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Memorial Tributes

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Contents

Foreword

THIS SECOND VOLUME OF *Memorial Tributes* issued by the National Academy of Engineering covers the period from January 1979 through April 1984. It is the second in what is expected to be a series of such volumes, to be published periodically, honoring the deceased members and foreign associates of the Academy. Publication of this second volume of NAE *Memorial Tributes* contributes to the observance of the twentieth anniversary of the founding of the NAE. It is intended that this and succeeding volumes will stand as an enduring record of the many contributions of engineering to the benefit of mankind. In all cases, the authors of the tributes had personal knowledge of the interests and 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.

ALEXANDER H. FLAX

HOME SECRETARY

Memorial Tributes

Turner Alfrey, Jr.

1918-1981

By Alfred E. Brown

TURNER ALFRY, JR., a giant of a man, died in Midland Hospital Center on August 10, 1981. Dr. Alfrey joined Dow Chemical Company in 1950 and continued an active scientific research program until the last few weeks before his death. He held Dow's highest research position, Research Fellow, and was one of only five people so honored. Turner Alfrey's contributions to polymer science and engineering were many, and it is no overstatement to say that he contributed greatly to the scientific underpinnings of industrial polymer technology as it is being practiced today.

Dr. Alfrey was more than a great scientist and engineer. He was also a great teacher. His unique teaching style, his quiet enthusiasm, and his humility, along with his ability to simplify and model the most complex problems, never failed to impress visitors to his laboratory and always left him in great demand. Yet he found the time to assist anyone who needed help, and his door was never closed. His patience seemed to be inexhaustible with young scientists and students.

Turner Alfrey, Jr., was born in Siloam Springs, Arkansas, on May 7, 1918. He was the first of three children born to Cleo Ellen and Turner Alfrey. The young Alfrey grew up in Muskogee, Oklahoma, and graduated from Muskogee High School in 1934. From these beginnings he attended Washington University in St. Louis, Missouri, where he received a B.S. in chemical engineering in 1938 and an M.S. in physical chemistry in 1940. His Ph.D. degree in polymer chemistry was granted by Polytechnic Institute of Brooklyn, New York, in 1943.

After working for two years as a research chemist for Monsanto Chemical Company, Dr. Alfrey returned to the Polytechnic Institute of Brooklyn as a member of the faculty in the Polymer Institute. His perhaps best-known work, the classical reference volume *Mechanical Behavior of High Polymers,* was completed while he was at the Polymer Institute. He joined the technical staff of the Dow Chemical Company in 1950 and quickly made his mark with co-workers. He rose rapidly through the organization and was the first individual named to the then highest research title, Research Scientist.

Throughout his career Dr. Alfrey received a number of awards and honors. These included the A. Cressy Morrison Award by the New York Academy of Sciences, the Bingham Medal by the Society of Rheology, the International Award in Polymer Chemistry from the Society of Plastics Engineers, the Witco Award in Polymer Chemistry by the American Chemical Society, and the H. H. Dow Medal by the Dow Chemical Company.

Dr. Alfrey was elected to the National Academy of Engineering in 1977. In addition, he was a visiting professor at several universities. He served on a number of advisory boards and committees, including a term as a member of the Committee of Macromolecular Chemistry of the National Research Council. He was a member of a number of scientific and professional societies, which included the American Chemical Society, the Society of Rheology, the New York Academy of Sciences, the Society of Plastics Engineers, the Society of Chemical Industry, and Sigma Xi, and he was a Fellow of the American Physical Society.

Throughout his career Turner Alfrey, Jr., was author or coauthor of about 100 technical publications and was inventor or coinventor of 24 U.S. patents. As mentioned above, he wrote the classical treatise *Mechanical Behavior of High Polymers* and, with Mark and Bohrer, published *Copolymerization,* which was the first comprehensive treatment of the subject. In addition, he was coauthor of a text for polymer engineers and he wrote several other chapters on a variety of subjects. And, of course, he wrote countless internal com pany reports, which to a large degree remain proprietary information of the Dow Chemical Company.

