, fuel cells, solar energy conversion, and fusion power. In addition to extensive work in the power generation field, Ken Roe and his company have worked on the Mercury and Gemini projects of the U.S. space program, the design and construction of process plants and commercial buildings, and the application of new technologies in environmental engineering.

Ken Roe was a man of great energy and enthusiasm. He frequently and openly displayed his pride in the achievements of his family, the reputation of his country, the performance of his company, and the prestige of his profession. He felt very strongly that people, like himself, who have benefited from the practice of a profession have an obligation to advance that profession and make education for it readily available to all who can benefit from it. He was active in a number of different engineering and technical societies. He served the ASME in many offices and was its president from 1971 to 1972. Those of us who had the pleasure of working with him during this period can vouch for the importance of his leadership in making decisions and getting things done. As one small example, I remember a breakfast meeting of the members of the executive committee of ASME during which he persuaded them to fund the first congressional fellowship sponsored by an engineering society. His service as president so convinced him of the importance of communication with the general public that in 1972 he endowed ASME's Ralph Coats Roe Medal, named for his father and given annually to an individual "for significant contribution to a better public understanding and appreciation of the engineer's worth to contemporary society."

Typical of the breadth of his vision, he specified that the award be made independently of the profession or society affiliation of the recipient. He was the first chairman of the ASME Foundation, which was established in 1986 to raise funds to broaden the research and educational activities of ASME.

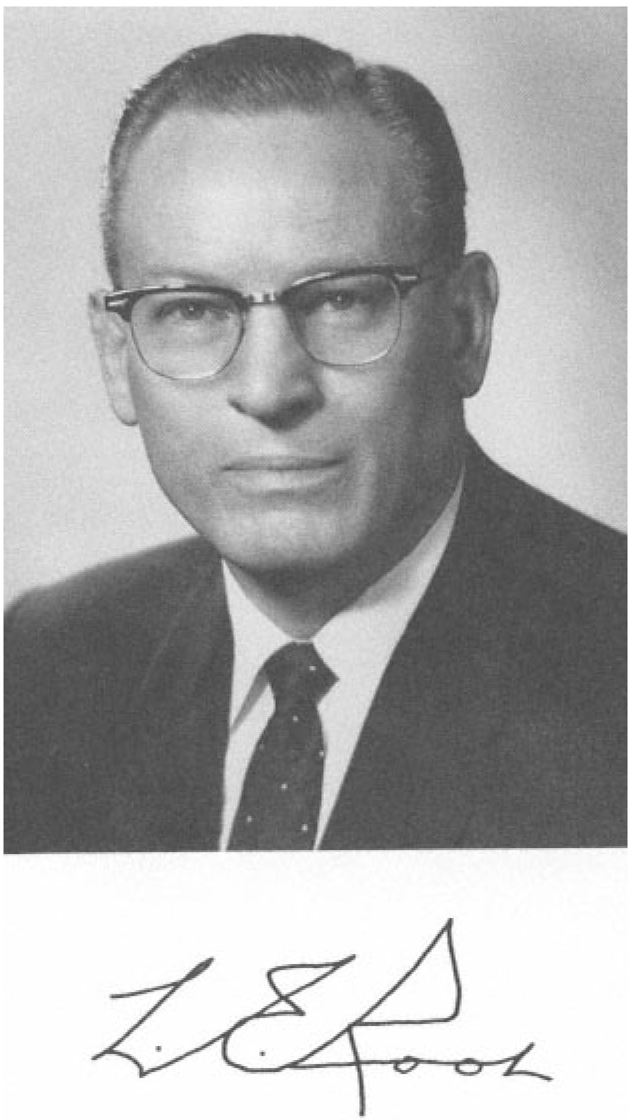
Delon Hampton caught the spirit of the man in some remarks presented at a recent meeting of the American Society of Civil Engineers. In commenting on Ken's role as a founding father of the Civil Engineering Research Foundation, he noted that Ken had a deep appreciation of the importance of professional engineering societies both to the individual engineer and to society in general. Dr. Hampton pointed out that Ken Roe's legacy was to remind us of the very essence of engineering through his ability to reconcile the possible with the necessary and to meet the challenge of providing for and sustaining the human spirit by creating a better quality of life.

He was a strong believer in the importance of unity in the engineering profession. As an officer of ASME, he encouraged cooperative efforts with other engineering societies both in this country and abroad. While he was chairman of the Engineers Joint Council in 1978, he concluded that engineering unity needed an organization with a stronger mandate from its constituency. He set to work with other like-minded engineering society officers, and in 1980 he participated in the creation of the American Association of Engineering Societies and became the founding chairman of its board of governors.

Ken was a cheerleader for engineering education. Having received his own education from four different institutions, he recognized the importance of variety. The ASME recognized his contributions by awarding him the Edwin F. Church Medal for eminent service in increasing the value of mechanical engineering education. He was a member of the board of trustees of the Stevens Institute of Technology and was a recipient of the Stevens Award. A member of Columbia University's Engineering Council and chairman of its engineering fund, he received both the Carl Kaan Award and the Pupin Medal. As a member of the board of overseers of the University of Pennsylvania School of Engineering, he received the school's D. Robert Yarnell Award. Ken served as vice-chairman of the board of trustees of Manhattan College and chairman of its Council on Engineering Affairs and its Committee on Planning and Development, and he was nominated for the Distinguished Service in Trusteeship Award.

Clearly he appreciated the importance of supporting engineering education in tangible and intangible ways. He contributed generously to a number of universities and served on their visiting committees. In addition, he traveled extensively throughout the United States to meet with and address student groups.

His achievements, and his service to his country and his profession, speak for themselves. What a simple listing of them cannot do is convey the effect that his enthusiasm and example had in initiating and sustaining projects that advanced the engineering profession. He did much more than point out what should be done for the benefit of engineers and engineering; he did it.



L. Eugene Root

1910-1992

Written By Robert E. Burgess

Submitted By The Nae Home Secretary

L. EUGENE ROOT, who helped design Douglas aircraft of the 1930s and 1940s and later led Lockheed Missiles and Space Company (LMSC) to maturity, died January 23, 1992, in Menlo Park, California. He was eighty-one.

He was a charter member of the RAND "think tank" and a cofounder of the American Institute of Aeronautics and Astronautics. He was elected to the National Academy of Engineering (NAE) in 1965 and was a councilor from 1968 to 1969.

Gene Root was born on July 4, 1910, in Lewiston, Idaho, one of five children. His family moved to the San Joaquin Valley of California—he often called himself "just a country boy"—and he entered the University of the Pacific (UOP) in 1928.

He augmented academic and athletic scholarships by a loan (which he repaid in seven years) from a hometown woman whose newspapers he had delivered. While at the university, Gene was a rushing guard on the football varsity, a member of Delta Upsilon fraternity, president of the honor society, freshman handbook editor, and a student government leader. He earned a bachelor's degree in engineering and mathematics in 1932. Then he was named outstanding alumnus in 1957 and received an honorary doctor of science in 1958. He was also a regent of UOP in the 1960s.

He received master's degrees in mechanical engineering (1933) and aeronautical engineering (1934) from the Califor nia Institute of Technology, plus the Alumni Distinguished Service Award (1966). He was a registered professional engineer in California.

The legendary aircraft designer Arthur E. Raymond hired Gene from Caltech to be assistant chief of aerodynamics at the Douglas Aircraft Company in 1934. Gene improved the flying qualities of Douglas's DC-3 transport and Dauntless dive bomber. He helped design and test DC-4E, DC-5, and C-54 passenger planes; A-20, A-26, and AD Skyraider bombers; the Skyrocket research aircraft; and the F4D-1 Skyray fighter.

In 1945 he went to Europe with the Navy Technical Mission to determine how German scientists achieved supersonic flight. Their data, which he compiled into five thousand feet of microfilm, showed swept wings, advanced jet engines, and air intakes. This information saved U.S. designers up to five years of development.

In 1946 Gene Root was one of four charter members of Douglas Aircraft's RAND Project—formed at the request of the U.S. Air Force to study strategic bombing needs—which evolved into the nonprofit RAND Corporation for studying national security problems. Secretary of Defense James Forrestal assigned Gene and then-Colonel Donald Putt to write *Standard Aircraft Characteristics,* the basic text for quoting aircraft performance. After that he produced similar key references.

Gene helped launch the U.S. Air Force's development planning office in the Pentagon from 1951 until he joined Lockheed Aircraft Corporation in Burbank, California, in 1953 as Lockheed's first director of corporate development planning. The company, an aircraft builder, had done research with X-7 rockets, but Gene's group convinced Lockheed's executives to thrust vigorously into the fledgling area of missiles and space. As a result, Lockheed created its Missile Systems Division (MSD, which is today's LMSC) in Van Nuys, California, in 1954.

Gene's unabashed vigor ensured MSD's first win, the prime contract for the U.S. Navy's Polaris Fleet Ballistic Missiles. At a contractor briefing on December 27, 1955, in Washington, attendees were asked to commit to the program. First to reach the chalkboard, Gene wrote "LOCKHEED," then turned and said, "We're ready. Who's next?"

That big Polaris contract meant MSD needed a bigger site. Gene helped influence the choice. It was to be in the agrarian Santa Clara Valley, where he'd picked apricots to help pay his way through college. There were major universities nearby—California, Stanford, Santa Clara, and San Jose State—plus a ready pool of employees. So in 1956 MSD moved from Van Nuys, building its main plant in Sunnyvale and laboratories in Palo Alto, a true Silicon Valley pioneer.

To head MSD, the corporation named Gene Root corporate vice-president and MSD general manager and named Herschel Brown MSD assistant general manager. Gene shepherded the development not only of Polaris, the world's first submarine-launched strategic missile, but of Agena, the workhorse spacecraft for the U.S. Air Force. Under him the company branched into ocean, ground, and information systems.

Gene went to broader corporate duties in Burbank in August 1959, and Herschel Brown ran the Sunnyvale operation. In June 1961 the division was upgraded to Lockheed Missiles and Space Company, and simultaneously Gene returned as its president.

Open heart surgery forced him to retire in September 1969, by which time the Fleet Ballistic Missile program was producing its fourth version (Poseidon), and the Lockheed Agena had been part of the first linkup of vehicles in space.

Gene served on the scientific advisory board to the Air Force chief of staff from 1948 to 1956, was a member of the Defense Science Board from 1957 through 1966 (except for 1963), and was active in many steering and advisory panels for the director of defense for research and engineering.

His honors included the U.S. Air Force's Exceptional Service Award (1957), the Navy's Distinguished Public Service Award for personal contributions to the Polaris missile team (1960), and the NASA Public Service Award for Lockheed's part in the Gemini program (1966).

