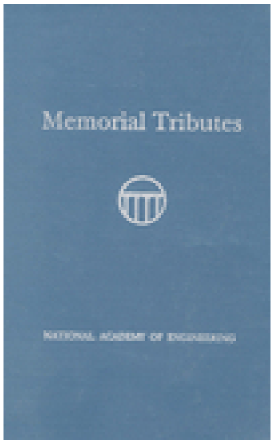


Memorial Tributes: National Academy of Engineering, Volume 8

National Academy of Engineering

ISBN: 0-309-55683-X, 320 pages, 6 x 9, (1996)

Memorial Tributes

NATIONAL ACADEMY OF ENGINEERING

Memorial Tributes

Volume 8

National Academy of Engineering
of the
United States of America

NATIONAL ACADEMY PRESS
Washington, D.C. 1996

International Standard Book Number 0-309-5575-X
International Standard Serial Number 1075-8844
Additional copies of this publication are available from:
National Academy Press
2101 Constitution Avenue, N.W.
Box 285
Washington, D.C. 20055
800-624-6242 or 202-334-3313 (in the Washington Metropolitan Area)

Printed in the United States of America

Contents

Foreword

This is the eighth volume in the series of *Memorial 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 most cases, the authors of the tributes are contemporaries or colleagues who had personal knowledge of the interests and the engineering accomplishments of the deceased members and foreign associates.

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

SIMON OSTRACH
HOME SECRETARY

Memorial Tributes

NATIONAL ACADEMY OF ENGINEERING

Jakob Ackeret

1898-1981

By Alexander Flax

Prepared with the assistance of Nicholas Rott

Jakob Ackeret, whose fundamental, comprehensive, and path breaking contributions to fluid mechanics and the understanding of high-speed and supersonic flows led to significant improvements in the science of flight, died April 1, 1981, in Kusnacht, Switzerland, at age eighty-three after a long illness.

Professor Ackeret was born March 17, 1898, in Switzerland. He received his diploma in mechanical engineering in 1920 and his Ph.D. in engineering science in 1930, both from the Federal Institute of Technology (ETH), Zurich. He served in 1920 and 1921 as a research assistant of Professor Stodola at ETH. From 1921 to 1927 he was a research associate of Professor Ludwig Prandtl at the University of Göttingen, Germany. He took part in the planning and preparations for the establishment there of the Kaiser Wilhelm Institute for Fluid Mechanics Research (today the Max Planck Institute for Fluid Mechanics Research) becoming its first director when it went into full operation in 1925. In 1928 he became chief engineer at Escher Wyss Ltd., Zurich, where he served until 1932, when he became a professor at ETH. There he founded and became director of the Institute for Aerodynamics, which became fully operational in 1934. He made that institute famous as a center for research on high-speed gas dynamics and thermodynamics and served as its director until his retirement from ETH in 1967. However, he maintained continuing, life long connections with Escher Wyss and contributed to the solution of many design problems and to inventions such as gas turbines and variable-pitch propellers.

Professor Ackeret was one of the pioneers in the theoretical and experimental investigation of supersonic flows about airfoils and in channels. He published in 1925 a definitive paper describing the small perturbation theory of supersonic flow of a perfect gas over a thin airfoil. The methods and results he obtained are to this day often identified as "the Ackeret theory," "the Ackeret pressure," and "the Ackeret lift." He was personally responsible for innumerable important contributions to theoretical and applied aerodynamics and fluid dynamics. He designed, built, and operated several high-quality subsonic and supersonic wind tunnels at both the University of Göttingen and at the ETH. His closed-circuit supersonic wind tunnel at ETH driven by a multistage compressor permitted independent variation of Mach number and Reynolds number and served for many pioneering experimental investigations. (The term "Mach number" was introduced by Ackeret in his inaugural lecture at ETH in 1929.) Professor Ackeret was one of the first to give clear, theoretically based, and experimentally validated explanations of the effects of compressibility in flow over aircraft components and thereby contributed uniquely to the successful design of high-speed flying machines.

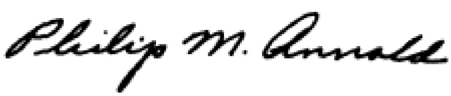
Professor Ackeret's aerodynamic research included the problems of gas flow at very high speeds through cascades and grids, and the basic problems of boundary layers and heat transfer at high subsonic and supersonic speeds. He was one of the early workers in the study of the effects of roughness on airfoil form drag and the boundary layer, and with his students he pioneered in fundamental investigation of shock-boundary layer interactions in supersonic flows. He did early significant work on the application of boundary layer suction on airfoils, which work was later carried on by his students, especially in investigations of the complex problems of practical applications.

His work in the 1930s and 1940s established much of the fluid mechanics and basic technology of the present-day gas turbine, as evidenced by his many technical papers at that time. He worked with Escher Wyss in the application of the gas turbine with a closed-circuit and a multistage axial compressor (the Ackeret-Keller turbine) as a stationary power source. He also investigated hydraulic turbine problems, especially cavitation. On Professor Ackeret's sixtieth birthday, Professor Theodore von Karman complimented him as the outstanding mechanical engineer among the pioneers of aerodynamics. Professor Ackeret's leadership in aeronautical engineering and fluid mechanics at ETH produced a great center of learning and many students who influenced practical aeronautics and aeronautical education around the world.

He was a respected student of the history of science, applied mechanics, and aerodynamic and hydraulic technology. His most significant contribution in this field was the editing of a volume of Euler's works on hydrodynamics.

Elected a foreign associate of the National Academy of Engineering in 1976, he was an honorary fellow of the American Institute of Aeronautics and Astronautics, the Royal Aeronautical Society of London, and the Institute of Aeronautical Sciences of New York. He was an honorary member of the American Society of Mechanical Engineers, a member of the Max Planck Institute for Aerodynamic Research in Göttingen, and a recipient of the Guggenheim Medal and the Prandtl Ring. He gave the second Daniel and Florence Guggenheim Memorial Lecture to the International Astronautical Federation in 1960.

Professor Ackeret's original publications numbered more than one hundred. In addition he contributed to twenty-four papers for the Institute of Aerodynamics and to forty-eight other publications with various collaborators. A bibliography of his work (and most of the work that was completed under his direction) was published in the *Journal of Applied Mechanics and Physics* (*ZAMP*), Vol. IXB, 1958.


Philip M. Arnold

Philip M. Arnold

1911-1994

By M. M. Johnson

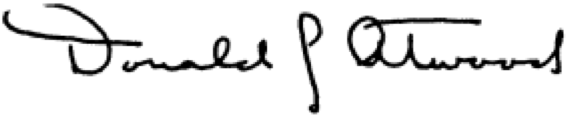
Philip M. Arnold, a former vice-president for research and development, Phillips Petroleum Company, died on October 28, 1994, at his home in Bartlesville, Oklahoma.

Mr. Arnold was born in Springfield, Missouri, where he received his early education. He earned his B.S. in chemical engineering in 1932 and his M.S. in 1941 from Washington University in St. Louis. In 1969 Washington University recognized Mr. Arnold as a distinguished graduate and in 1983 awarded him an honorary doctor of science degree. He joined the research department of Phillips in 1937 and became manager of research and development in 1950 and vice-president in 1964. He held this position until his retirement in 1976. Mr. Arnold played a pivotal role in Phillips's entry into petrochemicals, leading first the research effort and later the management teams that made Phillips a major producer of synthetic rubber, polyolefin plastics and fibers, engineering polymers, fertilizers, and a host of other products and processes associated with petrochemicals and petroleum refining. For his leadership in research related to treatment of natural gas and gas liquids, he received the Hanlon Award from the Gas Processors Association in 1975. He was the author of a text on hydrofluoric acid alkylation and held twenty-two U.S. patents.

Mr. Arnold was an involved member of a number of technical organizations, actively attending and participating in local sections of the American Chemical Society (ACS) and the American Institute of Chemical Engineers until his retirement. At the national level, he represented Phillips in the American Petroleum Institute, American Society for Testing and Materials, Coordinating Research Council, Directors of Industrial Research, and the Industrial Research Institute, serving as a director, vice-president, and president (1964 to 1965) of the latter organization. At the international level, he was chairman of the finance committee and the executive committee of the International Union of Pure and Applied Chemistry (IUPAC), and was a member of the permanent and executive councils of the World Petroleum Congresses, serving as vice-chairman of the U.S. National Committee from 1965 to 1971.

Mr. Arnold was active with the National Research Council as a member at large of the Division of Chemistry and Chemical Technology from 1959 to 1965, as the ACS representative from 1965 to 1968, and as a member of the executive committee from 1961 to 1965. He was also a member of the U.S. National Committee for IUPAC from 1961 to 1970, serving that committee as its chairman from 1964 to 1968. He was elected to the National Academy of Engineering (NAE) in 1970 and served on the Division of Engineering, Committees on Pollution Abatement Control, Ad Hoc Panel on Abatement of Sulfur Oxide Emissions from Industrial Sources (1970 to 1971) and the Panel for Engineering Unemployment in 1971 and 1972.

Always a scholar and an effective advocate for science and technology, Phil will be remembered and missed for his leadership, insight, and openness with his coworkers at Phillips and the members of the NAE.



Donald J. Atwood

1924-1994

By B. Paul Blasingame

Donald J. Atwood, past councillor and treasurer of the National Academy of Engineering, died on April 24, 1994, at the age of sixty-nine. Mr. Atwood was born May 25, 1924, in Haverhill, Massachusetts. He is survived by his wife, Sue, and by two children: Susan Atwood Lavoie and Donald J. Atwood III.

Elected to the National Academy of Engineering in 1980, he served on nine of its committees, two as chairman, over the period from 1984 to 1994. In addition, his public service included the Corporation of the Massachusetts Institute of Technology; the board of directors of The Charles Stark Draper Laboratory, Inc.; the American Institute of Aeronautics and Astronautics; the Society of Automotive Engineers; the board of directors of the Michigan Opera Theatre; and the national executive board of the Boy Scouts of America.

Mr. Atwood attended the Massachusetts Institute of Technology (MIT), with an interruption of several years' service in Burma with the U.S. Army Signal Corps. Upon return to civilian life, Don married Sue Harian, a graduate of Tufts University, and reentered MIT to complete bachelor's and master's degrees in electrical engineering. While at MIT, he was associated with the research work pioneering the development of inertial guidance systems. He served as a research associate in MIT's Instrumentation Laboratory from 1948 to 1952. Later, with an associate, he founded the Dynatrol Corporation, for which he served as vice-president and treasurer from 1952 to 1959. (In May 1988 Mr. Atwood received an honorary doctor of engineering degree from Rose-Hulman Institute of Technology).

In 1959 Mr. Atwood joined the AC Spark Plug Division of General Motors Corporation (GM) as a laboratory director and became director of engineering of that division's Milwaukee operations a few years later. The work in Milwaukee centered around inertial guidance and navigation for large missiles, the Apollo spacecraft, and commercial aircraft for airlines worldwide.

During the next two decades, Mr. Atwood progressed through a series of increasingly responsible assignments as GM chose him to manage its rapidly advancing technology-based business. In 1970, when the Detroit Diesel Engine and Allison Divisions were consolidated into the Detroit Diesel Allison Division, Mr. Atwood was named manager of the Indianapolis operations. In 1974 he became the first general manager of GM's new Transportation Systems Division and later that year was named general manager of the Delco Electronics Division. In 1978 Mr. Atwood was named vice-president of the corporation and general manager of the Detroit Diesel Allison Division. Three years later he was named vice-president and group executive in charge of the Electrical Components Group, and in 1981, he was assigned responsibility for the worldwide Truck and Bus Group. In 1984 he was named president of the GM Hughes Electronics Corporation, a subsidiary consisting of Delco Electronics as well as Hughes. Also in 1984 he was named executive vice-president of the corporation, and in 1987, was elevated to the position of vice-chairman of the board. Mr. Atwood's rapid progress through General Motors Corporation reflected his key leadership of three major changes in General Motors. First was his role in applying electronics to modernization improvements in automobiles and trucks. Second was his critical role in the acquisition of Hughes Aircraft Company, Inc., and third was a similar role in the acquisition of Electronic Data Systems.

In the first of these, the entire automotive industry was faced with making a giant step forward to bring emissions under control and at the same time improve fuel consumption, performance, and safety. This meant attacking the problem on a total systems basis in a situation in which fuel control devices were under development in one division, electronics to sense the system's needs and issue command signals were under development in another division and, the automobile was designed and built in any one of five other divisions. Mr. Atwood, with his extensive background in electronics, sensors, and dynamic systems, provided a key role overseeing individual component development and simultaneously tying all together in the automobile and demonstrating total performance of the whole.

His corporate roles required the human side of leadership, which Mr. Atwood had in great measure. For example, convincing three different business organizations—General Motors, Hughes Aircraft, and Electronic Data Systems—of their mutual needs and finding working protocols under which each could be productive was a gigantic assignment. Yet Mr. Atwood's practical business experience, his credibility, and his very human approach to such matters were probably the singular factor in making the synergy of these organizations realizable and successful.

As Mr. Atwood approached GM's retirement age, the new administration in Washington was searching for people of talent and dedication. President George Bush called Mr. Atwood asking him to become deputy secretary of defense. It was a time of soul searching when normal mortals seek a "few days off," but Don set aside his own comfort and with the support of his wife, Sue, signed on.

The next four years were more demanding than could have been imagined. Fortunately, Don Atwood and Secretary of Defense Dick Cheney made the perfect team. Of necessity, Mr. Cheney was swept up in a fast-developing sequence of international events from the coup to oust President Gorbachev to Desert Storm. Mr. Atwood, meanwhile, had to manage the defense establishment while at the same time overseeing domestic field operations. It was his task to send federal troops to stop loss of lives and rioting during a chain of hurricanes from the Virgin Islands to Florida to Guam and then to protect lives and property during the Los Angeles riots.

Washingtonians were delighted by the Atwoods. Don went about the defense management business with his typical down-to-earth Yankee wisdom. He proved to be a superb statesman and diplomat as he met with foreign diplomats as well as congressional and corporate leaders throughout the world. Frequently Don and Sue were called upon to travel to foreign locations where Don would deliver a sensitive message or resolve a potential problem. Using his quiet, credible diplomacy, he handled each situation without crisis. Don was frequently sought after to give major speeches around the globe because of his wealth of knowledge, clear perspective on events, and outstanding communication skills. It is rare that an appointed executive wins the overwhelming respect of the Washington bureaucracy, but Don did.

From laboratory engineer to business manager to government executive, Don Atwood was a leader with genuine humility, not one out to take credit or seek accolades, but in fact, a very natural person who took time to work with people out of concern for their well-being.

Hannskarl Bandel

1925-1993

By Anton Tedesko

Hannskarl Bandel, creator of imposing structures, was born in Dessau, Germany, on May 3, 1925. His father was an architect, owner of a construction firm. His mother's maiden name was Brechtel and she came from the family of the well-known German construction company called Brechtel. Hannskarl studied civil engineering at the Technical University of Berlin under the famous Professor Dischinger. Under Professor Sattler he earned his doctorate in engineering. After design and research experience with several firms in the German steel industry, he became an assistant of Professor Sattler, who suggested that he visit the United States to widen his experience with suspension bridges. Bandel, however, moved up the ladder with his work on building structures in the New York office of Fred Severud (former National Academy of Engineering member). Severud was so impressed by Bandel's creativity and outstanding structural design ability that he made him his associate. Three years later, he was made a full partner of the firm, subsequently known as Severud, Perrone, Sturm, Bandel.

It can be said that the reputation that the firm thereafter acquired was, to a great extent, due to Bandel's dynamic personality and his innovative vision. Personally, he was a shy and modest man who judged the work of others fairly, but he would speak out against poorly conceived solutions. His coworkers considered it a privilege to be involved in his efforts and were quite often astounded by the breadth of his ideas and his inventiveness.

During his years with Severud, he designed the Marina Towers in Chicago; with architect Eero Saarinen, he designed the 630-foot-high Jefferson Memorial Arch in St. Louis; and he worked on the cable-suspended Madison Square Garden arena roof in New York City; the Place St. Marie in Montreal; the Toronto City Hall; the Ford Foundation headquarters building in New York City; the Kennedy Center for the Performing Arts in Washington, D.C.; and the Crystal Cathedral in Garden Grove, California.

In 1978 he was elected a member of the National Academy of Engineering.

After Fred Severud's retirement, the firm, despite Bandel's objections, was bought by a Hungarian engineer. Bandel left the firm and became the senior vice-president of DRC Consultants, working on cable-stayed bridges and various other structures, following his original design ideas.

He was offered the chair of structural engineering at the University of Graz, Austria, in 1980, but graciously turned down the offer because the daily challenging assignments of his professional life in America were much more important to him than a highly visible, prestigious professorship in Europe.

Dr. Bandel recently conceived and developed the feasibility study making use of an arch to strengthen the cantilever truss on the Mathews Bridge in Jacksonville, Florida. He was involved in providing construction engineering services for the cable-stayed Sunshine Skyway Bridge in Florida and the cable-stayed Glebe Island Bridge in Sydney, Australia.

His ideas for the rehabilitation of deficient structures and in the retrofitting of long-span bridges will have repercussions for American infrastructure in the years to come. Structural engineering of the highest level was applied in his work on the National Aeronautics and Space Administration-commissioned study for the Pathfinder (man-to-Mars mission). This assignment encompasses the design of joints for a three-dimensional truss built in a zero-gravity environment without tools to subsequently sustain the loads associated with entering the atmosphere of Mars.

On December 29, 1993, as countless times before, he was on the ski slopes of the Aspen Highlands at Aspen, Colorado. His wife was with him when he suddenly suffered what seemed to be indigestion. The ski patrol placed him on a toboggan and rapidly descended with him to lower altitudes. But Hannskarl lost his oxygen mask during the trip and died due to heart failure. He had never been ill before and his friends observed that this was the way he wanted to go.

He will be missed by his many friends. He is survived by his wife, the former Irmtraut Sitter, living in Carbondale, Colorado.

Edward . G. Bowen

Edward George Bowen

1911-1991

Written by R. Stevens

Submitted by the NAE Home Secretary

This is in Memory of Edward George "Taffy" Bowen. He was counsellor (scientific) to the Australian Embassy in Washington, D.C., chief of the Radiophysics Division of the Australian Commonwealth Scientific and Industrial Research Organization, and scientific officer of the British Air Ministry. He was a pioneer in the development of radar, radio astronomy, radio navigation, and experimental cloud physics. At critical times, in war and peace, he was instrumental in achieving cooperation between academic, industrial, and governmental organizations of the United Kingdom and the United States. Dr. Bowen died August 12, 1991.

Edward George Bowen was born January 14, 1911, in Swansea, Wales. His parents were George and Ellen Ann Bowen. He attended University College, Swansea, earning a B.Sc. (first class physics honors) in 1930, and a M.Sc. in 1931. In 1934 he was awarded the Ph.D. by Kings College, London, for his research under radio physicist Professor Sir Edward Victor Appleton.

In 1935 Dr. Bowen joined a small team of scientists led by Robert Watson-Watt to research and develop the new concept of radar. The work was under the British Air Ministry; it was a closely guarded secret. At Orfordness and Bawdsey, the team soon demonstrated detection of aircraft 100 miles distant. Bowen's role was development of the high-powered pulse transmitter for the radar. The timely success of the work enabled building a costal radar network that was vital to winning the Battle of Britain.

Airborne radar to find and follow aircraft and surface ships, especially at night, was another of Britain's urgent needs. Late in 1935 Dr. Bowen was assigned responsibility to create such a radar for practical use in British combat aircraft. By mid-1939, early production models of a cable radar were being installed. Through the war, tens of thousands of the breed were installed in British and Allied forces aircraft. The radar was vital in protecting Britain from night air attacks and in protecting Allied shipping from submarine attacks.

By mid-1940 Britain had decided to share its defense technology with the United States and Canada. Sir Henry Tizard led a mission to the United States and Canada to initiate the process. Dr. Bowen accompanied the mission to advise on military radar and its application. He brought with him a working model of the secret British radar invention: the high-pulse-power centimeter-wave Magnetron. The Magnetron was a breakthrough, and in the course of the war, millions were made and used by Allied forces in Europe and the Pacific. Dr. Bowen remained in the United States for three years, advising scientific, industrial, and governmental leaders on military radar. He helped define the role, mission, and staff profile of a wartime United States radar research laboratory—what soon became the Massachusetts Institute of Technology (MIT) Radiation Laboratory with the distinguished academician Lee A. DuBridge as director.

In 1944 Dr. Bowen accepted an invitation to join the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO), and he and his wife, Vesta, departed for Sydney. Shortly afterward he was appointed chief of the Radiophysics Division, a position he held for twenty-five years. Dr. Bowen assembled and steadfastly supported a talented and energetic group of fledgling radio astronomers led by J. L. Pawsey. The radio astronomy endeavor of the Radiophysics Division soon became, and remains today, world renowned. Since it was commissioned in 1961, the 210-foot radio telescope at the CSIRO Parkes Observatory has been one of the radio astronomy community's premier technical facilities. Taffy Bowen made it happen.

In the mid-1950s, California Institute of Technology astronomy Professor Jesse Greenstein was devising the institute's entry into radio astronomy. He asked Caltech President Lee DuBridge about an outstanding leader for the enterprise. Dr. DuBridge talked with Taffy Bowen, his friend from the MIT Radiation Laboratory days, and soon John G. Bolton of the CSIRO Radiophysics Division arrived in Pasadena. John Bolton established the Owens Valley Radio Observatory and the initial radio astronomy program for Caltech; then in 1960 he returned to Australia and CSIRO to oversee the construction of Taffy's 210-foot antenna at Parkes.

In the early 1960s, the Caltech Jet Propulsion Laboratory (JPL) undertook for the National Aeronautics and Space Administration (NASA) to design and construct giant antennas to track scientific spacecraft throughout the solar system. William H. Pickering, JPL's director, discussed the project with his friend, Taffy Bowen. In due course, engineers from the Parkes telescope team, including drive system expert Harry C. Minnett, joined the JPL design team. The early collaboration and sharing of lessons learned helped immensely; the network of 210-foot spacecraft tracking antennas that resulted is the mainstay of the NASA/JPL Deep Space Network.

During the "Bowen Years" the Radiophysics Division performed valuable research and development work in radio navigation and experimental cloud physics. The Radiophysics Laboratory adapted and extended previous military developments to meet current civil needs. A very successful instance is the Distance Measuring Equipment (DME) system that provides a precise measurement by radio of the distance from an aircraft to a ground terminal. DME was developed and demonstrated on commercial aircraft by Dr. Bowen's staff in 1950; in 1954 it was required on all passenger aircraft in Australia. The question "How does rain happen?" was getting some scientific answers in the mid-1940s. In 1946 Nobel scientist Irving Langmuir reported that dry ice dropped in supercooled water vapor induced water drop formation. That interested many persons, including Dr. Bowen. He was especially interested because of the potential for inducing rain in the vast arid regions of Australia, and because he knew well how to use radar to observe internal processes of clouds. Through the 1950s, Bowen and his group investigated naturally and artificially induced rain formation in clouds. The program included carefully planned and executed cloud seeding experiments. The work made a major and lasting contribution to understanding the potential and problems of weather modification.

From 1967 to 1973 Dr. Bowen was a prominent and effective advocate for constructing the Anglo-Australian Telescope. He was appointed chairman of the Anglo-Australian Telescope Board in 1971, and through his good offices brought accord between the contending English and Australian astronomical communities. Design and construction of the telescope proceeded; it was commissioned in 1974.

Dr. Bowen was appointed counsellor (scientific) to the Australian Embassy in Washington, D.C., in 1973. He retired from that position in 1976 and returned to Australia.

Dr. Bowen was elected a foreign associate of the U.S. National Academy of Engineering in 1977.

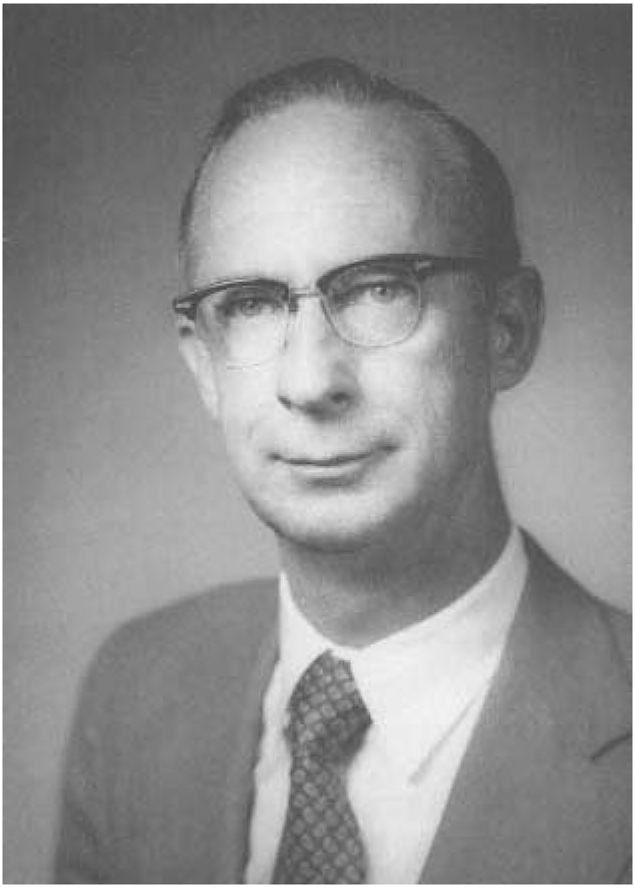
For his many accomplishments, Dr. Bowen received the following recognition:

- Officer of the Order of The British Empire for contribution to the U.K. war effort (1941)
- The U.S. Medal of Freedom for contribution to the U.S. war effort (1947)
- The Thurlow Award by the U.S. Institute of Navigation for outstanding contribution to the science of navigation (1950)
- Honorary D.Sc. by the University of Sydney (1957)
- Companion of the Order of The British Empire for contribution to Australian science (1962)

In addition Dr. Bowen held the following special memberships:

- Fellow of the Royal Astronomical Society
- Fellow and past vice-president of the Australian Academy of Science
- Fellow and first president of the Australian Institute of Navigation
- Foreign Member of the American Academy of Arts and Sciences
- Fellow of the Royal Society of London

Taffy was an accomplished sailor and cricketer. He had many friends worldwide who miss him dearly.



Hezzie Raymond (Ray) Brannon

1926-1994

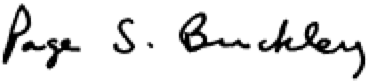
By Claude R. Hocott

H. Ray Brannon was a research scientist and engineer for Exxon Production Research Company from 1952 to 1986. He retired as senior research scientist (the major technical classification) in August 1986. It was that career of versatile, imaginative, and pioneering accomplishments that earned him the distinction of election to the National Academy of Engineering.

Ray was born January 23, 1926, in Midland City, Alabama, and attended Auburn University in that state. He received a B.S. in engineering physics in 1950 and an M.S. in physics in 1951. While at the university he was elected to Phi Kappa Phi, Sigma Pi Sigma, Sigma Xi, and Tau Beta Pi honorary societies. Shortly after graduation he began his career with Exxon. From the outset, his work demonstrated versatility and practicability in a broad area, including radiocarbon dating of recent earth sediments and gamma-ray logging of bore holes into these sediments of importance to geologists and engineers in exploration and development of petroleum deposits. He also developed the first gravity meter for the measurement of sediment density in shallow bore holes. This meter was most useful in the detection of foundation support for heavy construction. His numerical analysis methods for oil and gas reservoirs were a significant contribution to the emerging technology of modeling and prediction that forms the heart of modern reservoir management of oil fields.

In 1968 Ray moved into the rapidly growing areas of oceanography and marine technology, the application of which formed the basis for development of the nation's offshore petroleum deposits. His analysis of storm waves and the application of random noise analysis to storm waves led to the development of design technology in common use today. This work formed the basis for improved calculation of wave forces on offshore structures and enabled the design of platforms in ever deeper water for petroleum development and production. He led and supervised the engineering design of one of the earliest deep-sea, surface-piercing drilling and production platforms. His early development of the gravity meter for bore measurement of the density of sediments helped in the identification of suitable foundation support for the heavy platforms needed in this endeavor. Ray was involved in practically every development in offshore structures: platforms, pipelines, and submerged and bottom-founded drilling and production systems. It was these inventions and innovations that formed the basis for the overall petroleum industry and marine technology that is used today around the world. Ray held four patents and was the author or coauthor of ten publications.

Ray was especially active in cooperative efforts of both industry and professional societies through publications, consultation, and advisory groups. He was a member of the Society of Petroleum Engineers, the Society of Exploration Geophysicists, and the American Physical Society. The crowning effort of his career was his participation in panels, workshops, and committees of the National Research Council. His work on the Marine Board in the Commission on Engineering and Technical Systems (formerly the Assembly of Engineering) from 1976 to 1986 included service on the Panel on Civil/Navy Ocean Engineering in 1982 and 1983. In the Assembly of Engineering, Ray served on the Committee on Assessment of Safety and Outer Continental Shelf Activities (1980 and 1981) and on the Panel of Verification Guidelines for Offshore Structures (1978 and 1979) and the Panel on Offshore Structures Certification (1976 and 1977) of the Committee on Offshore Energy Technology.



Page Scott Buckley

1918-1995

By Sheldon E. Isakoff

Page S. Buckley, a pioneer in the field of chemical process control system design and retired principal consultant of E.I. du Pont de Nemours and Company, died on July 25, 1995, at the age of seventy-seven.

Page Buckley was born on June 23, 1918, in Hampton, Virginia. He attended Columbia University, from which he received his bachelor of science degree in chemical engineering in 1940.

Buckley began his long and distinguished career working for a brief time with a consulting engineer in Ottawa, Canada. In 1941 he joined the Monsanto Company, and over the next eight years had a wide variety of assignments, including research and development and plant troubleshooting, maintenance, and production.

He joined the Du Pont Company in 1949 as a senior engineer at the Sabine River Works in Orange, Texas, where he quickly became involved with the many complex engineering problems associated with Du Pont's continuous high-pressure chemical manufacturing process. During his six years at Sabine, Buckley initiated his pioneering studies of the control of chemical manufacturing processes, the field in which he subsequently made many outstanding, creative contributions throughout his professional career.

In 1955 Buckley moved from the Texas plant to the Engineering Research Laboratory at the Experimental Station, Du Pont's Research Center in Wilmington, Delaware. There, holding the position of research associate, Buckley focused his research on the dynamics, or unsteady-state characteristics, of process equipment and systems. He clearly demonstrated the necessity for understanding process dynamics in the development of control strategies and design of process control systems. Buckley's research defined the key concepts and methodology that provided a more effective, broadly applicable approach to control system design.

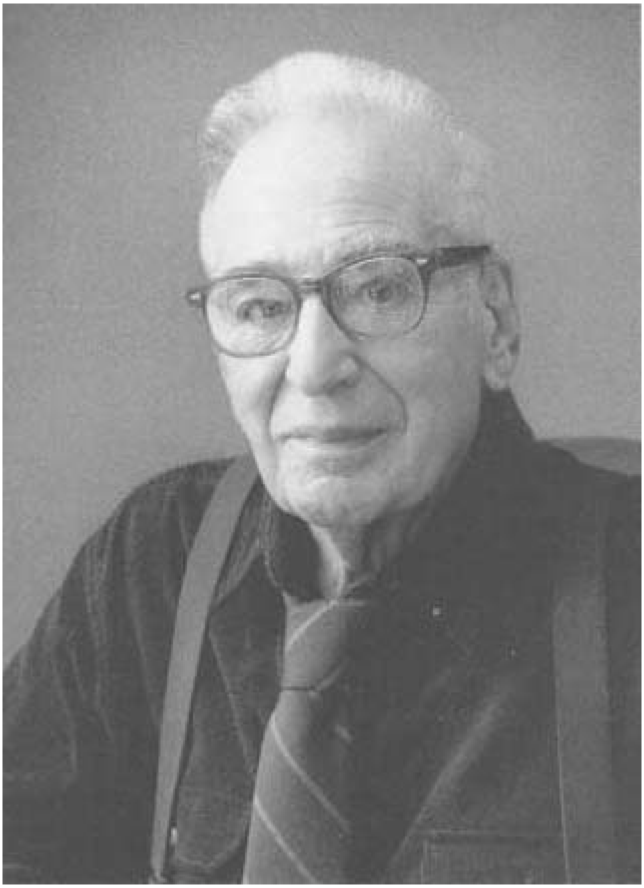
Buckley transferred in 1962 to the Design Division, where for many years he was responsible for providing the design of control systems for the new or modernized Du Pont plants. Buckley advanced to principal consultant, the highest ranked technical position in his company's project engineering organization. The new technology he introduced improved safety, energy use, and efficiency of many of Du Pont's processes. He received special recognition and awards within Du Pont for his outstanding engineering contributions and for the substantial economic benefits that accrued from them. Buckley retired from Du Pont in 1987.

Page Buckley was a true professional who contributed to the advancement of engineering through his publications, professional society activities, and teaching at several universities. He authored one of the earliest and most widely used reference books in his field, *Techniques of Process Control*, which has been translated into Japanese and Russian. With a colleague in Du Pont and Lehigh University, he was an author of the text *Design of Distillation Column Control Systems.* After he retired, he authored another book with over arching perspective, *Process Control Strategy and Profitability.* Buckley served for a number of years as an adjunct faculty member at the University of Delaware and lectured, led summer session courses, and was a member of the doctorate examining committee at Lehigh University. Buckley's rare ability to bridge the gap between complex theoretical developments and practical engineering applications, clearly evident in his textbooks and lectures, was highly prized by colleagues and students.

Buckley was an active participant in the Instrument Society of America (ISA) and the American Institute of Chemical Engineering (AIChE) and was honored as a fellow by both societies. He received many prestigious awards for his pioneering work, including the Outstanding Personal Achievement Award from C*hemical Engineering Magazine* in 1970, the Philip T. Sprague Achievement Award of the ISA in 1973, and the Founders Award of AIChE in 1988. He received an honorary doctor of engineering degree from Lehigh University in 1975 and was elected to the National Academy of Engineering in 1981.

Page Buckley was far more than a remarkably talented engineer. His students and associates in Du Pont considered him a perfect mentor. There was never a time inconvenient for him to respond to their questions. He welcomed discussion of their approach to problems rather than imposing his own.

He was devoted to his wife of forty-seven years, Betty, and to his four daughters, Annie Buckley of Denver, Colorado; Kebba Buckley of Phoenix, Arizona; Judith Buckley of Winter Park, Florida; and Bess Buckley of Roslyn Heights, New York. He will be missed very much by the many people whose lives he touched.



Marvin Camras

1916-1995

Written by Irwin B. Fieldhouse

Submitted by Thomas L. Martin, Jr.

Marvin Camras, often referred to as "the Father of Magnetic Recording," was born in Chicago on January 1, 1916, and died on June 23, 1995, at the age of seventy-nine. He was clearly an individual of extraordinary drive, imagination, and persistence.

As an undergraduate in electrical engineering at the Armour Institute of Technology (now Illinois Institute of Technology [IIT]), Marvin Camras became interested in magnetic recording. This is an old art, which had been the subject of laboratory investigation for many years. Camras brought to it a fresh and ingenious approach that resulted in outstanding improvements in high-frequency fidelity, signal-to-noise ratio, and freedom from distortion.

Marvin Camras's interest in recording sound came about because of his cousin's desire to be an opera singer. His cousin asked Marv if there was an inexpensive way to record and play back his voice. Marv, a junior in electrical engineering, recalled reading of Danish Professor Vlademar Poulsen's experiments with magnetic wire recording. However, these experiments failed in the marketplace because whenever the wire twisted, the magnetic signal was changed, resulting in distortion in the audio playback.

To solve this problem, Marv built a recorder in which the steel thread passed longitudinally through a small object about the size of a lump of sugar. This insignificant-looking item is what turned the trick. This was the recording head; it made wire recording possible by magnetizing the wire longitudinally and symmetrically about its axis, permitting a clear playback. The sound fidelity achieved was so dramatic that his professors urged him to join Armour Research Foundation (now IIT Research Institute [IITRI]) to continue the development of the recorder. In 1940 Camras joined IITRI and after further research, perfected "high-frequency bias," which greatly reduced noise and distortion. He continued to work on magnetic recording, bringing forth major improvements from 1940 to 1987.

When Camras joined IITRI in 1940, it was just small enough for his idea to reach the then director of IITRI, Thomas C. Poulter, and just large enough with mechanical, electrical, and metallurgical engineering departments to help bring his idea to the patent stage.

Camras's life was exemplified by the theme of Daniel Rosenthal's book, *A Blueprint for Living*. Rosenthal's three-part motto was "you will live as long as you learn, you will learn as long as it is interesting, and it will be interesting as long as it is fun."

Camras continued his academic studies at night school and earned a master of science degree in 1942. He received an honorary doctorate in 1968 from IIT. In addition, he took evening courses in nonengineering subjects such as biology, chemistry, physics, and social and political sciences at the University of Chicago.

As a result of his social science studies, he wrote a paper of some merit about a rural group in the vicinity of Washington, D.C. This paper served as excellent background material for University of Chicago researchers.

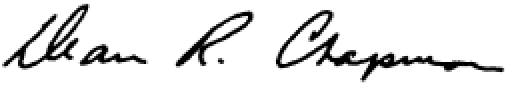
One of Marv's interests had been the building of decorative furniture. Possibly because his father had been a very skilled craftsman, Marv's designs had enough merit for woodworking instructors to use them as models for their classes.

In a short span of time, only seven years after graduation from IIT, Camras made outstanding contributions in the field of magnetic recording, contributions that created a new commercial product and a new industry. In those seven years, thirty-eight patents were issued with Camras as the inventor, and he applied for an additional seventy-five patents. By 1995 Marvin Camras had more than 500 patents for the invention and refinement of the technology that is the basis for audio and video recording and computer data storage. His accomplishments include the discovery of high-frequency bias, magnetic coatings using acicular particles of gamma ferric oxide, development of multitrack tape recording, magnetic sound for motion pictures, and stereophonic sound reproduction. His inventions launched what has become a multibillion-dollar electronic communications industry, and his patents have been licensed to more than one hundred manufacturers, including GE, Ampex, IBM, Wollensak, 3M, Kodak, and Sony.

Although Camras had no musical training, his firm belief in Daniel Rosenthal's motto made it easy for him to help his grade-school daughter, Ruth, when she needed a better violin in order to play in the school orchestra. Marv and Ruth went to dealers and found that they were asking $1,000 for violins that Marv considered to be of poor quality. A really good violin costs at least $10,000. It seemed to Marv that since he had been doing woodworking all his life, had access to excellent libraries, and knew how to use them, he should be able to build a violin that would be at least as good as the less expensive models. So he began making violins and soon succeeded in making one that he felt was good enough for Ruth to use. Being an experimentalist, Marv had made a total of thirty instruments (violins, violas, and cellos) by 1933, no two alike. Ruth, who is now a concert violinist, uses one of Marv's violins in her recitals. Her husband, who is the first violist of the Chicago Symphony Orchestra, has played in concerts on a viola made by his father-in-law. Marv's ambition was to improve on Stradivarius.

After retiring from IITRI in 1987, he continued to teach electrical engineering at IIT until 1994. He published numerous papers and wrote two books. He was inducted into the National Inventors Hall of Fame in 1985; and, in recognition of his enormous contributions, President George Bush in 1990 awarded Camras the National Medal of Technology, the nation's highest award for technological achievement. He received many other awards, including the John H. Potts Memorial Award, the IEEE Consumer Electronics Award, the U.S. Camera Award for Outstanding Contributions to Motion Picture Photography, the Institute of Radio Engineers PGA Achievement Award, the IEEE Information Storage Award, and the IIT Alumni Distinguished Service Award. He was a member of the National Academy of Engineering and a fellow in many organizations, including the IEEE, the Acoustical Society of America, the American Association for the Advancement of Science, and the Society of Motion Picture and Television Engineers.

Those of us who worked closely with Marvin Camras had a profound respect for his intellectual capacity, inventiveness, capacity for hard work, and modesty. Scientist, engineer, inventor, teacher, entrepreneur, husband, parent, mentor, and friend, Marvin Camras exemplified the best that America stands for, and one like him will not soon pass this way again.



Dean R. Chapman

1922-1995

By Robert T. Jones and Hans Mark

Dean R. Chapman, professor at Stanford University and former director of astronautics at the National Aeronautics and Space Administration (NASA) Ames Research Center, died at his home in Saratoga, California, on October 4, 1995.