Dr. Alfrey's fertile and active mind led him scientifically in many directions, and he seemed to pursue each new endeavor with vigor and dedication. Polymerization kinetics, organic polymer chemistry, reactions on polymers, swelling and diffusion behavior, colloid chemistry, mechanics, property-structure relationships, rheology, and fabrication technology were all investigated and researched in depth. At times he seemed to be thoroughly absorbed by his science, and rarely did he take more than a day or two of vacation a year. To Turner Alfrey, science was more than a job—it was his life, and perhaps his greatest pleasure was in exposing others to this wonderful world. His laboratory technique was as unique as his approach to science, and he often fashioned his apparatuses from the simplest of equipment. In fact, there were those who considered these measurements to be crude; however, they always seemed to have just the right level of sophistication to unravel the problem without complications, and he could just as quickly turn to the sophisticated methods when the occasion required exactness.

There was another side to this man: he was a welcome addition to any social affair. In his younger days he delighted in outwitting his co-workers in various contrived mental games. Seemingly always in good humor, he found just the right degree of eloquence for any occasion. In writing any tribute to Turner Alfrey, Jr., one would be remiss in not mentioning his wife, Jeannette, who provided continual support throughout his career.

Turner Alfrey, Jr., the man, the scientist-engineer, demanding of himself, tolerant of others, left only friends and admirers. His contributions remain as a living memorial to his life.

Benjamin Baumzweiger Bauer

1913-1979

By Cyril M. Harris

BENJAMIN BAUMZWEIGER BAUER, formerly Vice-President and General Manager of the CBS Technology Center in Stamford, Connecticut, died in Stamford on March 31, 1979.

Mr. Bauer's distinguished forty-two-year career in acoustic instrumentation and measurement, sound recording and reproduction, and underwater sound resulted in a long list of engineering accomplishments and led to his being granted more than 100 patents.

Ben Bauer was born on June 26, 1913, in Odessa, Russia. After spending his teenage years in Cuba, he came to the United States in 1930, where he remained, becoming a citizen in 1941. He received a degree in industrial engineering from Pratt Institute in 1932 and the electrical engineering degree from the University of Cincinnati in 1937. He pursued postgraduate studies at Chicago and Northwestern universities.

Mr. Bauer's career in industry, following his graduation in 1937, started with his employment as a development engineer at Shure Brothers, Inc., in Evanston, Illinois, where he eventually became Director of Engineering and Vice-President. One of his significant contributions to the field of acoustic instrumentation was the development, at Shure Brothers, of the first unidirectional (cardioid) microphone in a single transducer, the principle of which is widely used today in microphones of this type. In addition, he made important contributions to the field of recording, including disc-cutter and phonograph pickup designs. Another device that he perfected, the moving-coil pistonphone, was used widely in microphone calibration work.

During World War II he worked on the development of speech communication equipment for the Armed Services. One such device was the battle-announce microphone used both during and after the war by the U.S. Navy.

In 1957 he joined the CBS Laboratories in Stamford, Connecticut, where he headed audio technology development. He led a group of engineers in developments in stereo discs, magnetic recording, and other equipment leading to improvement in the quality of recorded music. His research efforts resulted in the development of a loudness-level indicator, a device currently used by the Federal Communications Commission and others in monitoring broadcast programs.

In 1970 he led a team that developed the SQ quadraphonic matrix system, which in 1977 was judged by the Federal Communications Commission Laboratory to be the best of all matrix systems tested. In 1975 Mr. Bauer was made Vice-President and General Manager of the CBS Technology Center at Stamford, where he directed research and development in areas of advanced television, highdensity recording, audio systems, and audio reproduction. His outstanding work at CBS was acknowledged in 1978 by presentation of the Distinguished Service to CBS Award.

In addition to his work in recording and reproduction of sound, Ben Bauer made significant contributions to the field of underwater sound, including the development of an underwater directional communications system for divers, directional gradient hydrophones used in Navy sonobuoys, and a calibrator for hydrophones.