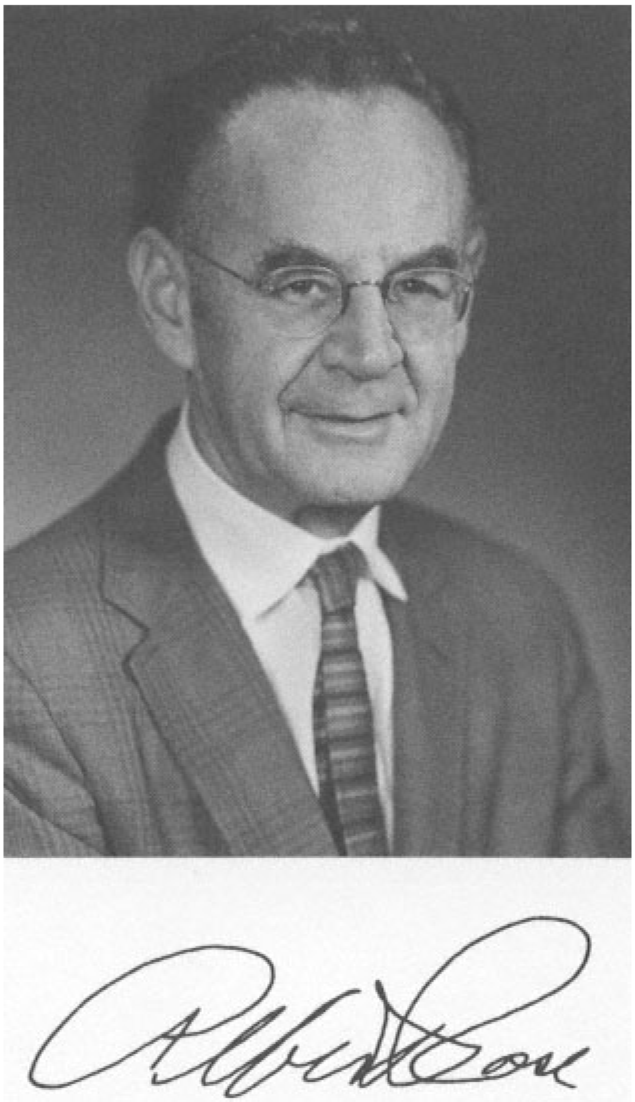
Another achievement occurred when Gene, as president of the Institute of Aeronautical Sciences, and William Pickering of NASA's Jet Propulsion Laboratory and president of the American Rocket Society, merged their organizations in 1962 to form the major U.S. aerospace society, the American Institute of

Aeronautics and Astronautics (AIAA). Gene was a fellow of the AIAA, the American Astronautical Society, the Royal Aeronautical Society, and the British Interplanetary Society.

Besides NAE, his memberships included the Operations Research Society of America, Society of Automotive Engineers, American Ordnance Association, Electronics Industries Association, California Society of Professional Engineers, and National Society of Professional Engineers. He was a 1987 inductee of the Santa Clara County Hall of Fame.

In retirement he qualified as a licensed amateur radio operator and was a life member of the American Radio Relay League. His call letters, WB6OOO (Oscar, Oscar, Oscar), honored his support of Project OSCAR (Orbiting Satellite Carrying Amateur Radio), representing a happy combination of his interests in space research and ham radio.

Gene and Laura Beryl Mount, a UOP graduate, were married in 1935 and celebrated their fiftieth anniversary just before she died in 1985. They are survived by two sons, Kirby Root and Brian Root. The Roots' daughter, Karen King, died in 1977.



Albert Rose

1910-1990

By Paul K. Weimer

ALBERT ROSE, an eminent research physicist and pioneer in the development of electronic imaging, died on July 26, 1990, at the age of eighty.

Born in New York City in 1910, Al received his A.B. from Cornell University in 1931 and his Ph.D. in 1935. Soon thereafter he joined the technical staff of the Radio Corporation of America (RCA) and spent most of his career as a research fellow at the RCA David Sarnoff Research Center in Princeton, New Jersey. Al's contributions to science and engineering were widely recognized, leading to his election to the National Academy of Engineering in 1975.

The development of television was already a major objective at RCA when Al joined the company in 1935. His first assignment was to design a new television camera with greatly improved sensitivity. At that time an optical image of the scene to be transmitted was focused on a light-sensitive "camera tube" such as an iconoscope that generated the video signal by scanning the image with a high-energy electron beam. Unfortunately, the secondary electrons produced by the high-velocity beam tended to degrade the charge pattern and diminish the signal. Al's first important advance in camera tubes was the use of a "low-velocity" scanning beam that eliminated the redistribution of secondary electrons. The resulting new tube, which was developed in collaboration with Harley Tams, was called an orthicon. It provided several times higher sensitivity than the iconoscope and better picture quality.

Al's second major innovation, just before World War II, was his invention of the "two-sided thin-glass target," which permitted the construction of a much improved camera tube to be known as the image orthicon. The image orthicon was developed with colleagues H. B. Law and P. K. Weimer for military purposes during the war, and it served for twenty years after the war for most television broadcasting. Its sensitivity exceeded that of its predecessors by a hundred times, permitting television pickup under very adverse lighting conditions.

Concurrently with the above work, Al began to examine the fundamental performance limitations of other types of image sensors, including photographic film and the human eye. He showed that the number of photons required to detect an image of a given contrast and resolution could be calculated for an ideal image sensor whose quantum efficiency was known. Publication of this work in the early 1940s received considerable attention. It was summarized again later in Al's book titled *Vision: Human and Electronic,* published by Plenum Press in 1973.

The complexity of the image orthicon and the rather low quantum efficiency of its photocathode suggested the desirability of a camera tube based on photoconductivity rather than photoemission. In 1948 Al initiated an investigation at RCA that resulted in the development of the first photoconductive camera tubes of the now well-known vidicon type. At about the same time, he began a reexamination of the nature of photoconductivity in a series of papers that presented its basic mechanism as we now understand it. He showed the dependence of its gain-bandwidth product (its figure of merit for devices) on the nature of the contacts to the photoconductor and on the internal distribution of its traps and recombination centers. This work was summarized later in his book titled *Concepts in Photoconductivity and Allied Problems,* published by John Wiley and Sons in 1963.

Although Al never sought a position in research management, RCA asked him in 1955 to direct the establishment of an RCA Laboratories research branch in Zurich, Switzerland. Al's prestige as a scientist and his stimulating personality attracted talented young applicants and helped establish an immediate rapport with other European laboratories.

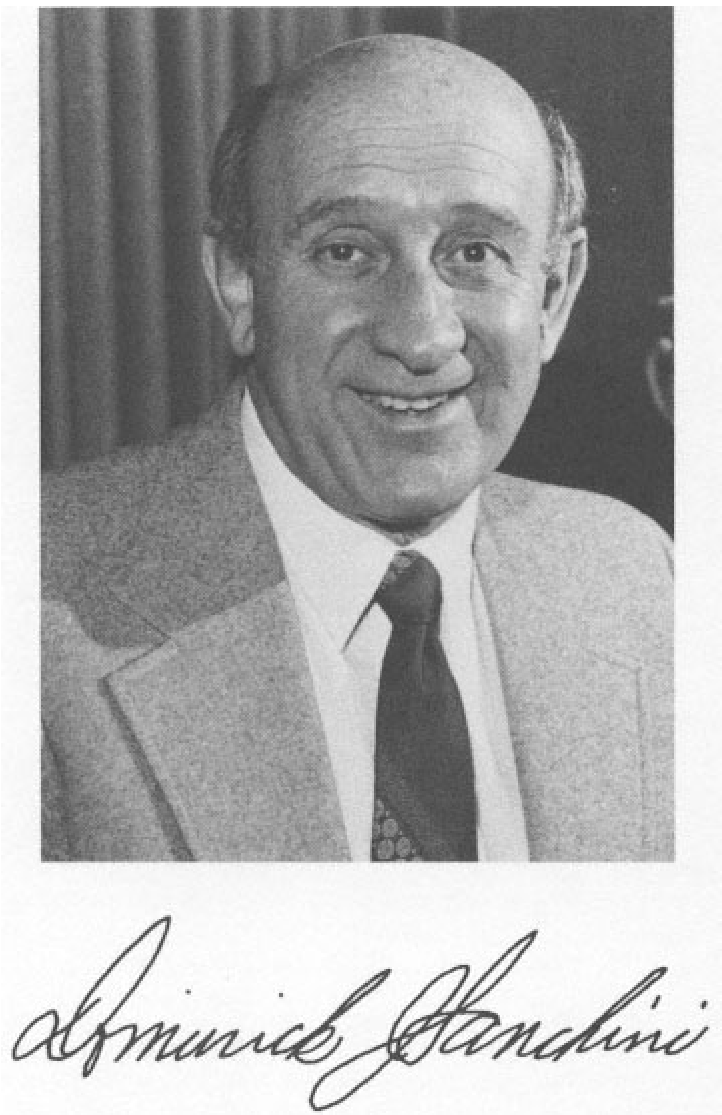
Upon returning to the Sarnoff Research Center in 1957, Al joined the solid-state physics group, where his superb grasp of fundamental physics and electronics was most valuable. His approach to problems and the warm regard of his colleagues were perfectly expressed by M. A. Lampert and P. Mark in the dedication of their book *Current Injection in Solids:* "To Albert Rose, who chose simplicity over precision, and thereby gave to all of us insight." Although Al published more than seventy papers, he always had time to help and advise younger colleagues.

For many years Al served as an associate editor of *Physical Review* and of *Advances in Electronics,* and he was on the editorial board of the *International Journal of Physics and Chemistry of Solids.* He also served on the organizing committees of many international conferences on subjects such as photoconductivity semiconductors, surfaces, electrophotography, and electronic imaging.

Upon his retirement from RCA in 1975, Al was appointed a Fairchild Distinguished Scholar at the California Institute of Technology, and in later years he was a visiting professor at Stanford University, Hebrew University in Jerusalem, and several other schools. After returning to Princeton in 1981, he worked as a visiting scientist at the Exxon Laboratories and later at the Chronar Corporation. He also supervised the republication of a collection of his later papers as a book titled *Electron-Phonon Interactions,* published by World Scientific in 1990. He continued to participate in technical conferences on electronic imaging and to present the Albert Rose Electronic Imager of the Year Award that had been created in his honor in 1986 by the Institute for Graphic Communications.

Al's work resulted in many awards. He was a fellow of the American Physical Society and of the Institute of Electrical and Electronics Engineers (IEEE) and a member of the Society Suisse de Physique and Phi Beta Kappa. Other honors included the Morris N. Liebmann Award of the Institute of Radio Engineers (now IEEE) (1945); corecipient of the Television Broad casters Award (1945); the Journal Award of the Society of Motion Picture and Television Engineers (1946); the David Sarnoff Gold Medal Award of the Society of Motion Picture and Television Engineers (1958); election to the National Academy of Engineering (1975); the Edison Medal of the IEEE (1979); an honorary doctoral degree from the Rochester Institute for Technology (1989); and, posthumously, a Pioneer Induction to the New Jersey Inventors Hall of Fame (1991).

As a strong advocate for the use of solar energy for power generation, Al received the Leo Friend Award for his paper titled "Solar Energy: A Global View," published in the *Chemtech* journal of the American Chemical Society (1981). This unexpected tribute from another discipline shows the breadth of vision of this creative and concerned humanist.



Dominick J. Sanchini

1926-1990

By George W. Jeffs

DOMINICK J. SANCHINI, a key engineer and manager in the design, testing, and development of high-performance cryogenic rocket engines, died on November 17, 1990, at the age of sixty-three.

Dom received a B.S. in mechanical engineering in 1951 from Lehigh University. He then concurrently pursued a professional career in aerospace and worked toward a law degree that he received in 1958 from the University of Southern California. He later become a member of the California Bar. Together with his inherent leadership qualities, this educational background well qualified him for the challenges ahead.