Dean was born in Fort Sumner, New Mexico, on March 8, 1922, one of three children. The family moved to Arizona for a short time and finally to Southern California in 1926. Dean was very close to his younger brother, Tom, and older sister, Carmen, as they grew up. Dean and Tom did almost everything together, from play to work. This included selling magazines door-to-door and delivering newspapers. The newspaper route meant getting up at 3:30 a.m. each morning to deliver them before going to school. Dean and Tom also loved to play basketball. The many hours devoted to basketball and selling newspapers may have contributed to Dean's average grades in high school. After high school Dean and two of his friends made plans to enlist in the Army Air Corps; however, there was a requirement of some college credits to qualify for preflight training, so it was off to Los Angeles City College (LACC) for Dean and his friends, Don and George. Don and George both completed their college requirements and enlisted in the Air Corps. Dean, however, was encouraged by a professor at LACC to take the entrance examination to the California Institute of Technology (Caltech). This professor was impressed with Dean's keen mind and intellect and was convinced that Dean would reach higher goals with an education at Caltech than with service in the Air Corps. Dean agreed, took the entrance exam, and was accepted with a scholarship. Dean graduated from LACC in 1941 with the highest scholastic honors in the class. At Caltech he distinguished himself academically and was also the star of their basketball team. He obtained a B.S. degree in mechanical engineering (highest scholastic average in class) and an M.S. degree in aeronautical engineering (outstanding student award for his class).

Upon graduation Dean accepted a position at the National Advisory Committee for Aeronautics (NACA) Ames Aeronautical Laboratory, now the NASA Ames Research Center. World War II was still being fought and there was some concern about essential personnel being lost to the draft; there was also some concern about essential security at the laboratory since the lab was located on United States property (Moffett Field). The government decided to draft all of Ames people into the Navy, thereby solving the aforementioned problems. So, Dean became an ensign in the Navy.

This created some strange inequities; some of the supervisors couldn't pass the physical exam and were given only the rank of chief, which created situations in which supervisors were outranked by subordinates. After the war Dean went back to Caltech and obtained his Ph.D. degree in aeronautics in 1948.

As a scientist Dean had some unusual qualities that would have an impact on his future performance. In addition to being an outstanding engineer, he was also an outstanding mathematician—a very unusual combination of talents. He also had a knack for simplifying a problem and reporting it with great clarity in the literature.

Dean started his career at Ames working in the 40x80-foot wind tunnel, which was, at that time, the largest wind tunnel in the world; however, he soon transferred to the 1x3-foot supersonic wind tunnel where he spent a good portion of his career. Much of Dean's early research centered on skin friction, base pressure, and heat transfer. For this work he received the Lawrence Sperry Award in 1952, one of the outstanding honors in aeronautics given annually by the Institute of Aeronautical Sciences. He also pioneered the use of gas mixtures for use in wind tunnels at high Mach numbers to avoid the problems of gas liquefaction.

Dean did a considerable amount of theoretical and experimental research on the character of separated flows and their effects on the heat transfer in these regions.

In 1957 the Soviet Union launched its first Sputnik, signaling the beginning of the space age. In 1958 NACA was renamed the National Aeronautics and Space Administration. Ames Aeronautical Laboratory was renamed Ames Research Center.

Dean's career at Ames Research Center spanned the years from 1944 through 1979. During this period he was to become one of the world's leading authorities on such subjects as skin friction, boundary layers, base pressure, separated flows, turbulence, use of gas mixtures in wind tunnels, arc-jet development, entry aerodynamics, ablation analysis, thermal protection, hypersonic real gas flows, computational aerodynamics and fluid dynamics, shock wave analysis, and tektites.

The research project that challenged Dean the most was his work on the origin of tektites. Tektites are strange glassy objects scattered over the earth's surface at various locations. They have been studied by scientists of various disciplines for more than a hundred years, and various theories have surfaced regarding their origin. Dean first learned of tektites when he visited the British Museum in the early 1960s where he recognized features of tektites suggesting they had been shaped by the heat and aerodynamic forces of entry into the earth's atmosphere. Using a device called an arc-jet, which simulated atmosphere-entry conditions, Dean successfully produced tektite shapes. By analyzing the ablation characteristics of Australian tektites, he was able to determine their entry velocities and entry angles, thus concluding that the most probable source of tektite origin was the moon.

H. Julian Allen, then director of Ames Research Center, congratulated Dean on this bit of scientific "sleuthing," but added, "If you are any good as an aerodynamicist, you should be able to determine from which crater the tektites came." Dean accepted the challenge. He performed specific gravity measurements on thousands of tektites and, by drawing on the results of extensive chemical analysis, was able to determine the landing patterns that the tektites traced on the surface of the earth. Using high-speed computers, he analyzed the moon-earth trajectories of all the large craters on the moon that could conceivably produce tektites. He was able to show that the crater Tycho produced landing patterns that matched those observed on the earth. In answering Allen's challenge, he was able to determine not only which of the moon's craters produced the tektites but also the particular ray of that crater (the Rosse ray). By 1965 Dean's detective work had become one of the most fascinating displays of scientific virtuosity in the annals of the Ames Research Center.

Although Dean concluded that tektites were formed by the impact of a large iron-nickel meteorite on the surface of the moon, these conclusions are not universally accepted by many scientists whose disciplines do not include atmosphere-entry aerodynamics. Dean also amassed a large collection of tektites from various parts of the world. This collection, together with the results of his many experiments, now resides in the Smithsonian Institution.

In 1963 at a ceremony in which Vice President Lyndon B. Johnson was the principal speaker, Dean was presented with NASA's highest scientific award, its Award for Exceptional Scientific Achievement. He was the first person at Ames to receive this award.

During his career at Ames, Dean received numerous other awards and honors. He received the Rockefeller Public Service Award for his outstanding work on spacecraft reentry trajectories. This furnished him the opportunity to pursue research at the university of his choice (University of Manchester in England). For his research on tektites, Dean received the H. Julian Allen Award from the NASA Ames

Research Center in 1972. He was awarded the Dryden Lectureship in Research by the American Institute of Aeronautics and Astronautics in 1979 and received NASA's Distinguished Service Medal in 1980. He was named Hunsaker Honorary Professor at the Massachusetts Institute of Technology from 1978 to 1979. He was a fellow of both the American Astronautical Society and the American Institute of Aeronautics and Astronautics.

In 1969 Chapman was appointed chief of the Thermo and Gas Dynamics Division at Ames and thus began a distinguished career as a research leader and administrator. In 1974 he became the center's director of astronautics. In that capacity he headed the center's work in fundamental and applied research in broadly defined areas of fluid mechanics, gas dynamics, materials, computer technology, and chemistry. More than five hundred people were employed in Chapman's directorate. Probably his most important contribution during those years was the establishment of the first significant research group to develop computational fluid dynamics using the best available high-speed computers. The first massively parallel computer, the Illiac IV, was installed at Ames in 1970 and, under Chapman's leadership, became operational in 1973. Chapman's work was recognized in 1975 by his election to the National Academy of Engineering.

In 1980 Chapman retired from Ames after more than thirty-four years of service and joined the faculty at Stanford University as a research professor of aeronautics and astronautics and mechanical engineering. He continued to work in the computational study of turbulence and hypersonic flow. He was instrumental in forming the Center for Turbulence Research and served on the center's steering committee. He supervised numerous students and was valued highly by his students and colleagues at Stanford as a teacher, mentor, and friend.

Dean is survived by his wife, Marguerite; son, Donald Chapman, of Santa Monica, California; daughter, Anita Hirsch, M.D., and three grandchildren, Rebecca, Sarah and

David Fingerhood, all of Belfast Valley, Maryland. He is also survived by his brother, Tom Chapman, of Murrieta, California, and his sister, Carmen Benson, of Downey, California.

An inspiring leader of scientific research and a good friend, Dean Chapman will be greatly missed by all who knew him.

Walker Lee Cisler

1897-1994

By Harvey A. Wagner

Walker Lee Cisler, former chairman of the board and chief executive officer of Detroit Edison, died on October 18, 1994, at his home in Grosse Pointe Park, Michigan. He was ninety-seven years old.

Born October 8, 1897, in Marietta, Ohio, Walker grew up in Gradyville, Pennsylvania. After serving in World War I, he graduated from Cornell University in 1922 with a degree in mechanical engineering. He then joined Public Service Electric and Gas in New Jersey, where he held various engineering and management positions.

In 1941 Walker Cisler was loaned to the Office of Production Management, later named the War Production Board. He served as chief of the Equipment Production Branch, where he helped organize utilities to serve both the military and civilian needs for power equipment for the United States and its allies.

In mid-1943 he joined Detroit Edison as chief engineer of power plants. However, he was quickly granted a leave of absence when General Dwight D. Eisenhower asked Walker to join his staff. Walker became the chief of the public utilities headquarters for General Eisenhower's command, the Supreme Headquarters Allied Expeditionary Force. His main job: rebuild the power plants in war-torn Europe. Walker served in Sicily, Italy, visited Russia, and entered Paris with General

Charles De Gaulle in August 1944. In less than two weeks, he had gas and electric service restored to Paris. By the time he completed his assignment in 1945, the French power system had been repaired and was generating more electric power than it had in 1938, the last normal year before the war.

He returned to Detroit Edison after the war as chief engineer of power plants and subsequently became executive vice-president of the company in 1948, president in 1951, and, in 1954, also chief executive officer. In 1964 he was elected chairman of the board, while continuing as chief executive officer.

From early in his association with the Detroit Edison Company, Walker became actively engaged in the development of atomic energy. He served as executive secretary to the Industrial Advisory Group of the Atomic Energy Commission in 1947-1948 and spearheaded Detroit Edison's participation in the Atomic Power Development Associates, Inc., and the Power Reactor Development Company-two organizations formed to design, construct, and operate the Enrico Fermi fast breeder reactor project, the first commercial breeder reactor to produce electric power. It was a remarkable engineering and scientific first.

He headed the two corporations in addition to being the president of the Fund for Peaceful Atomic Development, Inc. He was the first president of the Atomic Industrial Forum.

In 1991 the American Nuclear Society established the Walker Lee Cisler Medal to be awarded for distinguished contributions in the development of the fast breeder reactor. Walker Cisler was the first recipient of the award.

Active in professional, technical, and service organizations, Walker was a fellow of the Institute of Electrical and Electronics Engineers, the American Institute of Management, and the American Nuclear Society. He served as president of the American Society of Mechanical Engineers, the Engineers Joint Council, and the Edison Electric Institute.

Walker was a founding member of the National Academy of Engineering and was active in the formulation of its policies and objectives. Over the years, he gave liberally of his time in support of the needs of the growing Academy. The Academy's success can be attributed to the effort Walker and others like him devoted to its objectives.

In 1968 Walker was elected chairman of the International Executive Council of the World Energy Conference (WEC), becoming the first American to hold this high office. The WEC, which has representation in sixty-eight countries, celebrated its fiftieth anniversary in Detroit in 1974.

Walker has been honored with awards by the American Society of Mechanical Engineers, the Western Society of Engineers, the American Institute of Consulting Engineers, the Engineers Society of Western Pennsylvania, the National Society of Professional Engineers, and the Institute of Electrical and Electronics Engineers and has received joint awards from several of the engineering societies.

Deeply involved in education, Walker was a trustee of Marietta College and the Michigan Colleges Foundation; a director of Suomi College; an honorary trustee of the University of Detroit; and a member of the board of directors Development Fund of Northern Michigan University. Walker was deeply devoted to his alma mater, Cornell University, having served as a member of its board of trustees for many years, and was a trustee emeritus at the time of his death.

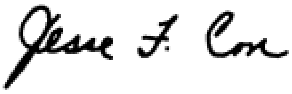
Besides working with service organizations of national scope, including the Business Council and Freedom's Foundation at Valley Forge, Walker was active in local civic and state affairs. He was chairman of The Economic Club of Detroit, chairman of the Michigan Committee of the Newcomen Society in North America, president of the Metropolitan Detroit Citizens Development Authority, chairman of the Governor's Commission on Land Use, a board member of Detroit Renaissance, and a member of New Detroit Incorporated. He also participated in many of Detroit's cultural organizations.

A project close to his heart was the Thomas Alva Edison Foundation. The foundation was established in 1946 under the presidency of Charles Kettering. Its objective was to preserve Edison's legacy of ingenuity and innovation and to help create a better understanding of science and technology, especially among today's youth. Walker assumed the leadership of the foundation in 1958, and he continued its work until his death.

To the very end of his life, Walker Cisler was dedicated to bringing the benefits of electric power to the world, founding Overseas Advisory Associates, a network of retired utility engineering and management executives to assist developing countries. These included Vietnam, Bangladesh, Brazil, Egypt, Saudi Arabia, Nigeria, Korea, Taiwan, and Jamaica.

Perhaps Cornell University said it best in presenting its Award of Honor to him on May 26, 1990. It reads as follows:

> "Walker Lee Cisler '22, social visionary and indefatigable champion of the peaceful uses of nuclear energy, honored worldwide for his extraordinary and unending efforts to develop cheap and plentiful electrical resources, recipient of eighteen decorations, seventeen honorary degrees, and ten awards in the field of engineering, honorary chairman of the World Energy Conference, highly valued presidential councillor and trustee emeritus.
>
> Cornell honors his generosity of spirit, his boundless energy and patience, his deep commitment to peace, and, in his own words, 'to making things better' for all people."



Jesse F. Core

1913-1993

By F. F. Aplan, J. M. Mutmansky, and R. V. Ramani

Jesse F. Core, age eighty, died at his home in State College, Pennsylvania, on November 29, 1993, after a long battle with cancer. He was alert, energetic, and interested in his profession up to the end. Jesse was a Distinguished Member of the Society for Mining, Metallurgy, and Exploration (SME) (1975) and an honorary member (1978), Legion of Honor Member (1986), and Erskine Ramsay Medal recipient (1971) of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). He was elected a member of the National Academy of Engineering in 1981.

Jesse was a native of Ford City, Pennsylvania, where he attended both grade and high school, and he graduated from Pennsylvania State University in 1937 with a degree in mining engineering. He was elected a distinguished alumnus of Penn State in 1966. While still in college, he began work as a coal miner with Hillman Coal and Coke Company. In 1938 he joined Pittsburgh Coal Company as an engineer, rising through the ranks of chief mining engineer and divisional engineer. He joined Buckeye Coal Company in 1947 as chief engineer of coal mines and later served as chief engineer for Island Creek Coal Company at Holden, West Virginia. In 1951 he joined the Frick District of United States Steel Corporation as district mining engineer, advancing to chief engineer and general superintendent of the Frick District. In 1958 he was named vice-president in charge of coal operations for U.S. Steel Corporation, including operations in Alabama, Colorado, Kentucky, Pennsylvania, Tennessee, Utah, and West Virginia.

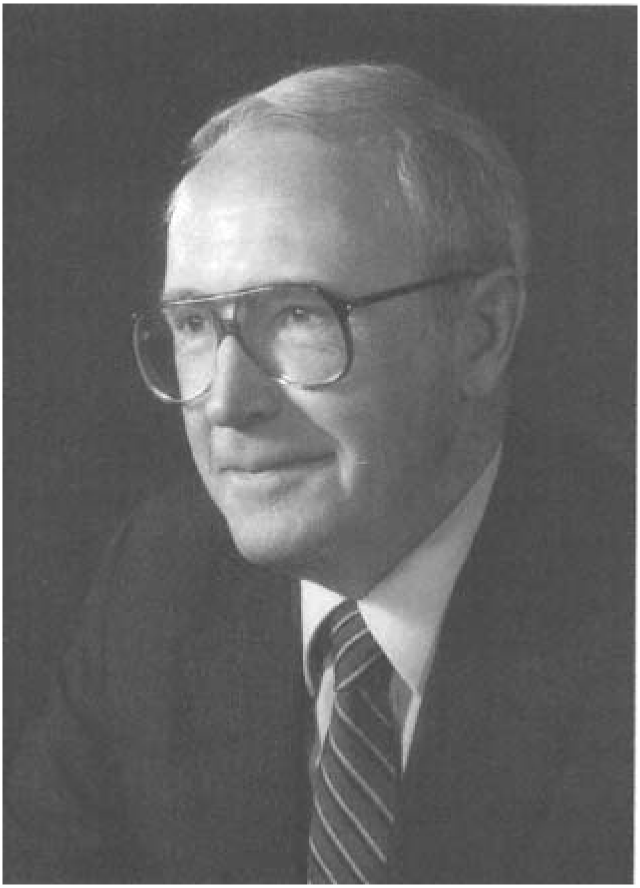
He retired in 1976 and became an adjunct professor of mining engineering at Penn State. His citations for both honorary membership in AIME and for the Erskine Ramsay Medal emphasized two major hallmarks for his career: promoting mine safety and assisting younger engineers to develop their full potential. Under his leadership, U.S. Steel developed a well-respected, comprehensive coal mine safety program. The lead article in the *Wall Street Journal* for January 19, 1973, cited U.S. Steel and Jesse for establishing the best safety record in underground coal mines. Jesse continually stressed that a safe mine was also a very productive mine. He was also known to be a strong mentor and an excellent role model for young professionals. This was manifested not only at the corporate level, but also by his service as an active member of the Old Timer's Club, which gives yearly awards to outstanding seniors in mining engineering at many of the country's leading universities. His assistance as an adjunct professor at Penn State is another example of his desire to help younger engineers.

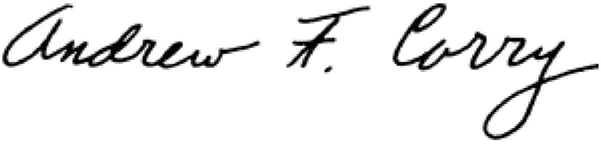
He was active in many professional societies and groups, including the SME Coal Division. He served as chairman of the Coal Division of the American Mining Congress and was a past president of the Coal Mining Institute of America and of the Mine Inspectors Institute of America. He was a cofounder and first chairman of the Keystone Bituminous Coal Association, a member of the National Mine Rescue Association, the American Iron and Steel Institute, and the Rocky Mountain Coal Mining Institute. He was a registered professional engineer in Kentucky, Pennsylvania, and West Virginia and held papers as a Pennsylvania fireboss and as a first-grade coal mine foreman. Jesse was the kind of engineer that was interested in many phases of engineering. This interest quickly translated into a love of railroads and railroading, initiated because most coal is moved by rail. He had an extensive book and video library of railroads and he took every opportunity to travel by rail. He spoke authoritatively on both the old narrow gauge roads and modern diesel practice. Jesse loved all aspects of mining and was an active mining history buff. This included an intense interest in the history of coal mining in both anthracite and bituminous coal mines, the Molly Maguires, the development of the United Mine Workers of America, and in hard rock mines in both the United States and abroad. He had a lifelong interest in geology, especially of Appalachia and the U.S. Southwest. His abiding interest in Southwest geology quickly extended to the mining and to the Native American art of that region. Shortly before his death, he gave all of his mining, geology, and railroading materials to his colleagues and his collections of minerals and paintings of mining scenes to Penn State's Earth and Mineral Sciences Museum.

Jesse's interests did not stop here. He was active in the Boy Scouts of America, holding various positions in the Allegheny Trails Council. Further, he was chairman of the Catholic Committee for Scouting for the Diocese of Pittsburgh and received the Silver Beaver and the St. George Awards for his service to scouting.

Since coming to State College, Pennsylvania, Jesse continued his services to his chosen profession. He was appointed by President Carter as a member of the President's Commission on Coal. At Penn State, he participated in resident and continuing education courses, and his views on educational, research, and industrial matters were sought out by the faculty.

His wife of fifty-one years, Margaret, predeceased him in 1992. He is survived by his daughters, Margaret of Pittsburgh and Mary Katherine Mitchell of Cincinnati; a brother, Daniel of Duluth; and three grandchildren. Jesse will be long remembered by his friends and acquaintances as one who proved one man can make a difference.




Andrew F. Corry

Andrew F. Corry

1922-1994

By Charles F. Avila

Andrew F. Corry, an international management consultant, died December 22, 1994, at his home in West Hyannisport, Massachusetts. He was seventy-two.

Born October 28, 1922, in West Lynn, Massachusetts, Andy lived for many years in Newton, Massachusetts, before moving to Cape Cod.

Andy had over forty-five years of experience in electric utility engineering and management. At the time of his death, he was a principal in Corry Associates. As a consultant, he provided counsel to various utilities throughout the United States and abroad.

He had been for many years an active member of the International Conference on Large High-Voltage Electric Systems (CIGRE)—an international study organization based in Paris—both as an author and as a participant in its committee work. He was the United States representative to the CIGRE study committee on high-voltage insulated cables from 1971 to 1978 and chairman of the United States technical committee from 1980 to 1985. From 1985 to shortly before his death, he was general manager of the United States National Committee on CIGRE. He became an Atwood Associate of CIGRE in 1993.

He was an internationally recognized expert in underground electric transmission and distribution systems. In 1978 he was elected to the National Academy of Engineering. He was a life fellow of the Institute of Electrical and Electronics Engineers (IEEE) and was honored with the Habirshaw Award in 1983 and the Centennial Medal in 1984. He was a member of the Insulated Conductors Committee of the IEEE for eighteen years, including secretary, vice-chairman, and chairman. He also served as chairman of the Underground Transmission Steering Committee of the Electric Power Research Council and chairman of the Cable Engineering Section of the Association of Edison Illuminating Companies.

Fourteen of his publications treat subjects related to his engineering specialties. These were written as guidance to other utilities, manufacturers, or policymaking organizations that have similar needs to develop practices beneficial to the public.

Although Andy's expertise was diverse, he had a special affection for high-voltage cables. These usually consist of three large copper conductors with compacted strands. Paper tape is applied to each conductor to a thickness of about a half inch. Then the conductors are placed in a vacuum tank where any water vapor and atmospheric gases are removed. Insulating oil is then applied at high pressure, saturating the insulation. Metallic shielding, protective tapes, and a skid wire are added for shipping and pulling the three conductors into eight-inch pipe welded into lengths up to several thousand feet. Each such cable set is joined in manholes that are air-conditioned for the work. Finally, a full vacuum again removes any gases before the pipe is filled with degasified oil and operated at 200 pounds per square inch of oil pressure. Such cable can carry up to half a million volts. Andy enjoyed the meticulous attention to detail required for the installation of such cable, including adapting to inevitable problems.

Andy donated his time and expertise to the National Research Council Commission on Engineering and Technical Systems. He served as chairman of the Committee on Electric Energy Systems from 1985 to 1986, reviewing the Department of Energy research and development programs, and as a member of the Committee on State and Federal Roles in Energy Emergency Preparedness from 1988 to 1989.

Before going into the consulting business, Andy was employed for thirty-six years by Boston Edison Company. Throughout his career, he was closely involved with all aspects of electric utility engineering, construction, operations, planning, and research and development.

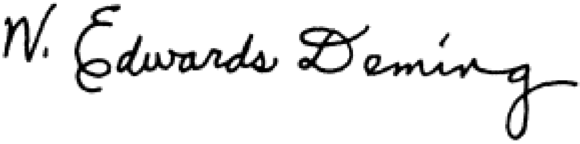
In the rapid expansion in the electric utility industry after World War II, Andy joined a division of Edison that had been formed not only to develop or gather rapidly changing technologies but to review any already in use. This included a wide range of engineering in specifications for purchasing, construction designs, maintenance practices, and reductions in service outages. An example was the development of rectifiers to serve dc power to concentrations of customers that had equipment such as printing presses or elevators too expensive to change to ac. The rectifiers continued to serve customers while permitting many tons of copper to be salvaged at favorable prices from the old dc network and substations and released miles of vacated duct lines for new circuits. Andy became head of that division, continued his effectiveness, and rose in the company ranks. He became assistant to the executive vice-president in 1969; director of engineering, planning, and systems operations in 1973; director of engineering, planning, nuclear, and systems operations in 1974; vice-president, electric, in 1975; and senior vice-president in 1979. He retired from Edison in 1983.

A graduate of the Massachusetts Institute of Technology, Andy was active in alumni matters. He participated in planning for the twenty-fifth to fiftieth reunions and served as chairman of the fortieth reunion. He was cosecretary of his class for ten years and a member of the Alumni Advisory Council. He completed the fiftieth Advanced Management Program at Harvard Business School and was a member of the Harvard Club of Boston. He interrupted his undergraduate education to serve in the Army Signal Corps during World War II.

He was the husband of Diane Kinch Corry. His first wife, Mildred (Dunn) Corry, died in 1977. He is survived by his wife, Diane; a son, James Corry of Houston, Texas; two daughters, Andrea Kantaros of Peabody, Massachusetts, and Janice Luongo of Wakefield, Massachusetts; a stepdaughter, Melissa Tritter of West Hyannisport, Massachusetts; and one granddaughter and four grandsons.

Andy had a fine sense of humor. He never mixed it with an important discussion, but one knew it was there and it kept matters down to earth. At other times he could wield it with a twinkling eye.

His friends and associates remember that joie de vivre as well as his diverse knowledge and interests; from history to opera, baseball to mathematics, wildlife to art. His warmth, wisdom, leadership, and friendship will be greatly missed.



W. Edwards Deming

1900-1993

By Myron Tribus

W. Edwards Deming, consultant in statistical studies, the man who transformed the style of Japanese management after World War II and who, thereafter, profoundly affected managerial practices throughout the world, died on December 20, 1993, at the age of ninety-three.

At the time of his election to the National Academy of Engineering in 1983, Dr. Deming was already famous internationally, having been awarded the Second Order Medal of the Sacred Treasure, from the Emperor of Japan, in 1960 for the improvement of quality and the Japanese economy, and the Shewhart Medal from the American Society for Quality Control in 1955. Subsequently, in 1986, he was enshrined in the Science and Technology Hall of Fame in Dayton, Ohio, and in 1987 received the National Medal of Technology from President Ronald Reagan. In 1993 he was awarded the Distinguished Service Award by the National Society of Professional Engineers. He was an honorary life member of the Royal Statistical Society, the American Society for Quality Control, the Biometric Society, the American Society for Testing and Materials, the Union of Japanese Scientists and Engineers, the Japanese Statistical Association, the Deutsche Statistische Gesellschaft, and the American Institute of Industrial Engineers. By the time of his death, he had received sixteen honorary degrees.

Born William Edwards Deming on October 14, 1900, in Sioux City, Iowa, to a family in strained financial conditions, he grew up in Powell, Wyoming, and attended the University of Wyoming in Laramie, where he supported himself by odd jobs as he studied for an engineering degree. After a master's degree in mathematics and physics from the University of Colorado, he was awarded a doctorate in mathematical physics from Yale University in 1928.

Dr. Deming's fame rests on four sets of contributions over a productive career of more than six decades. The first began in 1928, when he received his Ph.D. and began to apply statistical methods in science. In 1934, working with Raymond T. Birge, he published a significant paper on the estimation of errors in physical constants.

The second phase established his reputation as a professional statistician and involved him in the census of 1940. His work generated such interest that he was invited to apply statistical methods to elections in Greece, to national surveys in India, and to census activities in Germany and for the United Nations.

A third phase, which continued for the rest of his life, saw his attention directed toward the improvement of management. It began in 1944, in midst of World War II, when he published his first paper on the implications of statistical process control for managers.

The fourth area of contribution is to the field of economics. Economists have been slow to acknowledge this contribution. Japan was defeated in World War II more thoroughly than any other nation in modern times. Without natural resources, with a very large population on a small amount of tillable land, and without the benefit of conquering armies, Japan has created one of the world's foremost economies. There was nothing in economic theory that would have predicted that Japan would have succeeded. The Japanese, themselves, credit their rise largely to the teachings of W. Edwards Deming, whom they call the "Father of the Third Industrial Revolution." Dr. Deming's work demonstrates that quality, pursued relentlessly, can harness the energies of a people and defy the predictions of economic theorists.

In 1947 and 1950 Dr. Deming was invited by General MacArthur to assist in the first postwar census in Japan. In 1950, acting on the advice of Homer Sarasohn, then on MacArthur's staff in Tokyo, the Japanese Union of Scientists and Engineers (JUSE) invited Dr. Deming to Tokyo to give lectures on statistical process control. His lectures to large numbers of enthusiastic Japanese engineers were transcribed word for word, edited by him, and translated into Japanese. Thousands of copies were sold. When the Japanese offered to pay him royalties, he declined and suggested that they use the money to create a prize for companies that had shown exemplary performance in the improvement of quality. Japanese companies added funds, and today the Deming Prize is regarded around the world as the premier prize for quality. When the U.S. Congress understood the importance of the Deming Prize in Japan as a spur to increased attention to quality, it created the Baldrige Prize in the United States. Other countries are in the process of establishing similar prizes. The modest proposal he made in 1950 in Japan has become a global activity.

When Deming attempted to change managerial practices in the West, he found an enthusiastic response among engineers, but only rejection among managers. Therefore, after he saw the enthusiastic response of Japanese engineers, to guarantee that his work would not be subverted by Japanese management, he insisted that the JUSE arrange a meeting of the leaders of Japanese industry. Eighty of them came. In this lecture Deming told them that if they would follow his proposals to change their managerial style, within five years they would begin to capture a significant share of world markets. They did not believe him, but in the words of one attendee, "Since we did not argue, we would lose face if we did not at least try." Within a month a manufacturer of insulated wire reported a 30 percent increase in productivity. Others also found increases in productivity and quality. Thus was Japan's rebirth begun.

In the West his work in management was ignored. People continued to believe that quality added to cost and that people would not pay extra for quality. Japanese carmakers and electronics manufacturers proved them wrong.

Unable to convince western managers, Dr. Deming was not idle. He continued to work as a statistician. During the period from 1946 until 1980, he published or presented 105 papers on a wide variety of topics: the analysis of election results, the analysis of market surveys, the analysis of birth and death rates, the sampling of bulk materials, accidents with motor vehicles, statistical analysis as legal evidence, the birth and death of newspaper subscriptions, deaf patients of psychiatrists, fertility among schizophrenics, mental health of the deaf, and the use of statistics in the setting of rates for motor freight.

All this changed on June 24, 1980, when NBC broadcast the now-famous documentary entitled "If Japan Can ... Why Can't We?" In this documentary, Dr. Deming appeared briefly, with a few scathing remarks about American managerial practices in production. After seeing the broadcast, American managers, hard hit by competition from Japan, began to call him at his home in Washington, D.C. In 1982 the Center for Advanced Engineering Study at the Massachusetts Institute of Technology (MIT) published his first book on management, *Quality Productivity*, *and Competitive Position*, and released videotapes in which Dr. Deming discussed his "fourteen obligations of management." In addition, he was invited by MIT and a growing list of sponsors to give a series of seminars on management. These seminars increased in frequency and size, and during the last years of his life, he attracted audiences, including satellite stations, of over 5,000 people at a time and was reaching more than 120,000 people per year. In 1985 he rewrote and retitled his earlier book on management and called it *Out of the Crisis.* Over 250,000 copies of *Out of the Crisis* have been sold. It has been translated into French, Italian, Portuguese, and Spanish. A translation into Dutch is in progress. In the year before his death he published a third book, *The New Economics for Industry*, *Government, Education.* Over 30,000 copies have been sold.

Deming was at once both kind and generous and harsh and critical. When dealing with workers he was sympathetic. He aimed to put joy back into work. He believed, and produced evidence to back up his judgment, that current managerial practices robbed workers of the satisfactions so essential to do good work. When dealing with managers he was often scathing and derisive.

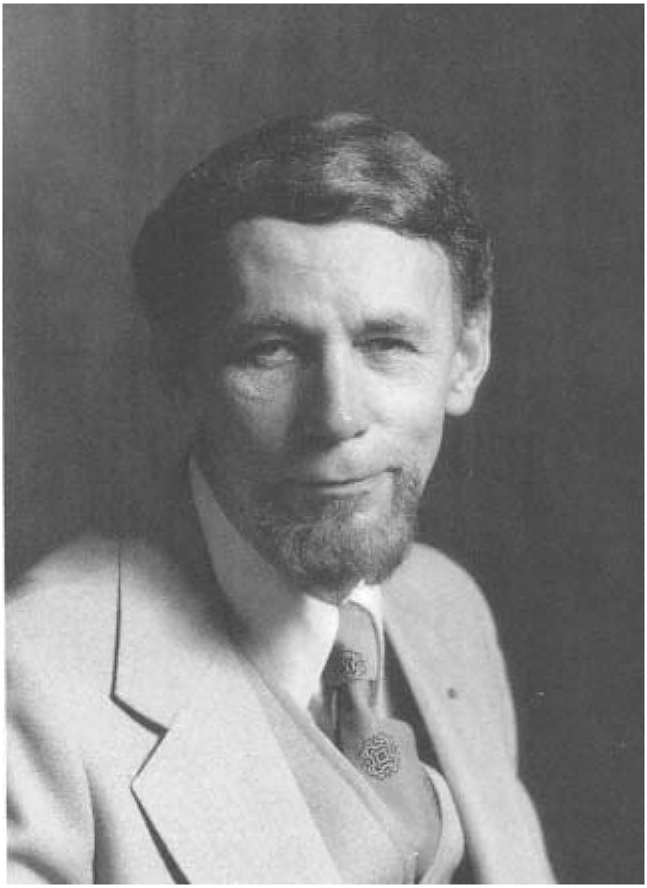
An early client in manufacturing in the United Sates was the Nashua Corporation of New Hampshire. Applying Deming's approach, Nashua began to achieve significant reductions in cost. After the broadcast of "If Japan Can . . . Why Can't We?," the Ford Motor Company called upon Dr. Deming to help. According to Don Petersen, former CEO and board chairman of Ford, Deming's approach was the key to the turnaround in the fortunes of Ford. Waste was reduced, labor relations improved, customer satisfaction increased, and Ford was able to stay in business and compete again. Petersen is unequivocal about the basis for Ford's success: "People want to do a good job. Dr. Deming's ideas and concepts, as we got them going through our system, gave people more and more this feeling that they had a better chance to do a good job. The rate of improvement, in many ways, was much greater than anything we could anticipate."

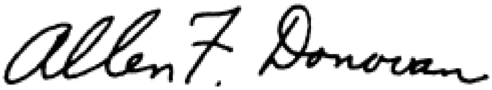
Deming was scornful of the practices of American managers and of the business schools that taught them. He chronicled these practices in his oft—repeated "fourteen points," his "deadly diseases," and his "profound knowledge." Although in 1980, no business school would acknowledge that Deming had developed a new approach to business, by 1992, two years before his death, he was able to see many schools, even prestigious ones like Chicago's School of Management, adopting his teachings.

His theory of management rests on the four elements of his profound knowledge. (1) *Variability:* All systems exhibit variability and this prevents accurate prediction of the consequences of managerial decisions. Failure to understand the role of variability leads to tampering with a system and can produce a result precisely the opposite of that intended. (2) *Systems:* The second element of Deming's profound knowledge is an ability to understand systems. The practice of dividing the company into separate business "profit centers" is, as Dr. Deming would often say, incompatible with optimization of the performance of the system as a whole. Dr. Deming insisted that managers look at the entire system of production, including the suppliers and the customers. In his view, the product in the hands of the customer is still in the system. (3) *Psychology:* The third element of his system of profound knowledge is an understanding of psychology. Deming understood that when people find joy in their work, their output rises, they make improvements in what they do, and they remain loyal to their colleagues and to the enterprise. In his list of deadly diseases and his fourteen points, he drew attention to the practices of managers that destroy joy in work, that make workers afraid to tell the truth, and that result in competition when cooperation is needed. (4) *A Theory of Knowledge:* Deming believed that western managers, in general, did not know, and were not taught, a theory of knowledge and, in consequence, did not know how to reason correctly and did not understand the nature of proof, the need for operational definitions, and why there is no true value of anything. This ignorance of profound knowledge, he argued, caused them to lay off people when they should have worked on increasing quality, to be unable to interpret the numbers placed before them, and, worst of all, to be unable to appreciate that the most important costs in any business are unknown and unknowable.

The greatest impact of Deming's teachings are yet to come. Six years ago Mt. Edgecumbe High School in Sitka, Alaska, began to apply quality management principles to the operations of the school. Within a few years the effects on the students were so dramatic that the school was besieged with requests for information. Today schools in many parts of the world are attempting the same transformation in their education systems. In the United States, Canada, the United Kingdom, and Argentina, schools are adopting quality methods. Second-and third-grade teachers have shown how quality management approaches applied in the classroom can enhance learning, increase student maturity and responsibility, and at the same time, make learning more enjoyable and more relevant to life. Ann Richards, the governor of Texas, launched a statewide movement to make quality management the central theme in Texas education. Other governors have followed suit.

Dr. Deming's contributions to science, statistics, and economics were important, but his development of a comprehensive theory of management overshadows all else. This theory has already changed the lives of millions of people. Applied to education, it promises to change future generations. Dr. Deming is gone. His legacy lives on.





Allen F. Donovan

1914-1995

By Alexander Flax and Ivan Getting

Allen F. Donovan began his engineering career in 1936 by working as a structures engineer at the Curtiss Aeroplane Division of the Curtiss-Wright Corporation in Buffalo, New York, after receiving his master's degree in aeronautical engineering from the University of Michigan. His first task was redesigning the wire bracing of the wings for the last production run of the Curtiss Hawk biplane fighter. Subsequently, he worked on a number of Curtiss fighters, including the Curtiss P-40 Warhawk, which saw extensive service in World War II with more than 15,000 produced. During the war, he played a key role in creating the Curtiss-Wright Research Laboratory, where, as head of structural and flight research, he pioneered in instrumented structural and flutter flight testing. Programs he conducted on the Curtiss Helldiver dive bomber and the Vought Corsair fighter made important contributions to these airplanes' operational capabilities. Working for the Manhattan Project, his structural design group ran structural and altitude tests on the Nagasaki atomic bomb design and developed bomb releases used in the drops on Japan.

After World War II, Curtiss-Wright donated its research laboratory to Cornell University, which renamed it the Cornell Aeronautical Laboratory and operated it as a nonprofit corporation with Donovan as head of the Aeromechanics Department. Here he directed the design and, in May 1947, the flight test of the unmanned rocket-propelled STV-1, the United States' first supersonic and transonic, aerodynamically stabilized and controlled vehicle (five months before the X-1 airplane flew supersonically). In 1948 he and two associates published a landmark paper on the stability and control of supersonic aircraft. He also had a strong interest in helicopter technology, and a group under his leadership developed, built, and test flew the first fiberglass composite helicopter blades. For the Army, he led the development of the Lacrosse missile —a system designed to enable a soldier in the front lines to guide a missile launched from approximately ten miles behind him to a precise strike with a warhead that would penetrate a heavily fortified target.

In 1955 he moved to Los Angeles to join the Guided Missile Research Division of the Ramo-Wooldridge Corporation (later a part of TRW), which had just been assigned the task of performing the "System Engineering and Technical Direction" for the Air Force Intercontinental Ballistic Missile (ICBM) Program. As head of the Aeronautics Laboratory, he guided the efforts on the rocket engines, the aerodynamics, the structural design and dynamics, and on the reentry vehicles of the Atlas, Titan, and Thor missiles. He also served as program director of the Titan system in its initial phase. Studies he led on the potential use of solid rockets for the ICBMs resulted in the Minuteman missile concept. Early in 1958, he convinced the Advanced Research Projects Agency of the Department of Defense to attempt the world's first lunar mission using the Thor missile with two additional rocket stages. This program of three launches, which was transferred to the newly created National Aeronautics and Space Administration (NASA) in October 1958, resulted in Pioneer I, the first of a long series of scientific space missions designated "Pioneer." The systems did not achieve their ambitious objective of returning a picture of the back of the moon; but Pioneer I, the second launch, did send back the first measurements of the earth's radiation field out to 80,000 miles.

In 1960, after the Air Force determined that its system engineering for the future space and missile systems should be provided by a nonprofit organization created specifically for that purpose, Donovan was elected by the founding board of trustees to be the senior vice-president, technical, and second in the line of command of The Aerospace Corporation, headquartered in El Segundo, California. Working with Ivan Getting, Aerospace's president, he built the staff up to two thousand engineers and scientists. In his eighteen years at Aerospace, he guided the engineering efforts in the entire Air Force space program—and in some areas supporting NASA. In the space launch vehicle field, this included the Atlas and Titan II families as well as the Agena rendezvous vehicles supplied to NASA and launched for NASA by the Air Force for the Mercury and Gemini astronaut programs, the development and use of the Titan III family of space launch vehicles, and studies for the Air Force and NASA that were of major importance in creating and defining the Space Shuttle Program. He personally initiated and guided a critical engineering effort for the Mercury space launch vehicle and produced an empirical solution to the problem of combustion instability in liquid rocket engines. For the Titan II vehicles, he formulated, initiated, and guided a program that produced both a theoretical analysis and its engineering application that solved the so-called Pogo problem of longitudinal oscillations of liquid rocket launch vehicles. These concepts were later used to solve the "Pogo" problem of Apollo's Saturn V launch vehicle's second stage and are in use today in the space shuttle.