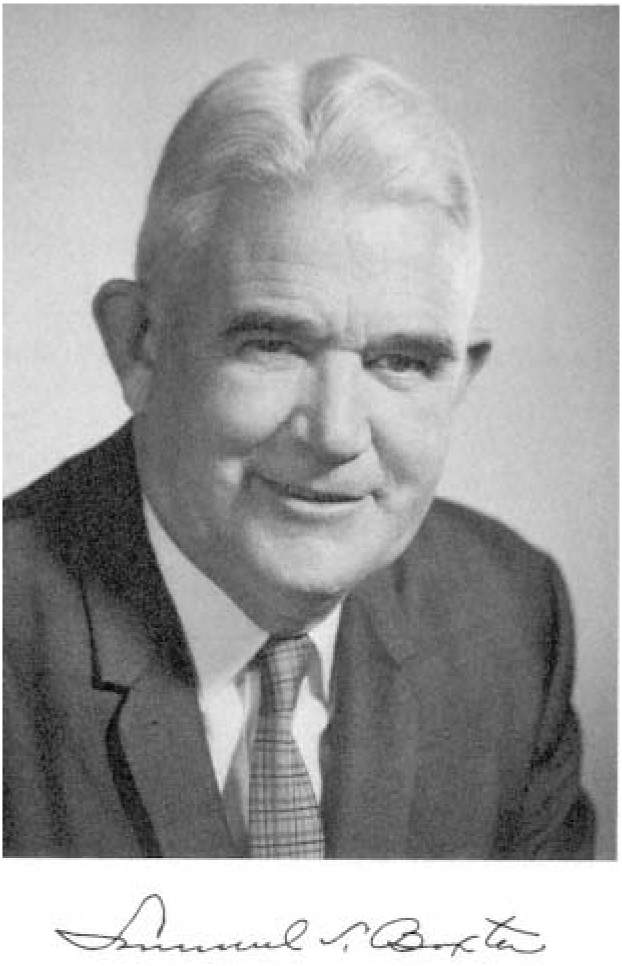
Among the many honors accorded Mr. Bauer were the Gold Medal Award of the Audio Engineering Society in 1963; the University of Cincinnati's Distinguished Alumni Award in 1969; the Institute of Electrical and Electronics Engineers' (IEEE's) Aerospace and Electronic Systems Group Honorary Life Member Award in 1969; the Silver Medal Award of the Acoustical Society of America in 1978; and membership in l'Ordre de Chevalerie de l'Etoile de la Paix, a Vatican-based nondenominational organization founded in

1229 and dedicated to peace. In 1974 he was elected a member of the National Academy of Engineering, and he served on the Naval Studies Board.

Ben Bauer was a prolific contributor to technical journals, with more than 100 papers to his credit, and he was the editor of a textbook on the acquisition, reduction, and analysis of acoustical data published by the U.S. Navy. He was a past President and Honorary Member of the Audio Engineering Society, a Fellow of the Acoustical Society of America and Associate Editor of its journal, and a Fellow of the IEEE and past National Chairman of its professional group on audio.

His many patents include basic inventions of directional microphones, and others in the fields of sound transmission and processing for recording and broadcasting, acoustic measurements and calibration, sound recording and reproduction, and quadraphonic disc technology.

He is survived by his wife, Ida, and two sons, Dr. Philip J. Bauer of Stamford and Dr. William E. Bauer of Studio City, California.



Samuel Serson Baxter

1905-1982

By Edward J. Cleary

SAMUEL S. BAXTER, consulting engineer, died at the age of seventy-seven in Philadelphia on February 7, 1982. He was in private practice for ten years following almost half a century of service as Municipal Engineer and Administrator in his native city of Philadelphia.

Among his peers Sam Baxter was regarded as a versatile practitioner who combined innovative thinking with energetic leadership in a variety of public works undertakings. National recognition of his performance found expression in election to the presidency of three professional organizations: the American Public Works Association (1947), the American Water Works Association (1966), and the American Society of Civil Engineers (1971).

Samuel S. Baxter was born February 6, 1905, in Philadelphia. He lived and worked in that city his entire life except for a four-year period of military service during World War II. Preparation for his career began at the Drexel Institute of Technology Evening College where he obtained a diploma in municipal engineering in 1926. One of his instructors, a senior city engineer, encouraged him to take a civil service examination for a surveyor's position in the Philadelphia Department of Public Works in 1923.

This episode initiated employment with the city that spanned a period of forty-nine years. His pragmatic engineering skills and managerial talents attracted recognition for promotion to greater responsibilities. Many challenging tasks were entrusted to him, including renovation of the exterior of Independence Hall in his role as coordinator of all federal work-relief projects in Philadelphia. Reflecting on these coordinator experiences he said, "It was complicated and frustrating work, but it turned out to be important because at that time I had more money to spend than practically all department heads in the city."

His administrative capabilities in handling this program attracted the attention of the Mayor, and at the age of thirty-five, Sam Baxter was designated Assistant Director of Public Works. A singular aspect of this appointment was that he was chosen despite the seniority status of several other competent candidates. Traditionally the assistant directorship had been reserved for a politician who handled only patronage matters. But the newly elected Mayor in 1940 concluded that this post should be occupied by a professional engineer who would be responsible for improving operation of all water, sewage, streets, highways, airports, public buildings, and street-lighting facilities. Mr. Baxter had no problem in accommodating to these various tasks.