In the earliest phase of his career, Dom was a member of the Aerophysics Laboratory of North American Aviation Inc. (NAA), working in the engine analysis and test group. From the Aerosphysics Laboratory, a number of the divisions of NAA Inc. were born, including the Rocketdyne Division, and Dom then became a member of the original nucleus of its staff. In addition to working in early engine analysis and design, he participated in developing the basic operating elements of Rocketdyne, including the Santa Susanna Field Laboratory (major test stands and supporting elements) and, of course, the growth of the engineering staff.

In the 1960s he demonstrated his management ability in the success of the 1.5 million-pound-thrust, Lox-JP-fueled F-1 en gine for the Saturn first stage booster. His family, who shared his interest and enthusiasm for the space program, came to accept the F-1 around the house as his "first baby." His team at the office was continually impressed with his ability to assimilate and effectively use and retain so much information in real time and also with his toughness as a "task master" on himself and his people. Moreover, the National Aeronautics and Space Administration (NASA) recognized him as a technically sound and responsible manager.

The heart of Dom's career was devoted to the development of the space shuttle main engines during the 1970s. He was instrumental in winning the development contract in the beginning, a victory he shared with his family the evening of that announcement—it was a family team celebration. Dom's resilience, dedication, and enthusiasm were instrumental in leading us through the development of this demanding high-performance (3,000 pounds-per-square-inch chamber, pressure-staged combustion cycle engine), reusable (goal was fifty-five flights—rocket engines were normally not recovered), and light-weight (for recovery after attaining orbit in the Shuttle Orbiter) engine. North American Aviation Inc. had merged with Rockwell International, and we were all fortunate to have a knowledgeable, experienced engineer for a chief executive officer. Nonetheless, we encountered some difficulty in convincing him that we would ever get one engine to start and operate through every safety constraint, let alone three engines simultaneously, with astronauts' lives at stake. As a result of hard work, though, solid engineering, and manufacturing and tests accomplished by a cooperative NASA-Rockwell team, the engines have started with repeated precision. It must be mentioned here in passing that in this latter period the Sanchini family kitchen was the site of the failure analysis table, covered with drawings and problem parts that had failed and been scrapped.

In the 1980s Dom became a senior member of management at Rockwell International, initially as executive vice-president of production of the Rocketdyne Division, then as president of the Rocky Flats plant, and finally as corporate vice-president for major programs. In all these assignments, he served with integrity, dedication, and distinction.

Throughout his career Dom made significant, lasting contributions not only to our base knowledge but also more particularly to our understanding of rocket-engine design and operation that have become part of a continuing legacy in our policies, procedures and design, and operational practices. He also left his mark on those of us who worked with him—many of our present propulsion and energy system managers having been members of his teams. Dom received many commendations and honors for his accomplishments, but the two of which he was most proud were his election to the National Academy of Engineering in 1984 for "meeting one of the greatest engineering challenges in aerospace with the design, development, and operation of the Space Shuttle Main Engine" and to receive the NASA Distinguished Public Service Medal for "meritorious contributions" to the space shuttle main engines—an understatement.

Dom spent much time away from home, working at Huntsville, Cape Canaveral, National Space Technology Laboratories, and later Boulder, Colorado, but he always found time to communicate in depth with his team at home, his wife, Claire, and his daughters, Donna and Rae. They shared the everyday status, along with the joy of the first *Columbia* launch and the tragedy of the *Challenger* loss. When his daughter Rae was asked to recall Dom's feeling for the space program, she wrote, "He was proud to have participated in one of the finest endeavors of modern man, and he had a lot of fun with it along the way. Until the very end, I think he considered himself truly blessed."

Sidney Eugene Scisson

1917-1990

By Clarence E. Larson

SIDNEY E. SCISSON, who pioneered development of underground storage of petroleum products and gas in the United States and throughout the world, died November 24, 1990, following a long illness. He reached the top in an exciting field into which few others had ventured. His innovative methods in attacking difficult engineering problems, particularly in construction of underground facilities, made it possible to complete difficult projects in a timely fashion.

Scisson, born February 4, 1917, in Danville, Arkansas, received his B.S. in general engineering from Oklahoma State University. He then went to work for the U.S. Corps of Engineers in Tulsa. During World War II he served in the U.S. Naval Reserve as an engineering officer on the aircraft carrier *Intrepid* and an instructor in the engineering department of the U.S. Naval Academy. Then after working for Pate Engineering Company in Tulsa for three years, Scisson was cofounder in 1948 of Fenix and Scisson, Inc., where he became president when the firm was incorporated in 1951. Fenix and Scisson was responsible for the execution of many engineering and construction projects located in twenty-three states and eleven foreign countries when Scisson retired as chairman of the board in 1987.

He designed and supervised construction of the first mined liquefied-petroleum (LP) gas storage cavern. Under his direction the firm designed and constructed more than 90 percent of all mined underground storage for LP-gas projects in the United States, including the Strategic Petroleum Reserve.

In 1963 the firm expanded its services to include solution mining of salt cavities for storage of petroleum products. Fenix and Scisson also acted as architect-engineer for the Atomic Energy Commission (AEC) for underground facilities in the nuclear testing program at the Nevada Test Site. Also for the AEC, for a nuclear test on Amchitka Island in connection with the Spartan Missile Program, the company developed new drilling and mining techniques that made possible the drilling a 96 inch diameter hole 6,108 feet deep, and the mining of a cavity more than 50 feet in diameter at the bottom of the hole. The company and the AEC were issued more than ten patents in connection with this work.

Scisson was elected to membership in the National Academy of Engineering in 1977. He was a member of the American and Oklahoma Societies of Civil Engineers; the National and Oklahoma Societies of Professional Engineers; the American Institute of Mining, Metallurgical and Petroleum Engineers; and the Moles. He held an individual membership in the American Gas Association and was company representative in the National Gas Processors Association, the Associated General Contractors of America, and the Beavers. Scisson held a number of patents on underground storage methods.

He was a registered professional engineer in Oklahoma, Illinois, Ohio, Kentucky, and Rhode Island. In 1978 he was inducted into the Oklahoma State University Engineering Hall of Fame and in 1979 received that university's Distinguished Alumnus Award. He was inducted into the Hall of Distinction of Arkansas State University and received Arkansas Tech University's Distinguished Alumnus Award in 1979.

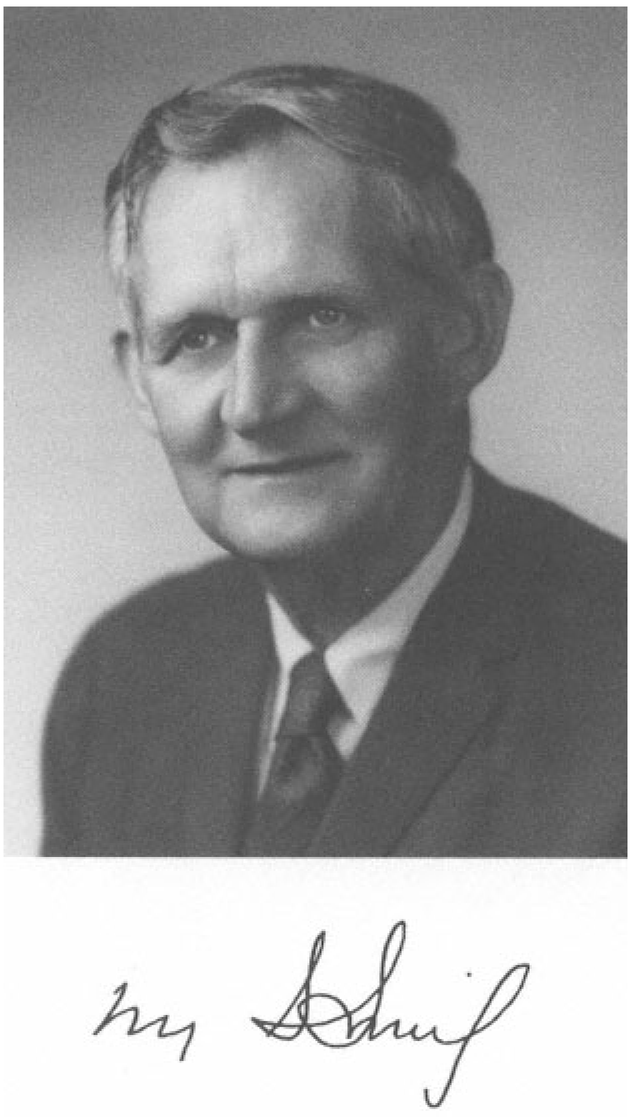
Scisson was a member of the Atlas Life Insurance Company board of directors and a past director of the Bank of Oklahoma. Active in civic and community affairs, Scisson served on the board of directors of Children's Medical Center in Tulsa, Oklahoma, and the Tulsa Civic Ballet, Inc., where he also served terms as president and treasurer. He served on the board of governors of the Development Foundation of Oklahoma State

University in Stillwater and was an honorary member of the board of directors of Tulsa Opera, Inc.

He was chairman of the board of Missouri Steel Castings Company, a steel foundry, and Strescon, Inc., a prestressed concrete manufacturing plant, both wholly owned subsidiaries of Fenix and Scisson. In 1965 he became a partner in Bledsoe and Scisson Ranches in Oklahoma and Kansas, a more than 6,000-acre ranch with 1,000 to 1,500 head of cattle.

Scisson is survived by two daughters, Mrs. Ray D. (Jane) Grimshaw of Tulsa and Mrs. Jack (Judith) Ferreri of Verona, Wisconsin, and three granddaughters.

It was my good fortune to view one of his projects being carried out near the Arctic Circle, a project requiring meeting "impossible" deadlines involving high-priority defense considerations. I still treasure a gift of a granite core sample from the deep drilling operation. His operations always typified his dedication to best engineering practices. Many of his contributions to underground engineering methods are today in evidence in projects throughout the world.



Wilbur S. Smith

1911-1990

By Donald S. Berry

WILBUR S. SMITH, internationally known for his achievements in planning, designing, and evaluating transportation systems, died on July 25, 1990, at the age of seventy-eight. At the time of his death he was chairman of the board of Wilbur S. Smith Management of Columbia, South Carolina.

Elected to the National Academy of Engineering in 1968, Mr. Smith was still active in the transportation field up to the time of his death. During his career he was an innovator in the development of modern transportation systems. Mr. Smith directed the specialists in his consulting firm, Wilbur Smith and Associates, in evaluating the feasibility of alternative locations and designs for major sections of the Interstate Highway System, the New Jersey Turnpike, other toll roads, the Chesapeake Bay Bridge Tunnel, and the mass transit system in Washington, D.C. He was also an adviser on many other projects such as the transportation tunnels under the English Channel.

Mr. Smith was born in Columbia, South Carolina, on September 6, 1911, and graduated from the University of South Carolina in electrical engineering. After receiving an M.S. in 1933, he was employed by the South Carolina Highway Department. In 1935 he was appointed the state's first traffic engineer. Several months later he enrolled as a fellowship student at the Bureau for Street Traffic Research at Harvard University. After completing a nine-month training program in 1937, he returned to the

Highway Department of South Carolina, where he headed the state's first Traffic Engineering Division.