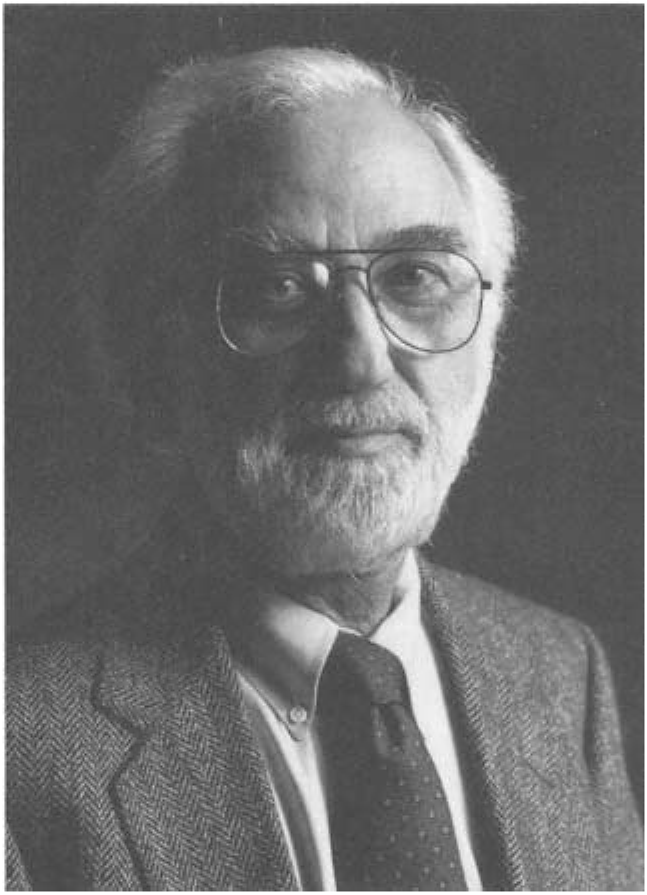
In the spacecraft field, his responsibilities included the Vela nuclear detection satellites, the infrared launch surveillance satellite systems, several generations of military communication satellite systems, the defense meteorological satellite program, and a number of highly classified satellite programs in the category referred to in arms control treaties as "national technical means of verification" managed and operated by the National Reconaissance Office for the President.

Al Donovan se red on the Air Force Scientific Advisory Board from 1948 to 1968 and was chairman of its Propulsion Panel from 1959 to 1968. The Air Force awarded him the

Civilian Exceptional Service Medal in 1968. In the mid-1950s he served as principal adviser for the air vehicle in President Eisenhower's panel studies leading to the development of the U-2 high-altitude reconnaissance aircraft. Between 1957 and 1978, he served as a consultant and member of panels of the President's Science Advisory Committee under five presidents.

In 1964 the University of Michigan conferred on him an honorary doctor of science degree in aeronautical and astronautical engineering. He was elected to membership in the National Academy of Engineering in 1969 and served on a number of committees, including the National Research Council's Assembly of Engineering Ad Hoc Committee for Review of the Space Shuttle Main Engine Development Program (1978). He became a member of the American Institute of Aeronautics and Astronautics in 1943, and was elected a fellow in 1963 and an honorary fellow in 1983.

Born in Onondaga, New York, on April 22, 1914, Allen Donovan earned his B.S.E. and M.S. degrees at the University of Michigan. During his lifetime, he participated in activities closely related to his scientific and engineering interests: in sailplanes, as a free balloonist, and as an airplane pilot prior to World War II. As he matured, he turned to sailing and was very proud of his 40-foot ketch. On retirement from active work and in failing health, he and his wife, June, moved to Corona del Mar where he died on March 11, 1995.



A. E. Dukler

1925-1994

By Dan Luss and Moye Wicks

On February 12, 1994, Professor Abraham E. "Abe" Dukler of the University of Houston died at the age of sixty-nine. Abe was known worldwide for his contributions to the understanding of multiphase flow. Among the other honors he received, Abe was elected a fellow of the American Institute of Chemical Engineers (AIChE) (1978) and a member of the National Academy of Engineering (1977). He served on the editorial boards of three major technical journals: *International Journal for Multiphase Flow, Desalination,* and *Chemical Engineering Communications.*

Abe was born in Newark, New Jersey, on January 5, 1925. He earned his undergraduate degree from Yale University in 1945 and his M.S. and Ph.D. in chemical engineering from the University of Delaware in 1949 and 1951, respectively. After three years with Rohm and Haas, he joined Shell Oil at its Houston refinery in 1950. From 1952 until his death, he was affiliated with the University of Houston's Chemical Engineering Department, where he achieved the rank of professor in 1961. As one of the department's founders, he led its rise to prominence among schools of chemical engineering in the United States. He was dean of the Cullen College of Engineering from 1976 to 1982, then returned to research-his first and continuing love.

Abe was executive director of the governor's Energy Council for the state of Texas from 1973 to 1975. He organized and supervised a state-funded coordinating program designed to provide information for policymaking in Texas. These efforts introduced sound technical considerations into Texas state policies on energy management, regulations, allocation, and control.

Abe's lifelong interest was in two-phase phenomena. Such phenomena appear frequently in chemical engineering practice and in many other industrial processes, and proper understanding and modeling constitute a crucial step in the design and scale-up of a large variety of chemical and physical processes. Unfortunately, despite the enormous practical importance of this subject, it is so complicated that most fluid-mechanics research experts chose to take simpler, "cleaner" problems. Although some simple cases can be treated from a strictly analytical point of view, most multiphase-flow phenomena are far too complex to yield to treatments that do not derive from a clear physical insight and an ability to make proper simplifying assumptions. It is in this sense that Abe Dukler made major contributions in this difficult and complicated field. Through an impressive series of publications, he led an effort to bring order to the understanding of two-phase flow and laid the foundation for follow-on scholarly work by himself, his students, and others.

Beginning with his doctoral work on falling films, Abe was one of the pioneers in the use of computational techniques, applying them in his 1960 paper on heat-transfer in condensers—a major extension of Nusselt's 1906 paper on heat-transfer through liquid films. From 1960 to 1965 Abe directed the American Gas Association-American Petroleum Institute project NX-28 at the University of Houston, a project that led to the first schema for data collection and reporting of multiphase-flow measurements. This "data bank" was continued and extended by workers at the University of Calgary in Canada and the Harwell Laboratory in the United Kingdom. Recognizing the lack of communication between academic researchers and industrial practitioners, Abe's drive and enthusiasm sparked the formation of the American Institute of Chemical Engineers' Ad Hoc Committee on Multiphase Flow.

Through his guidance and persistent efforts, the activities of this committee culminated in the establishment of the AIChE Design Institute for Multiphase Processing (DIMP). Abe served as the first chairman of its Technical Committee.

Abe was clearly a key force in the DIMP effort. With Y. Taitel and others, he developed methods to predict the types of flow regimes that exist under given conditions of flow rate, fluid properties, and pipe geometry, laying the groundwork for systematic studies of the phenomena contributing to pressure-drop and energy-loss in each flow regime. All flow regimes received a share of Abe's attention, and in each case the technical community was enriched by his efforts. Indeed, without these contributions, the petroleum industry probably would not have rational design tools to size offshore oil-and gas-transportation systems reliably. Abe's research led to major improvements in design methods for flow in vertical and deviated oil and gas wells and made accurate hydraulic design possible.

With great insight, Abe developed new, unique experimental tools and accompanying analytical methods to examine the detailed behavior of two-phase systems, including capacitance probes for film thickness and bulk-entrainment gauges. These techniques allowed flow-pattern identification from wall-pressure fluctuations, determination of local void-fractions and surface-wave thickness, and droplet-size and diffusion measurements. Abe's measuring methods have become standard techniques. He was also the first to break down complex two-phase flow problems into their component parts with subsequent systematic analyses of each part. An understanding of the underlying physical phenomena was then integrated and used to solve important "real-world" two-phase flow problems. Abe had a special ability to reach to the heart of complex problems, pulling out their essential features and obtaining solutions of academic interest and practical value. His rare insight permitted specific identification of which problems should be attacked and when. Whether to the inspiration or occasional dismay of his students, Abe kept a watchful eye on any advance in technology that might give insight into the macroscopic design information needed by practitioners.

In recent years, Abe worked on two-phase flow problems in space technology. In space stations, climate control is achieved by transporting heat from laboratories and living areas to space radiators placed in remote locations. Very efficient heat-transport may be achieved with volatile two-phase mixtures, often driven by capillary forces. Unfortunately, the behavior of two-phase flow in zero gravity is unknown. Abe and his students, in close collaboration with J. Fabré of L'Institut National Polytechnique de Toulouse, modeled the intriguing behavior of two-phase flow under microgravity conditions. In cooperation with the NASA Lewis Research Center and the Johnson Space Center, Abe designed and built two experiments to be conducted on the 1998 space shuttle flights. Sadly, these experiments will now be conducted without the benefit of Abe's keen insight.

Additional national and international honors earned by Abe Dukler during his career included a senior postdoctoral fellowship from the National Science Foundation (1967), the Alpha Chi Sigma Award for chemical engineering research from the AIChE (1970), the Lady Davis Visiting Scholar Award from the Technion Institute in Israel (1976), the Chemical Engineering Lectureship Award for Research from the American Society of Engineering Education (1976), and the Donald Q. Kern Award from the AIChE (1988). Local recognition included the bestowal of the Cullen College of Engineering Alumni Association (EAA) Distinguished Faculty Award (1989), the EAA's posthumous naming of the award in Abe's honor, the University of Houston's Esther Farfel Award for excellence in teaching (1989), and the "Best Fundamental Paper" award of the AIChE's south Texas section (eight times).

Out of respect for Abe's enduring and pioneering contributions, the Engineering Dean's Office of the University of Houston has established and is coordinating the Abraham E. Dukler Scholarship Endowment.

Harold Etherington

Harold Etherington

1900-1994

By David Okrent

Harold Etherington died on August 2, 1994, at the age of ninety-four. He was a pioneer in the development of the first nuclear submarine power plants and the early boiling water nuclear power plants, and was a major contributor to the safety of commercial nuclear power plants.

Harold was born in London on January 7, 1900. His wife Elesa, who was born in Cumberland, England, on September 22, 1903, died with him.

Harold attended Imperial College of Science and Technology, London, where he was awarded an ARSM (Associate of the Royal School of Mines), first class, in 1921. He also was awarded the B.Sc. Engineering, honors, first class, University of London, in 1921.

Harold worked as the superintendent of LENA Goldfields, Ltd. Steel Plant from 1926 to 1930, as an engineer at A. O. Smith from 1930 to 1932, and as an engineer for Allis Chalmers Manufacturing Company from 1933 to 1942. When he moved to the United States in September 1939 with his wife and son, Geoffrey, the trip was almost fatal. They arrived aboard the oceanliner *Athena,* which had been torpedoed by a German submarine during the voyage, resulting in the death of hundreds of passengers.

Harold worked for Allis Chalmers on engineering development and later on manufacturing from 1942 to 1946. His nuclear experience began in 1946 at Oak Ridge National Laboratory, where he served first as section leader of the Gaseous Diffusion Plant and then became director of the Power Pile Division. From 1948 to 1953, as director of the Naval Reactors Division at Argonne National Laboratory, he made major contributions to the early basic reactor design for the United States Navy's first atomic-powered submarine, the *Nautilus*. From 1953 to 1959 he served as vice-president, Nuclear Products Division, ACF Industries. From 1959 to 1963 he served Allis Chalmers as vice-president and general manager, Atomic Energy Division. In these capacities he led design, construction, and startup of the Elk River Reactor, as well as working on the initial operation of Pathfinder, an integral superheat reactor.

Harold retired from Allis Chalmers in 1963. For most of the period between 1965 and the early 1990s, he served as a member of the Advisory Committee on Reactor Safeguards (ACRS) then as a member emeritus, the only member ever so honored. By law, every commercial nuclear power plant has to be reviewed by the ACRS, prior to both the start of construction and the beginning of operation. A letter report from the ACRS to the U.S. Atomic Energy Commission (and after 1975 to the U.S. Nuclear Regulatory Commission) has to be in the public record before hearings on a construction permit or an operating license can proceed. As a member of the ACRS, Harold played a major role in the formulation of many decisions important to nuclear safety.

Harold was elected to the National Academy of Engineering in 1978, an honor well deserved.

In 1974 Harold was awarded the U.S. Atomic Energy Commission Citation and Gold Medal for his meritorious contributions to the U.S. nuclear energy program. He was a member of the American Society for Mechanical Engineers, the American Rocket Society, the American Nuclear Society, and the American Society for Metals.

Harold was the author of a book entitled *Modern Furnace Technology,* which was published by Charles Griffin, London. The first of three editions appeared in 1938. In 1958 McGraw-Hill published the much-used *Nuclear Engineering Handbook*, for which Harold served both as the editor and a major contributor. Not published formally, but of much fame, was the report "Reactor Physics for Amateurs" by Etherington, a remarkably clear introduction to the subject, one which was illustrative of Harold's depth of knowledge in disciplines other than mechanical engineering.

Harold held one patent on the use of soluble poisons in pressurized water reactors.

So much for Harold's formal technical record. What of Harold Etherington, the man? He was generally a quiet, soft-spoken man with a good sense of humor. I actually began my career at Argonne National Laboratory in 1951 in the Naval Reactors Division, which was headed by Etherington. But I really got to know him through our many joint years of membership on the Advisory Committee on Reactor Safeguards. Harold's amazing breadth of knowledge across the many aspects of nuclear technology, and his ability to see through a complex problem to the key phenomena involved, made him an invaluable member. When the steam-line break problem was brought up without prior warning at the ACRS meeting on the Prairie Island nuclear power plants, Harold was able to perform a back-of-the-envelope calculation within several minutes, which made it clear that a threat to plant safely existed. Similarly, in 1966, the "China Syndrome" issue was brought into the ACRS review of the Indian Point 2 and Dresden 3 nuclear power plants, without benefit of any meaningful estimate of the potential course and consequences of a large-scale core melt. In a relatively few days, Harold provided the other ACRS members with the results of a rough estimate of core and containment behavior. It turned out to be remarkably similar to the description of a core meltdown accident that appeared in the Reactor Safety Study, WASH-1400, nine years later (in 1975).

On issue after issue, Harold's thoughts were sought after by the other ACRS members. He was always constructive, always a gentleman.

Unquestionably, his long tenure on the ACRS is known best for his chairmanship of the subcommittee that prepared the 1974 landmark report entitled "The Integrity of Reactor Vessels for the Light-Water Power Reactors." This was a difficult and controversial subject on which a wide range of strong opinions were held. That report has withstood the test of time.

Let me close by quoting briefly from the letter sent to Etherington in 1986 by then ACRS Chairman David Ward on the occasion of Harold's decision to leave membership on the ACRS.

> "As a member of the ACRS you have, I believe, been the ideal colleague—bright, articulate, and dependable. You are always gentlemanly, but ready with a strong comment when it is needed. You can be counted on to furnish authoritative opinion and information from your broad field of personal expertise, but you also reliably provide balanced mature perspectives on the whole range of Committee deliberations from a deep personal resource of wisdom and common sense."

We who knew him will all miss Harold Etherington.

Frank J. Feely, Jr.

1918-1995

Written by Manuel Peralta

Submitted by the NAE Home Secretary

Frank J. Feely, Jr., retired executive vice-president for Exxon Research and Engineering Company, was born on August 26, 1918, in Chicago, Illinois, and died on January 1, 1995, in Center Harbor, New Hampshire. Mr. Feely enjoyed a very distinguished professional career that spanned more than four decades, a career characterized by technical and executive leadership in the petroleum industry. In 1979 Mr. Feely was elected to the National Academy of Engineering in recognition of his professional accomplishments coupled with a demonstrated, strong sense of responsibility and integrity along with a fundamental interest in advancing technological development to serve the needs of society.

Mr. Feely joined Standard Oil of New Jersey (Esso, later renamed Exxon) in 1940 after graduating from the University of Michigan, where he was elected to Sigma Chi and Tau Beta Phi. As an engineer, he gained prominence through his research on brittle fracture, which in the late 1940s led to new industry specifications for storage tanks, pressure vessels, and ships. This work on brittle fracture also identified the cause of the breakup of the Liberty Ships in the North Atlantic during World War II. Mr. Feely was also known for his work on air pollution control devices, evaporation control of gasoline from automobiles, and dispersement and control of oil spills.

As a result of his demonstrated technical and management skills, Mr. Feely in 1966 became the youngest person in Esso to be named vice-president of engineering, parallelling his father's career at Western Electric. As vice-president of engineering, he created a highly competent, motivated, and unparalleled Exxon (Esso) organization. Under his leadership the organization grew very rapidly in dealing with the changes and challenges facing the petroleum industry during the decade of the 1970s.

During this period, he was responsible for engineering designs on the Alaskan Pipeline and the Manhattan Ship Project, which demonstrated ice-breaking technology to allow oil transportation via the Northwest Passage. Also under his leadership, Exxon (Esso) developed state-of-the-art project management technology that established the company as a leader in the industry in the design and implementation of capital projects. During his tenure as engineering vice-president, Exxon (Esso) successfully carried out billions of dollars in capital projects, including several new refineries in the Far East and refinery expansions and upgrades in the United States, Europe, and Japan, as well as a number of petrochemical plants worldwide.

As part of his career development, Mr. Feely had an assignment with Exxon Corporation between 1971 and 1974 as manager of its worldwide logistics operations. After the assignment he rejoined Exxon Research and Engineering and subsequently became its executive vice-president. In addition to his many career accomplishments within Exxon (Esso), Mr. Feely was also very active professionally outside the organization. He was a fellow in the American Society of Mechanical Engineers, chairman of the American Petroleum Institute's Central Committee on Engineering, and a director (1967 to 1982) and chairman of the board (1979-1980) of the American National Standards Institute (ANSI). He also served on ANSI's Board of Standards Review from 1981 until his death.

ANSI is a private nonprofit organization that administers the development of voluntary U.S. national standards and represents U.S. interests in the International Organization for Standardization (ISO) and the International Electrotechnical

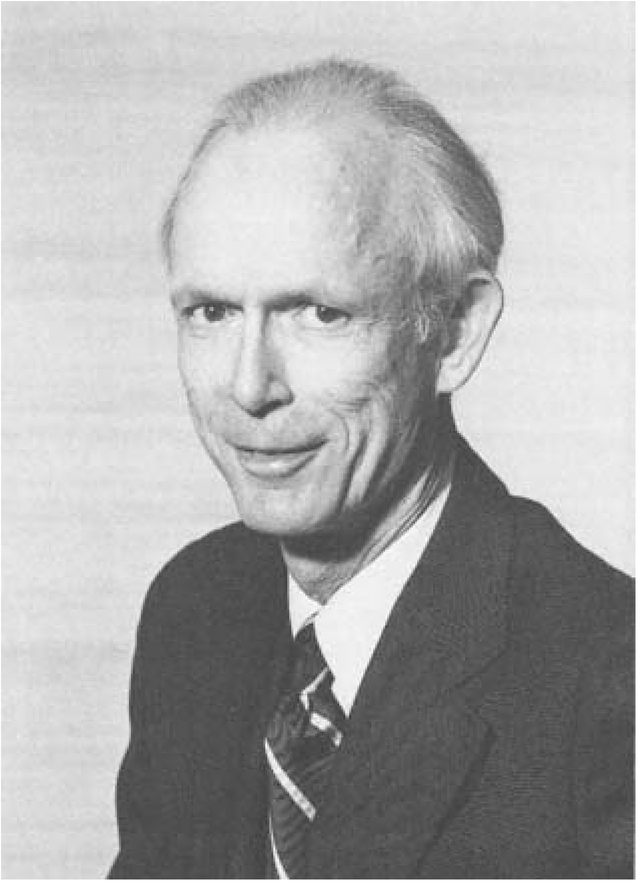
Commission (ITEC). During his chairmanship of ANSI, Mr. Feely led a successful campaign to defeat efforts by an element of the federal government to take over control of the voluntary standards system administered by the private sector. He was also instrumental in strengthening ANSI's national program and participation in international standardization programs. In recognition of his efforts, in 1982 Mr. Feely was awarded ANSI's Howard Coonley Medal. The award honors an executive who has rendered great service to the national economy through voluntary standardization.

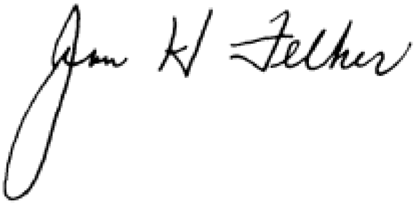
In addition to his professional career, Mr. Feely was very active in the United Methodist Church, in both Westfield, New Jersey, and Moultonborough, New Hampshire. He was also a board member of the Union County, New Jersey, Psychiatric Clinic, and a scoutmaster and trustee of the Westfield Boy Scout troop. In addition, he served as a volunteer with the Moultonborough Meals-on-Wheels Program, trustee of the Moultonborough Public Library, and founding member of the Friends of the Library. As an avid hiker and member of the Appalachian Mountain Club, he climbed all forty-seven mountain peaks above 4,000 feet in New Hampshire. As a high school junior in New Jersey he was state champion in the high jump and established a record that prevailed for a number of years.

Mr. Feely had a full and productive life, rich with many accomplishments and the respect of his family, friends, and associates. To all he will always be remembered as someone

- who was an outstanding professional and community leader,
- who instilled in individuals and organizations the values of integrity and concern for people,
- who was highly competent technically and who inspired others to achieve, and
- who was always positive and wealthy in the joy of his work, his family, and his friends.

Mr. Feely is survived by his wife, Muriel; sons, Joseph, Patrick, and James; daughters, Carol, Jean, Margaret, and Elizabeth; a sister, Ruth; twelve grandchildren; twenty-two nieces and nephews; and not to be forgotten, numerous friends. Mr. Feely's first wife, JoAnne, died in 1967.





Jean Howard Felker

1919-1994

By Brockway Mcmillan

Jean Howard Felker, a retired vice-president of AT&T Bell Laboratories, died on February 27, 1994. He had been a member of the National Academy of Engineering since 1974.

Born in Centralia, Illinois, on March 14, 1919, Felker received a bachelor of science degree in electrical engineering from Washington University in St. Louis, Missouri, in June 1941. He worked briefly for Emerson Electric Company and then taught mathematics at a training school for naval recruits. Commissioned in October 1942 as a second lieutenant in the Signal Corps, he went to England to learn radar at the Military College of Science. After a four-month tour he was returned to Fort Monmouth, New Jersey, to write and edit radar manuals until mustering out in 1945.

In December 1945 Felker joined Bell Laboratories at the Whippany, New Jersey, location in the Military Systems Laboratory. In 1948 he received three point-contact transistors, the first of a meager trickle allocated to that laboratory. By late 1950 he had demonstrated, with such devices, all the basic logic circuits of a digital computer, operating at a one megahertz rate, and had described in memoranda the architecture of a computer built on such elements. He had already dubbed this computer TRADIC— Transistor Digital Computer.

By 1951 Felker had demonstrated serial adders and multipliers and delay-line storage registers, all operating at one megahertz. In his notebooks of that time can be found preliminary analyses of bombsight and gun-laying computers. He had already concluded that a digital bombsight, as distinct from a gun controller, would not need a magnetic drum—the only mass storage medium then at hand—because of the relative simplicity of its ballistic tables. By late 1951 he had discussed with colleagues the feasibility of building a flyable model of a bombsight.

Drawing on this work, Bell Laboratories contracted with the Air Force in 1953 to design and develop a solid-state digital computer. The specific objective was to test ("demonstrate," said the optimists) feasibility for tactical applications. The project officially adopted the name TRADIC, and Felker was put in charge. Phase I was completed, at some effort, in one year. In that year it consumed the whole factory output of point-contact transistors-some 5,000. With its cathode-ray displays, this primitive computer demonstrated to the skeptics in the Air Force that digital machines could simulate the continuous actions of analog devices.

Phase I led at once to TRADIC Phase II—the flyable model of a digital bombsight. Using the basic circuits and architecture of Phase I, with consultation provided by Felker's laboratory, a group experienced in the design of the analog bombsight provided the final product. The airborne environment was a harsh one for point-contact transistors, but flight tests were ultimately successful.

Formally, Felker and his pioneering colleagues faced in Phase I of TRADIC such questions as: synchronous or nonsynchronous? (answer: synchronous); binary or decimal? (answer: binary); magnetic memory or semiconductor? (answer: for a tactical computer with a fixed program, transistor registers). Actually, these major design decisions were all founded on Felker's notes and memoranda of 1951 and earlier. They governed in Phase II, and the resulting architecture was basic to Phase III.

As fast junction transistors became available, Felker convinced the Air Force to undertake Phase III. This was a general-purpose digital computer with a magnetic-core memory, taking its program input from plug boards. Scaled to the capacity of the

Massachusetts Institute of Technology Whirlwind computer, model III occupied a case about the size of an office filing cabinet, contained 100,000 transistors, and consumed 50 watts. For a year it did general computing at Bell Laboratories in the military development laboratory, before delivery to the Air Force.

In 1955 Felker turned to a new assignment—to establish an organization for planning digital transmission services to be offered by the Bell System, for planning the associated digital systems, and for developing data processing systems to automate clerical and engineering functions common throughout the Bell System. By 1959 the latter function had evolved to the point that a separate organization was created to automate those functions suitable for general-purpose computers. Felker then moved to AT&T headquarters to become transmission engineer and later assistant chief engineer, of the AT&T Company. In 1962 he transferred to the New Jersey Bell Telephone Company as vice-president of operations. In the latter position he was a member of the board of directors and of its executive committee.

Felker retired from the Bell System in 1969 and set up in private consulting practice. In March 1971 he returned to Bell Laboratories as vice-president in charge of business information systems. In 1979 Bell Laboratories appointed him vice-president for software and processor technologies. He retired in May 1981.

The Institute of Electrical Engineers honored Felker as a fellow in 1959. The National Academy of Engineering elected him to membership in 1973, citing him for "design of the first transistorized digital computer and for the engineering of digital systems." He was a founding director of Bellcomm, the systems engineering organization that served the National Aeronautics and Space Administration for the moon landings and thereafter, and was a director of the Colonial Life Insurance Company and its successors for some twenty-five years.

It is clear from scraps of memoir that, from boyhood, Felker was both a practical tinkerer with things mechanical or electrical, and a dreamer. As an engineer, he was at once an ingenious inventor and a rational and imaginative planner. His sixteen patents range from transistor logic circuits to computer and memory systems. His many published articles cover a similar range, from techniques for logic circuit design to the basic principles underlying the organization of TRADIC III.

In all matters, Jean Felker was an original thinker. He heard his own drum —literally in at least one instance. I recall his amusement at the inability of the army drill instructors to reform his shambling gait. Neither in his engineering nor in his private life did he accept conventional wisdom without supporting evidence. He respected facts. A quiet iconoclast with a sharp sense of humor, indeed in many ways a determined nonconformist, he was not a revolutionary. When he chose his own way he did so with reason and good humor, and he did not impose it on others.

Jean Felker had an extraordinary sensitivity to and understanding of the feelings and needs of the people with whom he dealt. During the three extended periods, separate in time and in context, that I worked closely with him, I never saw him use this remarkable talent to any but constructive ends. He was never manipulative, always tactful, considerate, and humane.

Jean had a restless spirit. During his first brief retirement, he began painting with oils. The products I have seen are large abstractions, exactly geometric, complex in their symmetries, and rendered with exquisite precision in beautifully controlled textures and soft colors. He continued this hobby for many years. Restless also in mind, he was an omnivorous reader, an acute observer of the contemporary scene, and a student of history. Upon his second retirement, he bought a historic dwelling on the Delaware Canal. Soon, however, he set about to plan a permanent home in the rolling hills of nearby Durham, Pennsylvania. The construction and landscaping of this estate occupied him thereafter, and it is in this house that he died.

Marcelian Francis Gautreaux, Jr.

1930-1994

Written by Edward Mclaughlin

Submitted by the NAE Home Secretary

Marcelian Francis Gautreaux, Jr., affectionately known as Bim to everyone, died on February 13, 1994, at the age of sixty-four. He was an extraordinarily inventive chemical engineer, who has left his mark on the chemical industry by development of new technologies and by the diversity of specialty products developed under his leadership.

He was born in Nashville, Tennessee, on January 17, 1930, and attended Louisiana State University (LSU) for his chemical engineering training. He graduated magna cum laude in 1950 and completed his M.S. in 1951, after which he went to work for Ethyl Corporation as a process engineer. He stayed at Ethyl until 1955, when he returned to LSU to pursue his Ph.D., which he completed in 1958. During this time he served as an instructor and assistant professor teaching a wide range of courses in chemical process engineering. The distinctiveness that was always to characterize his work was shown at this stage by a seminal paper with Dr. Jesse Coates on activity coefficients at infinite dilution. His educational career at LSU was marked by many distinctions, and his leadership potential by his attainment of the rank of cadet major in ROTC as well as office holder in the various student societies.

On completion of his Ph.D., he returned to Ethyl Corporation as head of the engineering and mathematical sciences section, from which springboard he was to advance rapidly through the managerial ranks of the corporation with which he was to spend his entire professional career.

Dr. Gautreaux was the key figure, frequently the leader, and always the mentor in the development and commercialization of more than twenty new processes and products on which he held eight patents. Of these, the first was the oxychlorination of ethylene to produce ethylene dichloride from air, hydrogen chloride, and ethylene. Ethyl was already producing vinyl chloride by pyrolysis of ethylene dichloride. The value of the oxychlorination process was to make use of hydrogen chloride by-product from the cracking operation to produce additional ethylene dichloride. This permitted a "balanced" vinyl chloride plant with no net hydrogen chloride production (with the rapid growth of vinyl chloride, hydrogen chloride production was outpacing demand and becoming a serious economic issue for vinyl chloride producers.) This process was licensed to Solvay and ICI for worldwide use.

A major step in the diversification of Ethyl Corporation's product lines occurred with the commercialization of primary alcohol production by means of aluminum alkyl chemistry. Dr. Gautreaux led the development of this challenging chemical process, including a unique step that permitted tailoring the product range much more closely to the demands of the marketplace than did the conventional ethylene chain growth process. The aluminum alkyl chain growth chemistry was later expanded to include the production of linear alpha olefins in addition to primary alcohols. Again, Ethyl's process was able to control the distribution of C_2 through C_{20} products to a much greater degree than competitors. The chain growth chemistry plants now produce more than one billion pounds per year of linear alpha olefins and primary alcohols.

During Dr. Gautreaux's tenure, Ethyl Corporation became a major supplier of specialty chemical products to the detergent, agricultural chemical, pharmaceutical, polymer, and related industries. Products developed and commercialized included alkyldimethylamines and sodium alumino silicates for the detergent industry; dialkylanilines and various organic phosphorus compounds for the agricultural chemical industry; ibuprofen and other intermediates for the pharmaceutical industry; and orthoalkyled phenols, alkyldiamines, and organic bromides for the polymer industry. Proprietary Ethyl processes were discovered and developed for all these products. In a number of instances, Ethyl became the only supplier of the product worldwide.

In organometallic chemistry, he led the development of new antiknock compounds such as mixed lead alkyls (tetra ethyl methyl lead), a number of specialty aluminum alkyls, and production of polysilicon for the semiconductor industry. In this polysilicon area, again new technology was the major thrust as it had been for vinyl chloride and chain growth of alcohols and olefins. The process to produce ultrapure silicon involved purity enhancement by distillation of an organic derivative of silicon, followed by subsequent pyrolysis in a fluidized bed to produce a granular product, which opens the way for efficient, continuous "pulling" of single-crystal silicon used for semiconductors.

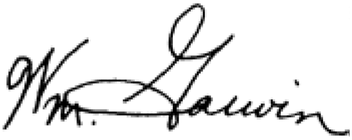
In all these areas of diversification of Ethyl from its reliance on tetraethyl lead, Dr. Gautreaux was the key figure. His winning personality and enthusiasm engendered the loyalty of his professional colleagues and instilled in all the will to succeed in technologically difficult chemistry and engineering. Not only was he fully involved in research, process development, and process design, but he was also active in the market research, market development, and contract negotiation phases for initial sale of most of these products on long-term contracts with user companies.

Throughout this period of a very productive career, he advanced rapidly from his initial appointment. In ten years he assumed the position of vice-president, research and development, in 1969 and then senior vice-president, research and development, in 1974. In 1972 he joined the board of directors and when ill health forced him to scale back his activities in 1981, he was made adviser to the executive committee of the board.

As was appropriate for such a distinguished record of achievement, Dr. Gautreaux was honored by many organizations. These include *Chemical Engineering* magazine with its PACE Award for personal achievement in chemical engineering when that award was introduced in 1968. In 1976 he received the Charles E. Coates Memorial Award, which is given jointly by the Baton Rouge chapters of the American Institute of Chemical Engineering and the American Chemical Society. He was elected to the National Academy of Engineering in 1977 and chaired the Chemical/Petroleum Engineering Peer Committee. He received the Chemical Marketing Research Association Memorial Award in 1978 for outstanding contributions to chemical marketing research, and his alma mater added to his honors by inducting him in 1979 as a charter member of its Engineering Hall of Distinction and awarding him an honorary doctorate of science in 1991. In 1981 he was elected a fellow of the American Institute of Chemical Engineers. In 1987 Ethyl Corporation, marking its centennial year, honored Dr. Gautreaux by endowing the M. F. Gautreaux/ Ethyl Corporation Chair in Chemical Engineering at Louisiana State University.

Apart from his professional life, Bim Gautreaux found time to assist in many community activities, including the Louisiana Arts and Science Center, of which he was a trustee, the LSU Foundation, and the board of directors of the Community Concerts Association. An avid and significantly better than average golfer, he hated cold weather and always looked forward to the coming of spring.

To those who met him, Bim was a charming person who always greeted you with a large smile, a characteristic that endured even during his last days. He was a people person and deeply committed to the sanctity of life. In 1952 he married Mignon Alice Thomas. He was a devoted family man and father to four children, Marc, Kevin, Marian, and Andrée. His summary of his life is contained in words he wrote elsewhere: "Any successes I have had are no more or less than the composite result of a supportive and loving wife and children, professional associates who have never let me down, a corporation whose ethics are the highest, a religious heritage from my parents and early schooling, and some God-given talents for chemistry and engineering."



William Henry Gauvin

1913-1994

Written by Terrence W. Hoffman

Submitted by the NAE Home Secretary

William Henry Gauvin, dedicated educator, world-renowned engineer and researcher, and champion of the coordination of university-industry-governmental research in Canada, died on June 6, 1994, at the age of eighty-one.

Dr. Gauvin was elected to the National Academy of Engineering as a foreign associate in 1987; he was a founding member of the Canadian Academy of Engineering in 1986.

Bill, as he was affectionately known, was born in Paris, France, of an English father and a French mother. After his father died, his mother remarried and later as a teenager Bill requested that his surname be changed to that of his stepfather. This explains why he has English Christian names and a French surname.

His early education was in London, Paris, and Brussels. He received all his university education in chemical engineering and physical chemistry at McGill University, obtaining his Ph.D. in 1945. During his Ph.D. studies he was a lecturer in the Chemical Engineering Department at McGill.

After two years in industry he returned to be an associate professor of chemical engineering at McGill and remained so until 1962. During this time, he was an active consultant to the Pulp and Paper Research Institute of Canada; in fact, he became the head of its Chemical Engineering Division in 1957 and so maintained major responsibilities in these two institutions.

During this time, he developed applications for his invention, the Atomized Suspension Technique (AST). This is a high-temperature spray system, which was used primarily to pyrolize waste from pulp and paper processes.

It was during this period at McGill that he attracted a large number of Ph.D. students, whose fundamental studies in fluid mechanics and heat and mass transfer related to the need for a better understanding of the AST process and other aspects of the pulp and paper industry. His studies of high-temperature gas-solid systems (he referred to them as pseudo gases) led him to study the transfer processes and chemical reactions in thermal, plasma jets, particularly in metallurgical applications. He has been considered a pioneer in obtaining a fundamental understanding of thermal plasma systems.

In 1961 he founded the Noranda Research Centre in Montreal and was its first research manager and later its director of research and development until 1983. During all this time, he was a senior research associate (directing doctoral thesis research) at McGill University. He has coauthored more than 190 technical papers in the fields of electrochemistry, high-temperature heat and mass transfer, fluid mechanics, and plasma technology; he also holds numerous patents in high-temperature chemical processing and technology of thermal plasma jets. He has directed the research of more than fifty graduate students.

Bill Gauvin was a staunch supporter and an active member in professional societies. He had membership in nineteen different societies at one time or another covering the chemical engineering, pulp and paper, metallurgical, engineering, and research management fields in Europe and North America. He served as president for many of them.

Bill was also invited to serve on many government scientific advisory committees, including the National Research Council of Canada (NRC), the Science Council of Canada, le Conseil de la Politique Scientifique du Quebec, Hydro Quebec's Institut de Recherche en Energie, Advisory Committee on Nuclear Safety, and the Industrial Materials Research Institute of the NRC. In these capacities, he played a major role in shaping scientific policy in Canada since the early 1960s.

His illustrious academic and industrial career has been recognized by academic, government, and professional institutions. He received four honorary doctoral degrees and sixteen prestigious medals from Canadian and European professional societies (in many cases their highest awards). He was elected an honorary fellow in Canadian and U.S. societies and won many prizes for best scientific papers. He was the recipient of the Izaak Walton Killam Memorial Prize (Canada's highest award) and the Prix du Quebec. He was also awarded the Companion of the Order of Canada by the Canadian government.

It is important to realize that much of his reputation as a researcher was established during the 1950s and early 1960s—a time when research funds were scarce, Canadian university professors were underpaid and overworked, and research was done not "because of" but "in spite of" the academic environment in Canada. Bill Gauvin worked hard at establishing industrial connections and relating his fundamental research to industrial needs, so that he could finance all his research activities. This often meant that he had to work in different research fields simultaneously.

Bill Gauvin was highly respected by his peers and graduate students alike for his technical knowledge, his strong sense of professionalism and integrity, his enthusiasm for doing research and acquiring knowledge, and his "joie de vivre" attitude toward life in general. He represented that dedication, enthusiasm, desire to learn, and sense of professionalism to which all students should aspire. It was and continues to be a source of real pride for all his students to be known as "one of Bill Gauvin's boys," as a Massachusetts Institute of Technology professor once referred to me.

T. Keith Glennan

1905-1995

By Gerald F. Tape

Thomas Keith Glennan, a man of many talents, a visionary, an inspired leader in whatever undertaking he selected, died from a stroke on April 11, 1995, at the age of eighty-nine.

His career encompassed many diverse activities in which his engineering background, his management skills, and his power of persuasion were most valuable. Starting as an engineer and a manager in the motion picture industry, he served at various times as director of a defense-oriented laboratory, president of a major technology-oriented university, and president of a research laboratory management organization. Public service, high on his agenda, included responsibilities as a commissioner of the Atomic Energy Commission, administrator of the National Aeronautics and Space Administration, and the U.S. representative to the International Atomic Energy Agency. Whatever his position, his commitment was total.

Keith Glennan was born in Enderlin, North Dakota, on September 8, 1905, the son of a railroad dispatcher. He spent most of his youth in Eau Claire, Wisconsin, graduating from the public schools in 1922. After a short stay at Wisconsin State Teachers College, Eau Claire, he entered Sheffield Scientific School at Yale University in 1924 and graduated cum laude with a B.S. in electrical engineering in 1927.

As with many other college graduates, Keith got more out of Yale than a college degree. In the course of working his way, he met a noted Yale economist, Thomas Sewell Adams, whose daughter Ruth he married. Their union in 1931 provided Keith with never-ending loving support in family and career.