At this time preparations for war claimed nationwide priority, and Sam Baxter, an Army Reserve officer, was called to duty in 1942. His first assignment with the U.S. Corps of Engineers was construction of a military airfield, which today is the Northeast Philadelphia Airport. Impressed with his experience in public works management, the Corps soon reassigned him to supervising the design, construction, and operation of a brand-new community to accommodate 70,000 people. This was Oak Ridge, Tennessee, where facilities were to be located for building the atomic bomb.

After military service he returned to Philadelphia in late 1945. With the title of City Projects Engineer, later Chief Engineer, he was charged with reducing a tremendous backlog of deferred public works. This included design and construction of water treatment, sewage disposal, airport terminal, and bridge facilities. In connection with the latter, he assembled a team of Belgian consultants to explore the feasibility of building a prestressed concrete girder bridge, which was a low-cost technique new to the United States. His boldness in undertaking this structural innovation, using a number of very small prestressed wires embedded in concrete, in building the Walnut Lane Bridge, is today a widely employed practice.

In 1952 political reform in Philadelphia led to the Democratic party's taking control of the city, which had been a Republican stronghold since the 1880s. With this change came a new city charter, one provision of which created several new departments to administer public works functions. One of these was a Department of Water, in which were consolidated the design, construction, and operation of all facilities associated with water supply, sewage disposal, and storm water drainage. A unique feature of the arrangement was the financing of operations. The Commissioner of the Department was empowered to establish appropriate service charges to ensure sufficient revenue to satisfy all funding requirements. This established the Commissioner as a powerful, independent member of the Mayor's cabinet.

Mr. Baxter promptly accepted the invitation of the new Democratic administration to serve as Commissioner. It was a further tribute to confidence in his competence and integrity by all factions in Philadelphia. Although he was a registered Republican voter, he was reappointed five times for four-year terms by Democratic Mayor's.

By the mid-1940s Philadelphia's water system facilities had greatly deteriorated and were inadequate for the city's needs. Its streams were heavily polluted, and its drinking water bad tasting and malodorous. Commissioner Baxter changed all of this during his tenure. He quickly launched what became a $500-million modernization program and on the first anniversary of his appointment announced that for the first time in ten years Philadelphia's drinking water had received an unconditional certificate of approval from the U.S. Public Health Service.

Sam Baxter left a legacy that included three modern water treatment plants, fifteen new or improved water pumping stations, several large storage reservoirs, three new water pollution control plants, and sanitary and storm water pumping stations. Also, 1,500 miles of new water mains and sewers were constructed. He introduced a number of concepts into his organization, including automation or computer control in Water Department plants, stream studies (including microstraining of storm water overflow, retention of such flow, distribution of rainfall, bottom sludge blankets, and effects of photosynthesis on streams), use of the computer for many operational reports and engineering studies, and he contributed much to the theory and practice of fixing water and sewer charges, since he was one of the few utility heads in the country with the power to fix these rates and charges. He established a financially self-supporting utility service organization that ranked among the best in the Nation.

A test of the Commissioner's achievements came during the Northeast draught of 1965. While other communities (including New York City) suffered water shortages, there was no shortage in Philadelphia.

Mr. Baxter was selected for important national assignments. In 1967 he was named by Secretary of the Interior Udall as a member of a special federal commission sent to Europe to observe technical progress in water resources and wastewater fields. In 1968 he was commissioned by the President as a member of the National Water Commission.

He received many honors in recognition of his distinguished career in public works: an honorary Doctor of Engineering from Drexel Institute of Technology; the Public Works Man of the Year from the American Public Works Association in 1960; the Engineer of the Year Award from the Pennsylvania Society of Professional Engineers in 1959; and numerous awards from Philadelphia, including the Robert K. Sawyer Good Government Award, Philadelphia Junior Chamber of Commerce, 1967; the George Washington Medal, Philadelphia Engineers Club, 1967; and the Man of the Year Award, Philadelphia City Business Club, 1965.

Sam Baxter was elected to the National Academy of Engineering in 1970. He cherished this honor and served as a member of the Committee on Public Engineering Policy and most recently as a participant in the round table on engineering and technical aspects of urban infrastructure.