During the next four years, Mr. Smith developed a statewide traffic control program with emphasis on unifying traffic control devices, correcting high-hazard locations on the state highway system, and providing assistance to local authorities. He built a staff of thirty persons. In 1941 he took a year's leave of absence to work at the Bureau of Highway Traffic at Yale University on a research project on the economies of motor vehicle transportation.

At the beginning of World War II Mr. Smith was recruited by the Federal Bureau of Investigation (FBI) to organize and carry out a training program for engineering officials and police on emergency traffic control during blackouts and air raids. He assembled a group of twenty traffic specialists and trained them to teach a one-week course on emergency management. These one-week courses were held throughout the country, with more than a thousand public officials receiving the training.

In 1943 Mr. Smith returned to Yale University to become associate director of the Yale Bureau of Highway Traffic, where he stayed until 1957. During this time he served as a consultant to the FBI and also to the Office of Civil Defense on war-related traffic and transportation problems. He also began serving as a consultant on the traffic problems of cities and other government agencies while still teaching at the Yale Bureau.

In 1952 he established the consulting firm of Wilbur Smith and Associates, with offices at New Haven, Connecticut, and in Columbia, South Carolina. During the next twenty-nine years the firm expanded a great deal, with offices established in twenty-eight cities of the United States and in thirteen foreign locations. Wilbur at times handled some one hundred projects simultaneously, traveling as many as 250,000 miles in a year to review them. Wilbur was a licensed professional engineer in all fifty states, the District of Columbia, the United Kingdom, New Zealand, Hong Kong, and Queensland, Australia.

In 1981 Mr. Smith merged his consulting firm into Armco, Inc., and in 1983 he retired from the firm. The firm later was acquired by its 750 employees and was renamed Wilbur Smith

Associates. Mr. Smith then established a firm called Wilbur S. Smith Management, while serving as senior consultant to Wilbur Smith Associates.

Mr. Smith received many honors and awards, including an honorary doctor of laws degree from the University of South Carolina (1963), and an honorary doctor of humanities degree from Lander College (1975). He was awarded honorary membership status in the Institute of Transportation Engineers, the American Society of Civil Engineers (ASCE), and the American Public Works Association. Other awards include Engineer of the Year of the South Carolina Society of Professional Engineers (1964); the Theodore M. Matson Memorial Award sponsored by the Institute of Transportation Engineers (1965); the National Research Council Transportation Research Board's Roy W. Crum Award (1980); the Institute of Transportation Engineers' Burton W. Marsh Distinguished Service Award (1982); the Duke University School of Engineering Distinguished Service Award (1982); the Highway Division Award from ASCE, now known as the Wilbur S. Smith Award (1983); the George S. Bartlett Award of the American Association of State Highway and Transportation Officials (1985); the NSPE Award of the National Society of Professional Engineers (1985); and the Francis C. Turner Lecture award of ASCE (1990).

Mr. Smith was elected a member of the National Academy of Engineering (NAE) in 1968. He served from 1974 to 1978 as a member of the NAE-sponsored Committee on Transportation of the Assembly of Engineering, National Research Council. He was a member (1958-1969) and chairman (1963-1964) of the executive committee of the Highway Research Board of the National Research Council and chairman of the board's Special Committee on International Cooperative Activities. In addition, he served (1969-1970) on the Department of Traffic and Operations of the Highway Research Board.

Mr. Smith participated actively in many other professional engineering organizations. He was president of the Institute of Traffic Engineers (1949-1950) and a member of its board of directors from 1942 to 1958. He was chairman (1967-1968) of the Executive Committee of the Highway Division of ASCE, chairman of the ASCE Committee on Transportation Planning, and chairman of the ASCE Committee on National Transportation Policy. He was president and chairman of the board of the Eno Foundation for Transportation for a great many years. He was national president of the American Road and Transportation Builders Association. He also was a member of the board of directors of the National Safety Council and was on the Board of the International Road Federation.

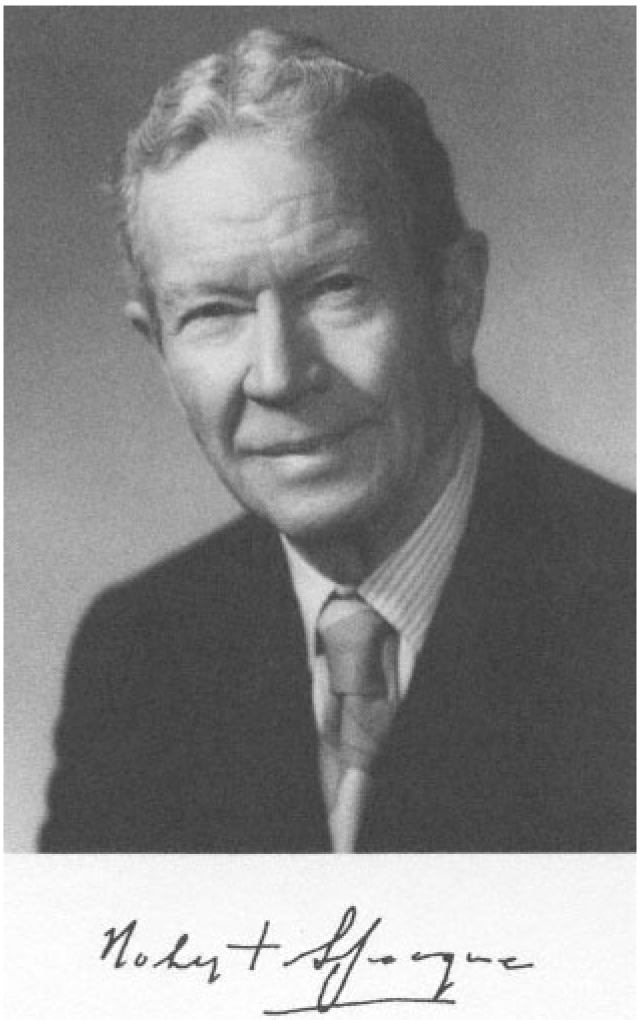
A partial list of Mr. Smith's memberships in other professional organizations includes the National Society of Professional Engineers, the International Bridge and Turnpike Association, the American Institute of Consulting Engineers, the Institute of Electrical and Electronics Engineers, the New York Society of Professional Engineers, the South Carolina Society of Professional Engineers, the Transportation Society of America, and the Institution of Civil Engineers in both Australia and Hong Kong.

Mr. Smith was a coauthor (with Matson and Hurd) of the first comprehensive traffic engineering textbook, which was published by McGraw Hill in 1955. Another early publication of which he was a coauthor was *State-City Relationships in Highway Affairs,* published by the Yale University Press in 1950. He was also author or coauthor of many publications on the state of the art, published by the Eno Foundation.

One of several papers of which Mr. Smith was the author or a coauthor in the 1960s is "Research and Worldwide Urban Transportation," published in *Highway Research Record No. 125,* Highway Research Board, 1966. Among the twelve papers he authored since the 1970s are "The Challenge in Developing a Multi-modal Urban Transportation System," *ITE Journal, June* 1978; "Current Trends in Toll Financing," *Transportation Research Record 900,* 1983; "Mass Transport for High-Rise High-Density Living," (with N. H. Westefeld) *Journal of Transportation Engineering,* v. 110, Nov. 1984; and "Observations on Australian Transportation," *Transportation Quarterly,* (with Thomas Larson) Oct. 1989. Many reports on contract research, written by staff members of Wilbur Smith and Associates, have been published over the years. Two published by the Transportation Research Board are "Bus Use of

Highways: State of the Art," *NCHRP (National Cooperative Highway Research Program) Report No. 143,* 1973, and "Bus Use of Highways: Planning and Design Guidelines," *NCHRP Report No. 155,* 1975.

Wilbur was a humanitarian who loved South Carolina. He moved his headquarters office to Columbia from New Haven in the 1950s. He served on many boards and advisory councils for the University of South Carolina, the Presbyterian College, the South Carolina Chamber of Commerce, the South Carolina Research Authority, the Salvation Army, the State Public Works Historical Society, the South Carolina Business Hall of Fame, and several banks and development corporations. He taught part-time at the University of South Carolina and at Clemson University while classes were suspended at the Yale bureau during part of World War II. He enjoyed bird hunting at one of his farms near Columbia.



Robert C. Sprague

1900-1991

By Robert C. Duncan

ROBERT C. SPRAGUE, engineer and entrepreneur who founded the Sprague Electric Company and developed it into a thriving company of eight thousand employees, died on September 27, 1991, at his home in Williamstown, Massachusetts. He was ninety-one years old.

Bob Sprague was born in New York City on August 3, 1900. He graduated from the U.S. Naval Academy (B.S.) in 1920, the U.S. Naval Postgraduate School (B.S.) in 1922, and the Massachusetts Institute of Technology (S.M.) in 1924. He continued his career as a naval architect and was a member of the staff that superintended the design and construction of the aircraft carrier USS *Lexington.* He resigned from the U.S. Navy in 1928.

As a twenty-six-year-old lieutenant in the U.S. Navy, Bob developed an adjustable "tone control" device to improve the sound quality of his radio. The heart of this device was a fixed paper condenser, which he patented. This was the first of a lifetime total of nineteen patent awards. This first patent led to the birth of the Sprague Specialties Company, which he and his wife, Florence, operated out of their Quincy, Massachusetts, home, using $25,000 in capital raised through limited personal savings and the sale of stock to a few friends and relatives.

Sales of those earlier capacitors were slow until Bob designed them to be smaller, lighter, and cheaper. His new company did $54,000 worth of business in 1927. By 1929 the company had grown to 525 people with sales of $500,000. He moved his company from Quincy to North Adams, Massachusetts, in 1930. He bought a new plant in North Adams three weeks before the stock market crash on "Black Friday" in October 1929.

The depression years were difficult for the Sprague Specialty Company; however, World War II provided a financial shot in the arm. Production, employment, and profitability boomed during the war years, largely because of many military applications for capacitors. Under Bob's leadership the company continued to grow in the postwar years to a peak of eight thousand employees in six U.S. facilities, and one each in Europe and the Far East. The company changed its name to Sprague Electric Company in 1943, and Bob retired as chairman in 1971.

Bob had a long history of service to his country and his community. He served from 1942 to 1945 as a member of the War Production Board's advisory committee on capacitors. In 1954 he was appointed by President Eisenhower as a consultant on continental defense to the National Security Council and a consultant to the Technological Capabilities Panel of the Science Advisory Committee to the Office of Defense Mobilization (Killian Committee). In 1957 he was appointed by the president to be director of the Security Resources Panel (Gaither Committee) of the Science Advisory Committee of the Office of Defense Mobilization.

Elected to the National Academy of Engineering in February 1985, Bob was a dedicated professional known for his technical expertise and his willingness to contribute his time and energy to many worthwhile causes. He was recognized by many awards and honorary degrees. He received honorary doctorates from Northeastern University, Williams College, Tufts University, Lowell Technological Institute, University of New Hampshire, North Adams State College, and University of Massachusetts. He was twice awarded the Medal of Honor by the Electronic Industries Association. He received the "Man of the Year" awards from the New England Council and the Hotchkiss Alumni Association. He was a fellow of the Institute of Electrical and Electronics Engineers and the American Academy of Arts and Sciences. He was a member of the corporations of the Massachusetts Institute of Technology and Northeastern University. He served on the board of directors for the First National Bank of Boston, Charles Stark Draper Laboratory, MITRE Corporation, Micro-Bit Corporation, Electrostatic Research Corporation, Federal Reserve Bank of Boston, and Associated Industries of Massachusetts. He was a trustee of Hudson Institute.