He entered the motion picture industry—the "talkies"— with Electrical Research Products, Inc., starting with the installation of motion picture sound recording and reproduction equipment in theaters at home and abroad. In England, where he was manager of Western Electric Company, Ltd., with a staff of about three hundred, he found that he had a taste and a talent for administration of a complex technical organization. At age twenty-three this was heady stuff. His responsibilities increased with expansion of the company's foreign service areas. Upon returning to the United States in 1930, his assignments took him into commercial motion picture production. During his five years at Paramount, he was first operations manager and then studio manager where he provided the logistics necessary to allow the studio's creative teams to stage their productions. He was credited with introducing departments of engineering and of industrial relations to the film industry. In 1941 he became studio manager of Samuel Goldwyn Studios.

Responding to wartime needs, Glennan joined the Navy Underwater Sound Laboratory in New London, Connecticut, and became its director in December 1942. The laboratory was operated by Columbia University under contract with the Office of Scientific Research and Development (OSRD). The laboratory was part of the OSRD family of wartime research and development laboratories. As director, he was brought into contact with others also involved in research and development in the public interest. His contacts with the enlarged company of scientists, engineers, and public servants proved to be most useful in his future undertakings.

With the termination of the war in Europe, Glennan resigned his position to return to the business world. After two years with the Ansco Division of General Aniline and Film Corporation of

Binghamton, New York, he looked for new challenges. Whatever mission he undertook, his objective was to make a difference, to make a positive contribution in a short time.

The presidency of Case Institute of Technology in Cleveland, Ohio, was neither the first nor the last challenge that Keith Glennan accepted. His goal at Case was to make it one of the top five or six engineering schools in the country. The physical plant was expanded and improved. The creation of an engineering division enhanced the institute's reputation as a scientific and technical institution. Case programs emphasized mathematics, chemistry, and physics, and to provide a broader education, a humanities program was geared to the interests of engineers. The institution grew rapidly in enrollment, physical plant, endowment, and prestige.

In his visionary way, Glennan recognized the merits of affiliating two great academic institutions, Case with its science and technology programs coupled with Western Reserve's liberal arts, law, and medical schools. Glennan and John S. Millis of Western Reserve initiated the process that culminated in Case Western Reserve University in 1967.

Although dedicated to Case, Glennan could not refuse the call to Washington by two presidents—Truman's in 1950 to become a commissioner of the Atomic Energy Commission (AEC) and Eisenhower's in 1958 to become the first administrator of the National Aeronautics and Space Administration (NASA). For each assignment of approximately two years, he took leave from Case, but continued close contacts.

The period of Glennan's tenure on the AEC was one that required major decisions to be made—the U.S. response to the emerging nuclear weapons program of the Soviet Union, the need for a second weapons development laboratory, the relationship between the Department of Defense and the Atomic Energy Commission involving "civilian control" of nuclear weapons, and the role of private industry in the development of nuclear power. He was an active participant in all aspects of the commission's deliberations.

In the late summer of 1952, the AEC started to focus on the need to inform the next president of the United States on AEC programs and long-term goals. Day-to-day issues squeezed out long-term planning. To quote the AEC history, "Glennan, who was always seeking a higher perspective for looking at Commission business . . . suggested that the commissioners get away from Washington for a few days to consider some of the broad questions." Conference "Topnotch" held only a month before Glennan's return to Case was a great success. It provided an opportunity for the commissioners to work together toward common goals and a basis for informing the incoming president.

The role of industry in the development of nuclear industry was not clear. Government controls, including classification and control of nuclear material, complicated matters. Glennan had long urged industry to become more involved, and in April 1953, former Commissioner Glennan announced the formation of the Atomic Industrial Forum, an organization of businessman, engineers, scientists, and educators interested in the development and applications of atomic energy. Following several metamorphoses, it now exists as the Nuclear Energy Institute.

Glennan's second leave of absence from Case was at the request of President Eisenhower to become the first director of NASA. The President's Science Advisory Committee had recommended that all nonmilitary space efforts be assigned to a strengthened and renamed National Advisory Committee for Aeronautics (NACA). Glennan's condition of acceptance was that Hugh Dryden, then NACA's director, become the NASA deputy director. A major achievement in the early years was bringing together the facilities and the expertise of the staffs of NACA, the Navy Vanguard project, the Jet Propulsion Laboratory, and the Army Ballistic Missile Agency. The planning, design, research, development, and procurement of the basic tools and facilities carried out by the new NASA provided a solid base for the space launches of the Kennedy period. As he had done during his tenure as an AEC commissioner, he supported a strong role for private industry, this time for communication and satellites in space.

Glennan's diary reveals how clearly he understood the tenor of the cold war atmosphere of the late 1950s. "I came to realize," he recalled in 1990, "that we couldn't have a program at all if we didn't have one that was exciting to the people. That was the reason for manned spaceflight. But I was interested in what the law required us to do for the benefit of mankind." He fashioned a program that incorporated a healthy human spaceflight element with a solid science and application basis. With the change to the Kennedy administration, Glennan returned to Case.

Keith Glennan was devoted to Case. It had grown and flourished under his guiding hand. Even while in Washington, he kept in contact. For Case he envisioned greater things to come and to be done, new directions, development fund drives, and the merger with Western Reserve. These were not to be overnight achievements; he concluded they should be the responsibility of a successor.

In 1965 Glennan became president of Associated Universities Inc., the nonprofit organization that operates the Brookhaven National Laboratory (BNL) for the Department of Energy and the National Radio Astronomy Observatory (NRAO) for the National Science Foundation. BNL and NRAO were operating successfully under strong directors, and the prospects for new projects where the corporation's expertise might be applied were bleak. Stimulated by Glennan, the trustees, during a retreat considered long-range objectives for the corporation. The resulting consensus was that while open to new endeavors, the corporation should, for the present, concentrate on its ongoing activities.

Throughout the years Glennan was active as a director of numerous public and private organizations. He was a member of the National Science Board and the Atomic Energy Commission's General Advisory Committee. He was a trustee of The Rand Corporation, a trustee of The Aerospace Corporation, and a consultant to the Department of State and the Department of Energy (DOE). For State he produced a report on technology and foreign affairs that emphasized the vital role played by science attaches in the embassies; for DOE he headed an advisory committee on a new reactor for the production of special nuclear material and tritium; for the Exxon Corporation he chaired a committee to advise on the application of nuclear material safeguards to the AVLIS process, a laser separation process for enrichment of uranium.

In 1970 he was appointed U.S. representative to the International Atomic Energy Agency (IAEA) by President Nixon and became heavily involved in international affairs. The Eisenhower Atoms for Peace initiative in 1953 gave rise to making the peaceful benefits of atomic energy available to all nations that refrained from developing or acquiring nuclear explosives. The IAEA was established to ensure that the member countries abided by their agreed upon undertakings. Glennan was a most active participant. When Congress limited the U.S. contribution to the budgets of the United Nations and its affiliated agencies to twenty-five percent, he intervened with congressional leaders who appreciated the role of the IAEA in the administration of nuclear material safeguards and obtained an exemption for the agency. He recognized the importance of strong support if IAEA's technical assistance programs for developing nations and sponsored such studies even to the extent of obtaining external funding. The United States had an important leadership role in the AIEA and provided an excellent and respectful representative, both nationally and internationally.

As previously stated, Glennan undertook tasks where he believed he could make a difference. When he had achieved his goal, he moved on. He resigned as ambassador to the IAEA but continued his strong support of its programs. He was convinced that more and better information was needed for the legislative and executive branches of government and for the public concerning the crucial role of the AIEA in the nuclear nonproliferation regime. Obtaining private funds, he sponsored studies under the aegis of Resources for the Future (RFF). This activity resulted in a widely distributed publication entitled *The Nonproliferation Role of the International Energy Agency*. Responding to Keith's enthusiasm, the National Academy of Engineering investigated setting up an international network involving foreign academies that could interact on a nongovernmental basis in support of international safeguards. Private funding that was required for NAE sponsorship was not forthcoming.

Glennan's initial effort with RFF became a continuing program under the Atlantic Council. This program now encompasses the entire field of nonproliferation and, through discussion groups, brings together experts and other interested persons in the Washington community.

T. Keith Glennan received many honors. He became a member of the National Academy of Engineering in 1967 and served on the Academy's Council (1969 to 1970) and on the editorial board of *the Bridge* (1983 to 1986). He was a fellow of the American Academy of Arts and Sciences. His honorary degrees are numerous. His government recognition includes the United States Medal for Merit (1946), the NASA Distinguished Service Medal (1966), and the Department of State Distinguished Honor Award (1973). He received the Henry DeWolf Smyth Statesman Award in 1988.

A memorial service held in May 1995 touched on Keith's career, but, more important, it reflected on his philosophy and values. The messages were conveyed by family members in words and song and by quotations from his diaries and from his letters to his children and grandchildren. We who had worked with him professionally were privileged to share this with his wonderful family.

Few individuals starting with an engineering degree have contributed to so many diverse fields of endeavor as did Keith Glennan. In spite of declining health, he continued to make a difference.

John M. Googin

1922-1994

By George R. Jasny

Successful, large-scale technical endeavors frequently trace their success to an individual who, because of an all-encompassing understanding of the key issues, is the vital force driving the project. John Googin, who died January 16, 1994, was such an individual.

John was born in Lewiston, Maine, on May 2, 1922, and earned his B.S. degree in chemistry in 1944 from Bates College in his hometown. His career, which spanned almost half a century, started that year when he was employed by the Tennessee Eastman Company, which, as part of the Manhattan Project, operated the Y-12 Plant in Oak Ridge, Tennessee. There, uranium isotopes were separated by the electromagnetic separation process to produce uranium 235 fuel for the first atomic bomb. John's first assignment was the daunting task of recovering and recycling the large fraction of precious uranium 235 that was deposited everywhere except in the product stream. That proved to be a useful apprenticeship. It gave him a solid grounding in separation technologies, the chemistry of uranium, and the realities of plant-scale chemical operations. It also established him as a brash, young talent who was willing to take on risky challenges, and who could get things done.

With the end of World War II and the start of the Cold War, the mission of the Y-12 Plant changed, and its operation was taken over by Union Carbide. The electromagnetic separation process was shut down, replaced by the gaseous diffusion process. Y-12 was assigned responsibility for converting the increasing quantities of uranium 235 produced by the gaseous diffusion plants into nuclear weapon components and for recycling large amounts of valuable chemical and metallic uranium scrap. A new task in the early 1950s was the preparation of hafnium-free zirconium for the first nuclear submarine core. Another assignment of major importance during the 1950s was a crash effort to produce large quantities of lithium 6 as fuel for the hydrogen bomb program. Starting in the late 1960s, and continuing through the early 1990s, the advent of nuclear-tipped missiles and the growing sophistication of nuclear weapons technology created a need for increasingly complex weapon components encompassing a wide range of ceramic and metallic materials produced to demanding chemical and physical specifications. In each of these efforts, characteristically conducted under stringent schedule demands and involving thousands of participants representing many different scientific, engineering, and production skills, John Googin played a pivotal role.

John had supplemented his not-insignificant scientific knowledge by obtaining a Ph.D. in physical chemistry from the University of Tennessee in 1953. He did this while working full-time on several critical programs and helping his wife, Janet, whom he had married in 1949, raise the first of their four daughters. Thus armed, he proceeded to make his mark.

There was a central element common to all of his accomplishments: the ability to combine a profound understanding of materials and their behavior with an unerring sense of what might work in the factory. Many people in various laboratories, engineering organizations, and production teams have contributed to the success of the American nuclear weapons program. None was a better bridge between the thinkers and the doers; none had a better feel for the elegant, practical solution. Firmly ensconced in the feedback loop that connected the physicists' dreams with the realities of production, he was frequently the final arbiter of what was doable and his batting average was very high. This effectiveness was enhanced to a significant degree by his ability to communicate with and inspire the hundreds of average people on whom success ultimately depended. This ability to put complex challenges in everyday terms, to generate trust, to co-opt people into reaching for yet another level of achievement was every bit as important as the depth of his technical insights.

One amazing aspect of John's accomplishments is that they came about without benefit of the authority of an administrative title. His enormous influence stemmed solely from the strength of his arguments and from his unquestioned success, but that influence, where it mattered, was greater than that of any of the executives who eagerly sought his advice. His was a technical man's dream assignment and he made the most of it.

John was a man of boundless energy and optimism. If he was ever discouraged, like most real leaders, he managed to hide it. The trademark of his persona was laughter: laughter to celebrate victory in an argument, defuse a tense confrontation, or cheer up the fearful. He was also a man of many contrasts: a chemist who was one of the finest engineers in the nuclear weapons program; a man who was always ready to question or challenge any renowned scientist or powerful administrator with whom he disagreed, but who always had time to listen to the ideas or problems of anyone who brought them to him; a patriot, who was proud of spending his life making sure that our nation had a credible, reliable nuclear deterrent and who, at the same time, was very active in the American Civil Liberties Union and in the Unitarian-Universalist Church; a man always willing to voice his opinion on almost any subject but never indiscreet when dealing with the many national secrets to which he was privy; a man cursed with bad feet who was always making rounds, taking the temperature of his beloved processes; and, last but not least, a man who could argue loudly for hours but who was unfailingly courteous and cheerful toward his protagonists.

Not surprisingly, many awards came his way. At the end of his working life he was a senior corporate fellow of the Martin Marietta Corporation, which had replaced Union Carbide in

1984 as manager of the Oak Ridge complex. Along the way he received the Ernest Orlando Lawrence Memorial Award of the U.S. Atomic Energy Commission (1967); was awarded an honorary doctor of science degree from Bates College (1968); was named a fellow of the American Society for Metals (ASM) (1974); received the McGraw Hill Chemical Engineering Magazine Award for outstanding personal achievement in chemical engineering (1982); was awarded the W. J. Kroll Zirconium Medal (1988); and received the ASM International Gold Medal (1989). He was elected to the National Academy of Engineering in 1988 and served on three committees of the National Research Council. John was not a retiring person and he enjoyed this recognition, but the award he doubtless cherished the most was the affection and respect that most of his associates, high and low, lavished on their beloved "Dr. John."

Fritz Ingerslev

1912-1994

By Per V. Brüel

The acoustical scientific community has lost a great personality—"noise professor" Fritz Ingerslev, who died on February 5, 1994, at the age of eighty-one. The title "noise professor" characterizes Fritz Ingerslev well. He was not only a famous and dedicated professor who worked industriously with technical research projects, but he also managed to simplify for the layman difficult concepts in acoustics and especially noise. It is, to a great extent, due to the achievements of Professor Ingerslev that highly effective work is carried out in today's Europe to prevent and solve noise problems.

Professor Ingerslev was born in Aarhus, Denmark, on July 6, 1912. He received his doctorate in electrical engineering from the Technical University of Denmark in 1936. In 1945 he became head of the Acoustical Laboratory at the Academy of Technical Sciences, where he served until 1981. From 1954 to 1982 Fritz Ingerslev was both professor of building acoustics at the Technical University of Denmark and the head of the Acoustics Laboratory at the university. From 1955 to 1963 he was chairman of the Danish Acoustical Society, which he himself had founded. Professor Ingerslev was highly motivated for international cooperation. It was quite natural that he became a longtime member of the coordinating committee for the International Congress on Acoustics, which was founded in 1951. From 1974 to 1987 he was the founder and president of the International Institute of Noise Control Engineering, which has organized INTER—NOISE each year since 1972. Ingerslev was president for INTER—NOISE in 1973. He was elected a foreign associate of the U.S. National Academy of Engineering in 1982. Professor Ingerslev was the author of more than fifty technical publications.

Fritz Ingerslev's career started when Professor P. O. Pederson, who was then the headmaster of the Technical University of Denmark (Den Polytekniske Laereanstalt), decided to concentrate on research activities in acoustics and emphasize the teaching of room acoustics. In 1941 the Acoustical Laboratory was founded under the Academy of Technical Sciences and a few years later it came under his daily leadership. In 1949 Ingerslev's book on building acoustics for engineers was published, and in 1953 his Ph.D. thesis on distortion in electrodynamic loudspeakers. In 1954 Ingerslev was appointed professor of acoustics. Under his leadership, laboratory activities increased significantly as well as the interest in the teaching of acoustics. It is solely due to Ingerslev's merits and his indefatigable struggle for his profession that the Danish Technical University today has one of Europe's largest anechoic chambers for teaching and research purposes.

Ingerslev had a special interest for international standardization. From the early 1950s he was active in the International Electrotechnical Commission (IEC) Committee of Electroacoustics, where he was deeply involved with the international standards for hearing aids. Later it became his task, as the chairman of the International Standards Organization (ISO) Acoustic Committee over a period of twenty years, to coordinate the international points of view and formulate common standards for sound and especially various types of noise measurements. The contagious effects of his enthusiasm on his fellow workers in Danish industry can be seen from the high Danish influence on international standardization for acoustics. The secretariats for both IEC's and ISO's acoustic committees are administered by the Danish Standards Association.

Professor Ingerslev's expertise, combined with his incredible involvement in the struggle to protect the individual from noise pollution, made him well known. Large traffic projects—for example, expansion of Kastrup Airport in Copenhagen—were originally planned without due consideration to the serious noise problems it would cause for the nearby community. It was Ingerslev's way of dealing with these problems that made the authorities realize how serious a threat noise could be to the environment. It often required untiring efforts and a good portion of pedagogy to reconcile technical scientific results to the authorities. Because of his success, directives for noise protection are in place today.

Professor Ingerslev was deeply involved in the pioneering work for the present Danish Ministry for the Environment and was instrumental in formulating twenty years ago a farsighted environmental policy, which is used as a model in many countries today.

Fritz Ingerslev was a great initiator, who not only could inspire his coworkers and the students at the Danish Technical University, but also knew how to struggle politically for his profession. The Danish electroacoustic industry, research, and education have much to thank him for. Those who continue development of the acoustic field today are deeply indebted to Professor Ingerslev. His efforts and international reputation will be remembered for many years.

Shiro Kobayashi

1924-1995

By Chang-Lin Tien

Shiro Kobayashi, professor emeritus of mechanical engineering at the University of California, Berkeley, died on December 20, 1995, in Berkeley at the age of seventy-one.

Shiro was born on February 21, 1924, in Gotsu, Japan. He received his undergraduate education at Tokyo University, where he completed his B.S. degree in mechanical engineering in 1946, a year after the end of World War II. Following graduation, he taught in high schools in Japan for seven years. In 1953 he was appointed assistant professor at Doshisha University, where he taught for three years before coming to the United States to further his studies.

Shiro came to Berkeley from Japan in 1956 to pursue his M.S. and Ph.D. degrees in mechanical engineering. He completed his master's degree in 1957 and his doctorate in 1960. Shiro started as assistant research engineer in the College of Engineering's Office of Research Services in 1958 while still working on his dissertation research and Shiro was hired as a lecturer in Berkeley's mechanical engineering department upon completion of his Ph.D. In 1961 he was appointed assistant professor in the Department of Industrial Engineering, where he taught for three years until his 1964 appointment as assistant professor in the Department of Mechanical Engineering. Shiro quickly rose through the ranks, achieving full professorship in 1968. After a productive and influential career of more than thirty years, he retired from active teaching in 1991. At the time of his death, he held the FANUC chair of mechanical systems at Berkeley, a position endowed in 1989 by a grant from FANUC Ltd., a Japanese maker of factory automation machines.

Elected to the National Academy of Engineering in 1980, Shiro was widely recognized for his work in manufacturing systems and metal forming. Particularly notable were his studies in numerical analysis of rigid-plastic deformation processes using the finite-element method, plastic deformation behavior of rate-sensitive materials, ductile fracture in metalworking processes, metal flow analysis at elevated temperatures, die design, and die manufacturing in metalworking.

Shiro's two books, *Mechanics of Plastic Deformation in Metal Processing* and *Metal Forming and the Finite-Element Method,* stand as testaments to his significant contribution to the field. Throughout his professional career, Shiro was recognized and honored for his contributions. In 1963 the American Society of Mechanical Engineers (ASME) awarded him the ASME Blackall Machine Tool and Gage Award. He was honored as the Battelle visiting professor in the Department of Metallurgical Engineering at Ohio State University from 1967 to 1968. The University of Birmingham, in England, was his home in 1970 during his term as the E. A. Taylor visiting professor in the Department of Mechanical Engineering. In 1976 the Japan Society for Technology of Plasticity awarded him the Aida Engineering Award, and in 1983 the Society of Manufacturing Engineering bestowed on him the Gold Medal.

Shiro's consistent service to ASME included serving as a member of the Honors Committee, a member of the Material Processing Field Committee on Production Engineering, and a member and chairman of the Joint Committee of the Materials Division and the Production Engineering Division. His notable editorial activities include serving as counseling editor for the *International Journal of Machine Tool Design and Research,* published in England, deputy technical editor, then associate editor of the *Journal of Engineering Materials and Technology,* editorial board member of England's *International*

Journal of Mechanics and the Japan Society for Technology of Plasticity, and editorial advisory board member for *the Journal of Engineering Production* of India.

Other professional service includes his membership on the scientific committee of the North American Metalworking Research Conference from 1973 to 1979. From 1983 to 1986 he was a member of the North American Manufacturing Research Institution of the Society of Manufacturing Engineers board of directors.

Robert F. Legget

1904-1994

By Alan G. Davenport

Robert Ferguson Legget, a Canadian engineer of international distinction, died in Ottawa on Sunday, April 17, 1994, at the age eighty-nine. His achievements were many. He was the driving force behind the establishment of the Canadian National Building Code, a model code now used throughout Canada; the founding director of the National Research Council of Canada's Division of Building Research (now the Institute for Research in Construction); the author of a dozen books; the founding president (1987) of the Canadian Academy of Engineering; and the recipient of many honors, including election as a foreign associate of the United States National Academy of Engineering in 1988.

Born in Liverpool, England, on September 29, 1904, of Scottish parents, Robert Legget graduated with both bachelor's and master's degrees (in 1927) from the University of Liverpool. After working in construction in Scotland, he came to Canada in April 1929. On his arrival, he worked in the design and construction of major power projects and geotechnical engineering.

Between 1936 and 1947 he taught civil engineering, mainly soil mechanics and foundation engineering, first at Queen's University at Kingston, Ontario, for three years and then at the University of Toronto. His students remember him as a superb teacher, always animated and well prepared with illustrations from practice. At the same time he continued to be involved with major engineering construction and wartime engineering works.

In 1947 he was invited to establish the Division of Building Research of the National Research Council of Canada. He laid down a complete spectrum of research on building problems in Canada, with particular emphasis on those arising from building in a cold climate. Through his leadership and the outstanding research staff, this organization became respected far outside Canadian borders. At the same time he initiated the work on the Canadian National Building Code.

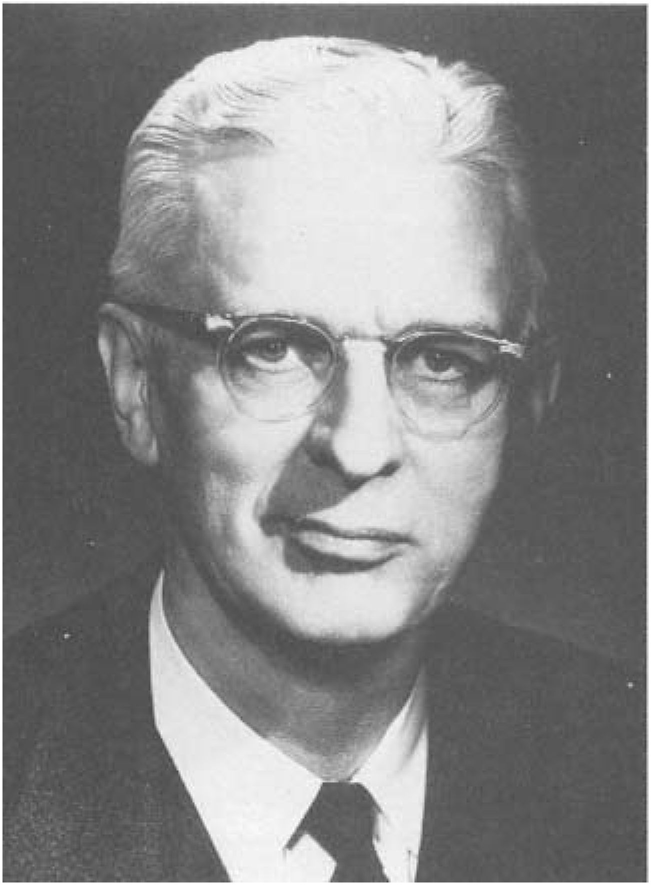
Robert Legget had a pivotal role in boosting geotechnical engineering in Canada and internationally. He established the Canadian National Research Council's Associate Committee on Soil and Snow Mechanics (later the Associate Committee on Geotechnical Engineering), held the first Canadian soil mechanics conference in 1947, and hosted the Sixth International Conference on Soil Mechanics and Foundation Engineering in Montreal in 1965. He established the Canadian Geotechnical Society together with the *Canadian Geotechnical Journal.*

He recognized the importance of close engineering ties internationally and in particular with the United States. In 1965 he became president of the Geological Society of America, and at the same time was president of the American Society for Testing and Materials—the first Canadian to hold these positions. From 1966 to 1969 he was also president of the International Council for Building Research, Studies, and Documentation.

He wrote extensively, his first book being a classic text on geology and engineering. His book on the Rideau Waterway describes the construction of the canal built between the Ottawa River and Kingston on Lake Ontario during hostilities between Canada and the United States in the early 1800s. Describing vividly an early engineering achievement in Canada, it has become popular with engineers and the public. His book helped to attract many visitors from the United States and elsewhere to this "silver chain of rivers and lakes linked by small locks and winding channels."

Robert Legget received honorary degrees from thirteen universities and a long list of honors and awards from around the world.

Robert Legget was widowed in 1984 and is survived by his son, David, who lives in Toronto.



Clarence H. Linder

1903-1994

By Walter L. Robb

At his memorial service on May 7, 1994, celebrating the life of Clarence H. Linder, three of his grandchildren may have said it best. He was above all, a gentleman, a kind parent, a master storyteller, and a warm friend.

To those of us in the engineering profession, and to those in his church, he was a leader, always thinking of ways to improve the world we live in. Clarence led the drive to establish the National Academy of Engineering. He lamented that the academically oriented National Academy of Sciences ignored the translation from basic research to the development of real products (an issue that continues to be debated). In modest triumph, he was a founding member of the National Academy of Engineering and in 1970 became its first full-time president.

Clarence received both bachelor's and master's degrees in electrical engineering from the University of Texas. In 1924 he began his General Electric (GE) career in typical fashion, on turbine night test. He qualified for the second class of the advanced engineering course and later served as an instructor for these courses.

Clarence had assignments throughout the Schenectady Works, which included serving as superintendent of the Searchlight Department, a rapidly growing and critical business at the start of World War II. During the 1940s he was assistant manager of the Schenectady plant, often filling in for an ill works manager. In 1951 he was named manager of the Major Appliance Division, and he had a key role in the creation of Appliance Park in Louisville, Kentucky.

In 1953 Clarence was appointed vice-president of engineering for the company, and in that position he traveled widely to raise the standard of engineering throughout GE and throughout the world. Then, in 1960, Ralph Cordiner asked Clarence to become group executive for the Electric Utilities Group, which was then badly in need of a highly creditable general manager in the wake of a price-fixing scandal. As Mr. Cordiner said, "Clarence has everyone's respect."

Clarence's retirement in 1963 marked the start of another career aimed at upgrading the status of—and respect for—engineers in this country. It began with his leadership in founding the Engineering Joint Council and the construction of a new headquarters in New York City. The Council's objective was to bring together the leaders of all of the nation's various engineering bodies.

Clarence was himself a leader in a number of professional groups. He was a fellow and president of the American Institute of Electrical Engineers and the Institute of Electrical and Electronics Engineers, from which he received the Haraden Pratt Award in 1972. He was a fellow of the American Society of Mechanical Engineers and a member of the American Society for Engineering Education and the National Society of Professional Engineers. He served on the executive committee of the Thomas Alva Edison Trustees and was active in the Massachusetts Institute of Technology Corporation and at Harvard University, Vermont Academy, and Union College.

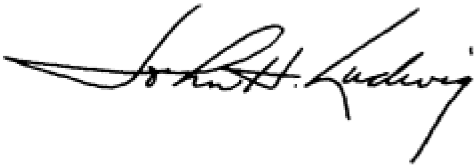
Clarence received honorary degrees from Clarkson College, Lehigh University, Union College, and Worcester Polytechnic Institute. He received the Distinguished Alumnus Award from the University of Texas in 1962.

In 1970 in a talk at Union College on the future of engineering in the United States, Clarence emphasized British architect Nicholas Butler's definition of engineering as "the link, the bridge between man and nature; a bridge over which man passes to get into nature to control it, guide it, to understand it, and a bridge over which nature and its forces pass to get into man's field of interest and service."

Further in this remarkable speech, Clarence said; "About two thousand years ago Vitruvius, the Roman engineer, observed that the engineer 'should be a man of letters, a skillful draftsman, a mathematician, familiar with historical studies, a diligent student of philosophy, acquainted with music, not ignorant of medicine, learned in the opinions of lawyers, familiar with astronomy and astronomical calculations. He should be fair-minded, loyal, and what is more important, without avarice, for no work can be done, truly done, without good faith and clean hands. Let the engineer not be greedy, nor have his mind busied with acquiring gifts, but let him with seriousness guard his dignity by keeping a good name.'"

What a wonderful description of Clarence Hugo Linder!

Clarence remains, today and for the future, a model and inspiration for engineers.



John H. Ludwig

1913-1995

By Earnest F. Gloyna

John H. Ludwig, engineer, scientist, scholar, designer, environmental pathfinder, and orchestrator of national policy, died on February 17, 1995. He was buried at Arlington National Cemetery with full military honors.

Elected to the National Academy of Engineering in 1971 as an engineer/scientist, John was a uniquely qualified professional. He initiated key solutions for many of the vexing problems associated with both traditional engineering design and rapidly changing environmental challenges.

John received his B.S. and M.S. degrees in civil engineering from the University of California, Berkeley (1934), and the University of Colorado, Boulder (1941), respectively, and his M.S. and doctor of science degrees in industrial health from Harvard School of Public Health (1956 to 1957). He was honored by membership in both Tau Beta Pi and Phi Beta Kappa. He obtained military training while an officer in the U.S. Army Air Corps, studying meteorology at New York University (1943 to 1944) and military government at the University of Virginia (February to April, 1945).

From 1935 to 1943, John's employment and first specialty assignments included the Metropolitan Water District, Los Angeles, California, construction engineer; the U.S. Bureau of Reclamation, structural/hydraulics; and the U.S. Corps of Engineers, hydraulic structures.

During World War II, John served as a meteorologist in Greenland and as a military government officer in Korea.

The postwar era brought on a new level of professionalism. As chief of the project design section of the Corps of Engineers, Sacramento District, California, from 1946 to 1949, John supervised sixty engineers and draftsmen. He exercised major influence on both hydraulic and structural design of the Pine Flat Dam, Folsom Dam, and Isabella Dam. From 1949 to 1951 John became a partner in Ludwig Brothers Engineering, Pasadena, California. This experience in applying engineering design to environmental solutions changed John's professional perspective and initiated his desire to expand his knowledge to the management of complex scientific, technical, social, and political problems associated with emerging environmental programs.

From 1951 to 1955, to further his interest in melding professional experience with the issues surrounding an increasingly complex world, he became a commissioned officer in the U.S. Public Health Service (USPHS) and accepted an appointment as special assistant to the division chief of waste-supply/water-pollution control, USPHS, Washington, D.C. This assignment provided an intimate and effective relationship with governmental institutions. The application of engineering and scientific principles to forward planning became a model, and a new era of environmental and urban planning was initiated. Concurrently, as a Department of Health, Education, and Welfare (HEW) alternate to the President's Committee on Weather Modification, John gained a new perspective on assessing societal issues.

From 1955 to 1968, concurrent with the establishment of the federal program in air pollution control and John's specialized education at Harvard, John provided leadership for new programs. He was directly responsible for development of the federal government's major air pollution research facility, spearheaded the cooperative research and development government/industry program, and catalyzed cooperative programs with major federal agencies. During this time, he was the director of the Federal Research and Development Program in Engineering and Physical Sciences in Cincinnati, Ohio.

From 1968 to 1972 as assistant commissioner for science and technology, National Air Pollution Control Administration/HEW, John exercised oversight of science and technology activities for HEW, other governmental agencies, and the private sector. He spearheaded the National Air Pollution Control Administration's program of (a) cooperative research and development with the private sector; (b) expanded research and development to bring the nation's resources to bear on environmental air pollution problems; and (c) numerous international activities. He was a U.S. delegate to the Air Management Research Group of the Organization for Economic Cooperation and Development, chairman of the Working Group on Air Pollution for the Economic Commission for Europe, a member of the World Health Organization's Expert Advisory Panel on Air Pollution, a member of NATO's Committee on the Challenges of Modern Society, and a responsible officer over a host of cooperative contracts with a multitude of countries.

John retired July 1, 1972, after thirty-four years of federal service. However, as a private consultant, he continued to provide valuable services to his country, and in particular, he assisted in furthering the course of effective air pollution control.

He was a registered engineer in California and Oregon and a diplomate (specialty license) of the American Association of Environmental Engineers (AAEE).

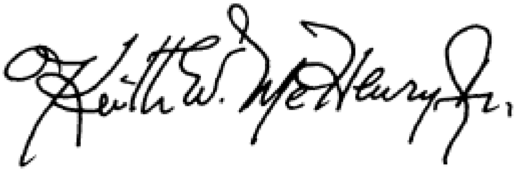
He was an active member in the American Society of Civil Engineers, American Meteorological Society, Air Pollution Control Association, American Public Works Association, American Academy for the Advancement of Science, and several honorary societies. Service honors included the Commendation Medal, HEW (1963); Superior Service Award, HEW (1967); Gold Medal for Exceptional Service, Environmental Protection Agency (1971); and the Gordon Fair Award, AAEE (1973).

John's scholarly attention to detail, professionalism, and dedication to the welfare of mankind helped to expand the body of knowledge for the civil and environmental engineering profession. His more than ninety publications attest his varied and comprehensive technical experience.

He was a superb water resources engineer during his early career; he was directly responsible for the development of the federal government's major research facility in air pollution control; he initiated an advanced level of forward planning for the United States and other governmental entities; and he established long-ranging air pollution control policies.

His love of family, a wife and two sons, was paramount and this was reciprocated in every respect. His sons have followed his interest in scientific and engineering fields.

He will be remembered for his professionalism, leadership, compassion, wit, modesty, and generosity.



Keith W. McHenry, Jr.

1928-1994

By Richard C. Alkire

Keith W. Mchenry, retired senior vice-president of technology for Amoco Corporation, died on January 21, 1994, at the age of sixty-five. Keith, who spent his entire professional career with Amoco Company and its affiliates, was a respected and progressive manager as well as a successful researcher in the area of catalysis. His research accomplishments included the development and commercialization of the world's most advanced residual oil hydroprocessor.

Keith was born in Champaign, Illinois, and raised in West Allis, Wisconsin. He received his B.S. degree in chemical engineering from the University of Illinois in 1951 and his Ph.D. in chemical engineering from Princeton University in 1958. He was most recently a Chicago resident.

Keith joined Amoco in 1955 as an assistant project chemical engineer in the Research and Development Department at Whiting, Indiana. While in this position, Keith made significant contributions to Amoco's research in the catalytic cracking and demetalation of reduced crudes. He was promoted to group leader in 1958 and supervised several discoveries, which led to Amoco patents, some of which dramatically increased the yield of gasoline from crude oil. In 1962 Keith became project manager and was promoted to research associate in 1966. In the early 1960s Keith led influential research on zeolite cracking catalyst technology. By 1967 Keith was named director of process research and was responsible for all research in catalytic cracking, thermal processing, and alkylation. Under his leadership, his group developed a reduced crude catalytic desulfurization process, which was the forerunner of a process commercialized by Amoco in the 1980s. In the early 1970s as director of process and analytical research, Keith managed the research/manufacturing interface and rapidly moved process and catalyst improvements from the laboratory to the refinery. Most notably, through his leadership, Amoco Oil was the first to introduce lead-free regular and premium gasolines nationwide.

In 1974 Keith moved to Amoco's Research and Development Department in Naperville, Illinois, first as manager of process research and one year later as vice-president. During his fifteen years in this position, Keith oversaw a number of innovations, including the development of long-lasting synthetic oils for automobiles, the development and successful operation of proprietary catalyst system and process configuration for upgrading vacuum residual oils, and developments that led to refinery units for hydroprocessing catalytic cracking feedstocks and resid blends.

As a research and development director and technology executive, Keith was an Amoco representative to the Industrial Research Institute, Inc. (IRI) for eighteen years, during which he served on its board for eight years and was president during 1988 and 1989. Before he became president of IRI, he chaired the institute's University Relations Committee, chaired the program committee for the institute's fiftieth Anniversary Meeting, and led an advisory group on moving IRI headquarters to Washington, D.C.

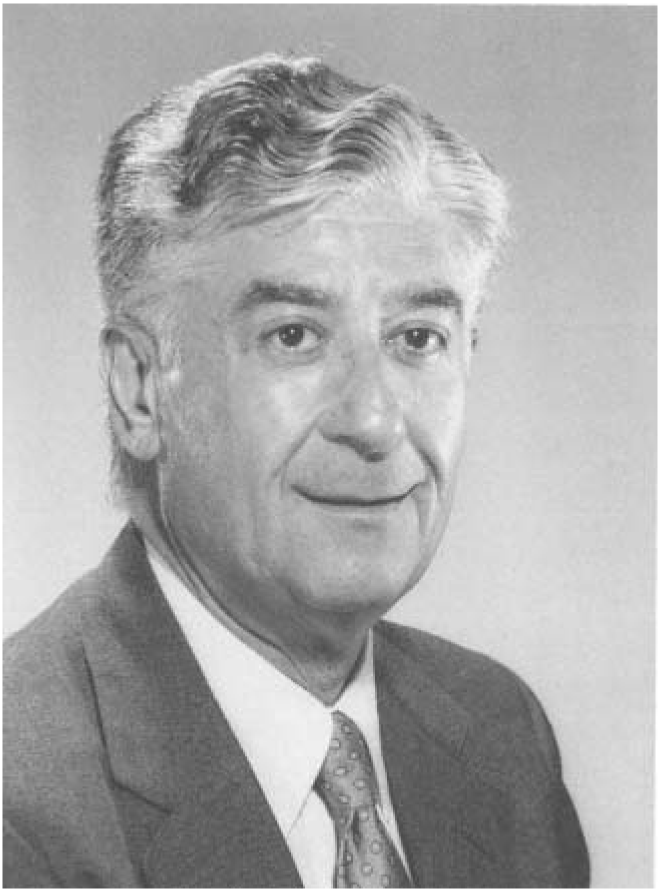
In 1989 Keith was elected senior vice-president of technology for Amoco. In this position he coordinated the research activities of Amoco and its operating companies and directed the development of new technologies. Keith had a wide-ranging vision and was involved in helping Amoco move ahead to explore alternatives for the time when oil would no longer be its main source of business. In addition, Keith was heavily involved in helping develop lower-pollution fuels, working particularly with Amoco's waste management subsidiary. Keith retired from Amoco in April 1993.

Keith was elected to the National Academy of Engineering (NAE) in 1982. Since that time he served on a number of committees, including the Committee on Membership, the Industry Panel of the Study on International Cooperation in Engineering, the Chemical/Petroleum Engineering Peer Committee, and the Committee on Forces Affecting the U.S. Academic Engineering Research Enterprise. Keith served on the National Research Council Commission on Engineering and Technical Systems (CETS) Committee on Strategic Petroleum Reserve and the joint CETS and Commission on Physical Sciences, Mathematics, and Applications (CPSMA) Committee on Chemical Engineering Frontiers: Research Needs and Opportunities. He also chaired the joint CETS and CPSMA Panel on Energy and Natural Resources Processing between 1985 and 1988.

Keith was a member of the American Chemical Society, the American Association for the Advancement of Science, the American Petroleum Institute, and the Catalysis Society, and he was selected as a fellow to the American Institute of Chemical Engineers. In 1988 Keith received the Award in Chemical Engineering Practice from the American Institute of Chemical Engineers for his contributions to the petroleum industry.