Supplementing his devotion to engineering and management of public works, Sam Baxter was indefatigable in lending support to local community activities. He served as President of the Philadelphia Council, Boy Scouts of America; Chairman of Disaster Services, American Red Cross; Board Member of the Methodist Hospital; Chairman of the United Fund Community Services; and

Director of the local Rotary Club. An important interest was promoting development of the East Gerard Savings Association of Philadelphia. He first became a Director of this institution in 1929, and from 1964 until his death he was Chairman of the Board that guided investment of assets totaling $375 million.

He was married to Norma Winter and was the father of two children, Richard and Linda. The family was planning a fiftieth wedding anniversary when he died. Norma was well known among his professional colleagues because she accompanied him on most of his travels.

In seeking further characterization of Sam Baxter, what comes to mind is the recent assessment of a former City Councilman of Philadelphia, Thatcher Longstreth, now President of the Greater Philadelphia Chamber of Commerce. Mr. Longstreth's views may be summarized in this fashion: "Baxter had prestige that few public officials can ever command. This stemmed from his competence, integrity and discipline as an engineer. In his appearances before city council we were in awe of him. He was highly respected and deserved it because he was a person of extraordinary stature."

Arthur Maynard Bueche

1920-1981

By Roland W. Schmitt

ARTHUR M. BUECHE, Senior Vice-President for Corporate Technology, General Electric Company, died at Bridgeport, Connecticut, on October 22, 1981. Dr. Bueche was widely known as a statesman and advocate for science and technology; as an adviser to the U.S. Government, to academic institutions, and to international bodies; and as an innovator in applying research results to the needs of society.

Born in Flushing, Michigan, on November 14, 1920, Dr. Bueche attended Flint Junior College, received his Bachelor of Science degree in chemistry from the University of Michigan in 1943, attended Ohio State University, and was awarded his Ph.D. in physical chemistry from Cornell University in 1947. At Cornell he was a protégé of Nobelist Peter Debye, with whom he was closely associated in furthering the Nation's synthetic rubber program.

After serving as a research associate at Cornell for three years, Dr. Bueche joined the staff of the General Electric Research Laboratory, Schenectady, New York, in 1950. He studied the effects of electron beam radiation and fillers on the strength and elasticity of silicone elastomers. His research into effects of radiation on polymers led to cross-linked polyethylene, and he also made important contributions to the understanding of fracture and crazing in polymers. During this period he was a prolific producer of patents and technical papers.

His move into management began in 1953 with appointment as

Manager of Polymer Research, and by 1961 he had been named Head of the Research Laboratory's chemistry department.

General Electric named Dr. Bueche a Vice-President in 1965 and simultaneously gave him the task of integrating the Corporate Research Laboratory and the Corporate General Engineering Laboratory into a cohesive Research and Development Center. From 1965 to 1978, under his leadership, this combined entity achieved a high degree of success, with the staff growing to more than 2,000, including 800 scientists and engineers.

Dr. Bueche's leadership of this operation was recognized as an outstanding example of managerial skill. He was innovative in the development of strategic and operational planning of technical work, in devising new methods of technical liaison and technical information exchange, in promoting and recognizing technical excellence, and in the transition of R&D results into beneficial industrial and business activity.

The achievements of the laboratories under his direction were many and noteworthy, which attest to the effectiveness of his leadership. In electronics, they include the development of significant advances in computed X-ray tomography; a solid-state imager based on charge-injection device technology; thermomigration, a process that reduces the time required to process semiconductors; the surface-charge correlator, a new semiconductor device for analog signal processing; and several new and improved solid-state power devices. Achievements in materials included the fabrication and commercialization of cubic boron nitride, a man-made material second in hardness only to diamonds, and polycrystalline diamonds for metal cutting; the laboratory creation of the first synthesized gem diamonds; the first simple and inexpensive technique for fabricating ceramic parts of silicon carbide; invention of a silicon/silicon carbide composite; and a wide variety of high-performance polymers that served as the basis for General Electric's achievement of a major commercial position in the field of engineering plastics. Meanwhile, in the field of energy, among the many achievements were advances in the development of more efficient turbines, sodium-sulfur batteries, coal-gasification technology, significantly improved motor and control technology, and the production of energy-efficient lamps.

The success of virtually all of these laboratory achievements subsequently has been marked in the marketplace.

Dr. Bueche was an active participant in scientific and industrial professional organizations, government advisory groups, and educational institutions. He was a leader in defining and promoting the roles of science and technology in government, education, industry and as important contributors to the welfare and security of people.