An avid skier until leg problems took him off the slopes at age eighty-three, Bob was the author of two books on skiing. Perhaps his greatest love outside his family and his office was the Williamstown Theatre Festival. Bob is widely considered to have been the person most responsible for the success of this summer theatre activity, which is considered by many to be the most outstanding program of its kind in America. The program was started more than thirty years ago and has a worldwide reputation for excellence. The list of performers in this summer theatre festival is a "Who's Who" of the stars of today's stage and screen, all of whom came to know and admire Bob Sprague as a patron and friend.

Arthur C. Stern

1909-1992

By Merril Eisenbud

ARTHUR CECIL STERN earned a worldwide reputation for his contributions to air pollution control during a career that spanned sixty years. He conducted important research, was a respected teacher, and organized important elements of the U.S. government programs in air pollution research and control. Above all, he possessed extraordinary abilities as a writer and editor.

Arthur was born in Petersburg, Virginia, but moved to Yonkers, New York, while he was still a child. He chose engineering as his profession and matriculated on full scholarship at Stevens Institute of Technology, from which he received his B.S. in mechanical engineering in 1930 and an M.S. in 1933. After a lapse of many years, in 1975 Stevens awarded him the doctor of engineering (honoris causa) in recognition of his accomplishments to air pollution control.

During the depression years it was not an easy matter for a young graduate to match his professional aspirations with the opportunities for employment that then existed. Stern was fortunate in this respect because a research assistantship to study methods of smoke abatement became available at Stevens. His first-of-a-kind studies of the quantities of particulates emitted from obvious sources of pollution, such as locomotives, ships, and electric utilities, gave him the raw material for the first of his many research papers, "Abating the Smoke Nuisance," which was published in *Mechanical Engineering* in 1932.

A major opportunity developed in 1935 when he began a two year study of smoke pollution in New York City. This investigation emphasized particulate pollution, and it provided the first systematic information about the quantities of airborne and settled soot. His studies were at that time supported by the Works Progress Administration, the agency created in the depths of the depression mainly to provide jobs for the needy but also to provide career opportunities for young people. The investment made by the federal government in this way was returned many times over during subsequent decades when Stern became a major force in development and implementation of the Clean Air Act.

In the early 1940s there was essentially no federal or state involvement in air pollution control, but Stern was fortunate to find himself in a good position to advance professionally while continuing his interest in the subject. He was appointed chief engineer with the New York State Department of Labor, Division of Industrial Hygiene and Labor Standards, a position that permitted him to develop new methods of treating waste-air before its discharge to the general atmosphere by industrial ventilation systems. He served in this capacity from 1943 to 1955 and had a major influence on the newly developing field of "air cleaning," including important improvements in bag-houses, cyclones, and electrostatic precipitators.

By 1947 Arthur Stern recognized the need for New York City to adopt legislation to control air pollution and wrote a letter to the New Y*ork Times* in which he suggested that there should be a study of the political mechanisms by which air pollution in the city could be brought under control. This initiative resulted in passage of the first air pollution control laws by city council in 1949.

Stern moved into the center arena in the early 1950s when the U.S. Public Health Service was given the responsibility by Congress for organizing a national effort to control air pollution. Stern was called to Cincinnati to assume a major role in the recently established Robert A. Taft Laboratory, where he was charged with developing training, research, and technical assistance programs. It was intended by the Congress that responsi bility for air pollution control should remain with the states but that the federal government should provide research support and technical assistance. It was when he was in this post that the landmark 1963 Clean Air Act was proposed to Congress.

In 1968 Stern accepted an appointment as professor of air hygiene in the Department of Environmental Sciences and Engineering at the University of North Carolina in Chapel Hill. Although he retired from that position in 1978, he remained active until the day of his death. From his hospital bed, with full knowledge that his long battle with cardiovascular disease was about to end, he spent part of his last afternoon working with his secretary on the final preparations for his last book, A *History of Air Pollution and its Control.*

It was his writing and editing, always on the subject of air pollution, that gave him his greatest satisfaction. In 1962 Academic Press published his two-volume reference book, *Air Pollution,* which was an immediate success. It has been revised and expanded and is now published as an eight-volume set, which is used worldwide as the reference of choice for knowledge about the sources of air pollution, its physical and chemical characteristics, how it is transported through the atmosphere, and how it exerts its damaging effects on materials and health. That eight-volume magnum opus has been accompanied by a more manageable *Fundamentals of Air Pollution,* which is widely used for teaching purposes.

Arthur Stern was blessed by the many honors he received. These included chairmanship of the Electric Power Research Institute Advisory Committee and of the U.S. Environmental Protection Agency's National Air Quality Criteria Advisory Committee, and presidency of the International Unions of Air Pollution Prevention Associations. In 1976 he was elected to the National Academy of Engineering, which culminated a long list of honors received from the professional engineering societies.

Arthur was married for many years to the former Dorothy Anspacher, with whom he raised their three children, Richard, Elizabeth, and Robert. Dorothy died in 1975, and he was later remarried to Katherine Barbour Perlman.

C. Guy Suits

1905-1991

By Walter L. Robb

A GIANT AMONG US has departed. How does one, in a few minutes, pay homage to a man's life, to the highlights of a loving husband and father, to an adventurer, leader, pioneer, in all his endeavors? For, yes, Chauncey Guy Suits lived a full, productive life.

In fact, writers of do-it-yourself books might well pause to consider his story. He designed his own boomerangs and skis; largely furnished his home with handsome handmade reproductions of antique furniture; rewove Oriental rugs; constructed his own customized leather camera cases; and designed, cut, and sewed dresses for Mrs. Suits. He also, at one time or another, was a self-taught professional clarinetist, a hiker, a hunter, a skier, and a yachtsman, a skin diver, a pilot, and a photographer extraordinary.

As Guy himself put it in a 1937 talk, "I have often heard people say that they would love to have a hobby, if they had the time. That is doubtless true in many cases, particularly with college students, but it is also true that it is not time that is lacking so much as the ability to make the best use of the available time. An active man can no more cease his activity at the point of a clock than he can stop breathing—activity is a part of his constitutional equipment. And so a portion of his leisure time activity is diverted to music, or painting, or archaeology, or botany, or hiking and skiing—and the list is endless."

If Guy had pursued all of his hobbies with his customary enthusiasm, they might well have interfered with his work. That never happened, as evidenced in 1945 at the age of thirty-nine. Already a distinguished scientist, he became the youngest officer of GE and director of one of the world's foremost industrial laboratories. He had been a member of the GE Research Laboratory since 1930 and was widely known for his work in many phases of scientific research, especially high-temperature, high-pressure electric-arc discharges. His studies ultimately resulted in seventy-seven patents.

During World War II, Guy devoted the major portion of his time to the direction of research under the auspices of the Office of Scientific Research and Development. As chief of Division 15 of the National Defense Research Committee, he headed the leading U.S. effort on radio and radar countermeasures. It was estimated that those countermeasures saved the U.S. Strategic Air Force some 450 planes and 4,500 casualties alone, effectively countering a $2 billion Axis radar system.

At the close of the war, Guy returned to GE and directed the extensive postwar expansion of the company's scientific research activities. This included the planning and construction of a completely new home for the research lab on a 600-acre site in Niskayuna, New York. Today, that facility, now forty years old, stands in clear testimony to that quality of design and construction that Guy insisted upon. No other laboratory I have visited has stood the test of time so well, and we pledged to maintain the lab as the living testimonial to Dr. Suit's memory.

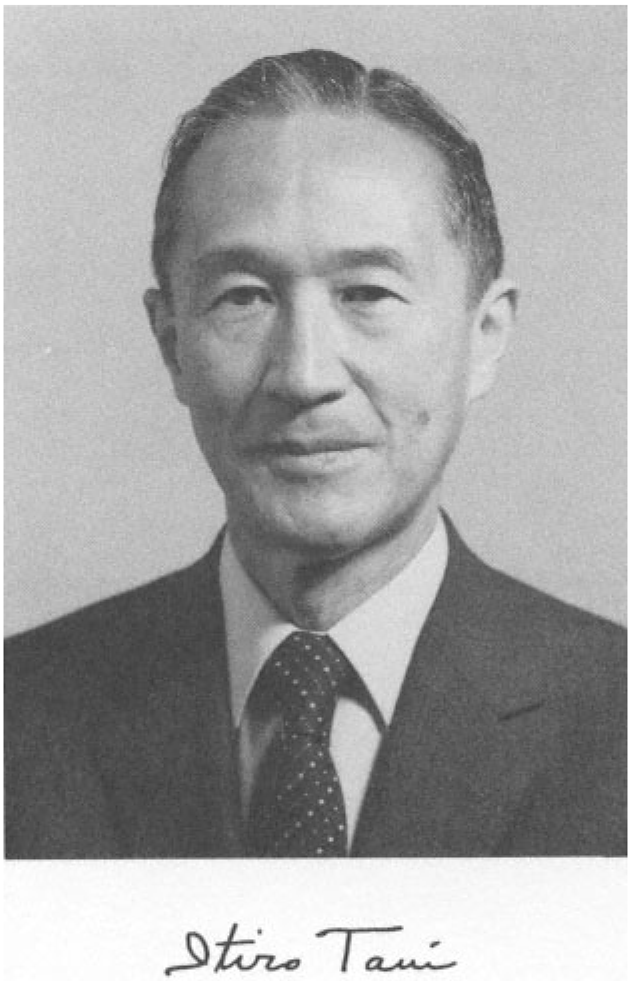
As director of research for GE, Guy organized research teams that made hundreds of inventions, enriched scientific knowledge, and yielded vast material benefits to mankind. Those innovations included the first Man-Made™ diamonds and the first commercial process for mass-producing them; Borazon® cubic boron nitride, a synthetic material second in hardness only to diamond; the Multi-Vapor® lamp, still the leading high-efficiency light source; chemical research that led to Lexan® and Noryl® resins, two of the world's most famous engineering polymers; and the demonstration of electron tunneling-work that later won Ivar Giaever a share of the 1973 Nobel Prize for physics.

Most impressively, many young scientists Guy and his team brought into the lab are still the world's leading experts in their fields, even twenty-five years after his retirement. His successors—Art Bueche, Roland Schmitt, and myself—were hired during his tenure, and we all owe Guy a huge debt of gratitude for his counsel and support. He loved his family and the Adirondacks, but he also loved GE and the people who made up the GE family.

While it is only human for us to mourn the loss of a loyal and courageous friend, we are also filled with thanksgiving for having shared in even a part of Guy's full life. He made each day exciting, each conversation stimulating, and each minute and hour time well spent. May his love for life challenge us to look within ourselves—to inspire us to even greater undertakings, knowing Guy would approve.

Guy was without peer—such a gentleman; kind husband and father; devoted environmentalist and adventurer; and an honorable, proud, and decent American.

But Guy Suits didn't waste a lot of words explaining his philosophy of life. On the contrary, he lived his philosophy and led by example. His message to all of us was, "Live life to the fullest!" He showed us the way . . . oh, so well.