Keith always remained visible to engineers outside of Amoco, as was evidenced by the numerous invitations he received as a distinguished lecturer. In 1981 he was the Charles D. Hurd Lecturer for the Department of Chemistry at Northwestern University; in 1983 he presented the Thiele Lectures in Chemical Engineering for the Department of Fuels Engineering at the University of Utah; and in 1987 he was invited as the Gerster Memorial Lecturer for the Department of Chemical Engineering at the University of Delaware. Keith was heavily involved in furthering industrial-academic relations. Not only was he a frequent speaker on engineering education, but he served on advisory boards for Princeton University, the University of Delaware, and the University of Illinois at both Urbana-Champaign and Chicago. Keith championed the University of Chicago School Mathematics Program, which showed his concern with science and mathematics education down to the elementary level. He also was a driving force in establishing the University of Delaware's Center for Catalytic Science and Technology, whose graduates are familiarized with industrial goals. Keith was convinced of the need to provide strong engineering education, and he acted on these convictions. He wrote, "The future of American industry—and the future of the nation—will depend on our success in educating the people we must have to develop and implement new technology in an increasingly technological world."

Keith McHenry had an impact on chemical engineering from a variety of dimensions. He was an influential researcher, a respected leader of Amoco Oil, and an effective advocate of close industry-university relations. Keith also had an impact on people, and he will be remembered with respect as a straightforward, honest person who cared deeply for family, friends, and colleagues.



Paul M. Naghdi

Paul M. Naghdi

1924-1994

By Ronald P. Nordgren

Paul M. Naghdi, professor of engineering science at the University of California, Berkeley, died on July 9, 1994, at the age of seventy.

Paul was elected to the National Academy of Engineering in 1984 in recognition of his "pioneering contributions to research in continuum mechanics, especially in the areas of shell theory and inelastic behavior of materials." His research encompassed nearly all areas of the mechanical behavior of solids and fluids. He was strongly attracted by fundamental theoretical questions, which he strived to treat at the highest possible level of generality. Paul is best known for his work on the theory of thin elastic shells and the behavior of elastic-plastic materials. In both areas he developed and refined systematic general theories and applied them to significant problems of engineering interest. In his forty-five-year career as an educator, Paul developed a comprehensive series of courses on continuum mechanics, first at the University of Michigan and then at the University of California. At these universities he guided many graduate students in their initial research endeavors. In addition, he was a leader in several professional engineering organizations.

Born on March 29, 1924, in Teheran, Paul Naghdi made a perilous crossing to the United States in 1943 seeking freedom and education. He graduated from Cornell University in

1946 with a B.S. degree in mechanical engineering. Following a brief period of service in the U.S. Army, Paul continued his studies in engineering mechanics at the University of Michigan, earning his M.S. degree in 1948 and his Ph.D. degree in 1951. He was granted U.S. citizenship in 1948.

At Michigan, Paul served as an instructor in engineering mechanics from 1949 to 1951. After graduation he was appointed assistant professor and rose rapidly to the rank of full professor in 1954. In 1958 Paul moved to the University of California, Berkeley, as professor of engineering science. There he led in the establishment of the division of applied mechanics in the Department of Mechanical Engineering and was chairman of this division from 1964 to 1969. In 1991 he was appointed to the Roscoe and Elizabeth Hughes Chair in Mechanical Engineering. In 1994 he advanced to the newly instituted position of professor in the graduate school. As an educator, Paul found the discovery and transmission of knowledge to be very satisfying complementary activities. He was highly devoted to the democratic ideals and processes of the Berkeley faculty and he participated vigorously in academic life.

Paul Naghdi's research interest in the theory of plates and shells was stimulated by a series of summer lectures in 1949 by the legendary applied mechanician Stephen Timoshenko (who immigrated to the United States in 1922). Subsequently Paul developed and refined basic equations for small deformations of thin elastic shells, an effort that culminated in the 1963 publication of a major research article entitled "Foundations of Elastic Shell Theory." During this same period, he and his coworkers also solved a number of static and dynamic shell problems of engineering interest. Continued research on the large deformations of elastic shells led Paul to formulate a strictly two-dimensional nonlinear theory of shells called the Cosserat Surface theory (after the French brothers who originated this idea early in the twentieth century). This approach to shell theory and the classical three-dimensional approach are both contained in Naghdi's definitive article entitled "The Theory of Shells and Plates" in the 1972 *Handbuch der Physik.* Further, Paul extended the

Cosserat surface approach to describe the behavior of fluid sheets and jets. He applied this new theory to solve a number of engineering problems.

The second main thrust of Paul Naghdi's research throughout his career was directed toward characterizing the elastic-plastic deformation of engineering materials. His early research in the 1950s included experiments and solutions to boundary-value problems (with coworkers) as well as contributions to the general theory of small elastic-plastic deformations. Subsequent research in collaboration with his longtime friend A. E. Green led in 1965 to the first systematic theory of elastic-plastic materials undergoing large deformations, published as *A General Theory of an Elastic-Plastic Continuum.* Paul continued to develop and refine this theory and gave a critical review of the subject in 1990. Over the years, he also made important contributions to linear and nonlinear elasticity, viscoelasticity, continuum thermodynamics, and mixture theory. Paul's most recent research focused on the micromechanical aspects of plasticity theory.

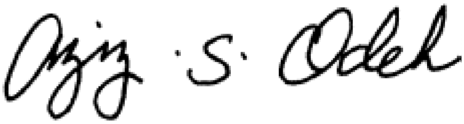
Paul Naghdi's educational activities constitute an important contribution to the engineering profession. His comprehensive lecture courses in many areas of the mechanics of continuous media enabled a large number of engineers to gain a fundamental understanding of this subject, at both the graduate and the undergraduate level. These lectures inspired many students to begin research under Paul's guidance and follow productive careers in applied mechanics.

Naghdi was an active member of many professional committees, including the Executive Committee of the American Society of Mechanical Engineers (ASME) Applied Mechanics Division (1967 to 1972; chairman, 1972); the National Research Council, Division of Physical Sciences, U.S. National Committee on Theoretical and Applied Mechanics (1972 to 1984; chairman, 1979 to 1980); the General Assembly of the International Union of Theoretical and Applied Mechanics (1978 to 1984); and the ASME Committee on Honors (1986 to 1994; chairman, 1991 to 1994). In 1977, for the fiftieth anniversary of the ASME Applied Mechanics Division, Paul prepared a comprehensive history of the division. In April 1994, at great personal hardship, he flew to Denver to chair the last meeting of the ASME Honors Committee under his leadership.

Paul Naghdi received a number of prestigious awards in recognition of his achievements. He was awarded ASME's Timoshenko Medal in 1980 for his fundamental contributions to plasticity and shell theory. This award placed him in the top echelon of engineering scientists of this century. Paul was made an honorary member of the ASME in 1983, and he was elected to the National Academy of Engineering in 1984. Paul received the Eringen Medal of the Society of Engineering Science in 1986. He held honorary doctoral degrees from the National University of Ireland (1987) and the Université Catholique de Louvain (1992). In 1994 he was honored with the Berkeley Citation, the equivalent of an honorary doctoral degree at the University of California. A collection of research papers by his former students and colleagues was published in celebration of Paul's seventieth birthday.[1]

Paul Naghdi's activities in research, education, and professional leadership have greatly enhanced the field of applied mechanics in particular and engineering in general. In addition to his specific accomplishments, Paul will be remembered for his inspirational enthusiasm for the research work that so filled his life.

[1] Theoretical, Experimental and Numerical Contributions to the Mechanics of Fluids and Solids," *Special Issue of Journal of Applied Mechanics and Physics* (ZAMP), J. Casey and M.J. Crochet, eds., 1994. This issue also contains a list of Naghdi's papers (numbering over 200) and an essay on his work.



Aziz S. Odeh

1925-1994

Written by Robert F. Heinemann

Contributions by Rafi Al-Hussainy, D. Krishna Babu, and Eve S. Sprunt

Submitted by the NAE Home Secretary

Aziz S. Odeh, one of the world's foremost petroleum engineers and retired senior scientist of Mobil Research and Development Corporation, died on July 16, 1994, in Plano, Texas, after an extended illness.

Aziz Odeh was born in Nazareth, Palestine, on December 10, 1925. He moved to the United States in 1947 to attend the University of California, Berkeley, where he received a B.S. in engineering in 1951. Dr. Odeh earned his M.S. from the University of California, Los Angeles (UCLA), in 1953 and then began employment with Magnolia Petroleum Company, which was incorporated into Mobil. He took a leave of absence in 1955 to pursue his Ph.D. at UCLA and received his degree in 1959. Dr. Odeh next worked as a reservoir engineer with Mobil Oil de Venezuela until 1961, when he transferred to the Field Research Laboratory of Mobil Research and Development Corporation. He advanced through a number of technical positions before he became manager of reservoir engineering in 1978. While managing and directing research, Dr. Odeh maintained his technical activity, which was recognized in 1980 when Mobil named him senior scientist, the company's most prestigious technical position. Dr. Odeh was inducted into the National Academy of Engineering in 1987. He retired from Mobil in 1989 but continued to work as a consultant to Mobil and a number of other organizations until his death.

Aziz Odeh exhibited a deep respect for the fundamentals of physics, chemistry, and engineering that is rarely associated with one working in the petroleum industry. This defining quality undoubtedly was nurtured by his early work on the effect of viscosity ratio on relative permeability, for which he received his doctorate. However, Dr. Odeh was also a pragmatic engineer, as evidenced by his landmark paper "Material Balance on Equation of a Straight Line," which he coauthored with Dave Havalena while working in Venezuela. This paper quickly became a petroleum engineering standard and is still used by virtually every petroleum engineer in its original form to determine the size, future performance, recovery mechanism, and aquifer geometry of the world's oil and gas reservoirs. It also contained the scientific qualities that became synonymous with Dr. Odeh's publications—using mathematics to describe a physical system and to generate results with such clarity and uniformity that a certain elegance was apparent to the practicing engineer.

These qualities were certainly evident in his large number of papers that advanced the state of the art of well testing. Dr. Odeh's research on variable rate testing and partial penetrations and completions is recognized as a cornerstone of this technology, which is used to predict well performance and measure a reservoir's physical properties. He also published an important body of work in well testing, which focused on non-Newtonian flow, fractural systems, wellbore damage, and nonlinear testing that is widely used in petroleum engineering.

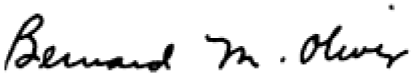
In the early 1970s, Dr. Odeh became interested in numerical reservoir simulation. Before that time, engineering analysis used electric analogs of physical models. These analog models were used to evaluate well patterns by sampling electric currents at various locations in the model and equating them to pressure potentials and fluid flow rates. With the explosion of digital computing in the 1970s and the 1980s, the petroleum engineer began using discretized approximations of reservoirs based on Darcy's Law and the usual continuity equations. The resulting set of nonlinear equations and the corresponding accuracy and stability of their solution would challenge petroleum technology for many years as simulation requirements became increasingly more complex. Dr. Odeh championed the development and use of the most complete and difficult algorithms—fully implicit linearizations with strongly coupled well representations—within his development group at Mobil. These techniques were at first considered to be too time consuming to be practical. However, as increasing computer power made them more palatable, their numerical stability became so attractive to practicing engineers that these algorithms became the standard in Mobil's portfolio of black oil, compositional, and thermal simulators as well as most commercial products in the marketplace.

Dr. Odeh constantly worried about the proper application of these tools. "Understanding of fundamentals is enlightening; the black box mentality is dangerous," he would often lecture to his peers and colleagues. However, he helped pioneer the use of the technology to develop major hydrocarbon resources in the North Sea, Middle East, and Southeast Asia. Reservoir simulators were used to determine realistically the facility and platform requirements, the number of wells to be drilled, and the predicted production rates and economic limits of a myriad of different oil and gas fields. The success of these applications helped make reservoir simulation a standard tool of petroleum engineering.

The development and application of reservoir simulation dominated Dr. Odeh's focus through the mid-1980s. At this point, and then through his retirement years, he turned his attention to horizontal wells. While attending a conference in the Middle East, he correctly predicted that horizontal wells were to be the dominant tools of oil production technology in the coming years. He then began research to predict and describe mathematically the performance of horizontal wells. The work resulted in an extremely complicated equation for computing the well's productivity. The real brilliance of this work (like his early work on material balance) was Dr. Odeh's reduction to a simple and easy-to-use expression similar to that for vertical wells. Again, the simplicity and elegance of this work made it an industry standard almost immediately. This body of work brought the number of papers that Dr. Odeh authored and coauthored to more than fifty.

In addition to his induction into the National Academy of Engineering, Dr. Odeh received a number of other awards and recognitions. He began his active involvement in the Society of Petroleum Engineers (SPE) in 1960 and received its prestigious John Franklin Carll Award in 1984. He was elected an SPE Distinguished Member in 1988 and was given the Outstanding Achievement Award from the Dallas SPE Section in 1989. Aziz was fiercely proud of his heritage and worked diligently to establish the SPE in the Middle East. He was a member of the board of directors of the Abu Dhabi National Reservoir Research Foundation until 1989. He also was an adviser to the Ministry of Oil in Qatar, Mexican Petroleum Institute, Abu Dhabi National Oil Company, Oil Services Company of Iran, and Saudi Aramco. Dr. Odeh received an honorary appointment as consulting professor at Stanford University in 1988. He was also listed in *American Men and Women of Science* and *Who's Who in Engineering* and received *News Circle* magazine's Man of the Year Award in 1990.

Equally as important as his technical and professional accomplishments were Aziz's human qualities. He was completely devoted to his family. He was also a passionate tennis player. He was a teacher at heart who taught and lectured at universities, industry schools, and Mobil courses his entire career. Aziz delighted in passing on his knowledge and enthusiasm for petroleum engineering to younger people and was a guiding influence in the careers of many engineers. Aziz probably summed this up the best in a 1988 International Mobil interview where he said, "My greatest accomplishment is the young people. I brought them in from universities and trained them. They rose to the challenge." I am honored and humbled to have been one of those young people.



Bernard M. Oliver

1916-1995

By David Packard

Bernard M. Oliver, Silicon Valley pioneer and director of research and development at Hewlett-Packard for four decades, died on November 23, 1995. He was seventy-nine years old.

Dr. Oliver, known to his friends and family as "Barney," a man of enormous intellect, curiosity, and vision. He leaves behind a legacy of extraordinary contributions in the field of electronics, radio engineering, physics, astronomy, computer science, and biology.

Born in Soquel, California, Barney studied electrical engineering at Stanford University, graduating with a B.A. degree in 1935 at the age of nineteen. Two of his fellow students were William Hewlett and David Packard, both of whom were impressed by their precocious classmate. The following year Barney earned an M.S. degree from the California Institute of Technology. He then spent a year studying in Germany on an exchange scholarship, returning to Caltech to complete his Ph.D., magna cum laude, in 1940. He was twenty-four years old.

Barney then joined the renowned Bell Telephone Laboratories in New Jersey, where he quickly established a reputation for brilliant, creative insights and clever inventions. He made major contributions to the development of the new and all-important "radar," and was a key contributor to the earliest television systems. His paper on pulse code modulation, "Philosophy of PCM," remains a seminal work to this day. While at Bell Labs, he met and married a young actress named Priscilla Newton, who was to share his life until she died in 1994. They had three children: Karen, Gretchen, and William Eric.

While Barney was making his mark at Bell Labs, William Hewlett and David Packard were starting a new electronics instrumentation firm in Palo Alto, California. They decided that Barney was the person they needed to lead their research efforts. After many discussions and increasingly attractive offers, they persuaded Barney to join their fledgling operation. In 1952 Barney returned to his beloved California to become director of research for the Hewlett-Packard Company.

A hands-on director, Barney immediately set the standards for excellence that have become Hewlett-Packard's hallmark. In 1957 he became vice-president of research and development, and in 1966 he established Hewlett-Packard Laboratories (HP), the company's central research and development organization, which he directed until his retirement in 1981. Under Barney's leadership HP Labs quickly became one of the world's foremost research and development organizations as well as the birthplace of many of HP's successful products, including the HP2116, HP's first computer; the HP9100 desktop scientific calculator; and the HP35, the first scientific hand-held calculator. Barney also served on the Hewlett-Packard board of directors from 1973 until 1981.

While at HP, Barney continued to pursue a lifelong interest in radio astronomy. His background in radio engineering prompted an interest in radio astronomy and the possibility that radio telescopes might be a means to detect extraterrestrial intelligent life. He was fascinated when, in 1960, attempts were made to detect radio waves from other civilizations. He had already calculated that such a search, with existing telescopes, made sense. He visited this first search at the National Radio Astronomy Observatory in Green Bank, West Virginia, but it was not until 1971 that he was able to immerse himself fully in this endeavor. Taking time off from HP, Barney guided a major feasibility study of possible radio telescope systems for the search for extraterrestrial intelligence (SETI), sponsored by Stanford University and the National Aeronautics and Space Administration (NASA) Ames Research Center.

This effort spawned "Project Cyclops," a seminal and grandiose plan for a radio telescope system capable of detecting quite ordinary extraterrestrial radio signals from great distances in our galaxy. Although the design was very sound and the report a monument to fine scientific and technical writing, the projected ultimate cost of the project, some tens of billions of dollars, far exceeded what was politically acceptable. The report stands to this day as a sound description of an ingenious and noble albeit unfulfilled enterprise.

Barney retained a close relationship to SETI throughout the rest of his life. He made numerous contributions to the scientific and technical design of SETI searches and systems. Following his retirement from HP, Barney devoted his energies full-time to SETI, serving as director of the NASA Ames SETI office from 1983 to 1993. During this period SETI became a major project within NASA with an overall budget of more than $100 million. This project reached a milestone in the fall of 1992 when its extremely sophisticated radio receiving equipment started searching the extraterrestrial radio signals at both the Goldstone tracking station of NASA and the Arecibo Observatory in Puerto Rico. Unfortunately, the U.S. Congress cut off funding for this project just one year after the searching began.

Some ten years earlier, Barney had been a prime mover in the formulation of the SETI Institute, a not-for-profit scientific institute that was formed to conduct research related to life in the universe with maximum efficiency and at the lowest possible cost. Disdaining bureaucracy and waste, Barney saw the SETI Institute as an experiment that would demonstrate that the highest research could be done with minimal management and overhead cost. Upon his retirement from NASA in January 1994, he joined the board of directors of the institute. Over the decade since its inception, the institute has become an extremely successful research center, just as Barney imagined and planned it would. His last act for the institute was to provide it with a major bequest to ensure its continued activity and success for a very long time.

Barney received a host of awards during his life, foremost of which was the National Medal of Science, which he received at the White House in 1986. He served as vice-president (1962) and president (1965) of the Institute of Electrical and Electronics Engineers (IEEE), after being made a fellow of its predecessor organization, the Institute of Radio Engineers, in 1954 and director-at-large in 1958. In 1966 he was appointed to the President's Commission on the Patent System. In 1990 he received both NASA's Medal for Exceptional Engineering Achievement and the Pioneer Award of the International Foundation for Telemetering in recognition of a lifetime of service to the telecommunications profession.

Other significant honors include the Caltech Distinguished Alumnus Award for 1972; IEEE's Lamme Medal for meritorious achievement in the development of electronic instrumentation and measuring devices, 1977; the Halley Lectureship on Astronomy and Terrestrial Magnetism of Oxford University, 1984; and the Harvey Mudd College Wright Prize for Multidisciplinary Scientific or Engineering Accomplishments, 1984. He was an adjunct professor of astronomy at the University of California, Berkeley, and served on the boards of directors of the Exploratorium in San Francisco, Geostar Corporation, and Associated Universities, Inc. He was a founder of the Biosys Corporation, which seeks environmentally sound means to eliminate agricultural pests.

Barney was awarded some fifty patents, with some pending, and he authored some seventy-one publications in more than seven scientific and technical fields. In 1991 Hewlett-Packard Laboratories established the Bernard M. Oliver Symposium on the Future, an annual distinguished lecture series in his honor. He received the NASA Group Achievement Award for the NASA SETI project in 1993.

Barney also generously donated his time in the service of education and the community. He served on the Palo Alto Unified School District Board from 1961 to 1971 and was a member of the engineering advisory councils at both Stanford and the University of California, Berkeley. He was appointed for ten years as a consultant on the engineering and safety of the new San Francisco/Oakland Bay Area Rapid Transit (BART) System. He served as a consultant to the Army Scientific Advisory Panel and a member of the Congressional Review Committee for the National Bureau of Standards. Just before his death, Barney was an active member of the Dean's Advisory Council for Natural Sciences at the University of California, Santa Cruz.

He was a generous donor to causes he felt were important, although he never sought public recognition for his philanthropy. He made major contributions to the universities he had attended, as well as to the Universities of California at Berkeley and Santa Cruz. At Santa Cruz he endowed a scholarship fund in theater arts in honor of his wife, Priscilla Newton. He contributed to many educational enterprises, including contributions of computers and associated equipment to middle schools.

Barney especially liked to support scientific enterprises he deemed worthy but, in some cases, neglected, especially if they might contribute to understanding and discovery of life in the universe. He made major contributions to the Exploratorium, the Monterey Bay Aquarium, and the San Francisco State University/Marine World Dolphin Communications Project. Among his largest gifts was one to the Allegheny Observatory at the University of Pittsburgh to allow the upgrading of the lens of its largest telescope, which was being used to search for extrasolar planetary systems. Another was a $200,000 challenge grant to the Monterey Institute for Research in Astronomy (MIRA), which used the funds to build a high-quality observatory at Chew's Ridge, near Carmel, which was named the "Oliver Station" in honor of Barney.

Barney was widely known and admired for his strong communications skills, a trait Barney attributed to his mother, a teacher who instilled in him at an early age a reverence for proper grammar. As a result, his scientific papers were models of clarity, his conversations terse and to the point. In short, he believed that clear, concise communication was important to success, whether the communication be with humans, dolphins, or people of other stars. As one final bequest to humanity, just before he died Barney finished the manuscript of a book detailing the fine points of English grammar and why they in fact ensure clarity in communication.

Barney Oliver's cornucopia of intellectual and practical gifts to the world, as well as his personal example, will continue to enrich us far into the future.

Robert H. Park

1902-1994

By Charles Concordia

Robert H. Park will long be remembered by electric power system engineers and electrical machine designers as the originator of what are universally known as "Park's equations." These were given in an American Institute of Electrical Engineers technical paper in 1929. Essentially, they provided a set of relations that made practical and simple the calculation of the dynamic performance of electric (ac) generators (and motors). Such a tool was necessary, but not yet available, for the calculation of the dynamic performance of electric power systems to ensure stable and reliable operation in the face of possible disturbances. This seminal paper has been the basis not only for an enormous flood of useful work in the field but also for many careers in the field. It was, and still is, unmatched in that respect. By itself it would have been enough to make Park famous among power system engineers worldwide.

Before Park's work, several papers had been written on electric generator equations. However, they were so complex as to be of little practical use. David M. Jones, for whom Park then worked at General Electric, recognized this and also recognized that Park was the person who could bring order out of chaos. So he assigned the job to Park, with world-shaking results. Incidentally, it is ironic that the resulting paper did not elicit any discussion when it was presented.

Although he fully recognized the significance of his contribution, Park was equally interested in many other things. About the same time, he had made contributions to the determination of switching transient voltages and was a major influence in promoting the importance of, and showing how to produce switch gear with, very much smaller interrupting times than were then thought possible.

During World War II, he served in the Naval Ordnance Laboratory in charge of mine development, resulting in seventeen patents (assigned to the U.S. government).

In the 1950s and 1960s he manufactured plastic bottles, inventing the machinery to automate the process.

Later, his interest returned to electric power. He formed a company, Fast Load Control, Inc., to promote the idea of fast control of turbine valves as a means for improving power system stability, and developed several means for accomplishing this.

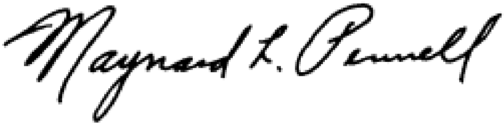
Rather late in his life, he was recognized by the Institute of Electrical and Electronics Engineers as a fellow in 1965 and was awarded the Lamme Medal in 1972 "for outstanding contributions to the analysis of a-c machines and systems." He had received (in 1945) the Navy's highest civilian award "for distinguished service to the U.S. Navy in time of war in the designing of magnetic mines." In 1986 he was elected to the National Academy of Engineering.

Perhaps the lateness in recognition by "the establishment" was due to the nature of his contribution. It was not a new machine, nor yet a new method of analysis. It was a new structure particularly well suited to facilitate analysis and application to new problems. It has been said that it was a ladder that others could climb and that it was the opening of a gate so that others could enter and cultivate the garden. Thus, it was appreciated immediately by the young engineers at the bottom of the ladder long before those at the top realized what was going on. "Park" was a household word among the young engineers and students long before any awards came. Even at the Lamme Medal award ceremony in 1972, his contribution was compared with that of two other engineers as being similar, apparently without realization of the difference: their papers remained on the shelf, Park's paper took fire and traveled around the world.

Robert Park was an original thinker, a prolific innovator, and a forceful advocate of his ideas. This was his forte. He did not spend time thinking about his past accomplishments but was more interested in his new projects. He was an inventor and proud that he did not require an attorney to help him prepare his later patents. (He had 64.)

Robert Park was a clear thinker, sure in his opinions (which stood well the test of time) and was neither very diplomatic or sentimental. And he was a valued friend, whose counsel was always sound as well as illuminating.

Park was born in Strassburg, Germany, while his father, the sociologist Robert Erza Park, was studying and teaching at Heidelberg University. He grew up in Wollaston, Massachusetts, and graduated from the Massachusetts Institute of Technology in 1923 in electrical engineering. He did postgraduate work at the Royal Technical Institute in Stockholm, Sweden. He worked on a wide variety of subjects in a wide variety of companies and organizations, among which are General Electric, American Cyanamid, the Naval Ordnance Laboratory, the Bureau of Ordnance, Emhart Manufacturing Company, R. H. Park Company, and Fast Load Control, Inc. He was a private consultant to the end of his life. He is survived by a daughter, three sons, and a nephew.



Maynard L. Pennell

1910-1994

By Philip M. Condit

Maynard L. Pennell, who played a leading role in the design of the Boeing 707 and many other landmark aircraft during his thirty-four year career, died on November 22, 1994.

Maynard was born in Skowhegan, Maine, in 1910. The harsh Maine winter had contributed to the fatal illness of an older brother, and in 1919 the family decided to move to a more temperate climate. Seattle was chosen because the University of Washington at the time offered a nearly free college education, and the Pennell's had high academic aspirations for their four children.

Maynard was fascinated by flying at an early age and enrolled in the aeronautical engineering program at the University of Washington. After graduation, he worked for the Navy Bureau of Aeronautics and Douglas Aircraft in Los Angeles, where he showed his flair for structural design as part of the team that created the DC-3. In 1940 Maynard returned to Seattle, where he would spend the next three decades as one of the most influential and respected engineers in the history of Boeing.

During World War II, Maynard made substantial contributions to the B-29 project. After the war, when the company was struggling to develop new products for the commercial market, he headed up the initial studies to determine the feasibility of jet transports.

Maynard soon became the company's leading advocate for designing its own commercial jet despite the huge cost and risk. He went on to serve as senior project engineer on what was called the "367 Dash 80," the prototype for the Boeing 707, which would help revolutionize the air travel industry. A remarkably small work force (300 designers and technicians and 300 shop workers) turned out the Dash 80 in the remarkably short time of twenty-six months. About one quarter of the company's net worth ($16 million) was riding on the airplane's success.

After 1954, when the 707 prototype first flew, Maynard held a series of management positions, including that of chief engineer for the transport division, and then director of engineering, where he sought to persuade Boeing management to build a "family" of airplanes to serve various market needs. The enormously popular three-engine Boeing 727 followed, and the strategy of creating an airplane family proved to be a key element in establishing the company's market leadership.

In 1963 Maynard was appointed manager of Boeing's SST proposal team, engaging in a government-sponsored contest against Lockheed for the right to manufacture the airframe for the nation's first supersonic jetliner. By mid-1966 he had unveiled the model of the 300-passenger, 330-foot-long aircraft designed to fly at 1,800 miles an hour, with a range of about 4,000 miles. Boeing won the competition against Lockheed, but the SST project lost support in Congress and the plane was never built.

In 1969 Maynard became vice-president of product development and went on to serve the company in a number of senior executive positions before his retirement in 1974.

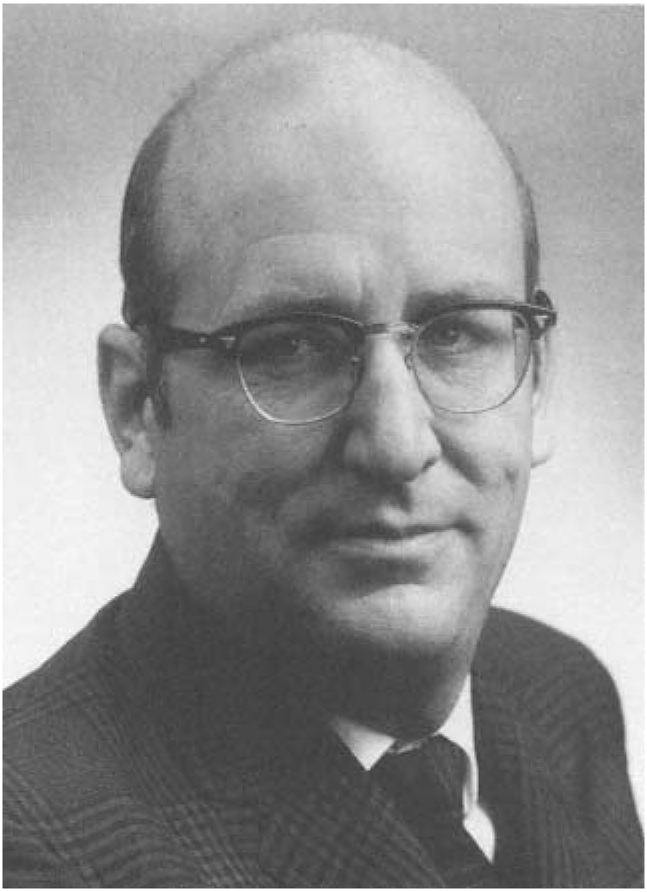
For his achievements at Boeing, Maynard was honored with the 1965 Elmer A. Sperry Award for distinguished engineering. He was a member of the American Institute of Aeronautics and Astronautics and was elected to the National Academy of Engineering in 1968.

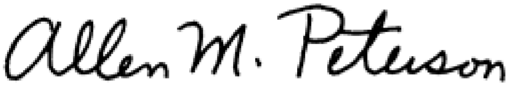
In 1989 Boeing established the Maynard Pennell Professorship in Structural Analysis at the University of Washington in his honor.

Maynard was not only a talented, visionary engineer but also an exceptional leader and manager with that rare ability to motivate and inspire the people who worked for him and to keep them focused on achieving a common goal.

He was known for his calm, quiet assurance and for his ability to steer people through a crisis without losing his composure or his sure grasp of what needed to be done. Maynard was also known as a manager who believed that everyone on a project had something to contribute. And like all superior leaders, Maynard was always willing to listen but never afraid to lead.

Maynard embodied the highest standards of his chosen engineering profession. And he has left his mark, not only on the history of The Boeing Company, but on the history of aviation.




Allen M. Peterson

Allen M. Peterson

1922-1994

By Von R. Eshleman

Allen Montgomery Peterson, emeritus professor of electrical engineering, died of a heart attack at his home in Los Altos, California, on August 17, 1994. He was seventy-two.

He was born in Santa Clara on May 22, 1922. He served in the Army Air Force during World War II and was in the Battle of the Bulge. At Stanford University he received B.S. (1948), M.S. (1949) and Ph.D. (1952) degrees in electrical engineering. He rose to the rank of professor in 1961 and became emeritus in 1992.

Peterson's association with Stanford University as student, researcher, and professor spanned half a century. Starting in 1954, Peterson held dual positions at the university and at the Stanford Research Institute (SRI), Menlo Park, through a special arrangement made by the late Frederick Terman, often called the father of Silicon Valley. At SRI, Peterson was a senior scientific adviser and was the key person in initiating and building up what became the Radio Physics Laboratory and the Communications Laboratory, where about three hundred people have been involved in communications and defense problems.

At Stanford, Peterson developed and taught courses on radar systems, digital signal processing, microprocessors, logic design, and digital filters. He worked with a large number of graduate student assistants and was the mentor for approximately one hundred students who received advanced degrees. Although officially retired, Peterson was the adviser for seven graduate students at the time of his death.

With students and colleagues, Peterson initiated several significant areas of research, including radar oceanography and radar-acoustic sounding of the atmosphere. His dissertation studies and later research were instrumental in the development of the over-the-horizon radar systems that were installed in the United States and the Soviet Union for early warning of ballistic missile attack. His work in the 1950s on radar reflections from the trails produced by meteors helped initiate continuing applications to communications and basic studies of the upper atmosphere. He was active in ionospheric and auroral studies during the International Geophysical Year. The innovative method Peterson invented for sounding the atmosphere with a combination of acoustic and radar waves led to commercial systems and stimulated international conferences on this method of environmental and weather measurement. He also helped start the discipline of radar astronomy, which has provided new methods to study surfaces and atmospheres of the other planets of our solar system.

Commercial applications of digital systems developed by Peterson and his students include a widely applied filter bank for transferring between time and frequency division multiplex signals in telecommunications systems; worldwide sales of this and similar devices were on the order of a billion dollars during the mid-1980s. Related studies at Stanford led to an early concept for a million-channel receiver for the national program called the Search for Extraterrestrial Intelligence. At the time of his death, Peterson was working with a former student on a technique for vastly reducing the power consumption of electronic chips.

For decades up to the time of his death, Peterson was involved with several Silicon Valley start-up companies, the Department of Defense, and other governmental agencies. Since 1961 he had been a member of the JASON group of about fifty academics who meet yearly to advise the secretary of defense on scientific matters related to national defense.

He was a member of the White House Science Council on Space Defense related to the Strategic Defense Initiative, the Naval Strategies Board, the Air Force Studies Board, the Voice of America Broadcast Engineering Advisory Committee, the Jet Propulsion Laboratory Advisory Council, and several National Research Council committees.

Peterson served as a consultant to a number of companies and to the President's Science Advisory Committee, the Defense Atomic Support Agency, the Advanced Research Projects Agency, the Institute for Defense Analyses, the Office of Telecommunications, and the Office of the Secretary of Defense. He served for a time as the chief scientist of the Science Applications International Corporation. He had a long-term association with the Geophysical Institute of the University of Alaska and caused a "northern exposure" fracas when his radar studies of the aurora led to an account in a local newspaper that he planned to turn off the northern lights.

Allen Peterson touched the lives of numerous students, colleagues, and friends throughout the world. He will be sorely missed by all.

He is survived by his wife of fifty-one years, Shirley, a full partner in the esteem of colleagues and students who were welcomed to their home, and by four children, three grandchildren, and two brothers.

The Allen Peterson Memorial Fund has been established in the Electrical Engineering Department at Stanford and will be used to assist graduate students.

Fred H. Poettmann

1919-1995

By Lloyd E. Elkins, Sr.

A true scientist-engineer, Fred H. Poettmann was elected to the National Academy of Engineering in 1978. He also had the qualifications to be considered for membership in the National Academy of Sciences.

Fred's main attribute throughout his career was the ability to bring to engineering systems the appropriate mix of scientific facts. He knew how to match engineering systems to the rigid requirements of plant design or to the highly complex porosity systems forming underground oil and gas reservoirs.

Fred realized early in his career that one must ask the right questions or pay the penalty for making choices leading down blind alleys.

The first two phases of his career were in research with major companies—Phillips Petroleum (1946 to 1955) and Marathon Oil Company (1955 to 1983)—his leadership and research on oil and gas recovery highlight the technology profile now becoming available to the world at large on the Internet.

The last phase of Fred's career was teaching and challenging graduate students at the Colorado School of Mines in oil and gas recovery and in refining operations (1983 to 1995). Upon his death he left a legacy of technology and, through his students, a legacy of talent to a variety of oil and gas resource systems needing special consideration as we move into the next century.

Born on December 20, 1919, in Moers, Germany, Fred came to the United States with his parents at an early age. He was left with a walking disability after a childhood bout with polio. But rather than let this handicap hold him back, he used his "recreation time," while his friends took part in athletics, to advance his interest in scientific and engineering matters. His academic education began at the Case Institute of Technology, where in 1942 he earned his B.S. degree in chemical engineering. He then went on to the University of Michigan, where he received a master of science degree in 1944 and a doctor of science degree in 1946, both in chemical engineering.

While earning his doctorate, he was exposed to the many phase-relation problems prevailing in petroleum processes. His professor at the University of Michigan advised the Phillips Petroleum Company of Fred's great potential. So upon graduation in 1946 he joined the Phillips Research Department as a manager of hydrocarbon phase research in oil and gas production. During his nine years at Phillips, Fred demonstrated to both Phillips and the industry at large the need to incorporate the fundamentals of phase relations in most oil and gas operations.

In the early 1950s Marathon took steps to join the ranks of a dozen other major oil and gas companies and create a strong program in exploration and production research. The company built a large research center in Littleton, Colorado, and wisely chose to build personnel from the top down, selecting Fred to fill a key spot in the production research effort. This was the beginning of a highly productive program in which he played a major role for twenty-eight years (1955 to 1983).

It was during this period that the major oil and gas companies began developing and improving technology for maximizing oil recovery over that achieved by primary and conventional gas injection and water flooding. Their primary motivation was to perfect performance parameters and transfer the technology to their own company operations. For example, they sought unique chemical combinations that would make a process more effective. Many of the patents filed were defensive in nature. Under Fred's stimulating leadership, Marathon mastered most of the enhanced oil recovery (EOR) methods offered through the industry's technology-transfer programs. Marathon obtained a patent on a microemulsion Micellar-Polymer-Flooding System, which was then trademarked as Maraflood and available under license.

At the same time, a group of EOR systems was being designed and pilot tested. The basic technology and field test results were documented in the appropriate technical literature. There were four broad types of systems, all of them involving phase shifting, interfacial forces modification, or viscosity adjustments: (1) thermal—steam front sweep; and in situ combustion sweep, (2) improved water flood sweep and displacement efficiency; (3) injection of hydrocarbon fluids miscible with reservoir oil; and (4) carbon dioxide injection to swell oil and reduce viscosity and significantly improve water flood displacement and sweep efficiency. In all these systems the reservoir, after oil recovery, is left full of fluid—essentially water, residual oil, and perhaps some trapped gases.

Fred was involved in several national studies pointing up the potential of EOR techniques for significantly adding to U.S. oil reserves. However, two major hurdles had to be cleared first; the well-defined technologies had to be selected and adjusted to match individual reservoir systems, and the price of crude oil had to be adequate for profitability.

While some massive EOR projects are getting by at prices controlled by the Organization of Petroleum Exporting Countries (e.g., Prudhoe Bay miscible gas injections), many smaller scale projects are lingering on the shelf waiting for a sustained world price increase of 10 to 20 percent. Whether or not Fred sensed that the aggressive type of research that he had been directing had accomplished its major objectives, he only knows.

In the early 1980s, the Colorado School of Mines (CSM) apparently sensed the need to strengthen its petroleum engineering teaching staff. Fred was a natural candidate because of his vast knowledge and the fact that he lived only a short drive from the campus. Taking early retirement from Marathon, he joined the CSM staff as a professor in the Petroleum Engineering Department in 1983.

From early in 1984 until late 1994, Fred coauthored with graduate students twenty-six technical papers. Every one of the students who had the privilege of working with this brilliant man, whether they realized it or not, learned one great truth: keep asking the right questions, and with perseverance a defensible answer can be developed. After formally retiring from CSM in 1990, Fred became an adjunct professor and remained as a part-time teacher and director of graduate research.

The most straightforward way to reflect on Fred Poettmann's total commitment to his profession and on his life of service is through the many honors and awards he received. In the following list, awards granted in recognition of outstanding overall achievement are indicated with an asterisk.