Itiro Tani

Itiro Tani

1907-1990

By Yasuo Mori

ITIRO TANI, researcher in fluid dynamics and aeronautics, died on May 28, 1990, at the age of eighty-three.

Elected foreign associate of the National Academy of Engineering in February 1979, Dr. Tani was a world-famous scientist known for dedicating his time and effort to the study of fundamental phenomena in his field.

During his career, which extended over six decades, Dr. Tani published more than one hundred scientific papers and ten books. In particular, he made substantial, pioneering contributions to the theory of the boundary layer and its applications. He worked at the University of Tokyo, in teaching and research, for thirty-eight years. He was invited, as a distinguished scholar, to universities and research institutions throughout the world and presented invited lectures in international conferences.

Dr. Tani received his B.S. at the University of Tokyo in 1930 and was appointed lecturer in the Department of Aeronautics at the University of Tokyo. He immediately reported on two studies on ground effect and wall interference in wind-tunnel testing—this research was carried out at the university's Aeronautical Research Institute. In 1932 he was appointed assistant professor in the Department of Aeronautics and the institute. In 1943 he became professor and was awarded the doctor of engineering degree for his important thesis on the theory of laminar-boundary-layer airfoils.

The mathematical theory of the fluid boundary layer had been first reported by Professor L. Prandtl of Göttingen in the early 1900s, but at first it was not fully understood by most fluid-dynamic experts. Dr. Tani was introduced to this theory in the early 1930s; he grew extremely interested in the subject and began to concentrate his efforts on it. In 1939 and 1940 he published papers on laminar-boundary-layer separation and on the transition from laminar to turbulent flow in boundary layers.

In the late 1930s he focused his attention on the development of airfoils with small friction drag, known since that time as laminar-boundary-layer airfoils. These airfoils are shaped so as to maintain laminar flow in their boundary layer as extensively as possible. In the 1930s, when high-speed computers were not yet available, Dr. Tani reported pioneering methods for calculating the aerodynamic performance of airfoils and wings, and further, he wrote a famous paper on the design of shapes for which transition from laminar- to turbulent-boundary-layer flow is substantially delayed. These highly original papers were published in reports of the Aeronautical Research Institute, as were the results of his research on permissible surface roughness in the laminar boundary layers. These reports were published between 1939 and 1943, during the Second World War.

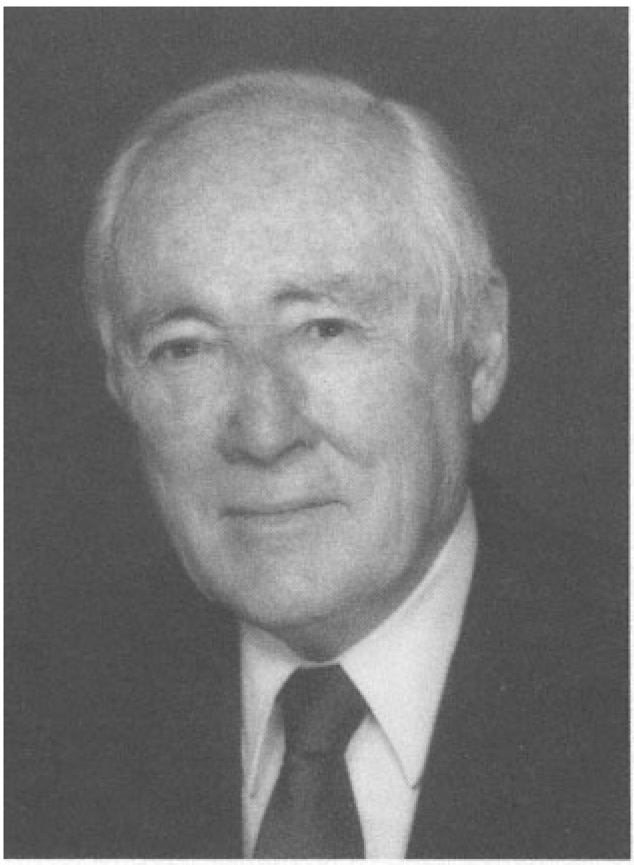
Following the war Dr. Tani's papers on laminar-flow airfoils represented a great, worldwide academic contribution in the progress of fundamental fluid mechanics. It may be emphasized that his work on laminar boundary layers and airfoil design, extended to compressible-fluid flow, has been instrumental in the development of modern airfoils for jet aircraft. Still in a day when high-speed computers were unavailable, he continued his efforts in the theoretical solution of laminar-boundary-layer problems and, in parallel, the problem of boundary-layer transition induced by two-dimensional and isolated roughness elements, streamwise vortices, steps, grooves, and unsteady conditions.

In the 1960s he became interested in the turbulent boundary layer, and wrote extensively on turbulent shear flow, the response of turbulent boundary layers to sudden perturbations, and the response of a turbulent shear flow to a stepwise change of wall roughness.

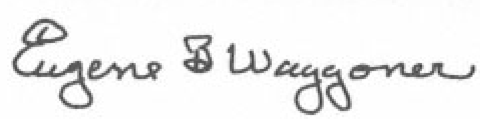
Examples of his contributions outside the realm of boundary layers are those concerning magnetohydrodynamics and, remarkably, the aerodynamics of ski jumps. In the former category he studied steady flow of electrically conductive fluids in channels under transverse magnetic fields with consideration of the Hall effect. In the latter category, he treated ski jump dynamics from the airfoil-theory standpoint and arrived at desirable ski jump configurations.

Throughout his career as a scientist and as a member of the Japanese Academy, Dr. Tani received many prestigious awards, both in Japan and internationally. He received the Toyo Rayon Science and Technology Award in 1966, and in 1968 the Japanese Academy honored him with the Japan Academy Prize, which is considered to be Japan's most honorable distinction. He was given the Second Class Order of the Rising Sun in 1977 by the Japanese government, was made a foreign member of the Indian Academy of Science in 1987, and was awarded the Premio Marco Polo Prize in Italy in 1979 and the Ludwig Prandtl Award in Germany in 1988.

Dr. Tani's dedication, insight, and expertise have not only set a standard to be emulated by research workers around the world, but have also furthered the science of fluid mechanics in general and our understanding of the phenomena of the boundary layer in particular.



Photograph by Barry Evans.



Eugene B. Waggoner

1913-1991

By William W. Moore

EUGENE B. WAGGONER, an internationally recognized engineering geologist and former chief executive officer of Woodward-Clyde Consultants, died in Napa, California, on November 30, 1991.

Born in Kansas City, Missouri, in 1913, Gene Waggoner received his B.A. and M.A. in geology from the University of California, Los Angeles, in 1937 and 1939, respectively. He began his professional career as a petroleum geologist during the heightened need for oil in World War II. After the war he worked for nearly a decade in government service for the U.S. Bureau of Reclamation, where he was a staff geologist in the Office of Chief Engineer and Assistant Commissioners, with technical control of engineering geology in western Reclamation Regions II and III. His responsibilities in this work included coordination of geologic work on the boundary between the United States and Mexico and of the Snowy Mountain Diversion Project for the government of Australia. He supervised all phases of engineering geology in this work, from site selection and investigation through design, specification, and construction of all types of irrigation and hydroelectric projects.

In 1954 he founded in Denver a private consulting practice to provide services to major engineering firms, contractors, other private firms, and foreign governments. His work included field reconnaissance and appraisal of groundwater potential, recom mendations on methods of development, design of wells, preparation of specifications, supervision of construction, and completion and testing of wells.

In June 1960 he merged his firm with Woodward-Clyde and Associates, and he became executive vice-president and comanager, providing engineering and geologic consultation on major engineering projects throughout the United States and foreign countries. Seven years later Waggoner was appointed president and chief executive officer of Woodward-Clyde. In 1973 Waggoner retired to a private consulting practice in engineering geology.

During his career Waggoner served as a consulting engineering geologist for major hydroelectric, irrigation, and tunneling projects throughout the world, working in some fifty countries, and his credentials and accomplishments in his field are second to none in both quality and quantity. The important theme that served as the foundation of all of his work is the amalgamation of theory and practice toward the successful completion of major works for society. His advice was actively sought by owners, designers, and contractors. What established his reputation was his outstanding ability to understand a regional geology, interpret the exploratory work in that context, arrive at remarkable definitive conclusions, and then to explain them. His work ultimately brought meaning and demonstrated the value of practical, understandable consulting geologic service to groundwater development and control in the United States and foreign countries. Because he was an advocate of a multidisciplinary approach to distribution, conservation, power generation, and pollution control of water, he was called upon to lead assignments on projects such as the West Pakistan Salinity Control and Reclamation Project, the Bhumipol Dam and Power plant in Thailand, and similar major projects worldwide. He was also highly regarded for his expert testimony and skill in translating complex geologic conditions into everyday language.

Perhaps Mr. Waggoner's greatest contributions came as a result of his service to the engineering profession, applying his technical knowledge and management skills for the benefit of professional practice. He contributed his time generously to a number of organizations, including the American Consulting Engineers Council (ACEC), where he served as national president in 1966-1967. At ACEC he contributed important improvements to engineering practice such as developing peer review programs for engineering practice that came to be widely used by ACEC. He actively supported the national Association of Soil and Foundation Engineers (ASFE), in particular in his support of the ASFE Peer Review Program. He was requested to peer review more than a dozen ASFE and ACEC firms, another measure of the respect with which he was held within the profession. He also gave unstintingly of his time to various other professional organizations, including the Association of American Geologists, International Society of Rock Mechanics, International Commission on Large Dams, and the American Society of Civil Engineers.

Mr. Waggoner contributed substantially to the work of the National Research Council (NRC), primarily through the U.S. National Committee on Tunneling Technology. He participated in the writing of several NRC documents, including *Better Management of Major Underground Construction Projects* and *Better Contracting Practices.* One of Waggoner's major contributions to the NRC was his chairmanship of the Subcommittee on Site Investigation for underground structures of the U.S. National Committee on Tunneling Technology. As chairman he led the efforts of fifteen of the country's top professionals in the tunneling industry toward the publication in 1984 of the two-volume report *Geotechnical Site Investigations for Underground Projects.*

An honorary member of the Association of Engineering Geologists, Waggoner was also a member of Sigma Xi, honorary science fraternity; and Phi Delta Kappa, honorary education fraternity.

Mr. Waggoner was an elected member of the Board of Education in Lakewood, Colorado; a member of the Intercountry Regional Planning Commission in Colorado, and served as a president of his Kiwanis Club. He also was a member of the Vallejo Gem and Mineral Society, Vallejo Yacht Club, Vallejo Symphony, Vallejo Concert Association and Historical Museum, and the Navy League. He was a 32nd degree Mason.

Mr. Waggoner is survived by his wife of fifty-three years, Wini, of Vallejo, California; two daughters, Diana Davies of Dixon, California, and Teri Nebeker of Sacramento, California; a son, Alan, of Pittsburgh, Pennsylvania; and six grandchildren.

Aubrey J. Wagner

1912-1990

Written By W. F. Willis

Submitted By The Nae Home Secretary

AUBREY J. "RED" WAGNER, who served the Tennessee Valley Authority (TVA) for forty-four years, a record seventeen years on its board of directors and sixteen of those years as its chairman, died July 14, 1990, in Knoxville, Tennessee, at the age of seventy-eight.

Wagner was born January 12, 1912, in Hillsboro, Wisconsin. He received his B.S. degree, magna cum laude, in civil engineering in 1933 from the University of Wisconsin. It was also in that year that he married the former Dorothea J. Huber of Sioux City, Iowa.

In 1934 he began his long and distinguished career with TVA, which had been created a year earlier. His first assignment was as an engineering aide in the General Engineering and Geology Division, where he worked in the navigation program and assisted with the planning and construction of Tennessee River navigation facilities. Later he also worked on transportation economics studies that were intended to develop the fullest possible contribution of low-cost transportation to TVA's total program for integrated resource development.

In 1948 he was named chief of the Navigation and Transportation Branch, where he was responsible for general planning of TVA's navigation program, including both engineering matters and economic studies involved in the growing commercial use of the newly improved Tennessee waterway. Wagner was appointed

TVA assistant general manager in 1951 and general manager in 1954. In this capacity he was the agency's chief administrative officer.

In 1961 President John F. Kennedy appointed Wagner to the TVA board of directors. When Chairman Herbert D. Vogel resigned the following year, Kennedy designated Wagner as chairman. When Wagner's first term neared an end in 1969 without a reappointment, he prepared to leave. However, President Richard Nixon reappointed him at the last minute, and he returned to serve another nine years—longer than anyone else who had been chairman.

During his tenure, Wagner gained a degree of respect and personal loyalty among rank-and-file TVA employees that was almost unprecedented for a large organization. He was called "Mr. TVA" by many, and historians say his influence on TVA's direction and programs is equaled only by that of the first board of directors. He is remembered for his tireless energy, never letting up until he accomplished what he was trying to do. Although he could be very stubborn when he was convinced he was right, he would listen to others and worked hard to gain broader perspectives. He was a builder who always kept the big picture in mind. He never saw TVA's projects as ends in themselves but as tools to create good jobs and build a better quality of life for the Tennessee Valley.

Wagner was a special friend of the small towns and rural areas of the Tennessee Valley, and he made sure that TVA worked closely with the people of these areas to increase their economic opportunities. Because he was disturbed by the migration of many of the area's young people, who often had to leave their homes and families to find work outside the Tennessee Valley, he was proud of TVA's role in reversing that flow by stimulating economic expansion and helping to create good jobs for the people of this region.

Elected a member of the National Academy of Engineering in 1973, Wagner was a member of the President's Appalachian Regional Commission, President's Council on Recreation and Natural Beauty, President's Council on Cost Reduction in Government, Engineering Advisory Committee of the Tennessee

Technological University, the Tennessee Governor's Science Advisory Committee, National Advisory Council for the 1974 World Energy Conference, Advisory Committee for the 1972 United Nations Conference on Human Environment, Atomic Energy Commission's Senior Utility Steering Committee, and member and vice-chairman of the Breeder Reactor Corporation.

Wagner traveled extensively overseas as a consultant and adviser on resource problems. For example, in 1964 he participated in a river development conference at Aswan in the United Arab Republic. The conference was sponsored by the Ford Foundation and concerned the multipurpose applications of the Aswan High Dam. He was the keynote speaker and a participant in the Lahore, Pakistan, Seminar on Problems of Public Enterprise, which was sponsored by the Pakistan National Institute of Public Administration. He also served as a lecturer for the Agriculture and Natural Resources Session at the Salzburg Seminar in American Studies.

Wagner received an honorary doctor of laws degree from Newberry College in 1978 and an honorary doctor of Public Administration from Lenoir Rhyne College in 1970. He received the N. W. Daugherty Award from the University of Tennessee in 1969, the Distinguished Service Citation from the University of Wisconsin in 1962, the Lambda Chi Alpha Order of Achievement in 1970, and the Walter H. Zinn Award of the American Nuclear Society in 1978. In 1979 Wagner was named Chapter Honor Member of Chi Epsilon, in 1981 Engineer of Distinction by the Tennessee Technological University, and in 1978 a Honorary Lifetime Member of the American Public Power Association. He was the author of more than thirty-five publications.

After his retirement in 1978, Wagner's keen interest in the work of TVA continued, and on many occasions TVA and countless other organizations called on him to share the benefits of his experience. Today people who travel the Valley can see the legacy he left behind. Yet his legacy resides in more than TVA's concrete and steel. It lives on in the hearts and minds of the TVA employees. He challenged them as individuals and as an organization to build a TVA that would mean great things to the region.

He had confidence in TVA, and he instilled that confidence in others. That attitude of confidence and a "can-do" spirit still serves TVA well today.

On September 13, 1991, the towboat "Red Wagner" was christened. That boat was chosen to carry his name because it is a workhorse for TVA, day-in and day-out, like Red was for TVA. As John B. Waters, TVA director, said at the christening ceremony, "I know what this boat can do ... because last summer it served as the 'flagship' for my river inspection tour. That 'Voyage for the Valley' took me the full 650-mile length of the Tennessee River... and this boat never missed a beat. Red was like that from the time he joined TVA. Some of his earliest work at TVA involved surveying the river banks for the dams that would follow, so it is appropriate that his name travel the river system that he helped build."

Red Wagner is missed by everyone who knew and admired him. But his legacy continues to be a vital force throughout the Tennessee Valley.

An Wang

1920-1990

By Leo L. Beranek

BORN IN A SMALL CITY about thirty miles from Shanghai, China, An Wang created and nurtured a small high-tech company into a major worldwide supplier of office information systems. Early in primary school, he discovered he was good in mathematics, but he found subjects that required rote memorization, like history and geography, difficult. English was compulsory at school from the fourth grade onward, but his command of the language was solidified by his father, who was an English teacher. His mother taught him Confucianism, a practical philosophy, which he always emphasized was important to success in business, being characterized by the attributes of moderation, patience, balance, and simplicity combined with the golden rule.

At thirteen he entered Shanghai Provincial High School, considered the best in China. His mathematics texts were those used in freshman classes of American colleges, and his geography and history books were written in English. At the age of sixteen he entered the MIT of China, Chiao Tung University in Shanghai. After graduation in 1940 he spent the next year as a teaching assistant in electrical engineering. In the summer of 1941 he escaped through the Japanese invasion lines to central China and was put in charge of a group designing radio equipment to be used in the war. While there, he learned about a program that sent highly trained Chinese engineers to the United States to prepare them for the reconstruction of China.

He applied, was successful, and in June 1945 arrived at Newport News, Virginia, with a stipend of $100 per month for support. He was sent to Georgetown University, where he stayed briefly.

Luck was with him. He applied for admission to the graduate school at Harvard and was accepted in the Applied Physics Department solely on the basis of his letter. With straight A grades, he earned his M.S. in two semesters in 1946. He was offered a Harvard part-time teaching fellowship at $1,000 a year, which permitted him to work for his doctorate. His thesis topic was in applied mechanics, and he received the Ph.D. in the spring of 1948.

Wang went to work in the new Harvard Computation Laboratory under Howard Aiken, designer of the Mark I IBM computer, then called Automatic Sequence Controlled Calculator. Aiken gave him the problem of finding a way to record and read magnetically stored information without mechanical motion. Out of this work came a basic invention that Harvard allowed him to keep and patent—a magnetic core memory, which led to a practical delay line. Following a vital extension of the concept by Jay Forrester of the Massachusetts Institute of Technology, his invention was the basis for the core memories in computers for the next twenty years.

In 1949 he married Lorraine Chiu, who had come to the United States as a special student at Wellesley College. There are three children, Fred, Courtney, and Juliette. In 1955 An and Lorraine became American citizens.

With $600 in savings, he opened Wang Laboratories in Boston in 1951. Wang's product was magnetic, toroidal-shaped, nickel-iron cores, around which wires were wound. It was in this period that he learned the principles of manufacturing, marketing, and management. In 1956 he assigned his patent to IBM for $500,000.

In 1965 Wang Laboratories introduced LOCI, a desktop calculator, the forerunner of today's pocket computers. That year they sold twenty calculators and the following year six times as many. Improvements followed; the calculator became programmable; and the company grew from thirty-five employees in 1964 to four hundred in 1967. In 1965 John Kemeny of Dartmouth developed the computer language BASIC, which Wang recog nized would spell the death of his desktop calculator. He decided to develop a minicomputer, similar to DEC's later PDP-8, which, after several false starts, led to the model 2200 computer, first shipped in late 1972.

Next came more elaborate word processing systems. Under Dr. Wang's general direction, an engineer Harold Kaplow and his team developed the word processing system that made Wang Laboratories the world's leader in sales of office equipment. That new machine was cathode ray tube-based, so the user could manipulate text by moving words as they appeared on the screen. The system was driven by a series of menus, so at each decision point a secretary could respond to a clear set of choices. It was perhaps the first computer with which an ordinary person could interact.

In addition, a decision was made to allow multiple access to a central station, a concept already employed by IBM, but different in that Wang's workstations were semi-intelligent. This permitted the addition of a Wang workstation at about one-third the cost of a competitive workstation. In October 1977 Wang Laboratories introduced a general-purpose computer, the VS, which combined word processing with general-purpose computing. Business grew at a compound rate in excess of 40 percent annually, and Wang Laboratories in 1985 reached a sales level of $2.4 billion.

Throughout that period, An Wang was a brilliant conceptualizer, both in guiding the products of his company and in entering the financial markets at exactly the right times to permit the company's extraordinary growth. As one director said, "He has done so much right for so long that you become a believer, a disciple." He was concerned about loss of control of his company and devised a combination of two classes of stock that assured him of permanent control. Wang said in his autobiography (Addison-Wesley, 1986) that no outside shareholders would manage the company as well. "There is the fact that the company bears my name," he wrote. "I take its health and performance personally.... I have more interest in seeing the company prosper than any other shareholder."

In 1982 Wang was elected a member of the National Academy of Engineering.

Dr. Wang was generous with his time in community affairs. He gave Boston's Metropolitan (performing arts) Center $4 million, which, when matched, produced $10 million in restoration support. It is now called the Wang Center. He endowed the Wang outpatient care unit of the Massachusetts General Hospital and contributed $1 million to support Chinese studies at Harvard. Through the years he provided help to Chinese persons in many ways through scholarships and support of cultural institutions. Dr. Wang's death left a void not only in his company but also in the hearts and well-being of the residents of Greater Boston.

Gabriel Otto Wessenauer

1906-1990

Written By Roland A. Kampmeier

Submitted By The Nae Home Secretary

G.O. WESSENAUER, manager of power for the Tennessee Valley Authority for twenty-five years, died on September 30, 1990, at the age of eighty-three.

He was born on October 21, 1906, at Sewickley, Pennsylvania, the son of Gabriel and Meta Schletter Wessenauer. After studying in the local public schools, he entered Carnegie Institute of Technology, where he earned a B.S. in civil engineering. He had a high scholastic standing and was elected to Tau Beta Pi.

G. O. Wessenauer was "Jim" to his family circle and church friends. He was "Wess" to his fellow workers and business and professional associates.

After a total of eight years with the West Virginia Power and Transmission Company and the West Penn Power Company, Wess joined the Tennessee Valley Authority (TVA) as an assistant hydraulic engineer in 1935. He was assistant to the manager of power by 1941, was acting manager of power in 1943, and became manager of power in 1944. He held that position, in which he was in charge of the entire TVA power program, until he retired in January 1970. He then continued to do some consulting for TVA and others.