1983

participated in Department of Energy (DOE) Peer Review on "EOR using

1986

Carbon Dioxide" and "EOR Heavy Oil Program", respectively

1987

chairman, Panel on "Reservoir Management" Conference on Research Needs for Hydrocarbon Fuels, sponsored by DOE

Publications: sixty-four publications forty-six plus U.S. and foreign patents coauthor or coeditor of ten books

Professional Societies:

Society of Petroleum Engineers (SPE) of the American Institute of Mining, Metallurgical and Petroleum Engineers, 1946-1995

director, Denver Section, 1958 to 1962

chairman, Denver Section, 1961

national SPE director, 1966 to 1969

AIME board of directors, 1970 to 1973

vice-president, AIME, 1973

distinguished member SPE, 1983

honorary member AIME, 1985

chairman or member of twenty plus AIME or national SPE committees over the period 1962 to present

National Academy of Engineering

Chemical/Petroleum Peer Committee, 1980 to 1983 member, National Research Council's Commission on Engineering and Technical Systems Committee on Innovative Concepts for Energy Conservation, 1984 to 1985

American Institute of Chemical Engineers, 1943-1995

Denver Section secretary and treasurer, 1957 board member, Denver Section, 1962 chairman of joint symposium committee member of AIChE-SPE, 1961 chairman, National Program Committee, 1962 fellow, AIChE-1974 member, executive committee, Toledo Section, 1976 to 1977

American Chemical Society, 1942 to present

member, Petroleum Research Fund Advisory Board, 1963 to 1966

American Petroleum Institute, 1955 to 1983

member of Research Committee, 1947 to 1965 Oil Recovery Domain Committee, 1947 to 1965 Project 37 "Fundamentals of Hydrocarbon Behavior", late 1940s

Interstate Oil Compact Commission, 1967-1995

appointed by Governor Love to the Research Committee, 1967 to present appointed by Governor Lamm to the Enhanced Oil Recovery Committee, 1980 to present chairman, Research Committee, 1988 to 1991

Honors and Awards:

Lester C. Uren Award of SPE, 1966

* University of Michigan Sesquicentennial Award of College of Engineering as Outstanding Alumnus, 1967

John Franklin Carll Award of SPE, 1971

* fellow, AIChE, 1974

* elected to the National Academy of Engineering, 1978 distinguished member, SPE, 1983

EOR pioneer, SPE/DOE, 1984

* honorary member, AIME, 1985

Herbert C. Thober Award for Chemical Engineering, Toledo Section, AIChE, 1975

Henry Mattson Technical Service Award, Denver SPE, 1983

honorary member, SPE, 1985

Halliburton Professional Award in Teaching, 1986

DeGolyer Distinguished Service Medal of SPE, 1990

* Charles F. Rand Memorial Award of AIME, 1992

honorary doctorate from the Mining University of Leoben, Austria, June 1992

* Katz Medal of the Gas Processors Association, March 1993

Civic Activities:

South Suburban Metropolitan Recreation and Park

District (elected office-Littleton, Colorado), chairman, 1966 to 1971

Littleton Press Council, chairman, 1967 to 1971

board member, Hancock Recreation Center (Findlay, Ohio), 1973 to 1977 chairman, South Suburban Foundation (Littleton, Colorado), 1980 to 1983

president, Columbine Villas Townhouse Association, 1981 to 1982

member and president of board, Columbine Villas

Townhouse Association, 1989 to 1992

By all standards, Fred has left to all a legacy of technology that can lead to maximizing oil and gas recovery worldwide. This should be of special significance to interests in North America, where premature abandonment of marginal wells can make reentry into reservoirs for enhanced oil recovery a little too costly.

When any engineer accesses the various on-line sources of information on oil and gas recovery technology, Fred's name will be a frequent discovery. In fact, a printout of all of his papers on any specific oil or gas recovery technology would lead to most of the EOR technology available today.

Fred is survived by his wife, Anna Bell, who was his constant traveling companion on his innumerable trips to worldwide symposia, conferences, and society meetings. In her special way, she assisted and supported Fred. She is therefore behind the legacy that Fred has left to all of the technologists in transition into the next century. He is also survived by a son, Phil, who graduated from Colorado School of Mines, and a daughter, Trudy, and their families.

Rowland Wells Redington

1924-1995

By Lewis S. Edelheit and Walter L. Robb

Rowland W. "Red" Redington, who died on June 22, 1995, was a physicist and manager of technology who led enormously successful innovation projects that set the world standard in CAT scanning and magnetic resonance imaging. His greatest strength was captured by a journalist who labeled him "medical imaging's player coach." Red had a remarkable ability to bring out the best in each member of the large teams needed to create world leadership in medical imaging systems.

Red's colleagues most vividly recall his laugh. Sharp, explosive, and infectious, it expressed the zest that marked his efforts whether it was skippering a sailboat, learning woodworking, or leading a research and development team on a technical leap that would carry General Electric beyond the competition in a pioneering field.

Red was born in Otega, New York, in 1924. His mother was a schoolteacher, and his father ran a feed store and tinkered with farm machinery. He earned his bachelor's degree in mechanical engineering from Stevens Institute of Technology in 1945 and went to work as an aerodynamicist for Curtiss Wright in Buffalo, New York. But the view from his window of war surplus airplanes being scrapped contrasted sharply with the excitement being generated not far away in Ithaca, where Cornell University was assembling one of the world's best physics departments, under the leadership of Hans Bethe, Richard

Feynman, and Robert R. Wilson. Red earned a Ph.D. degree in physics from Cornell, writing his dissertation on the diffusion of barium in barium oxide. On graduation in 1951, he joined General Electric's (GE) Corporate-level Research and Development Center in Schenectady, New York.

At the bench, he worked on new concepts for electron multiplier tubes for infrared-light imaging, helped develop improved video cameras, published papers on subjects ranging from electrostatic optics to infrared absorption, and earned patents in such areas as camera tubes and electrophotographic processes. He would ultimately publish ninety-nine technical papers and earn twenty-six U.S. patents.

By the early 1970s Red had become a manager of a small group developing imaging technology. Its efforts ranged from a concept for three-dimensional television that never made it out of the lab to a program on electronic fluoroscopy for GE's x-ray business that achieved some technical success.

Then, in 1973, an innovation burst on the scene. Godfrey Hounsfield, an engineer at EMI in Great Britain, introduced the first practical computerized axial tomography x-ray system, soon popularly known as the CAT scanner.

GE x-ray marketers were not initially impressed. X-rays had achieved a resolution of one millimeter or less while the CAT scanner could at best achieve one centimeter. X-ray imaging was instantaneous, while the first CAT scanner required minutes to acquire data. Surely CAT was at best a research device with a market measured in tens of units, not hundreds or thousands.

Red, however, appreciated the advantages that had inspired Hounsfield. Here was a way to distinguish density differences of as little as one-half of one percent, a feat impossible with conventional x-ray systems. That meant, for example, that brain tumors could now be found without painful and sometimes dangerous injection of air or other contrast materials, or exploratory surgery. Hospitals began ordering CAT scanners instead of conventional x-ray systems. This got the attention of GE business leaders, and they came to the Research and Development Center and to Red.

Hounsfield's initial machine had used a principle called "translate-rotate" to send and detect the hundreds of pencil-shaped x-ray beams that provided data for making an image. One might get into the business by simply imitating this approach. However, Red and his colleagues at the Research and Development Center thought they could do better.

In 1974 Red sold a more daring approach to GE Medical Systems business leadership. GE would leapfrog the EMI approach with an advanced scanner employing a fan beam instead of a pencil beam, and continuous rotation of the x-ray tube and detectors in place of the translate-rotate approach. It offered a faster scan, one that might image the head or body in just five seconds. But it also offered daunting challenges. Neither the required detectors, nor the complicated mathematical algorithms needed to reconstruct the image, then existed. Housfield himself had looked at the continuous rotation approach and declared it impractical.

Red and his team initially developed the concept for a prototype capable of imaging a five-inch diameter object, and targeted mammography as an application. In 1974 the GE Research and Development Center launched a joint project with the Mayo Clinic to build a fan-beam CAT scanner for breast cancer screening. Putting together a multidisciplinary team of dozens of people, Red led the effort that built, on schedule, this pioneering fan-beam scanner. Even before its delivery to the Mayo Clinic in 1975, however, GE committed to a next step, a "whole body" fan-beam scanner aimed at the commercial market. It was built on the foundation created by Red and his team. For example, the algorithms for fan-beam CAT scan reconstruction were developed for GE by Gabor Herman and colleagues at the University of Buffalo, and the xenon x-ray detector was developed by GE's John Houston and N. Rey Whetten.

As the fan-beam scanner quickly moved from lab project to commercial product, Red remained deeply involved. He spent one week a month at the University of California, San Francisco, in 1976, helping to coax top performance out of GE's first prototype scanner. He helped solve a crucial problem that had led to images that made skulls look thicker than they actually were.

The "third generation" CAT technology that Red championed has since become the world standard. As it did, and as GE built a highly profitable business, Red began looking for another frontier. It proved to be magnetic resonance (MR).

MR had entered physics in the late 1940s with the pioneering work of Bloch and Purcell and was applied to medicine in the early 1970s by Lauterbur and Damadian. It offered a way to use the combination of a strong, uniform magnetic field and radio signals that make images of the inside of the body without x-rays. Again, here was an area that initially looked dubious as an improvement on x-rays. Resolution was poor, and though you could make a two-dimensional "slice" image, it looked initially like a bad CAT scan.

Red, however, saw opportunity. Asked to put together a team on MR, Red went out and looked for the very best people in the field. Two of the university researchers he found were recognized as world class, but he was warned that they were prima donnas who could never work together. He hired them both anyway, and under his coaching, they complemented each other as technical leaders. Red was similarly able to bring out the best in people already available at the GE lab and blend them into what became a world-class team.

Red urged that MR's advantage was the ability to do spectroscopy as well as imaging: that is, to measure the levels of chemicals inside the brain or body without surgery or use of needles. When GE Medical Systems suggested that Red lead a research program on imaging, Red replied: "that's not research, that's development." The outcome was an agreement by GE Medical Systems in 1981 to purchase for Red's research team a 1.5 Tesla magnet, about three times the field strength of the magnet other MR researchers were using, for research on both spectroscopy and imaging.

Competitors said that good images could never be made on high-field systems. Red's team proved them wrong by producing, in 1982, better-quality images than those seen anywhere else in the world. As MR established its ability to provide images of "soft" tissues of the brain that were much better than even CAT scanning, this capacity gave GE a competitive edge. (Spectroscopy, the other target of the program, was accomplished with technical success, but has not so far proven of major clinical value.) Again, close teamwork with GE Medical Systems rapidly turned the lab prototype into a product. GE's Signa® magnetic resonance imager, introduced in 1983, put GE into a commercial leadership position that it has never relinquished.

Red subsequently returned to the bench to do research on magnetic resonance microscopy, and retired from GE in 1989. Among his numerous awards were the prize for Industrial Applications of Physics sponsored by the American Institute of Physics, and the "Engineer of the Year" award from 1989, presented by *Design News Magazine*. He remained a great coach and mentor to many scientists and engineers.

Throughout his career, Red pursued a wide variety of interests. He was an avid sailboat racer on Lake George. His crews never left the boat without a good day. Winning was less important than trying out new gadgets. He enjoyed practical jokes. He collected old mantelpieces and parts for MG automobiles and was a long-standing volunteer fireman.

Red's marriage to the former Shirley Bennett in 1947 resulted in a devoted lifelong partnership. Their shared interest in gardening led to an outstanding garden of dwarf conifers, and leadership in many local and national horticultural societies. Their deaths were only a few months apart.

Red's success resulted from his rare combination of skills. He could do first-rate technical work himself, head a team to come up with a new idea, sell the idea to a skeptical management, and defend the idea when the world said it couldn't be done. Through it all, he earned not only the respect but also the affection of all involved. Themes he pioneered in the 1970s and 1980s are staples of the research and development of the 1990s: teamwork between businesses and laboratories, multidisciplinary effort, speed, and quality. As he put it: "build it the very best way you know how, grab the top of the market, then work at reducing costs. But whatever you do, don't compromise quality at the start, because you can never recover."

Ben Rich

1925-1995

By Willis M. Hawkins

Ben Rich died on January 5, 1995, after a full career as an engineer, a designer, and an effective and cherished executive. I first knew Ben when he joined the Lockheed Aircraft Company in Burbank back in 1950. He came to us from the University of California, Berkeley, and University of California, Los Angeles, with a master's degree in mechanical engineering. At the time, I was in charge of the Advanced Design Organization under the Deputy Chief Engineer C. L. "Kelly" Johnson, and we were working on our first Mach 2+ Air Force fighter proposal, which became the F-104. Ben was assigned the task of analyzing the aerothermodynamic performance of the power plant with little or no existing state of the art for supersonic inlets. It is a testament to Ben's understanding of this specialty that the inlet configuration was classified by the Air Force and the details obscured in Air Force-released pictures of the airplane for a number of years.

The Lockheed "Skunk Works," which had originated during the design and development of the original P-80 prototype "Lulu-Belle," was being reactivated at about the time that the F-104 was conceived. Its specific purpose was the secret development of the U-2, and Ben was "borrowed" by Kelly Johnson to help on that program. His "temporary" assignment became his career. Under Kelly, Ben pursued his specialty of aerothermodynamic analysis. After the U-2, he was called upon to produce power plant design concepts for a supersonic airplane having the same missions as the U-2 since it was clear that the U-2, in spite of its remarkable high-altitude performance, would soon be vulnerable to opposing air defense systems. Still unknown to most of the technical world was Ben's leadership in designing a Mach 2.0 airplane with the same radius of action as the U-2. It appeared at the time (before air-to-air refueling) that the only way to accomplish such a mission was by using hydrogen as a fuel. Ben created and directed the development of the power plant system and demonstrated its feasibility by means of full-scale operational test rigs. This system incorporated cryogenic tanks, practical insulation, fuel pumps and valves, refueling hardware, and power plant operation years before such equipment would become available in national space programs. Since the planned use of the airplane involved secret bases in remote areas worldwide, the logistical problems of supplying liquid hydrogen at such bases drove the systems cost to insupportable heights and the program died.

Ben and Kelly both realized that high performance was essential for accomplishing the reconnaissance mission, and out of the remains of this unfulfilled program, including the Pratt and Whitney engine work, came the beginnings of the SR-71 Blackbird incorporating a power plant concept still unequaled in performance nearly thirty years after it was conceived. At this point in Ben's development, his influence on new airplane designs was substantially expanded to include the aircraft materials, the fuels, the environmental protection of the crew, and the creation of the myriad systems that had to work at the elevated temperatures accompanying Mach 3.0+ flight. Although management hierarchy was nonexistent in the Skunk Works, it was clear that Ben, more and more, was being depended on by Kelly for ideas and concepts and for the day-to-day technical decisions necessary to produce the unique classified high-performance aircraft being demanded.

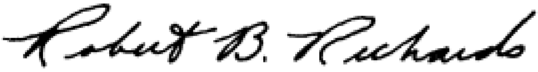
Addressing aircraft vulnerability to sophisticated air defense systems led to unusual concepts depending on characteristics other than speed and altitude to achieve invulnerability. Ben participated in early efforts to reduce the radar signature of the airframe and its power plants. Even U-2 modifications were attempted, and the unique shape and materials used in the SR-71 attest to early "stealth" efforts, all of which ultimately produced the exceptional configuration exemplified by the F-117A and the concept confirmation vehicles that preceded it.

The constant infusion of new technologies into aircraft design concepts demanded of Ben, now clearly a deputy to Kelly Johnson, a technical judgment role that was unprecedented. Kelly and a majority of the Air Force leadership were comfortable in their dependence on speed as the dominant factor in superior tactical effectiveness, and stealth, as a concept, appeared to many to be a retrograde step. Ben's persistence, technical and operational logic, articulate support, and patient salesmanship finally brought true, effective stealth into operational thinking, and the F-117A came into being. The F-117A earned the 1989 Robert J. Collier Trophy for Rich and the Air Force Lockheed Team. In addition, as a result of all his accomplishments as well as the F-117A, Secretary of Defense Harold Brown awarded Ben the Pentagon's highest civilian defense award—the Medal for Distinguished Public Service.

With Kelly's retirement and increasing health problems, Ben became the leader of Lockheed's unique Skunk Works organization, the chief Skunk. I was intimately involved in this transition since the Skunk Works had always been a part of the Lockheed California Company, and my own assignment at the time was as president of this company—Ben's boss. Watching Ben work with the creative engineers, the production artists, the ingenious test teams—all of whom had grown up in this remarkably spontaneous and individualistic environment—was a rewarding experience. Kelly, his mentor, and a giant by any standards, was not an easy man to work with. He was intolerant of average performance and intellect, and he was a technical one-man show. Ben was the antithesis of this. He delegated completely, he was open to suggestion—almost to a fault—and he was quick with praise for any, even small, contribution. He was also an enthusiastic salesman who relished the accomplishments of those around him.

Ben's peers recognized his accomplishments. In 1972 the American Institute of Aeronautics and Astronautics, Inc. (AIAA) honored him with its National Aircraft Design Award, and in 1991 he was made an honorary fellow. In 1988 he was the invited Wright Brothers Lecturer in Aeronautics by the AIAA and Royal Aeronautical Society. In 1981 he was elected to the National Academy of Engineering. His unique management approach earned him Silver Knight and Golden Knight awards from the American Management Association.

Lockheed and the nation will miss Ben—a technically sound, enthusiastic leader—proud of what his troops accomplished and effective in selling what these same troops could do. The nation must not lose the wonder and the appreciation of the power of new ideas that constantly motivated Ben.



Robert B. Richards

1916-1988

By Karl P. Cohen

Robert Benjamin Richards, a distinguished nuclear engineer who made major contributions to understanding of the nuclear fuel cycle and to the design of thermal and fast-spectrum nuclear reactors during a thirty-six year career with the General Electric (GE) Company, died in San Jose, California, on July 26, 1988, at the age of seventy-one.

Bob was born November 18, 1916, in Scranton, Pennsylvania, and was brought up in that city. He attended Central High School. After graduating in 1934, he became a chemical laboratory assistant at Central for two years, showing an early propensity for chemistry. He received a B.S. in chemical engineering from Pennsylvania State College in 1939, an M.S. in organic chemistry in 1941, and a Ph.D. in organic chemistry in 1946 from the same school. His doctoral thesis was entitled 'The Viscosity Properties of Polymeric Solutions." His thesis advisers were Merrell R. Fenske and Grover C. Chandlee. While working toward his doctorate, Dr. Richards did chemical engineering, organic chemistry, and physical chemistry research at the Pennsylvania State College Petroleum Refining Laboratory.

He joined the General Electric Research Laboratory in Schenectady, New York, in 1947. At that time GE had just taken over as operations manager at the Hanford nuclear facility under contract to the Atomic Energy Commission (AEC).

The highest priority program was the development of a replacement process for recovering plutonium from irradiated fuel. The wartime process—coprecipitation of plutonium with bismuth phosphate—was a batch process that did not recover the main component of spent fuel, uranium. Research on the Redox solvent extraction process took place at Argonne National Laboratory, Oak Ridge National Laboratory, and elsewhere. Reduction to practice, as a continuous process in pulsed columns, was to be at Hanford. Bob was transferred to the Hanford Atomic Plant in Richland, Washington, and was soon in the midst of this effort. He held a variety of managerial positions and is credited with major contributions to the technological development of the Redox, Purex, and metal recovery processes. Due to the fog of classification, it is difficult to be more specific, but Bob was manager of separations technology in 1954 and was appointed coeditor of the fuel processing volume of the AEC *Reactor Handbook.*

In 1953 Bob became manager of the pile technology group, with responsibility for the improvement of the Hanford graphite reactors. In 1956 he became manager of the research and engineering operation for the plant's Chemical Processing Department and was directly responsible for all classified chemical engineering design work at Hanford.

Following the revision of the Atomic Energy Act in 1954, which opened the door to civilian atomic power, GE set up a new division in San Jose, California, to produce boiling water reactors (BWRs). Dr. Richards was called down from Richland in 1957 to become manager of engineering.

The challenge facing him was to define the product. BWRs present a great variety of design options. The power chain can be direct cycle, indirect cycle, or mixed. There can be dry or wet (pressure suppression) containment. The geometry and cladding of the fuel elements and fuel bundles must be chosen. The fuel irradiation lifetime must be predicted and the fuel composition (including burnable poison) selected. The number of coolant circulation loops and the type of pumps can vary, as can the number of styles of control drives and auxiliary safety loops.

Many scientists and engineers worked on these issues, but final ratification of the engineering decisions rested with Bob Richards. In his decisions, he was particularly concerned with both the economics and the safety of the product. He sponsored the elaboration of a development program specifically directed at improving BWR economics, and personally participated in companywide nuclear safety reviews.

Dr. Richards was elected to the National Academy of Engineering in 1970. His citations included, among other things, the design of the first commercial nuclear power plant (Dresden I); the first nuclear plant with internal steam separation (KRB); the design and operation of the first nuclear plant with nuclear superheat (ESADA-VESR); and the design of the standardized offerings of GE's BWRs in the range of 500,000 to 1.1 million kilowatts.

In 1968 he became manager for engineering of the Reactor Fuels and Reprocessing Department. In October 1971 he became manager of the Special Fuels Programs with overseas licensing responsibilities for the Nuclear Energy Division. He was appointed manager, international business development, Overseas Projects Department in January 1973. In August 1974 he was appointed general manager of the Fast Breeder Reactor Department, Energy Systems and Technology Division, located in Sunnyvale, California, a position he held until his retirement in 1983. Dr. Richards was a fellow of the American Nuclear Society (ANS), a fellow of the American Institute of Chemical Engineers (AIChE), and a member of the American Chemical Society. He was a past chairman of the Nuclear Fuel Cycle Division of the ANS. He received the 1970 Robert E. Wilson Award of AIChE.

He served on the advisory committees for the Nuclear Engineering Department of Brookhaven, Argonne, and Oak Ridge National Laboratories.

Dr. Richards was a dedicated supporter of the nuclear power industry and of fast-spectrum reactors. He was particularly fond of pointing out the huge energy resource available to the United States through fast reactors, compared to the reserves of coal, oil, gas, or even U-235.

Until one of his hands was disabled late in life by a shortened tendon, Dr. Richards was a talented and proficient pianist. He was married to Jean Urie and had two children.

Frank E. (Bill) Richart, Jr.

1918-1994

Written by Richard D. Woods

Submitted by the NAE Home Secretary

F. E. (Bill) Richart, W. J. Emmons Professor Emeritus of Civil Engineering, the University of Michigan, engineer and educator, died on September 16, 1994, at the age of seventy-five at his home in Ann Arbor, Michigan.

Elected to the National Academy of Engineering in April 1969, Bill was an outstanding engineering educator, dedicated to the development of four generations of university students. He was also a pioneer in defining the specialty field of soil dynamics, including the development of design procedures for the selection of foundations for vibrating machinery, sensitive instruments, and structures subject to earthquake shaking.

Bill received his education from the University of Illinois— B.S. (1940), M.S. (1946) and Ph.D. (1948). He received his bachelor's degree in mechanical engineering, his master's in civil engineering, and his Ph.D. in engineering/ applied mechanics and structures. He later received honorary degrees from the University of Florida and Northwestern University in 1972 and 1987, respectively.

During his academic career, Bill taught at Harvard University as an assistant professor from 1948 to 1952, the University of Florida as an associate professor from 1952 to 1954 and as full professor from 1954 to 1962, and the University of Michigan as a professor, 1962 to 1986. At the University of Michigan, Bill served as chairman of the Department of Civil Engineering from 1962 through 1969, and under his leadership, the department gained national stature and recognition. He was an outstanding technical leader, researcher, administrator, and recognized authority in his field. He chaired eighteen doctoral committees, developing nine engineering educators and countless engineering practitioners.

F. E. Richart's contributions in engineering science have made it possible to design foundations and structures to resist the destructive forces of water waves, earthquakes, and other ground-borne vibrations. These contributions were made through the branch of civil engineering known as geotechnical engineering and specifically in the subdiscipline for which he is credited as an originator, soil dynamics.

Before the research of F. E. Richart, the design procedures for dynamically loaded foundations of structures and earth dams were mainly empirical and often produced less than satisfactory results. In 1962 Bill published the award-winning paper "Foundation Vibrations," which for the first time tied together theoretical mechanics and soil properties for use in analysis and design. Bill offered the first graduate course in soil dynamics in the United States and possibly the world in the fall of 1961 at the University of Florida. In 1970 he coauthored the world-renowned textbook *Vibrations of Soils and Foundations* with former students J. R. Hall and R. D. Woods. This text remains after twenty-five years the basis for most courses in soil dynamics and has been translated into Japanese, Chinese, and Romanian.

Bill was one of the first to recognize that soils behave differently under cyclic and dynamic loads than under static loads, and he initiated research in the 1950s to define this behavior. The response of soils to cyclic loads plays a role in the effects of wave forces on structures in the marine environment, the resistance of foundations to earthquake shaking, and the behavior of foundations for sensitive instruments and vibrating machinery. To measure appropriate soil parameters, he directed the development of both laboratory and field testing apparatus and techniques. He guided the development of the resonant column and cyclic torsional shear apparatus, which have become standard equipment for the laboratory, and the adaptation of seismic crosshole and seismic surface wave techniques for *in situ* measurement of soil properties.

Bill's more than 180 special lectures, seminars, workshops, and short courses in the United States, Europe, the Middle East, India, China, and Japan over three decades resulted in applications of his developments throughout the world. One of his lectures was the Terzaghi Lecture, the most prestigious named lecture in his field. His services were required in the 1950s for large radar antennas for the Distant Early Warning (DEW Line) system. Later his work was applied to the design of Texas Towers for both offshore tracking towers and oil exploration. The current state of the art in the design of foundations for large structures, earth dams, and nuclear power plants to resist earthquake shaking is heavily based on the methods developed by Bill Richart.

He shared his knowledge through more than seventy publications, for which he won nine prestigious national awards, and through his work as a consultant to many private and government agencies. These included the U.S. Army Corps of Engineers Waterways Experiment Station, U.S. Army Chief of Engineers, U.S. Air Force Weapons Laboratory, U.S. Air Force Science Advisory Board, U.S. Department of the Interior Bureau of Reclamation, NASA Apollo Lunar Landing program, and the Nuclear Regulatory Commission Advisory Committee for Reactor Safety.

Throughout his career, Bill was dedicated to the highest standards in engineering education. As department chairman of civil engineering at the University of Michigan, he greatly enhanced the quality of civil engineering through recruitment of outstanding new faculty members, many of whom have become leaders in their own right. He nurtured many graduate students who have gone on to make significant contributions as researchers, practicing professional engineers, university professors, department heads, and deans of engineering.

A loyal member of the American Society of Civil Engineers (ASCE), he served in many roles as chairman of technical committees and, most important, as chairman of the Executive

Committee of the Geotechnical Engineering Division from 1968 to 1969. He received the Terzaghi Award and later was recognized for his service to the ASCE, being elected as an honorary member in 1986.

Bill was a lifelong avid golfer, winning many tournaments both as an individual and with his wife Betty and sons John and Willard. He served as coach of the women's golf team at the University of Michigan before a professional was appointed.

Emilio Rosenblueth

1926-1994

Written by Luis Esteva

Submitted by the NAE Home Secretary

In the early morning of January 11, 1994, ended the life of an exceptional man, after an outstanding career in engineering research and practice in Mexico, rich in contributions of international relevance.

Emilio Rosenblueth was born in Mexico City in 1926. In 1948 he graduated as a civil engineer from the National Autonomous University of Mexico (UNAM), and in 1951 he obtained his Ph.D. degree from the University of Illinois. His dissertation contains contributions to the analysis of structural response, which still today, more than forty years later, form part of the criteria recommended for the practice of earthquake-resistant design.

Upon his return to Mexico from Illinois, he spent several years working as a researcher at the Institute of Geophysics of UNAM, and as a structural designer at the Federal Commission of Electricity. At the same time, he started his career as a consulting engineer. He was appointed professor of the School of Engineering at UNAM in 1954 and researcher at the Institute of Engineering of the same university upon its opening in 1956. He acted as director of that institute from 1959 to 1966 and remained a member for the rest of his life, with the exception of the period 1977-1982, when he was under-minister of educational planning at the Ministry of Public Education of Mexico. From 1966 to 1970 he split his time at UNAM between the activities of scientific research and the responsibilities of dean of science.

From the start of his career, Emilio remained at the forefront of research in earthquake engineering and structural reliability in the world. His influence on the development of these areas was decisive because of both the value of his own contributions and the impact they had on the work of other researchers. His work is characterized by his ability to identify new relevant problems, define them conceptually, formulate rational frameworks for their analysis, evaluate their importance through the use of simplified models preserving the essential features of the detailed ones, and present his conclusions in forms useful both to those who would apply them in the practice of structural engineering or in the formulation of recommendations, and to those who would take them as starting points for new research programs. His work was always valuable by itself and for the ideas it sowed. Emilio was a world leader in the development of the probabilistic theory for the analysis of seismic response of linear systems, as well as of simplified models, based on that theory, which form the basis of criteria applied in the practice of earthquake-resistant design of complex systems. This encompasses his contributions to the methods for seismic response analysis of multi-degree-of-freedom systems, of systems with in-plan eccentricities, and of slender structures, such as chimneys. Equally valuable, because of their simplicity and their practical relevance, are the methods and criteria he proposed for taking into account the simultaneous action of several earthquake-ground-motion components.

The first high-intensity earthquake to affect Mexico City after several tall buildings were constructed occurred in 1957. Emilio played a prominent role in updating the Mexico City Building Code, in particular its earthquake-resistant-design chapter, where he introduced a number of innovative concepts, many of which were incorporated later on in the regulations for earthquake-resistant structures of the most advanced countries. Shortly after this, he developed a probabilistic model for studying the influence of soft soil, such as the clay formation in the Valley of Mexico, on the characteristics of earthquake ground motion.

Even during his days as under-minister of educational planning for the Ministry of Education, he found reason and time to formulate conceptual mathematical models of problems that appear when making decisions under uncertain conditions. His ideas about the processing of doubtful information and the combination of expert opinions in decision making belong to this time. Those ideas crystallized some time later in published articles. A large number of articles of analysis and dissemination about education in general and problems specific to that field in Mexico were also produced during those years. At the end of 1982, Emilio resumed his career as a full-time researcher.

Emilio was not only a researcher capable of identifying the essence of the problems, studying them, and solving them. The profoundness and rigor of his work did not keep him away from the world of practical criteria and simple formulas. On the contrary, everything he produced would end up modifying a norm, furnishing a new tool for everyday work, or changing the ways of looking at a practical problem; and he did not leave all applications to others. He was the author of several innovative structural systems that helped in obtaining efficient solutions to important engineering problems.

Most of Emilio's professional work as a structural designer and as a consultant in this and related specialties took place at DIRAC, a leading group of consulting engineering firms in Mexico City, of which he was one of the founders in 1956, its general director from 1956 to 1970, and its president from 1970 to 1977. Many outstanding projects in Mexico and abroad benefited from his unusual ability to grasp the most relevant theoretical and practical problems, from his clear and wide vision, and from his decided drive to optimize. His involvement in practice was the source of a fertile interaction with his research programs, as well as with his participation in building code revisions.

He was always guided by the same rule of action, optimizing for society. Thus, he felt compelled to know and understand other disciplines besides engineering in his search for the information and tools needed to solve the problems that the real world posed to him. He understood the need of researchers to isolate themselves in the laboratory or in their mathematical models, the problems they want to solve; but he taught us that engineers, on the contrary, must understand the interactions occurring among nature, men, and engineering works if they are to achieve their goal of optimizing. But optimizing implies assigning values to the possible consequences of those interactions as they are affected by engineering decisions. This takes an engineer to the study of the values of individuals and societies, of their preferences and their attitudes in the face of uncertainty and risk. In the search for information, tools, and social values an engineer interacts with specialists in diverse disciplines: mathematicians, geophysicists, and sociologists, among others; an engineer learns from them and contributes to their fields.

Emilio's work as an educator is also outstanding. Very few have known how to stimulate their students as well as he did with new problems and novel ideas. He let them do their jobs and forced them to make use of all their resources and capabilities. Those who worked with him will not forget the challenges he made them face and the profit derived from having overcome those challenges.

In 1976 Emilio was designated an honorary member of the American Concrete Institute and an honorary foreign member of the American Academy of Arts and Sciences; in 1977, an honorary member of the International Association for Earthquake Engineering; in 1982, an honorary member of the American Society of Civil Engineers. In 1970 he was elected to the U.S. National Academy of Sciences, and in 1977 the National Academy of Engineering, both as a foreign associate member. He was a member of the National Research Council's Division of Engineering Committees on Earthquake Engineering Research, Ground Motion Panel (1966-1969) and the Structural Synthesis and Design Panel (1967-1969); the

Commission on Engineering and Technical Systems, Committee on Reliability Methods for Risk Mitigation in Geotechnical Engineering (1992-1993); and the international liaison representative to the U.S. Committee for the Decade for Natural Disaster Reduction (1989-1991).

Emilio was the recipient of a large number of national and international awards. To name a few among the Mexican awards, he received the Research Award of the Mexican Academy of Scientific Research in 1963, the National Science Award in 1974, and the UNAM Award in Physical Sciences in 1986. The international awards he received include the Walter L. Huber Civil Engineering Research Prize in 1965, the Moisseiff Award in 1966, the Alfred M. Freudenthal Medal in 1967, and the Nathan M. Newmark Medal of the American Society of Civil Engineers in 1987; the Prince of Asturias Prize offered by the King of Spain in 1985; and the Bernardo A. Houssay Inter-American Science Prize from the Organization of American States in 1988. In 1987 he was designated emeritus professor of UNAM. A few weeks before his death he received from the hands of the president of Mexico the National Engineering Award, granted by the Organization of Civil Engineers of Mexico (Colegio de Ingenieros Civiles de México).

To enumerate the positions held by Professor Rosenblueth in the scientific and professional organizations of Mexico and the rest of the world, the actions he carried out, the groups with which he collaborated, and the fruits he left would be an exhausting job. His work will endure in the daily work of many who devote their efforts to putting science and technology at the service of mankind, in particular those who strive to develop and apply criteria and methods to make optimum use of the resources of society for human safety and well-being.

Shinroku Saito

1919-1994

By Rustum Roy

Dr. Shinroku Saito, chairman of the board, Kanagawa Academy of Science and Technology (KAST), and president of Nishi Tokyo University, died on November 21, 1994, at the age of seventy-five. Shinroku Saito was born March 30, 1919, in Utsunomiya, Tochigi Prefecture, Japan.

Dr. Saito was elected to the U.S. National Academy of Engineering as a foreign associate in 1994 and was deeply affected by this honor from his American colleagues. Already in poor health for nearly a year, he was unable to attend the installation ceremony in October 1994. He arranged, however, for his son, who makes his home in Paris, France, to attend the ceremony and receive the honor in his place. His son then flew to Tokyo and handed over the NAE foreign associate certificate, hardly one month before Dr. Saito died.

Shinroku Saito was educated as an aeronautical engineer graduating from Tohoku University in 1943. Immediately after graduation he was attached to the Central Research Laboratory for Aeronautics for the duration of the war.

In 1945 he moved to the Tokyo Institute of Technology, which was to be his main professional base for the next thirty-five years. He had changed fields to materials engineering in 1945 and became one of Japan's leading engineers in structural ceramics.

He rose through the ranks from 1945 to 1977 as research associate, associate professor, and professor in the Research Laboratory for Engineering Materials of the Tokyo Institute of Technology. In 1977 he was selected as president of the institute.

After mandatory retirement in 1981, Dr. Saito served as president of the Technological University of Nagaoka. In 1989 he was the principal driving force, together with the governor of the prefecture, in establishing the Kanagawa Academy of Science and Technology (KAST) near Yokohama. This unique new style of institution for research and graduate training may prove to be one of Dr. Saito's greatest innovations. It is located in Kanagawa Science Park, possibly the biggest "research park" in the world, enabling KAST to interact with some 100 companies on-site and to do state-of-the-art research at the same time. Finally, he also became president of the Nishi-Tokyo University, part of a most innovative worldwide chain of educational institutions started by his colleague, Dr. Shoichi Okinaga.

Yet Dr. Saito's impact on materials engineering took place mainly in the realm of national research and development policy. He, with two or three other individuals such as Dr. T. Yamauchi, who preceded him in the presidency of Tokyo Institute of Technology, helped put Japan's industry ahead of the world in the field of ceramics.

Dr. Saito served on numerous advisory committees to the government, many more than can be mentioned here. In the Ministry of Education and Culture, he became chairman of the Japan Society for Promotion of Science committee from 1970 to 1982.

He served on four major committees of the Ministry of International Trade and Industry. He was a pioneer in the Fine Ceramics Project in 1979 and was affiliated with it until 1993. He also served on the Key Technology Center, New Energy and Industrial Technology Development Organization, and Small Business Corporation committees, and was a councillor to the International Superconductivity Technology Center.

In the Science and Technology Agency, he was involved in key committees such as the National Space Development Agency of Japan (1979 to 1994) and the Research Development

Corporation of Japan (1993 to 1994). He chaired the Exploratory Research for Advanced Technology committee as well as the Advisory Committee of the National Institute for Research in Inorganic Materials.

He also served in the Prime Minister's office from 1981 onward on the Council for Science and Technology and Space Activities Commission.

Dr. Saito was a key figure in Japan's rise to the top of the ceramic materials world through the Tokyo Institute of Technology, Ceramic Society of Japan, the Japan Fine Ceramics Association, and Kanagawa Academy of Science and Technology.

Among the honors he received are a dozen of the most significant such in Japan. Internationally, in 1993 he was elected to distinguished life membership in the American Ceramic Society, and as a Chevalier de l'Orde National du Merite of the Republic of France. Dr. Saito was a champion of international collaboration. With his blessing, his colleague Professor S. Somiya established the first U.S.-Japan Cooperative Seminar in Ceramics in 1968. He was given the Pioneering Bridge-Builder Award for such activities by the Pennsylvania State University's Materials Research Laboratory.

Dr. Saito was not a narrow scientist-engineer. He grew up in a strongly religious culture and home and maintained a deep and abiding interest in the interaction of science and technology with society. He wrote widely on various aspects of globalization and "negentropy." I was pleased to attend the Second Yoko Conference on "Creating the Future of Mankind" in 1989 and observe this deeper side of Professor Saito in a gathering of the world's leading theologians and philosophers.

Dr. Saito has set a very high standard for citizen-engineers. His broad involvement not only in research but in engineering, technology, national policy, and even philosophy and religion, is a model for all.

Owen Saunders

1903-1993

Written by N. P. W. Moore

Submitted by the NAE Home Secretary

Owen Alfred Saunders, mathematician, engineer, and distinguished university administrator, formally professor of mechanical engineering, dean and acting rector of the Imperial College of Science Technology and Medicine, London, and vice-chancellor of the University of London, died on October 10, 1993. It is somewhat unusual for tributes to be composed after a certain interval, but in the case of Owen Saunders this is no disadvantage. On the personal side, tributes have continued to come in from old students and colleagues across the world. Almost exactly a year ago a memorial service was held in London at St. Margaret's Westminster attended by representatives of universities, learned societies, government and industrial research, by members of his family, numerous friends, and colleagues stretching back to his days at Cambridge in the early 1920s. One old student had crossed the Atlantic and the Japan Society of Mechanical Engineers presented a memorial plaque. It was not a sad occasion, and following the service friends and colleagues gathered at his old college where his presence had been quietly dominant since 1932. Someone said, "we will not see another gathering the like of this."

Owen Saunders was born in London on September 24, 1904. His father was a practical engineer with an inventive turn of mind; his mother, a school teacher of Welsh origin, greatly encouraged Owen in his early studies. The family were of modest means and times were hard. However, Owen entered Emanuel School, London, and his sister Nancy studied music and became a concert pianist. Many memories of the young Owen as a highly intelligent, somewhat solitary schoolboy survive. He tended to find his own way in his studies and surprised his family by constructing his own crystal wireless receiver. He also overcame the advice of his headmaster and abandoned classics for science.

In 1921 Owen entered Birbeck College, London, and gained a general science degree in 1923. He was delighted with science and proceeded to Trinity College, Cambridge, with a scholarship to read natural sciences. In 1924 he gained an open scholarship. The freedom of Cambridge was greatly to his liking; he was inspired by the lectures of Horace Lamb and Rutherford. In the slender collection of papers in his study when he died were neatly bundled sets of notes of all his Cambridge lectures from so long ago. As we expected there was scarcely a note of his later achievements; he was the most modest of men.

It was during his years at Cambridge that Saunders first became interested in heat transfer research and its application to engineering design. Again, his independent nature intervened, and having failed to find facilities for the work he sought in Cambridge, he moved to the Government Fuel Research Station at Greenwich in London to work with Professor C. H. Lander. This was the beginning of a career-long devotion to the fundamentals of heat transfer in all its applications. It was also the beginning of a remarkable cooperation with Dr. Margaret Fishenden who had herself worked with Rutherford in Manchester. Together they set about correlating data particularly relating to furnace design. They also formulated a wide-ranging program of fundamental research.

Both Saunders and Fishenden had strong backgrounds in applied physics, mathematics, and fluid mechanics. They were also convinced of the value of close collaboration between industry and research in universities and government establishments. In this they were strongly influenced by Sir

Henry Tizard, and Saunders particularly was drawn into the inner sanctum of scientific effort that was so vital during the Second World War.

In 1932 *The Calculation of Heat Transmission* by Fishenden and Saunders provided, for the first time, a source book that enabled designers to apply, logically, the mass of data on all modes of heat transfer. It did more than this; it uncovered gaps in understanding and formed a basis for new experiments and correlations. It was in 1932 that Saunders moved to Imperial College where Sir Henry Tizard was rector; and Lander, professor of mechanical engineering. Margaret Fishenden also joined the team at Imperial College. In retrospect we can see this period as not only highly productive in research, but also as the beginning of a new style in mechanical engineering teaching with less emphasis on practical experience, (Saunders later referred to this as the "oily rag" approach) —and instead a devotion to fundamentals. This led to a softening of the boundaries between science and engineering.

It was at this time that Saunders undertook his pioneering studies of free convection over a wide range of conditions, including elevated pressure. In all his work there is a strong devotion to fundamentals and a fascination with the principle of similitude and logical design of experiments. A series of papers in the *Proceedings of the Royal Society* records his work on natural convection in liquids, including mercury; studies of flow and heat transfer in granular beds, and measurements of radiation were the subject of other important papers at this time. The heat transfer laboratory at Imperial College flourished and Saunders was drawn into the teaching of thermodynamics and dynamics in the mathematics department as well as in the engineering departments. War clouds were gathering over Europe and Saunders, under the influence of Tizard, was increasingly drawn into work for government.

From 1940 Saunders embarked on a series of full-scale experiments to boost the output of piston engines for military aircraft operating at high altitude. He showed that some 30 percent increase in thrust could be obtained by optimizing the wave effects in the exhaust system. Later experiments to boost power output by the injection of liquid oxygen remained vividly in Saunders' memory. This was in part due to his having destroyed one Merlin engine on the test bed before the oxygen flow was well-regulated and also a curiosity, in long retrospect, as to the legality of carrying his oxygen injector on the London Underground!

It is almost certain that Saunders was aware of the work of Sir Frank Whittle on jet propulsion at an early stage. He would have been fascinated by the drive and inventive genius of Whittle. Saunders' own contribution sought to refine the mixing in the combustion chambers and improve the control system. As the cloak of secrecy was gradually lifted, we learned that Saunders had made important contributions to research on rockets and to a number of aspects of petroleum warfare.

In 1946 Saunders was appointed professor and head of the Department of Mechanical Engineering at Imperial College. He later served as dean of the City and Guilds College (the Engineering School of Imperial College) as pro-rector and for the years 1966 to 1967, acting rector. In 1967 he became vice-chancellor of the University of London. Throughout these years Saunders raised the standing of his department to a level of international distinction and contributed to the creation of the expanded Imperial College as a center of excellence in engineering and science. Saunders moved easily between scientists and engineers and was no stranger to the corridors of government.

Despite so many tasks, Saunders continued his research. His fascination with the future development of gas turbine in the air and on land and sea provided a focus for much of his effort. Pioneering work on heat transfer in supersonic flow proceeded side by side with flame radiation studies and fundamental work on the cooling of turbine blades.

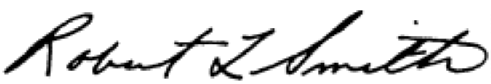
Saunders continued to be closely associated with government and industrial research. Old interests were revived in the convective heating of liquids, improved studies of regenerators for gas turbines were undertaken, and there was constant concern with problems of flame radiation in collaboration with the International Flame Radiation Committee of which Saunders was a founding member. Fundamental papers on natural convection and on heat transfer and flow associated with rotating discs were presented to the Royal Society. Saunders' last experimental studies examined the heat transfer and lubrication performance of piston rings.

It was some time before the interdisciplinary approach that flourished during the war years influenced the design of engineering courses. Saunders had a clear vision of the patterns of education that were needed, and he knew where to look for guidance. Friendships with McAdams and Max Jakob were long standing. The Massachusetts Institute of Technology was a Mecca for academics in the 1950s. New friendships developed with Professor J. H. Keenan and Professor H. C. Hottel. Both were frequent visitors to the United Kingdom and Saunders encouraged his young staff to venture across the Atlantic. Research was encouraged, and perhaps even more important, there was a near revolution in the teaching of engineering thermodynamics under the direct influence of Kennan. In addition, the advantages of teaching postgraduate courses were slowly appreciated. A course in gas turbine technology was the first, followed by nuclear power. Both courses had strong participation from industry on both sides of the lecture bench. New material filtered down to the undergraduate courses, which were finally extended to four years, and individual projects became a feature of the final years.

Honors both civil and academic were bestowed on Owen Saunders. He was elected to the fellowship of the Royal Society in 1958, he was president of the Institution of Mechanical Engineers in 1961. Honorary membership in the American Society of Mechanical Engineers followed also in 1961 as well as honorary membership in the Japan Society of Mechanical Engineers in 1965. Saunders was immensely proud to have been awarded the Max Jakob Memorial Award of the American Society of Mechanical Engineers and the American Society of Chemical Engineers in 1966. By a happy chance a comment by Max Jakob has been preserved in the record of the National Academy of Engineering: "There is scarcely a corner of heat transfer in which something he has written is not to be found." In 1965 Saunders was created a Knight Bachelor. Honors from universities in the United Kingdom and overseas followed, and again it was a measure of his modesty that he never made a list of them! As vice-chancellor of London University in a time of change, his persuasive skills in administration were invaluable. It is significant that major reforms now (in 1995) being formulated are based in part on the *Saunders Report* written some twenty years ago.

The early years of a long retirement were saddened by the death of Marion, his first wife, and the loss of a gifted daughter. Owen was the most resilient of men. He remarried in 1981, and Daphne welcomed old friends to a new home closer to London. Life was still rich in music and friendships. He wrote sparingly but took immense trouble to pen accurate appreciations of old colleagues.

Saunders was a richly gifted man. He moved easily between mathematical analysis and experimental science. He had vision and clarity and applied both to engineering science and university administration. He was convinced that imagination was vital for success in engineering experiment and design. He was suspicious of solutions based only on experience of what had been done before. A friend of many years' standing, Dr. G. R. Feilden ended his appreciation of Owen with these words, "Let us all remember him for his teaching and research achievements, as a major advisor to governments, but above all, as a delightful and humane man."



Robert L. Smith

1923-1995

By Ross E. Mckinney

Robert L. Smith, professor emeritus of Water Resources Engineering at the University of Kansas, died on December 9, 1995, at the age of seventy-two.

Bob was born on October 31, 1923, and raised in Schaller, Iowa. Growing up in Iowa gave Bob a strong work ethic and a sense of responsibility. He graduated from Schaller High School as valedictorian in 1941 and began his college education at the University of Iowa. World War II interrupted his education. Bob served with the United States Army in the South Pacific. He was a staff sergeant in the 756th Field Artillery Battalion. After the war Bob completed his B.S. in civil engineering with honors at the University of Iowa and went on to obtain his M.S. in civil engineering while working at the Iowa Institute of Hydraulic Research under the watchful eye of Hunter Rouse in 1948.

With his M.S. degree in hand, Bob Smith moved to Lawrence, Kansas, and joined the Kansas University Engineering School faculty as an assistant professor of applied mechanics. He remained on the faculty from 1948 to 1952 during the brunt of the World War II veterans enrollment.

In 1952 Bob was appointed executive director of the Iowa Natural Resources Council. Over the next four years Bob gained an insight into some of the water problems that faced the Midwest. He also began to learn that political solutions to water problems were not always the same as engineering solutions. As a young engineer, he found that real-world problems were not as simple to solve as the problems in engineering textbooks. His success in Iowa attracted attention in Kansas. In 1956 Bob Smith was appointed as executive secretary and chief engineer of the Kansas Water Resources Board. For Bob this was a perfect opportunity. Kansas had suffered through periodic floods and droughts and needed a sound water resources policy. With great effort Bob was able to help develop the Kansas Water Plan and to get the Kansas legislature to accept it.

As Bob Smith stepped back to look at his accomplishments at the Kansas Water Resource Board, the University of Kansas decided to establish a new graduate program in Water Resources Engineering and Water Resources Science. Dean John McNown persuaded Bob to join the civil engineering faculty at the University of Kansas and develop this new graduate program in water resources. It was a perfect opportunity to put his knowledge of water resources into teaching to help a new generation of engineers gain a better understanding of how the public and policymakers view engineering decisions concerning water resources issues. The new program was interdisciplinary drawing upon engineering, liberal arts, and the law.

Emphasis on water research at the federal level resulted in the establishment of Water Resources Research Institutes at land-grant universities across the country. Because of Bob's Water Resources Program at the University of Kansas, the state of Kansas established its Water Resources Research Institute at both Kansas State University and the University of Kansas. It was only natural that Bob Smith was appointed the director of the Water Resources Research Institute at the University of Kansas. In 1966 Bob was appointed chairman of the Civil Engineering Department at the University of Kansas as well as being invited to serve as special assistant to the director, Office of Science and Technology, under President Lyndon B. Johnson. This gave Bob an opportunity to help influence critical water resource decisions at the national level and gave him new insight into how engineering decisions are made in Washington. He served as chairman of the Committee on Water Resources Research for the Federal Council for Science and Technology. After a year in Washington, Bob returned to the University of Kansas as chairman of civil engineering and helped the department to grow and mature as a major engineering research department. He stepped down as department chairman in 1972 to devote more time to teaching and research.

Bob's water resources research dealt with the development of quantitative methods for evaluation of floods and droughts. His midwestern experience had shown him that periodic floods were followed by periodic droughts and that engineers should understand both extremes. It was important for young engineers to be able to measure the normal water cycles and to predict the consequences.

Bob Smith was elected to the National Academy of Engineering in 1975 in recognition of his contributions to water resources planning and engineering. Over the years he served on a number of committees for the Academy and the National Research Council. His last committee assignment was for the Commission on Geosciences, Environment, and Resources, Committee to Evaluate the Hazardous Materials Management Program of the Bureau of Land Management, March 1989 through December 1992.

Bob was also very active in the American Society of Civil Engineers (ASCE). He was chairman of the Water Resources Planning Committee of the Hydraulics Division in 1962 and president of the Kansas Section in 1963. At the University of Kansas Bob served as faculty adviser to the student chapter of ASCE from 1967 to 1969. In 1972 he chaired the Committee on Water Resources Education and in 1976 the Water Resources Planning Committee. He served as chairman of a Special Inter-Divisional Committee on Federal Policies in Water Resources Planning from 1981 to 1985, and he chaired the Local Arrangements Committee from the ASCE National Specialty Conference, Division of Water Resources Planning and Management in 1987. Bob was very proud to be a member of the

ASCE and strongly believed that all civil engineers should be members of ASCE and actively participate in the society's activities at all levels.

It is not surprising that Bob was willing to serve on other committees at the state and federal levels. He was a member of the United States Geological Survey (USGS) Advisory Committee on Public Use of Water Data from 1965 to 1988. He served on the Office of Water Research and Technology Advisory Panel on Water Resources Research in 1976. From 1956 to 1965 Bob was chairman of the Kansas Negotiating Team for the Kansas-Oklahoma Compact on the Arkansas River Basin. He was a member of the Governor's Economic Research Advisory Committee in Kansas from 1964 to 1966; and vice-chairman of the Governor's Task Force on Water Resources, 1977 to 1978. He never turned down a request for assistance if he could help.

In addition to serving as chairman of the Civil Engineering Department and director of the Water Resources Research Institute at the University of Kansas, Bob Smith was an active participant in committee assignments at the university level, the engineering school level, and at the department level. Bob's greatest academic concern was always for his students. He attracted the best students and challenged them to rise above the accepted standards to reach their highest potential. One of his greatest rewards was working with his students on special projects after they had graduated and had entered professional engineering.

Bob received a number of awards in recognition of his accomplishments over the years. In 1967 the Kansas Engineering Society recognized him as the "Outstanding Engineer of the Year." He received the USGS Centennial Plaque in 1980 and the Kansas University, School of Engineering, Miller Award for Professional Service in 1985. The Water Resources and Management Division of ASCE gave him its Julian Hinds Award in 1988. The University of Iowa gave him its Distinguished Alumni Achievement Award in 1990; while the University of Kansas gave him its Distinguished Engineering Service Award in 1993. The American Institute of Hydrology bestowed on Bob its Ray K. Linsley Award in 1991.

At the University of Kansas, Bob served as the Glen Parker Distinguished Professor of Water Resources and as the Deane Ackers Distinguished Professor of Civil Engineering, retiring in 1989 as professor emeritus. During the course of his teaching, he was an inspiration not only to his students but also to younger faculty members. He always gave his best and expected everyone around him to do the same.

A major part of Bob Smith's success came from the loving support he always received from his wife, Lucy. Bob Smith and Lucille Johnson were married in Rochester, New York, in 1947. They had two lovely daughters, Barbara and Deborah. Both daughters went on to become medical doctors and raise their own families. For Bob, the most fun in the summer came when he was fishing with his five grandchildren in Minnesota.

Bob Smith was a teacher, a researcher, and an engineer's engineer. He was a leader in developing engineering water resource policies that made life better for everyone.

Julius Adams Stratton

1901-1994

By Edward E. David, Jr.

Julius Adams Stratton, eminent scientist, educator, leader of institutions, and an important figure in the ultimate establishment of the National Academy of Engineering, died on June 22, 1994. He was ninety-three years old.

Dr. Stratton grew up in Seattle, Washington, where he was born on May 18, 1901, and attended the University of Washington for one year before transferring to the Massachusetts Institute of Technology (MIT), from which he received his bachelor's degree in electrical engineering in 1923. He spent the following year in France at the Universities of Grenoble and Toulouse, returning to the institute for his master's degree, also in electrical engineering, which was awarded in 1926. With an institute traveling fellowship for study abroad, he enrolled at the Swiss Federal Institute of Technology in Zurich and received his doctorate in mathematical physics in 1928. He then returned to MIT as an assistant professor of electrical engineering and proceeded through the ranks to a full professorship in the Department of Physics to which he had transferred in 1930.

In the late twenties he had joined with other young faculty members returning from study abroad in urging substantial curricular reform, particularly in physics, in the light of recent developments in the field. His eventual transfer to that department had been anticipated when he returned to Cambridge in

1928, and it occurred at an important time of change, coinciding with the appointment of Karl T. Compton as president. A strong believer in "science for its own sake" and also as an important source of enrichment for engineering education, Compton would soon take steps leading to major changes in the department—among them, the appointment of John C. Slater as its leader. The physics curriculum was revised, and plans went forward for increased opportunities for graduate work in both theoretical and experimental physics.

Dr. Stratton's research prior to World War II focused on short electromagnetic waves—their launching, propagation, and reception—and was carried out at the institute's Round Hill Field Station in South Dartmouth, Massachusetts. Out of this work came a deep understanding of radio systems at all frequencies, but more important was the development of tools drawn from Maxwell's equations for analysis, design, and the implementation of such systems. This fundamental understanding was later to become important to the development of microwave radar during World War II and for the emergence of microwave radio, widely used today in telephone, television, and data communication. Through this work MIT made major contributions to communications technology that has evolved over the years, and Dr. Stratton was an early contributor. His seminal writings and publications on electromagnetic theory were registered in his 1941 book by that name. *Electromagnetic Theory* is still in use today.

In 1940 he joined the famous Radiation Laboratory, which developed microwave radar and pioneered the LORAN navigation system. At that time he was a member of the Theory Group. By 1942 and for the remainder of World War II he was in Washington as an expert consultant to Secretary of War Henry L. Stimson. There he worked on radio guidance systems for aircraft, ground-based radar, and all-weather flying systems, leading naturally to his assistance in the planning for the use of radar in the Normandy invasion. For his contributions to the war effort, he was awarded the United States Medal for Merit not only for his "tireless efforts and skillful application of his professional knowledge," but also for his judgment and his "unique tact and vision in enlisting the active cooperation of industry and the development agencies."

In the words of Dr. Stratton, the Radiation Laboratory had produced more than "hardware." It had also produced "enormous advances in the entire field of electronics," a field encompassing the disciplines of both physics and electrical engineering. When the laboratory was disbanded at the end of World War II, the institute was ready with a proposal put forth by John C. Slater to continue this important work through a "new kind of laboratory" to be established jointly by his department of physics and that of electrical engineering. By late 1944 Dr. Stratton had been chosen leader, and he played a key role in its founding and in negotiating its support through a "tri-services" research contract. On July 1, 1946, the Radiation Laboratory's Basic Research Division, which he had headed for several months, became the nucleus of the institute's new Research Laboratory of Electronics (RLE).

During his tenure in this position, RLE became a major resource for educating graduate students and some undergraduates in carrying out both focused and fundamental research. Among the activities he supported and encouraged were construction of a linear particle accelerator, development of technologies based on Norbert Wiener's mathematics, fundamental explorations in plasma physics, efforts in modeling neurons and the nervous systems of animals and human beings, analog computation and simulation, and various other subjects—truly an interdisciplinary mix at the cutting edge of research. This pattern of interdisciplinary research and collegial cooperation established by Dr. Stratton is still evident in RLE. In 1980, and in keeping with this theme, William R. Hewlett, an alumnus and founder of the Hewlett-Packard Company, established at MIT the Julius A. Stratton Professorship in Electrical Engineering and Physics, to be held alternately by a faculty member from these two departments.

The year 1949 brought a major change in his career. He became the chief academic officer of MIT as its first provost, with the added title of vice-president two years later. He was named chancellor in 1956 and acting president late in 1957. On January 1, 1959, he took office as the eleventh president of the institute. When he reached mandatory retirement age in 1966, his influence had been felt throughout the institution for nearly two decades. During this time of change and expansion, he had maintained a firm commitment to students, the quality of their education and the environment in which they lived and studied. A major building program had included a much-needed dormitory for women, making possible an increase in their enrollment. He had overseen the integration of the humanities, social sciences, and management within the context of the institute's central mission in science and technology, and he had encouraged the growth of research and interdisciplinary centers following the general pattern of RLE. As he left the presidency, he was elected a life member of the MIT Corporation.

In 1966 he moved to New York as chairman of the board for the Ford Foundation, of which he had been a trustee since 1955. There he streamlined the board's function to allow more time for in-depth review of program trends, instituted a system of board visiting committees for the various divisions, and served as an influential spokesman in the cause of private philanthropy. When he reached yet another mandatory retirement age, he returned to Cambridge, where he continued to be concerned with MIT affairs.

Dr. Stratton was elected to the National Academy of Sciences in 1950 and served as vice-president from 1961 to 1965. During that period he chaired an Academy committee to explore with the Engineers' Joint Council the possibility of founding a similar organization for engineering, proposals for which had been set forth from time to time over the years. The road was not easy, but in 1964 a National Academy of Engineering (NAE), of which he became a founding member, was established under the charter of the Academy of Sciences, of which Frederick Seitz was then president. He and Dr. Stratton have been credited with finding acceptable bases for the NAE.

His service to the engineering and scientific community was continuous and distinguished. He was a member of the National Science Board and its Executive Committee from 1956 to 1962 and was reappointed in 1964. He resigned in 1967, however, when he was appointed by President Lyndon B. Johnson as chairman of the Commission on Marine Science, Engineering, and Resources recently established by Congress. Two years later their thorough review of the entire field and its relation to national needs appeared in a landmark report, *Our Nation and the Sea*, which led to the establishment of the National Oceanic and Atmospheric Administration (NOAA), a Coastal Zone Management Program, and the National Advisory Committee on Oceans and Atmosphere (NACOA) on which Dr. Stratton served from 1971 to 1973. He was a life trustee of the Boston Museum of Science and served on the board of the Charles Stark Draper Laboratory.

In the field of education he was a trustee of Vassar College and Pine Manor College and the Carnegie Foundation for the Advancement of Teaching and also served for several years on the board of the ESSO (now Exxon) Education Foundation.

His awards and decorations were legion and included the Medal of Honor of the Institute of Radio Engineers (now the Institute of Electrical and Electronics Engineers [IEEE]), and the Faraday Medal of the British Institution of Electrical Engineers. He was an officer of the French Legion of Honor, a knight commander of the Order of Merit of the Federal Republic of Germany, and a commander of the Colombian Order of Boyacá. He held seventeen honorary degrees from institutions both here and abroad. He was in addition a life fellow of the IEEE, a fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, and the American Physical Society, and a member of the American Philosophical Society.

This recitation could go for many pages. However, the two dominating features of Dr. Stratton's character were evident in all of his activities. The first of these was his insistence on excellence and integrity. He was a protagonist of the first-rate, recognizing that the futures for institutions and nations lay in cultivating excellence through people and their education. The second of his traits concerned people, students, and humanity. Though he nourished quality, he recognized that people grow in their abilities, some later, some sooner. His philosophy made room for all those climbing toward achievement. He aided such people personally and through institutional policies. His balance between excellence and compassion for individuals led to the respect and regard in which he was held by all who knew him.

Verner Edward Suomi

1915-1995

Written by Terri Gregory and Donald R. Johnson

Submitted by the NAE Home Secretary

Professor Emeritus Verner E. Suomi died at University Hospital in Madison, Wisconsin, on Sunday, July 30, 1995, after a long battle with heart disease. Internationally recognized as the father of satellite meteorology," Professor Suomi invented numerous satellite instruments, leading to a better understanding of the global atmospheric circulation. For his Ph.D. thesis (1953), he studied the local energy budget, using a cornfield as his experimental laboratory. In conducting the first meteorological experiment from the *Explorer VII* satellite in 1959, he analyzed the radiative energy balance of the earth. This was followed by planetary investigations with similar instruments for Venus and Jupiter space probes. Professor Suomi's most influential invention was the spin-scan camera, enabling geostationary weather observations. The technology is still used worldwide today.

Professor Suomi was born December 6, 1915, in Eveleth, Minnesota. He received a B.S. in 1938 from Winona Teachers' College, Winona, Minnesota, where he met Paula Meyer. They were married August 10, 1941, in Immanuel Lutheran Church, Potsdam, Minnesota, near the Meyer family farm. The Suomis have three children: Lois was born in 1943; Stephen, in 1945; and Eric, in 1950.

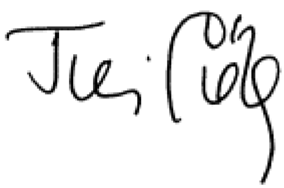
Professor Suomi taught science in Minnesota high schools from 1938 through 1941. At the start of World War II, he enrolled in a civil air patrol course and began studying meteorology. He was so taken with the nascent science, he initiated studies at the University of Chicago and taught practical meteorology to pilots. He came to the University of Wisconsin (UW) in Madison in 1948, and was one of the first faculty members of the Department of Meteorology. In 1953 he received his Ph.D. at the University of Chicago. He taught at UW-Madison for his entire career, except for appointments at the National Science Foundation (1962) and as chief scientist of the United States Weather Bureau (1964). In Wisconsin, Professor Suomi taught in the Departments of Meteorology and Soil Science and the Institute for Environmental Studies. He held the Harry Wexler professorship in meteorology and twice directed the department (1950 to 1952 and 1954 to 1957). Professor Suomi retired from formal teaching in 1986 but continued teaching a weekly undergraduate meteorology course in emeritus status, saying it was a joy to him.

In 1965 Professor Suomi founded the Space Science and Engineering Center to specialize in atmospheric research and instrument development for satellites and space probes. Later, the computer system McIDAS was developed to manage data from "his" satellites. He was also the first director of the Cooperative Institute for Meteorological Satellite Studies, founded in 1980 through the joint sponsorship of UW and the National Oceanic and Atmospheric Administration. Professor Suomi never forgot his real employers or purpose, he said, and every morning looked at the dedication plaque in his Center: "to the understanding of man's physical environment and its use for the benefit of mankind." That characterizes his work. His inventions led to useful products that expanded knowledge—geostationary satellites to show weather systems passing over the face of the earth, a powerful computer system to enable earth scientists to "drink from the fire hydrant" of enormously large satellite databases and to enhance images of the planets, and instruments to measure Earth's and other planets' heat budgets.

Professor Suomi was honored numerous times during his scientific career and each time acknowledged the help of his colleagues. At the ceremony in May 1994 to present him with the World Meteorological Organization's International Meteorological Organization Prize, he recognized University of Wisconsin contributions to his success, "all the way from deans to technicians. Without their very significant encouragement and help, it never would have come to pass." His earlier honors include the National Medal of Science, the first Walter Ahlstrom Prize (Finland), the Franklin Medal (given by Pennsylvania's scientific Franklin Institute), and awards from the American Meteorological Society, National Aeronautics and Space Administration, and National Oceanic and Atmospheric Administration. He was a member of the National Academy of Engineering, the American Meteorology Society, the American Geophysical Union, the Finnish Academy of Sciences (Helsinki), the Deutsch Akademie der Naturforscher, the International Academy of Astronautics (Paris), the American Philosophical Society (Philadelphia), the Academy of Arts and Sciences (Boston), Phi Kappa Phi, and the American Association for the Advancement of Science. He was elected president of the American Meteorological Society and of the American Geophysical Union's Atmospheric Science Section in 1968 and served on many influential committees, many of them as a director.

University of Wisconsin Provost John Wiley, who worked with Professor Suomi while he was dean of the graduate school, said, "Verner Suomi was a giant of modern science. His inventions were simple and elegant, and their consequences are ubiquitous. Anyone looking at a satellite image of Earth on the evening weather is looking at the product of a rare mind."

Professor Suomi credited the schools of iron-range country in northern Minnesota with giving him a grounding in practical scientific thought, an emphasis that he instilled in his many students. It was said of him that "he studied nature with the efficiency of an engineer and with the subtlety and insight of a true scientist." He brought that insight to his teaching, much done informally outside the classroom. Professor Suomi's professional contributions are enormously important, but his work has a far greater impact among the ranks of new scientists who are involved in observing and increasing the understanding of our global geophysical environment and in direct applications of weather imaging to humankind's daily activities.



Julian Szekely

1934-1995

By Walter S. Owen

Julian Szekely, one of the most distinguished founders of modern materials engineering, died in the Massachusetts Institute of Technology (MIT) infirmary after a long and courageous struggle with cancer on December 7, 1995. He was sixty-one years old.

Born in Budapest, Julian was a student of engineering in Hungary at the time of the uprising of October 1956. He escaped and eventually reached London, England, where he continued his studies and graduated from Imperial College with a B.Sc. degree in chemical engineering in 1959. He was awarded a Ph.D. two years later. These academic achievements become even more remarkable when it is realized that, in the very short time available, he taught himself English to a level that enabled him successfully to defend his thesis in a public examination. Julian taught for a few years at Imperial College, and it was while he was there that he met and married Joy Pearn. In more than thirty years together, they raised a happy and devoted family, four boys and a girl, all of whom were with Julian in his last days.

In 1966 Julian was appointed to the faculty of the Department of Chemical Engineering at the State University of New York at Buffalo. He became a citizen of the United States in 1972. In 1975 he accepted an invitation to join the faculty at MIT and happily spent his last twenty years at the institute teaching courses in materials engineering, based in large measure on the results of his own research and experiences, and working with his graduate students and research associates. His research group, which attracted many senior researchers from other laboratories at home and abroad, always included a half dozen or more of the brightest graduate students at MIT.

Julian first became interested in steel through his association with the BISRA research group at Imperial College and his studies of mass, heat, and fluid flow in steel-making processes continued and expanded throughout the three decades he spent in the United States. The computational modeling techniques he developed to study and optimize these complex, interactive, dynamic processes have had an important influence on the design of modern iron and steel-making processes from the blast furnace to the continuous caster. Today, they are used in all major steel-making countries.

His interest in steel making soon led him to think about the steel industry in a broader context at a time when a large segment of the industry was being transformed from a small number of integrated steel plants, built in the immediate postwar period, to many smaller specialized units described as mini-mills. At the same time, the country was experiencing the first of several oil crises, and environmental problems were assuming ever-increasing importance. Julian devoted much effort to developing models of the energy consumption and environmental impact of steel plants and the processes they employ. His intense interest in these problems and issues was first expressed publicly at the C. C. Furnas Memorial Conferences of 1972, 1973, and 1975. The proceedings, edited by Julian, were entitled, respectively, *The Future of the World's Steel Industry*, *The Steel Industry and the Environment*, and *The Steel Industry and the Energy Crisis.* Julian's close association with the steel industry continued throughout his years at MIT through his contributions to many conferences, his memberships on committees of the National Research Council's National Materials Advisory Board, and his consulting visits to steel companies in the United States, Europe, and Japan. His continuing study and analysis of the problems of the world's steel industries culminated in what he described as "A Top Executive Steel Summit," held in Mattsee, Austria, only four months before he died, at which he made a major contribution to discussions exploring future directions that the industry might take.

At the same time as he was modeling and studying the big picture, he continued to study critical components of individual processes. One of the most important of these was the modeling of the swirling flow in the nozzles of continuous casters, a subject on which he published a number of papers in recent years. This, like much of his work, has had a major influence on the direction of research in Japan and Europe as well as in the United States.

Julian's enthusiasm for his work was tireless, his range of interests unlimited, and his output prodigious. The list of his most recent publications illustrates the amazing breadth and depth of his research interests. In 1994 alone he published twenty-eight papers, most of them the result of penetrating studies in materials processing using computational numerical methods. They include papers about the role of turbulence in weld pool behavior, mathematical models of arc welding processes, ferrosilicon production in a plasma arc furnace, and optimization of casting design. But, as always, in a few papers he set out his always-stimulating and often controversial views on everything from the future of the global steel industry to the shortcomings of engineering education.

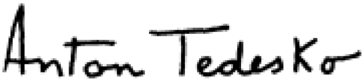
Earlier, he had studied metal spray deposition processes and this led him to consider the difficult problem of the influences of surface stress and internal fluid flow on the size and shape of an isolated droplet in gravitational and magnetic fields. This was not a new problem but, by the imaginative application of numerical, finite element techniques, Julian found a way forward that has produced some elegant answers and, in his hands, has proved to be a powerful research tool for the study of related phenomena in soldering and other metal deposition processes.

In recent years he became interested in problems of electronic materials and made important contributions to our understanding of chemical vapor deposition and the growth of single crystals. It is not surprising that he should direct his attention to the potential for processes using electromagnetic stirring or electrostatic and magnetic levitation to produce new or improved electronic materials. These interests led, in turn, to studies of gravitational effects and, inevitably, to microgravitational processing. More than two decades of study of earthbound processing uniquely prepared him to enter the space age, and he seized the challenge with his unusual, unquenchable enthusiasm. He was a major contributor to the design of the experiment involving crystal growth in microgravity, devised by various American and German universities, which was flown in 1995 by NASA. This work is continuing, and a further experiment will be flown in 1997.

In total he, together with colleagues and students, was awarded eight patents and published more than four hundred scientific papers. He published four books, three of them with colleagues, and edited eight books of conference proceedings. His books *Fluid Flow Aspects of Metal Processing*, *Optimization in Process Metallurgy* (with W. H. Ray), and *Rate Phenomena in Process Metallurgy* (with N. J. Themelis) are widely used standard texts. In all this he had the loyal and enthusiastic support of the many students and associates who gathered around him at MIT; who were taught and inspired by him; and who continued his work in countries throughout the industrialized world. His teaching style, although sometimes unconventional, was always stimulating. He taught students to concern themselves only with demonstrable facts and quantitative arguments. He was a demanding supervisor and collaborator who inspired loyalty and respect in full measure. Julian always emphasized the importance of the contributions of all the members of his research team. His name stands alone only on publications in which he expounds his personal view of some global problem; all the others carry the names of those involved in the study. Some papers have as many as five authors.

Julian was elected to the National Academy of Engineering in 1982. His remarkable career and achievements were recognized also by many awards and honors bestowed by learned societies and organizations in many different countries. Some gave him the opportunity to astound his friends by his amazing ability to master foreign languages. It was perhaps not too surprising that he should respond to an award from the Max Planck Institute in flawless German or to the Institute National Polytechnique de Grenoble in excellent French, but that, in 1992, he addressed the Japanese Engineering Academy for more than an hour in fluent Japanese is surely a truly remarkable achievement. He spent a sabbatical in Japan where he had many friends, some of whom had studied with him in the United States, and he gave much thought to ways in which the close collaborations that exist between institutions in the two countries could be further strengthened and enriched. His horizon was not bounded by geography and in the last few years he was building collaborations with groups in China and South America, two places that presented him with more linguistic challenges.

A few sentences extracted from the resolution of the faculty of MIT on the death of Julian Szekely capture much of the personality of the man: "Julian was a man of boundless energy. He loved a vigorous game of tennis or squash as much as he enjoyed a spiritual conversation. Indeed, he could often be seen in the 'infinite corridor' with a student or colleague involved in animated discussion on a vast range of educational, technical, sociological, or political topics. He was a mentor of minority students and took special pride in their achievements." To that I can only add that he was a most distinguished scholar, and engineer, an enjoyable and valued friend, and a good man.


Anton Tedesko

Anton Tedesko

1903-1994

By Ivan M. Viest

Anton Tedesko, designer of long-span reinforced concrete shells and of structures for launch facilities for military and civilian rocketry, died in Seattle, Washington, of myelofibrosis on April 2, 1994, at the age of ninety. He was associated for many years with the design firm Roberts and Schaefer, last serving as vice-president.

Elected to the National Academy of Engineering (NAE) in 1967, he served on several Academy committees, particularly during its formative years, was always on the lookout for deserving candidates, and attended NAE meetings regularly as an active participant. Congenial, attentive to his fellow members, and concerned with the well-being of his profession, he became to many of us over the years Mr. Civil Engineer of the Academy.

Anton was born of Viennese parents on May 25, 1903, in Germany, and grew up and was educated in Austria. He spent his early years in Vienna, went to high school in Graz-Wiener Neustadt, and pursued academic studies at the Institute of Technology in Vienna, where he had superb teachers. Anton considered himself lucky to have studied at the institute during the post-World War I years, which were a period of great cultural and intellectual activity in Vienna. Famous men of many fields lived in the city and influenced the worlds of science, art, literature, drama, and music. Anton went to more than one hundred music and theater events each season. It was this deep exposure to the Vienna climate and experiences that contributed to his well-rounded education. The formal results of his studies included a civil engineering degree from the Institute of Technology in Vienna in 1926, a Diploma Engineering degree from the Technological University of Berlin in 1930, and a D.Sc. degree from the Institute of Technology in Vienna in 1951.

Upon graduation in 1926 and after a brief construction experience in Vienna, he departed for the United States, where he spent two years working as a detailer and steel designer. On his return to Austria he became an assistant at the Institute of Technology under Ernest Melan, professor of steel design and construction. He was also placed in charge of a team designing industrial structures. Twenty years later, under Professor Melan, he wrote a dissertation on his experiences with strain gages placed inside full-scale long-span concrete structures, which was the basis for his science doctorate.

In 1930 Tedesko joined Dyckerhoff and Widmann, engineers and constructors known as outstanding builders of dams, bridges, and tunnels, who pioneered reinforced concrete. Tedesko felt fortunate that he was accepted as a coworker under brilliant and stimulating leaders. Two of them, Ulrich Finsterwalder and Hubert Rüsch, were later elected foreign associates of the NAE. Tedesko worked on the design of the Great Market Hall in Budapest and on the detailed analysis of the shell of a large storage hall at Tertres (Belgium), which became a prototype for many subsequent structures. One of Dyckerhoff and Widmann's new specialties was thin-shell concrete construction, and someone came up with the idea that Tedesko should return to the States and introduce shell construction to America.

An agreement was signed with Roberts and Schaefer Company to promote shell construction, and Tedesko joined the firm's office in Chicago. The depression slowed progress; many designs were made, few structures were built. Tedesko traveled by rail all over the United States. He became well acquainted with different parts of the country and years later was proud to note that he had been to all fifty states.

A major breakthrough came when the Hershey Chocolate Company wanted to build a shell structure for a sports arena. Tedesko became, at thirty-three, the designer, organizer, decision maker, and construction supervisor. When completed in 1936, the Hershey Sports Arena was the longest-span concrete building structure in the world. Tedesko established his own rules for the design and construction, which were later adopted by the industry. Publicity relating to the Hershey Arena opened the door for other shell structures. World War II found Tedesko as the manager of the Roberts and Schaefer office in Washington, where many shells were designed for Army, Navy, and Air Force installations. These structures used a minimum of scarce strategic materials and were built using industrial production methods.

After the war, he became structural manager of Roberts and Schaefer in Chicago and from 1956 to 1967 served as vice-president in New York. His responsibilities included engineering, design, cost estimating, and supervision of construction. Leading architects, such as Minoru Yamasaki and I. M. Pei, teamed up with him at times. He was responsible for the coliseum in Denver; ice arenas in Victoria, British Columbia, and Quebec City; and airplane hangars in Buenos Aires, San Diego, and Rapid City, South Dakota. As a consultant to the U.S. Air Force Headquarters from 1955 to 1970, he was involved as a troubleshooter and in decisions leading to innovative solutions for new construction and renovation.

Anton Tedesko and his Roberts and Schaefer team worked on underground launch control center domes for the ballistic missile division of the Air Force. This led to his involvement in the development of concepts and criteria for ground installations pertaining to large rockets. He became the responsible engineer for the launch pad of the Atlas Centaur space vehicle at Cape Canaveral, which included a 200-foot movable tower and a concrete dome control center. This installation was considered the takeoff point for the first trip to outer space. It was successful and later led to Tedesko's involvement in the Apollo manned lunar landing program. He was one of the four principals of URSAM, the multidisciplinary team of designers and consultants working for the National Aeronautics and Space Administration.

He considered his most exciting assignment that as structural engineer responsible for the assembly and launch facilities for the manned lunar landing program, including the Vehicle Assembly Building, the largest building on record, built in record time. The project received the 1966 Outstanding Civil Engineering Achievement Award of the American Society of Civil Engineers. Anton spoke in glowing terms of his first experience at an Apollo moon launch, the miraculous lift-off, the enormous sound, and the flames. He was stunned and shaken by this encounter.

In 1967 he left Roberts and Schaefer and opened his own office, continuing along the same lines as structural engineer on high-rise buildings and as a consultant to government agencies, contractors, and other engineers. As an investigator of structural failures, he planned the rehabilitation of damaged structures, such as the bridges of the Chicago rapid transit system. He belonged to the panel of arbitrators of the American Arbitration Association. Among his most stimulating assignments was that of one of three referees in the Federal Court in North Dakota in connection with the failure of an eighteen-mile prestressed concrete pipeline.

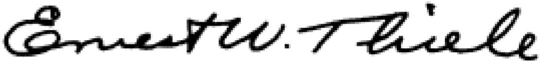
Tedesko was an invited lecturer at Columbia, Cornell, Illinois, Kansas, Lehigh, Notre Dame, Princeton, Purdue, and numerous other universities, and served as a speaker or moderator at many professional meetings. He steered graduate programs at North Carolina State and Cornell Universities. His technical publications, numbering about seventy, documented many of his structures and contributed to the advancement of design and construction in both practical and theoretical aspects. He was active in many professional groups, serving as a member of the board of directors of the American Concrete Institute (ACI), director of a section of the American Society of Civil Engineers (ASCE), and a member of numerous technical committees and councils. For nearly eight years he served as the first chairman of the Joint ACI-ASCE Shell Committee, which prepared the basic report on concrete shell practice; he remained a member of the committee until his death. He served many years on the executive committee of the Reinforced Concrete Research Council and as a U.S. delegate on the Permanent Committee of the International Association for Bridge and Structural Engineering. He attended congresses in North and South America, Europe, and Japan.

Anton Tedesko received numerous awards. He was the first American recipient of the International Award of Merit in Structural Engineering given by the International Association for Bridge and Structural Engineering. The American Concrete Institute gave him the Alfred E. Lindau Award and the Henry C. Turner Medal for accomplishments in long-span structures and for innovations and professional competence. He received the Arthur J. Boase Award in recognition of his pioneering work and his achievements in the field of shell structures. The American Society of Civil Engineers, the American Concrete Institute, and the International Association for Shell and Spatial Structures made him an honorary member. Lehigh University and the University of Vienna awarded him honorary doctorates in engineering and in science.

Tedesko had many interests besides engineering. He was an enthusiastic skier for most of his life and loved the mountains; his favorite ski vacation spots were in Utah and Colorado. He rowed in his racing shell during the years he lived close to Lake Michigan. The composers whose music he knew best were Beethoven, Richard Wagner, Gustav Mahler, and Richard Strauss.