Wess was elected to the National Academy of Engineering in April 1968. He was a member of the Academy's Steering Committee on Power Plant Siting and of the NRC Commission of Sociotechnical Systems' Committee on Processing and Utilization of Fossil Fuels.

He served on numerous national and international advisory groups concerned with electric power supply, its reliability, its environmental impacts, and research and development of better ways to provide electric service. He served as chairman of the Electric Research Council and as a director of the Atomic Industrial Forum. He was a fellow of the American Society of Civil Engineers (ASCE), an honorary life member of the American Public Power Association, and a member of the Chattanooga Engineers Club.

Wess received the Rockefeller Public Service Award for outstanding service to the nation as a federal employee. He was the author of several papers, including one that won the ASCE Collingwood Prize and three papers for World Power Conferences.

It would be impossible to record the illustrious history of the TVA and its power program without referring to Wess time and time again. Likewise, a memorial tribute for Wess would be far from complete without at least a brief review of the story of TVA power. It was he who steered the TVA power program for more than twenty-five years—far longer than any other person. During his stewardship the TVA power system outstripped all others in the nation in size and scope and set records for efficiency and low cost.

The constant goal of Wess and the team he assembled and led was to provide the people of the Tennessee Valley region with an abundant supply of electric energy at the lowest practicable cost. The system's generating capacity was expanded tenfold under his direction. It evolved from a predominantly hydroelectric system to one that included some of the world's largest and most cost-effective coal-burning power plants, and nuclear plants were being added. The major transmission voltage was increased from 161 kilovolts to 500 kilovolts. The cost per kilowatt-hour of electricity use, which TVA had already lowered dramatically, was further reduced.

Wess saw clearly the importance of electric energy in the social and economic development of the region. He worked with the municipal and cooperative systems that distribute TVA power to encourage industrial development and to see that rural distribution lines were extended to every farm and cabin. Fewer than one rural home in four had electric service when Wess took charge; by the time of his retirement, rural coverage was virtually 100 percent. He and his associates persuaded Congress of the feasibility and wisdom of discontinuing the TVA power program's reliance on congressional appropriations and allowing TVA to issue its own securities.

The *Chattanooga Times said* of Wess: "He sees his job in human terms as well as kilowatts and self-financing plans. He likes to think of the transformation TVA power has wrought in countless farm houses and mountain cabins, where water is now pumped instead of carried, and where modern ranges, refrigerators, and washing machines lighten the housewife's burden."

Although his work was of major importance to an entire region, Wess was a humble, private person. He was a man of spotless integrity. His example was reflected throughout the organization he led; it had an enviable worldwide reputation for quality and effectiveness.

Wess the engineer was ever efficient and usually reserved. But he was also Jim, the loving husband, father, grandfather, and churchman. He was a member of the church council and was a Sunday school teacher for over fifty years. He was preceded in death by his son, the Reverend James Wessenauer, and left his devoted wife, Jenny; daughter, Joy; and six grandchildren.

Sakae Yagi

1904-1991

By Hoyt C. Hottel

SAKAE YAGI, former head of chemical engineering at the University of Tokyo, then executive vice-president of Chiyoda Engineering and Construction Company, died on July 15, 1991 (born Meiji 37) at the age of eighty-six. Because of his contributions to chemical engineering education, research, and industrial applications, Dr. Yagi was elected a foreign associate of the National Academy of Engineering in 1981 and was considered by many of his associates to be Japan's number-one chemical engineer.

Dr. Yagi's higher education started at Tokyo Imperial University in applied chemistry and led to research in the fields of optics and infrared spectroscopy. Dr. Yagi left Tokyo Imperial University to become an assistant professor in chemical engineering at Tokyo Institute of Technology, where he developed his interest in fuels, furnaces, radiative transfer, and combustion. In 1935 he was given a two-year leave of absence to study abroad. His first year was spent in the Chemical Engineering Department of the Massachusetts Institute of Technology (MIT), where he carried a heavy load of graduate subjects while doing research on flame lengths. In a farewell dinner party for the chemical engineering staff, he said that he would return to Japan to start many chemical engineering departments in his nation's universities. His audience did not visualize the enormousness of his coming effort to make that statement come true. Dr. Yagi spent his second year abroad visiting important industrial companies and federal re search agencies in the United States and similar organizations in Europe. During these visits, he had discussions in his principal areas of interest with notable scientists and engineers, including G. I. Taylor and Theodore von Karman, among many others.

On returning to Japan Dr. Yagi became the first head of the new chemical engineering department at Tokyo Institute of Technology. A few years later he accepted a professorship at the University of Tokyo, where he became the prime mover in establishing first a petroleum engineering department, then a department of chemical engineering, and later, an expansion of the applied chemistry department. He was a faculty member of both of these universities, and students in chemical engineering could study or do research at either institution, or both. A few among many other activities in Dr. Yagi's early postwar period were his involvement in a nuclear power plant project, another visit to MIT to discuss research problems, and the heading of Japan's first world trade fair. He had been one of the founders of the Society of Chemical Engineering, Japan, in 1936. In 1961 he was elected its president and arranged for a celebration of the society's 25th anniversary, with invitations to members of the world's major chemical engineering departments; a two-week symposium was held, one week in Tokyo and one in Kyoto.

From heading the chemical engineering department at the University of Tokyo, Dr. Yagi moved on to become dean of engineering, then head liaison among chemical engineering, applied chemistry, and petroleum engineering. Full retirement from the university came in 1965, when he was made the executive vice-president of Chiyoda Engineering and Construction Company.

It is typical of the career of many a scientist-engineer-turned-administrator to drop slowly out of direct productive research as management activities increase. Not so with Dr. Yagi. His definitive research and outstanding technical papers and lectures continued throughout his career. A brief summary of his output in three areas follows.

The first field of interest that Dr. Yagi developed and expanded was industrial furnaces and the areas of heat transfer, fluid mechanics, and chemical kinetics on which furnace con struction and operation were based. There followed papers on flame luminosity, flame length, heat transfer, and a book in the early 1930s on industrial furnaces. A generation later the book was reedited and enlarged.

From 1948 to 1961 Dr. Yagi published many papers on chemical reactions in fluidized beds, papers typically showing that his strong interest in theory and his high analytical competence were motivated by the need for theory to guide practice. Attention to fixed beds overlapped the fluidized-bed research; papers and lectures came on the effective thermal conductivity of packed beds, coefficients of heat transfer, axial movement of solids in packed beds, and temperature and concentration distribution in fixed-bed reactors.

In Dr. Yagi's later years he turned to the broad objective of integrating knowledge of chemical reactors to achieve an economic optimum in their design and performance. The papers were first on the properties of different reactor types, then on the overall process of optimization. While heavily loaded with managerial activities under Chiyoda, he still found time to lecture at Nagoya University on reaction engineering and to write a book on the subject. Collaboration with Professor H. Nishimura produced an optimized process network based on a linear model, which drew from an American expert the assessment that the model was superior to more mathematically complex models available at that time.

On retirement as executive vice-president of Chiyoda, Dr. Yagi became senior adviser and chairman of the board of directors of Chiyoda International Company, Inc. This involved many more trips to the United States. Later he was appointed senior adviser to Japan's Ministry of International Trade and Industry (MITI). When in response to a request from the U.S. Department of Energy the National Research Council set up an ad hoc committee on the Industrial Energy Conservation Program, the committee arranged a trip to Japan. Dr. Yagi, representing MITI, was a prime source of information for the committee. That exchange, between Japan and the United States, of knowledge about progress in engineering and science was characteristic of Sakae Yagi's dedication to the educational process, worldwide.

Appendix

Members	Elected	Born	Deceased
John Bardeen	1972	May 23, 1908	January 30, 1991
Harry F. Barr	1965	August 28, 1904	March 5, 1990
Gilbert Y. Chin	1982	September 21, 1934	May 5, 1991
James Wallace Daily	1975	March 19, 1913	December 27, 1991
John Frank Elliott	1975	July 31, 1920	April 15, 1991
Karl L. Fetters	1965	November 28, 1909	October 3, 1990
James C. Fletcher	1970	June 5, 1919	December 22, 1991
Jacob M. Geist	1980	February 2, 1921	March 22, 1991
Milton Harris	1976	March 21, 1906	September 12, 1991
Fred L. Hartley	1980	January 16, 1917	October 19, 1990
Richard Hazen	1974	August 5, 1911	February 12, 1990
Edward H. Heinemann	1965	March 14, 1908	November 26, 1991
Frederic A. L. Holloway	1965	November 8, 1914	November 30, 1990
Marshall G. Holloway	1967	November 23, 1912	June 18, 1991
Grace Murray Hopper	1973	December 9, 1906	January 1, 1992
Richard Ralston Hough	1983	December 13, 1917	July 9, 1992
Robert I. Jaffee	1969	July 11, 1917	November 28, 1991
Clarence L. "Kelly" Johnson	1965	February 27, 1910	December 21, 1990
Edward Conrad Jordan	1967	December 31, 1910	October 18, 1991
John Fisher Kennedy	1973	December 17, 1933	December 13, 1991
Augustus B. Kinzel	1964	July 26, 1900	October 23, 1987
Philip S. Klebanoff	1981	July 21, 1918	May 2, 1992
Alan G. Loofbourrow	1977	June 9, 1912	December 1, 1990
Gerald T. McCarthy	1973	May 5, 1909	November 21, 1990
James R. Melcher	1982	July 5, 1936	January 5, 1991
Frank R. Milliken	1975	January 25, 1914	December 4, 1991
Kiyoshi Muto	1978	January 29, 1903	March 12, 1989
Jack N. Nielsen	1985	November 21, 1918	October 31, 1990
Zenji Nishiyama	1982	October 14, 1901	March 12, 1991
Robert N. Noyce	1969	December 12, 1927	June 3, 1990
Thomas O. Paine	1973	November 9, 1921	May 4, 1992
Alan J. Perlis	1977	April 1, 1922	February 7, 1990
Milton S. Plesset	1979	February 7, 1908	February 19, 1991
Robert F. Rocheleau	1981	December 28, 1920	February 24, 1991
Louis Harry Roddis, Jr.	1967	September 9, 1918	September 15, 1991
Kenneth A. Roe	1978	January 31, 1916	June 3, 1991
L. Eugene Root	1965	July 4, 1910	January 23, 1992
Albert Rose	1975	March 30, 1910	July 26, 1990

Members	Elected	Born	Deceased
Dominick J. Sanchini	1984	December 2, 1926	November 17, 1990
Sidney Eugene Scisson	1977	February 4, 1917	November 24, 1990
Wilbur S. Smith	1968	September 6, 1911	July 25, 1990
Robert C. Sprague	1985	August 3, 1900	September 27, 1991
Arthur C. Stern	1976	March 14, 1909	April 17, 1992
C. Guy Suits	1964	March 12, 1905	August 14, 1991
Itiro Tani	1979	May 20, 1907	May 28, 1990
Eugene B. Waggoner	1987	January 7, 1913	November 30, 1991
Aubrey J. Wagner	1973	January 12, 1912	July 14, 1990
An Wang	1982	February 7, 1920	March 24, 1990
Gabriel Otto Wessenauer	1968	October 21, 1906	September 30, 1990
Sakae Yagi	1981	July 26, 1904	July 15, 1991

Acknowledgments For The Photographs

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