Anton Tedesko and Sally Murray were married in Chicago and had two children and four grandchildren. Daughter Suzanne produced documentaries and has collaborated with Seattle's public television station. Son Peter is an electrical engineer and marketing manager with Westinghouse Electric Corporation.

Anton Tedesko was an outstanding engineer, eminent designer, and builder of pleasing and innovative structures, one with a warm human touch who has given guidance and strength to many in his profession.



Ernest W. Thiele

1895-1993

Written by James P. Kohn

Submitted by the NAE Home Secretary

On November 29, 1993, only nine days short of his ninety-eighth birthday, Ernest W. Thiele died in Presbyterian Nursing Home in Evanston, Illinois. His longest professional work experiences were with the Standard Oil Company of Indiana and the University of Notre Dame. He retired as associate director of research at Standard Oil (now the Amoco Corporation) in 1960 after thirty-five years there and then served as a visiting professor of chemical engineering at Notre Dame until 1970. His name was known to every chemical engineer trained after 1927, since by then all departments of chemical engineering were teaching the McCabe-Thiele method for determining distillation parameters. After 1939, most chemical engineers interested in designing chemical reactors employing solid catalysts became familiar with the Thiele modulus and catalyst effectiveness factors, which were inventions of Thiele.

Ernest Thiele was born on December 8, 1895, in Chicago, Illinois. He earned an A.B. degree from Loyola University (Chicago) in 1916. While serving briefly in the U.S. Army, he was stationed at the University of Illinois at Urbana, where he was a student of chemical engineering. He received a B.S. in chemical engineering at Illinois in 1919.

After graduation, he spent six months as a process analyst for Swift and Company in Chicago and later in Baltimore. He then was employed as a chemical engineer with Peoples Gas, Light and Coke Company in Chicago from 1920 to 1922. In the fall of 1922 he started graduate study in chemical engineering under Professor R. T. Haslam at Massachusetts Institute of Technology (MIT). He obtained a master of science degree in 1923 and a doctor of science degree in 1925. While waiting for his doctorate readers to read his dissertation on steam-carbon reactions, he developed the idea that resulted in the McCabe-Thiele method of graphical design of fractionating columns. The paper was published in *Industrial and Engineering Chemistry* (*I&E Chem.*) in 1925. After leaving MIT in 1925, he joined the Standard Oil Company of Indiana as a chemical engineer. He became assistant director of research in 1935 and associate director of research in 1950. During the wartime development of atomic energy, he was on loan to the University of Chicago to work on the Manhattan Project. In 1942 and 1943 he was in charge of process design and start-up of the heavy water extraction plant at Trail, British Columbia. In 1948 he served on the Lexington Project for the evaluation of nuclear propulsion of aircraft. In 1949 he was a consultant for the Senate and House Joint Committee on Atomic Energy investigating the apparent disappearance of uranium 235 from Argonne Research Laboratories.

During his thirty-five years with Standard Oil, he displayed extraordinary creativity in development of new petroleum refining processes. He developed very efficient apparatus for distillation of hydrocarbon mixtures. His classic paper with R. L. Geddes on the methodology for stage-wise distillation computations was published in *I&E Chem.* in 1933. He was active in formulating efficient methods of solvent extraction of lubricating oils. His work on processing petroleum residual led to the development of delayed coking, which is still being used in some refineries.

As catalytic techniques began to be employed in petroleum refining, elusive problems arose in heat and mass transfer and its relation to catalyst particle size. Dr. Thiele's salient analysis led to the *I&E Chem.* paper "Relation Between Catalytic Activity and Size of Particle" in 1939. His theoretical treatment led to many patents and extensions of his theory which greatly influenced modern catalytic processing cracking, paraffin isomerization, alkylation, and reforming. His work between 1921 and 1960 resulted in seventeen publications, twenty-seven U.S. patents, and two Canadian patents.

Thiele was a member of the Chicago Chemists Club and the American Chemical Society and was a fellow of the American Institute of Chemical Engineers. In 1966 he received the Founders Award of the American Institute of Chemical Engineers. Election to membership in the National Academy of Engineering came in 1980. The University of Notre Dame had awarded him an honorary doctorate in 1971. The Department of Chemical Engineering at Notre Dame established the Thiele Lectureship in Chemical Engineering in 1986. The lectureship is intended to recognize outstanding contributions by a younger member of the chemical engineering profession. Dr. Thiele was very pleased to be present at the first lecture, given by Professor D. Lauffenburger. A special symposium in honor of Thiele's ninetieth birthday was held in Chicago in 1985 at the annual meeting of the American Institute of Chemical Engineers. Thiele, who was in attendance, seemed as vital and mentally alert as when I first met him in 1958.

After retirement from Standard Oil, Thiele came to Notre Dame to teach. He was an energetic man who walked everywhere and spent much time in libraries. He taught four undergraduate courses a year for the ten years he was at Notre Dame. He usually taught both of the thermodynamics courses, a kinetics course, and an instrumentation course, which he turned into a course in process control and simulation. He designed and built a pressure controller, which he demonstrated in class. Every student was assigned to do a self-formulated experiment on the controller outside the class.

Thiele was a kind, gentle person who listened well to everyone whether it was in a classroom, a seminar talk, a faculty meeting, or in his office while advising a student. In fact, he was the best listener I ever met and never interrupted a speaker no matter what the occasion was. When he was finally asked to speak, he would give a short statement or suggestion which, upon inspection, was found to be invariably correct and valuable. At our frequent department technical seminars in which invited speakers delivered their seminar talks, Thiele would always sit in the front row. The speaker, fifteen minutes into his talk, might conclude that Thiele was asleep, because he often had his eyes closed and rarely moved. However, when the talk was over and the speaker entertained questions from the audience, the last questions asked were by Thiele. Many of the speakers had trouble answering Thiele's questions intelligently because the questions were not only difficult but showed that Thiele had deeply probed into the elusive essence of any technical shortcomings of a speaker's methodology.

After ten years of teaching at Notre Dame, Thiele returned to Chicago and spent the next 27 years in the Skokie-Evanston area. He returned a few times to Notre Dame to visit those of us who had been his faculty colleagues. He always traveled by the South Shore electric train and seemed to greatly enjoy his excursions to Notre Dame.

Thiele loved traveling in Europe and went many times, often concentrating his visits in France and Germany. He wrote and spoke both French and German and felt comfortable in those two countries.

In his last three decades, he walked to the libraries of Northwestern University weekly. Occasionally, he rode the "El" to south Chicago to Crerar Library, where he would spend the greater part of a day reading technical material.

By his passing from this life, the profession of chemical engineering lost one of the premier minds in our 100-year history and a truly admirable and good person.

Allyn Collins Vine

1914-1994

By Fred Noel Spiess

An energetic person, yet kind in his relationships with everyone, bubbling with his own ideas, yet always willing to listen to those of others, Allyn Collins Vine enjoyed a long career as a key member of the Woods Hole Oceanographic Institution (WHOI), a career that ended with his quiet, unexpected death at home in January 1994. From his first summers with Maurice Ewing at the Oceanographic in the late 1930s, he was a sea-roving innovator based on Cape Cod, but as likely to appear in Washington, D.C., in Hawaii, or somewhere on a Navy ship as in the corridors of WHOI's Bigelow Building or on the WHOI piers.

Al was born June 1, 1914, in Garrettsville, Ohio, the second of four sons. He enjoyed school and recalled several great teachers. While his early life in Ohio did not presage an orientation to the ocean, it clearly had the beginnings of a love of, and aptitude for, creating new devices. He is credited with adolescent raids on the local telephone company junk piles for wires and electrical equipment to build contraptions such as burglar alarms. Characteristic of his approach to ocean engineering, his comment on this aspect of his life was that engineering education today lacks adequate exposure to junk piles. "Too many engineers are designing from catalogues, while not enough are doing innovative work," he said. "This doesn't ... inspire creativity."

Completing high school in 1932, Al entered Hiram, a nearby small liberal arts college, because it was the least expensive option. Fortunately, it was a very good school. He majored in physics, earning part of his expenses as an assistant, setting up experiments for his professor. In 1936, upon completion of his bachelor's degree, he was accepted in the physics graduate program at Lehigh University. At this point the ocean entered in the form of his professor, Maurice Ewing. Ewing was in the early stages of his own role as a leader in marine geophysics (not a well-known term in those times). Working from his Lehigh base, Ewing would go with his students for the summer to the fledgling WHOI, working on the early developments of reflection seismology and seafloor photography. Vine, with J. Lamar Worzel and others, spent the summers of 1937, 1938, and 1939 on the Cape and at sea in Woods Hole's ship *Atlantis,* developing the first deep-sea cameras and learning how to handle explosives for seismic studies. In 1940 with war raging in Europe, Ewing's group, among others, began year-round, National Defense Research Council-sponsored operations at WHOI with antisubmarine problems as the major focus. For Al this was a time that determined the course of the rest of his life. With his master's degree and a full-time job, he proposed marriage to Adelaide Holton, a young woman he had come to admire while at Hiram, and the two of them settled in Woods Hole, raising three children, converting a barn into a comfortable house with a view of Vineyard Sound, and playing their considerable part in the hospitable Woods Hole community.

The war years brought physicists from many places into ocean-oriented laboratories in San Diego, New London, and Woods Hole, collaborating to understand the propagation of sound in the sea and how to use that understanding to improve Allied abilities to carry out antisubmarine warfare. Vine was particularly involved with improving instrumentation to measure and record the speed of sound (as characterized by water temperature) as a function of depth, in order to understand the performance of ship-mounted sonar systems. The basic instrument (BT, or bathythermograph) had been devised by Athelstan Spilhaus for research and was quickly adapted by Vine and his associates for use from destroyers and other ships engaged in antisubmarine warfare.

After the United States became involved in the Pacific, a significant part of that effort quickly moved into the pro-submarine arena. Vine was at the forefront of that change, modifying the BT to be mounted on submarines, and ingeniously providing additional displays to help diving officers know how their boat's buoyancy as well as sound propagation would change with depth. Most important in this were the interactions that Vine developed with the operating forces. Since most submarines were being built on the northeast coast of the United States, he and his colleagues arranged to ride nearly every new boat on its initial trials as instructors, ensuring that crews went to the Pacific with full understanding of the environmental factors that would help them to be effective, and even in many instances, to survive.

While his instrumentation development and sound propagation studies were the tangible engineering activities of his World War II period, a much more important and enduring contribution came in the form of the friendships that he fostered between members of the science community and the submarine operators. He epitomized the atmosphere of cooperation and mutual concern between the civilian ocean science community and working submariners, an atmosphere that prevailed on into the Cold War era.

It was this cooperation that accelerated the exploitation of the "convergence zone" effect in underwater sound propagation. In 1947 Vine and his close friend Bill Schevill realized that the permanent deep sound channel, already studied for several years by Ewing, Worzel, and others as a means for long-range sound transmission, also meant that sound from near-surface sources would be strongly focused at range intervals of about 70 km. After a few confirming controlled experiments, according to Al, "we started working with the submarines listening to each other in snorkeling, and so for the first time they could count, they could plan on listening to other people's submarines . . . thirty-five miles away, seventy miles away. This changed the tactics, because you didn't go to general quarters just because you heard someone. They might not be in sight for another hour or two." Not long after, major sonar system and weapon development projects were under way at the primary Navy in-house laboratories.

In the late 1950s the National Research Council Committee on Oceanography carried out a major study to chart the course of that discipline for the decade of the 1960s. Vine's stature in the community can be measured by the fact that he was chosen to chair the panel producing the chapter on engineering requirements for ocean exploration. This group underscored the needs for small, deep-diving research submersibles and manned, spar-buoy laboratories (inspiration for Scripps' Floating Instrument Platform, or FLIP), moving ideas of the 1950s into reality a few years later. Still another development that he espoused—narrow-beam echo sounding array systems—led in the 1960s to development of the swath mapping equipment that has revolutionized studies of seafloor morphology.

Vine's persistent pushing to put oceanographers down into the medium that they study began to pay off in the early 1960s. First, as an outgrowth of Ed Wenk's 1950s engineering studies, J. L. Reynolds decided to build a deep-diving aluminum submarine, which the Navy (in the person of Captain C. B. Momsen, Jr., of the Office of Naval Research) in turn planned to lease. Primarily at Vine's urging, WHOI was chosen to be the operator of the craft—Aluminaut—for the oceanographic research community. With typical pragmatic concern for the usefulness of this new tool, Al and his colleagues built a full-scale mockup of the forward part of the sub and immediately suggested alterations, eventually adopted, to make it more effective. When lease arrangements with Reynolds fell through, Momsen was able to shift the allocated funds to WHOI for construction of a smaller, shallower-operating, but more maneuverable craft, and the Oceanographic became the developer as well as the operator, with Vine playing his usual part as critical adviser. His role in bringing this new instrument into being was immortalized by his colleagues, who insisted that it be christened *Alvin.* Typically, at the time of the christening ceremony, Al was at sea diving in the new French bathyscaphe, *Archimede,* in the Puerto Rico Trench.

Beyond these many specific contributions, Al played the role of adviser on unnumbered committees and studies, often being the participant who would ask what at first seemed to be an irrelevant question, or make the key irreverent remark, that would turn the discussion in some new and fruitful direction. No matter what the venue, he could be counted on to have some sort of bright idea. His style is best captured in a passage from Kaharl's book about *Alvin*—"Vine always had an idea. He passed them out like a gentleman farmer with a bumper tomato crop, needing no credit for the sauces they went into. He was just glad to grow them, the strikingly perfect ones and the bruisers." Unlike many idea generators, however, he also was always ready to listen, to learn about what others were doing, and to let them tell of their bright thoughts as well. Beyond having new ideas, he also had a knack for coming up with the quotable phrase, such as "Even rescue submarines don't pack them in as tightly as we did on double dates in a model A roadster," or "The one chance in a thousand that happens nine times out of ten."

His wide-ranging contributions were recognized in 1972 with the awarding of a Navy Oceanographic Commendation and in 1982 with his election to the National Academy of Engineering for "contributions to oceanographic engineering and design of deep submersibles for research." He will always be remembered as a kind, trusting, very imaginative person who made our science fun.

Eric A. Walker

1910-1995

By Charles L. Hosler

Eric A. Walker, electrical engineer, educator, patriot, former president of the Pennsylvania State University, and founding member of the National Academy of Engineering, died on February 17, 1995, at the age of eighty-four.

As an engineer and researcher, Dr. Walker earned distinction for his work in undersea acoustics and weaponry during and shortly after World War II, and in commercial power transmission and insulation, an area in which he held several patents for high-voltage devices.

As an educator, he served on the engineering faculty at three universities and, as a longtime force in the American Society of Engineering Education (ASEE), he had an important impact on shaping American technical training over a period of more than four decades.

As president of Penn State (1956 to 1970), he led that institution to become an internationally recognized academic center for scientific and engineering research. Its admission in 1958 to the Association of American Universities reflected his dynamic, visionary leadership. He provided the same caliber of leadership as a member (1958 to 1962) of the executive committee of the American Association of Land Grant Colleges and State Universities.

The life of Eric Arthur Walker was that of a self-made man. He was born in humble circumstances on April 29, 1910, in Long Eaton, England. His family sent him to Canada at age eleven and then to Wrightsville, Pennsylvania, where he settled with an aunt in 1923. He attended Harvard University, supported by an academic scholarship and many part-time jobs. He earned a bachelor's degree in electrical engineering in 1932 and continued at Harvard for graduate work, receiving a master of science degree in business administration in 1933. By the time he received his doctorate in general science and engineering in 1935, he had been teaching mathematics at Tufts University for two years. Tufts named him head of its Department of Electrical Engineering in 1938, and in 1940 he accepted a similar headship at the University of Connecticut, Storrs.

In 1942 Dr. Walker was appointed associate director of Harvard's Underwater Sound Laboratory, where he helped to develop the acoustic homing torpedo for the U.S. Navy, an achievement for which he won a presidential certificate of merit. When Harvard closed the laboratory in 1945, Dr. Walker supervised the transfer of a portion of its Navy-supported work to Penn State, where it was re-created as the Ordnance Research Laboratory. Investigations there continued in such fields as cavitation and underwater shapes for torpedoes, submarine hulls, and guided missiles.

Dr. Walker was also named head of Penn State's Department of Electrical Engineering. In 1950 he took a leave of absence to serve as executive secretary of the Research and Development Board in the Defense Department. In 1951, however, he returned to Penn State as dean of the College of Engineering and Architecture. Two years later, he introduced the nation's first associate in engineering degree program. It came in response to the demand for skilled practitioners in fast-growing technologies and served as a model for similar programs at other colleges and universities nationwide. At the other end of the academic spectrum, he inaugurated one of the nation's first baccalaureate programs in engineering science. It gave students of exceptional abilities the opportunity to participate in a more rigorous curriculum designed to prepare them for research, development, and other creative aspects of engineering. Finally, as dean, he oversaw the construction of a nuclear reactor to study the peaceful applications of atomic energy. In 1956 Penn State thus became the first university to operate a reactor under license from the Atomic Energy Commission.

That same year Dr. Walker was named Penn State's first vice-president for research. Within weeks, however, Milton Eisenhower, president of the university, suddenly resigned so that he could spend more time as adviser to his brother, President Dwight Eisenhower. Milton and Eric were close friends, and Milton persuaded the university's board of trustees to name Dr. Walker as his successor.

The next fourteen years witnessed significant advances in Penn State's influence and reputation as one of the nation's front-rank public universities. Dr. Walker listed his four greatest accomplishments as expanding the university's physical plant (which tripled in value) through nonpartisan support of Pennsylvania's governors and legislators; the creation of a College of Medicine and teaching hospital with a $50 million gift from the charitable trusts created by chocolate magnate Milton S. Hershey; recruitment of an internationally distinguished faculty; and the establishment of a series of seventeen "Commonwealth Campuses" that enabled many Pennsylvanians to receive the first two years of a Penn State education while living at home. The Commonwealth Campuses fulfilled much the same role as community colleges and were controversial in some political quarters of the state. But Dr. Walker rightly pointed out that the campuses enabled students to keep costs down and filled a void in Pennsylvania, which was slow to enter the community college arena. By 1970 nearly half of all Penn State freshman began their college careers at a Commonwealth Campus. The university's total enrollment at that time was 40,000, three times the number of 1956.

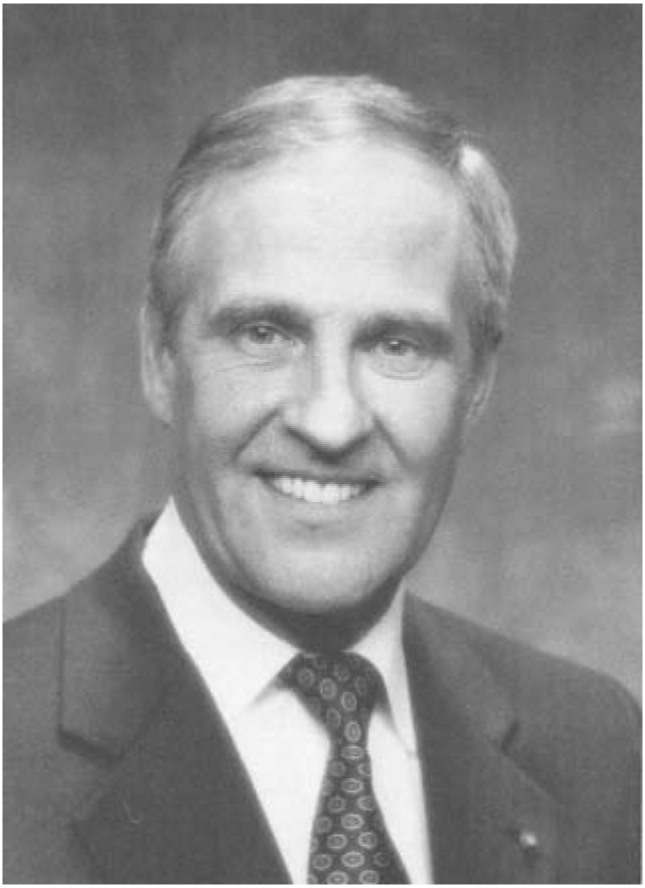
Leading Penn State during the period of student unrest in the 1960s, Dr. Walker in typical wry fashion commented that he found himself in the ironic position of counseling moderation for student activities, while in the 1950s he had counseled activism for that generation of "apathetic" students.

While serving as dean of engineering and as university president, Dr. Walker continued to provide national leadership for engineering education. In addition to serving on many committees of the ASEE, he chaired the Engineering College Research Council (1952 to 1954), was vice-president (1952 to 1954), and president (1961 to 1962) of the ASEE, and chaired the society's task force on Goals of Engineering Education (1963 to 1968). He also chaired the National Science Board (1964 to 1966), was president of the Engineers Joint Council (1962 to 1963), and headed the Department of Defense's Naval Research Advisory Committee (1963 to 1965). He was a member of a special panel (1961 to 1963) of President John F. Kennedy's science advisory committee that provided the blueprint for federal support of technical manpower training programs well into the 1980s.

Serving in these prominent leadership posts convinced Dr. Walker that engineers needed a voice in national policy alongside that of their scientist brethren if the nation were to establish effective, comprehensive policies in such matters as weapons systems and space technologies. To that end, in 1964 he helped to found and became vice-president of the National Academy of Engineering (NAE). He became president of the Academy in 1966, serving in that position for four years, and served on seven NAE committees. He also worked as a consultant over a span of three decades to various units of the Department of Defense and was a long-term member of the National Research Council's Division of Physical Sciences Committee on Undersea Warfare.

After retiring from Penn State as president emeritus in 1970, Dr. Walker became vice-president for science and technology at the Aluminum Company of America (ALCOA). Private industry was not unfamiliar territory for him. He had worked as a consultant to such firms as Colts Fire Arms Company and the Koppers Company and served on the board of directors of a half-dozen industrial and commercial firms. He retired from ALCOA in 1975 but remained a force in engineering education, chairing the National Science Foundation's Committee on Centers of Engineering Excellence, and consulting in industry and higher education.

He authored or coauthored more than 300 publications and in 1989 published an autobiography, *Now It's My Turn: Engineering My Way.* The ASEE honored him with its Benjamin Garver Lamme Award in 1965. The National Science Foundation, through the U.S. Geological Survey, named a glacial ridge for him in Antarctica, and he received a multitude of other honors from groups as diverse as the Royal Society of the Arts, the American Society of Military Engineers, the Institute of Radio Engineers, and the American Academy of Arts and Sciences. In 1970 President Richard Nixon awarded him a White House Citation in recognition of his many career achievements, and the Department of Defense presented him with its Distinguished Public Service Medal. He received honorary degrees from the University of Pennsylvania, Hofstra University, the University of Notre Dame, and nearly a dozen other institutions. But of all his honors, Dr. Walker was especially proud of the Horatio Alger Award, accorded him by the American Schools and Colleges Association in 1959 for "enhancing the American tradition of overcoming obstacles to achieve success through diligence, industry, and perseverance."



Albertus D. (Bert) Welliver

1934-1994

By Philip M. Condit

Bert Welliver, senior vice-president of engineering and technology research and engineering for the Boeing Company, died March 22, 1994, at the age of sixty.

He was recognized throughout the international aerospace industry for his technology leadership in the development of new aircraft propulsion systems, advanced airplane design, and manufacturing.

His vision and leadership in promoting a close working relationship between engineering and manufacturing, together with pioneering modern engineering design tools, proved invaluable to Boeing process improvement efforts in the late 1980s and early 1990s.

He was one of the key architects in shaping the company's approach to designing and building the new 777. In the 1991 book on Boeing, *Legend and Legacy,* Bert discussed the innovative approach to the new airplane:

> This is as big an experiment as the original 747 was, because we're trying to redesign The Boeing Company even as we design this airplane. Some friends of mine have told me Boeing may be going too far and too fast, that the process is ten years ahead of where Boeing should be. My answer is that we can't

> sit around for ten years doing nothing. Yes, it's a gamble, but I think we can do it. If there's one thing current management can leave as a legacy to future management, it's to fix our system of designing and building airplanes and get rid of all the non-value added work."

There is no doubt that he was a driving force behind the Boeing approach to designing and building airplanes in the future, even before there was a 777 program. His focus was to initiate improvement in order to maintain market leadership.

He was a visionary who looked beyond traditional practices toward involving people in teams to redefine and improve processes. The Boeing experience on the 777 program has proved Bert right.

Born in Danville, Pennsylvania, on February 26, 1934, Bert graduated from the Pennsylvania State University in 1956 with a degree in mechanical engineering. He joined Boeing in 1962 after spending six years with the research division of Curtiss-Wright Corporation.

During his thirty-two years with Boeing, he conducted extensive research into all aspects of aircraft propulsion systems and worked on the development of the Boeing 747 propulsion systems installation as well as the supersonic transport (SST) program, supersonic tactical aircraft, and other military programs. As a corporate senior vice-president, he served on the company's executive council and had responsibility for all Boeing critical, high-level engineering and technology development activities.

Bert worked closely with federal science and technology leaders in identifying and revitalizing the nation's aeronautical research and technology priorities. He served on the executive committee of the Council on Competitiveness.

He was a past chairman of the Aeronautics and Space Engineering Board of the National Research Council's Commission on Engineering and Technical Systems and a past member of both the National Aeronautics and Space Administration's Aeronautical Advisory Board and the United States Air Force Scientific Advisory Board.

As the Boeing senior engineering executive, he was active in efforts to improve the relationship between Boeing and its engineering and technical employees. Bert was a guiding force behind establishing the Boeing Technical Fellowship program in 1990.

He was recognized also for his leadership in Boeing efforts to encourage minority students to study mathematics, science, and engineering, including establishing Boeing engineering scholarships at the nation's historically black colleges and universities. In 1991 he was appointed to the board of directors of the National Action Council for Minorities in Engineering.

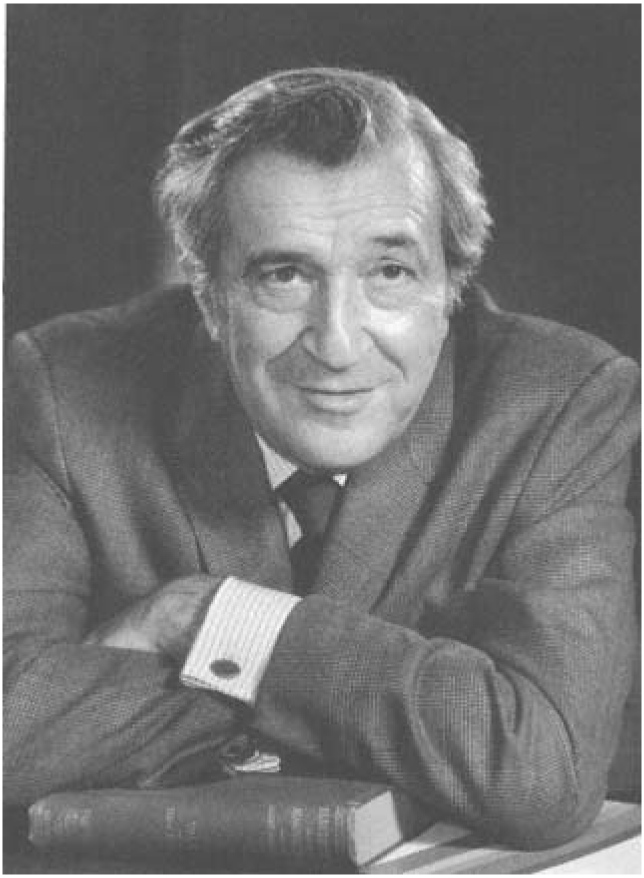
Bert was a fellow in both the American Institute of Aeronautics and Astronautics and the Royal Aeronautical Society, and a member of the National Academy of Engineering.

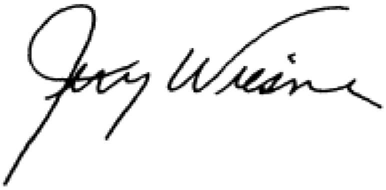
In 1987 he was honored as a Pennsylvania State Outstanding Engineering Alumnus and was elected as an alumni fellow in 1991.

Bert took a vital interest in engineering and business education and served a number of institutions in an advisory capacity. Those schools included the University of Washington, the University of Southern California, Stanford University, and the Massachusetts Institute of Technology.

At Pennsylvania State, he served the College of Engineering through membership on the Industrial and Professional Advisory Council, and the advisory committee for the National Science Foundation Coalition of Schools for Excellence in Education and Leadership.

Away from the job he enjoyed outdoor activities, particularly fishing, and he was an avid woodworker. Visitors to Bert's office at Boeing headquarters often were shown photographs of his greatest sources of pride: his family and his latest woodworking projects.





Jerome Bert Wiesner

1915-1994

By Paul E. Gray

> In or out of public positions, he never stopped caring or working for the country's good. He never thought it was not his problem . . . [He] performed the office of public citizen better than any contemporary I know. . .
> Anthony Lewis The New York Times October 28, 1994

Jerome B. Wiesner—engineer, educator, adviser to presidents and the young, passionate advocate for peace, and public citizen—died on October 21, 1994, at his home in Watertown, Massachusetts, at the age of seventy-nine. Throughout his life, he applied his intellect and wisdom and energy to improve the many institutions with which he was involved, to ameliorate the problems clouding the future of humankind, and to make the world a better, safer, more humane home to all its citizens.

Jerry was born in Detroit, Michigan, on May 30, 1915—the son of a shopkeeper—and grew up in nearby Dearborn, where he attended the public schools. He attended the University of Michigan at Ann Arbor, where he earned bachelor of science degrees in electrical engineering and mathematics in 1937, the master of science degree in electrical engineering in 1938, and the doctor of philosophy degree in electrical engineering in 1950.

He began his professional career in 1937 as associate director of the University of Michigan broadcasting service, and in 1940 moved to the Acoustical Record Library of the Library of Congress, where he served as chief engineer. In that capacity he traveled throughout the South with folklorist Alan Lomax recording the music of the black folk and blues tradition.

In 1942 he joined the Radiation Laboratory at the Massachusetts Institute of Technology (MIT), beginning an association that with brief interruptions for government service, lasted until his death fifty-two years later. At the Radiation Laboratory, he played a major role in developing microwave radar—a tool that Winston Churchill characterized as decisive in the Allied victory in World War II.

In 1945 he moved for a year to Los Alamos to work on instrumentation for nuclear weapons tests in the Pacific.

In 1946 he rejoined MIT as assistant professor of electrical engineering, working in the Research Laboratory of Electronics (RLE), a multidisciplinary center for basic research in electronics, physics, and communications, which grew out of the wartime Radiation Laboratory. He made significant contributions to the continued development of airborn radar systems and to the development of tropospheric-scatter microwave communications systems, which provided highly reliable long-distance communications.

Promoted to full professor in 1950, he became director of RLE in 1952 and head of the Department of Electrical Engineering in 1959.

In 1961 Jerry took leave from MIT to serve as special assistant for science and technology to President John F. Kennedy and as chairman of the President's Science Advisory Committee (PSAC). He also held these posts for a short time under President Lyndon B. Johnson, following President Kennedy's assassination in 1963. He had known government consulting and advisory service in prior years as a member of PSAC since 1957 and as a participant in several panels. He participated in the Pugwash Group, which enabled him to develop strong personal relationships with Soviet scientists and leaders.

He was remarkably gifted in his ability to elucidate complex issues and to explain the effects of policies and their technical and political consequences, as in his 1961 book *Where Science and Politics Meet.* He wrote extensively on the issues of arms control and nuclear disarmament. He understood the deadly collateral hazards associated with nuclear weapons production and testing, and an unrestrained nuclear arms race. With persistent persuasive argument he convinced others, in the East and West, that the world must move off this dangerous course. His influence was central in bringing about the ban on atmospheric weapons testing and in generating interest, on both sides of the Iron Curtain, in parallel systematic reductions in nuclear weapons.

Jerry Wiesner's passionate involvement with these issues was evident throughout his life. His 1969 publication (with Abram Chayes) of *ABM: An Evaluation of the Decision to Deploy an Antiballistic Missile System* earned him a place on President Nixon's "enemies lists." In 1993 he published, with his MIT colleagues Kosta Tsipis and Philip Morrison, *Beyond the Looking Glass: The United States Military in 2000 and Later,* calling for deep cuts in American military procurement and expenditures. And in the days before his death he was corresponding with Secretary of Defense William Perry about Pentagon needs and budgets.

When Jerry returned to MIT after his service in the White House, he became dean of science, having been appointed institute professor in 1962, MIT's highest faculty rank. In 1966 he became provost, and was elected thirteenth president of MIT in 1971, serving in that position until 1980. As dean, provost, and president, he expanded MIT's teaching and research programs in health sciences, humanities, and the arts. He sought new ways in which MIT's expertise in science and engineering could be brought to bear on social issues such as health care, urban decay, mass transportation, and housing. He was instrumental in establishing the MIT program in Science, Technology, and Society to focus on ways in which science and technological and social factors interact to shape modern life. Jerry was centrally involved in the creation of the Program in Media Arts and Sciences and the Media Laboratory, which are housed at MIT in the Jerome and Laya Wiesner

Building. He was deeply committed to the goals of this nation's civil rights movement, and the period of his leadership of MIT produced the greatest progress in bringing women and minorities to the student body and the faculty.

After his retirement as president, Jerry devoted himself to teaching and research in technical and policy areas related to science, technology, society, and world peace.

Jerome Wiesner was elected to the National Academy of Engineering (NAE) in 1966 and to the National Academy of Sciences (NAS) in 1960. He was a fellow of the American Academy of Arts and Sciences (1953) and of the Institute of Electrical and Electronics Engineers (1952). In 1985 he was awarded the NAE's Arthur M. Bueche Award for long-term contributions to public understanding of the risks of the nuclear age, and in 1992 he received the National Science Foundation's Vannevar Bush Award for outstanding contributions in science and technology that are significant to the national welfare. In 1993 he received the National Academy of Sciences Public Welfare Medal, the highest honor of the NAS, for distinguished contributions in the application of science to the public welfare.

Jerry received honors throughout his life from professional, academic, and philanthropic organizations in the United States, from distinguished international associations, and from foreign governments. He was the recipient of honorary degrees from premier universities—Harvard, Tufts, Rensselaer Polytechnic Institute, and Notre Dame among many others. This extraordinary stream of honors, although warmly appreciated by the recipient, never altered his fundamental modesty; the distinguished elder statesman of the 1990s was, in fact, not very different from the junior engineer who arrived at MIT fifty years earlier: still a little shy, but friendly, humorous, and always accessible.

Jerry Wiesner was a reliable friend, and all at MIT and elsewhere (including this writer) who relied on that friendship and on his counsel and guidance, are unlikely to find its replacement.

For Jerry's inauguration as president of MIT on October 7, 1971, Archibald MacLeish wrote and delivered a poem that spoke the truth of this remarkable man. It ended with these lines, which are the best words to conclude this remembrance:

Advisor to Presidents the papers call him.
Advisor, I say to the young.
It's the young who need competent friends,
bold companions,
honest men who won't run out,
won't write off mankind, sell up the country,
quit the venture, jibe the ship.
I love this man.
I rinse my mouth with his praise in a
frightful time.
The taste in the cup is of mint,
of spring water.

Appendix

Members	Elected	Born	Deceased
Jakob Ackeret	1976	March 17, 1898	April 1, 1981
Philip M. Arnold	1970	February 9, 1911	October 28, 1994
Donald J. Atwood	1980	May 25, 1924	April 24, 1994
Hannskarl Bandel	1978	May 3, 1925	December 29, 1993
Edward George Bowen	1977	January 14, 1911	August 12, 1991
Hezzie Raymond (Ray) Brannon	1980	January 23, 1926	August 9, 1994
Page Scott Buckley	1981	June 23, 1918	July 25, 1995
Marvin Camras	1976	January 1, 1916	June 23, 1995
Dean R. Chapman	1975	March 8, 1922	October 4, 1995
Walker Lee Cisler	1964	October 8, 1897	October 18, 1994
Jesse F. Core	1981	March 6, 1913	November 29, 1993
Andrew F. Corry	1978	October 28, 1922	December 22, 1994
W. Edwards Deming	1983	October 14, 1900	December 20, 1993
Allen F. Donovan	1969	April 22, 1914	March 11, 1995
A. E. Dukler	1977	January 5, 1925	February 13, 1994
Harold Etherington	1978	January 7, 1900	August 2, 1994
Frank J. Feely, Jr.	1979	August 26, 1918	January 1, 1995
Jean H. Felker	1974	March 14, 1919	February 27, 1994
Marcelian Francis Gautreaux, Jr.	1977	January 17, 1930	February 13, 1994
William Henry Gauvin	1987	March 30, 1913	June 6, 1994
T. Keith Glennan	1967	September 8, 1905	April 11, 1995
John M. Googin	1988	May 2, 1922	January 16, 1994
Fritz Ingerslev	1982	July 6, 1912	February 5, 1994
Shiro Kobayashi	1980	February 21, 1924	December 20, 1995
Robert F. Legget	1988	September 29, 1904	April 17, 1994
Clarence H. Linder	1964	January 18, 1903	May 3, 1994
John H. Ludwig	1971	March 7, 1913	February 17, 1995
Keith W. McHenry, Jr.	1982	April 6, 1928	January 21, 1994
Paul M. Naghdi	1984	March 29, 1924	July 9, 1994
Aziz S. Odeh	1987	December 10, 1925	July 16, 1994
Bernard M. Oliver	1966	May 27, 1916	November 23, 1995
Robert H. Park	1986	March 15, 1902	February 18, 1994
Maynard L. Pennell	1968	April 10, 1910	November 22, 1994
Allen M. Peterson	1973	May 22, 1922	August 17, 1994
Fred H. Poettmann	1978	December 20, 1919	July 15, 1995
Rowland Wells Redington	1986	September 26, 1924	June 22, 1995
Ben Rich	1981	June 18, 1925	January 5, 1995
Robert B. Richards	1970	November 18, 1916	July 26, 1988

Members	Elected	Born	Deceased
Frank E. (Bill) Richart, Jr.	1969	December 6, 1918	September 16, 1994
Emilio Rosenblueth	1977	April 8, 1926	January 11, 1994
Shinroku Saito	1994	March 30, 1919	November 21, 1994
Owen Saunders	1979	September 24, 1904	October 10, 1993
Robert L. Smith	1975	October 31, 1923	December 9, 1995
Julius Adams Stratton	1964	May 18, 1901	June 22, 1994
Verner Edward Suomi	1966	December 6, 1915	July 30, 1995
Julian Szekely	1982	November 23, 1934	December 7, 1995
Anton Tedesko	1967	May 25, 1903	April 2, 1994
Ernest W. Thiele	1980	December 8, 1895	November 29, 1993
Allyn Collins Vine	1982	June 1, 1914	January 7, 1994
Eric A. Walker	1964	April 29, 1910	February 17, 1995
Albertus D. "Bert" Welliver	1987	February 26, 1934	March 22, 1994
Jerome Bert Wiesner	1966	May 30, 1915	October 21, 1994

Acknowledgments for the Photographs

JAKOB ACKERET, by Blackstone-Shelburne, New York

HEZZIE RAYMOND BRANNON, by Cantu Studio, Houston, Texas

DEAN R. CHAPMAN, courtesy of NASA Ames Research Center, Moffett Field, California

MARVIN CAMRAS, by Lloyd De Grane

ANDREW F. CORRY, by Fabian Bachrach

W. EDWARDS DEMING, by Ankers Capitol Photographers, Washington, District of Columbia

ALLEN F. DONOVAN, courtesy of The Aerospace Corporation, Los Angeles, California

HAROLD ETHERINGTON, by Bert & Richard Morgan's Cameras and Cards Photography, Tequesta, Florida

MARCELIAN FRANCIS GAUTREAUX, JR., by Jan Photographs, Baton Rouge, Lousiana

T. KEITH GLENNAN, by Conway Studios

FRITZ INGERSLEV, by Elfelt, Rosenhavn, Denmark

SHIRO KOBAYASHI, by the Imagemaker

CLARENCE H. LINDER, courtesy of General Electric Company

PAUL M. NAGHDI, by Ed Kirwin Graphic Arts, Berkeley, California

FRED H. POETTMANN, by Grissinger Studio, Littleton, Colorado

FRANK E. (BILL) RICHART, JR., by Bob Kalmbach, courtesy of the University of Michigan, Ann Arbor, Michigan

VERNER EDWARD SUOMI, by Norman Lenburg, courtesy of the Office of Information Services, University of Wisconsin-Madison

JEROME BERT WIESNER, © Karsh, Ottawa