As a particularly active member of the National Academy of Engineering, he served on the Executive Committee of the Council. He was also a member of the National Academy of Sciences and its Academy Forum Advisory Committee. In government he served on advisory groups to the President's Office on matters related to science and technology and also on a wide variety of science and technology committees. At various times he was a consultant to the National Science Foundation, the National Aeronautics and Space Administration, the U.S. Air Force, the National Bureau of Standards, and the Energy Research and Development Administration. He was Cochairman of President Reagan's Science and Technology Task Force in 1980 and headed the Science and Technology Policy team in the transition period before the inauguration.

In education he served on the Board of Trustees of Rensselaer Polytechnic Institute, Albany Medical College, and the Hudson Mohawk Valley Association of Colleges and Universities. He had been a member of Visiting Committees at Massachusetts Institute of Technology and at Harvard, Connecticut, and Duke universities, and was a member of the Board of Overseers of the School of Engineering and Applied Science at the University of Pennsylvania. He was particularly active at his alma mater, Cornell, where he served the university and its engineering school in a broad range of activities, including chairmanship of the College of Engineering Council. His public service also included membership on the boards of Ellis Hospital, Sunnyview Hospital and Rehabilitation Center, and the Schenectady Savings Bank, all in Schenectady, New York.

His honors were many. They include the Industrial Research Institute Research Medal for Leadership, the American Society of Metals Medal for the Advancement of Research, the Fahrney Medal of the Franklin Institute, the Gold Medal Award of the Amer ican Institute of Chemists, the Centennial Medal of the American Society of Mechanical Engineers, eight honorary degrees, and election as a Fellow in both the American Physical Society and the American Association for the Advancement of Science.

In the words of a resolution passed by the U.S. Senate following his death, "Dr. Bueche displayed exemplary personal qualities, leadership skills, devotion to public service, and a rare combination of knowledge and abilities."

Stanley W. Burriss

1910-1979

By Elmer P. Wheaton

STANLEY W. BURRISS, retired President of the Lockheed Missiles and Space Company, died on March 22, 1979. He joined Lockheed in 1954 and swiftly rose to become one of the key leaders in the development of the revolutionary Fleet Ballistic Missile weapons system. He not only assumed the task of directing this unprecedented scientific, engineering, and management undertaking, he also contributed a number of significant technical ideas and methods that helped assure the project's success.

Stan Burriss was born on July 15, 1910, in New York City. He received a B.S. degree in electrical engineering from the Newark College of Engineering and pursued further studies in mathematics, management, radar and electronics, nuclear physics, and global strategy at City College of New York, Bowdoin College, Massachusetts Institute of Technology, the Los Alamos Laboratory, and the Naval War College.

His engineering and management accomplishments earned him many honors. He was a Fellow of the American Institute of Aeronautics and Astronautics and of the Royal Aeronautical Society of Great Britain. He was elected a member of the National Academy of Engineering in 1968. He was a member of the Association of the U.S. Army, the Air Force Association, the Navy League, the U.S. Naval Institute, the American Ordnance Association, and the Armed Forces Management Association.

Mr. Burriss received the National Management Association's Sil ver Knight of Management Award; the Edward F. Weston Distinguished Alumni Award and the honorary Doctor of Engineering degree from Newark College of Engineering; the Certificate of Appreciation from the Secretary of the Army; and the Navy's highest civilian honor, the U.S. Navy Meritorious Public Service Award.

Stan Burriss had a crowded lifetime of technical and management accomplishments, but the most significant was his contribution to the creation of the Fleet Ballistic Missile, the several generations of Polaris, Poseidon, and now Trident. These missiles are unique among existing devices; they are required to operate in three media: water, the sensible atmosphere, and near space. They were begun in a period of perceived national peril when the task of developing the revolutionary new system had to be accomplished in an unprecedented time span. In addition to directing this massive effort, he made personal contributions that led to completing the project more than five years ahead of schedule.

A major example was his decision to reduce R&D test instrumentation by 40 percent after the scientists and engineers of both Lockheed and the Navy had attained the irreducible minimum thought possible at that time. This decision resulted in the delivery of operational Polaris missiles in half the time that traditional methods would have required.

In addition, he contributed in many technical areas such as the development of beryllium applications and thrust control methods— jetavators, jet tabs, asymmetric nozzle rotation—all of which were innovations in practical aeronautics at the time of their application to Polaris development vehicles. Of particular significance, the reentry problems that were solved provided invaluable data for future manned spaceflight and reentry.

Over a period of eight years, Mr. Burriss introduced and persuaded Navy, submarine, and missile people on technical compromises without which schedule commitments would not have been met. His judicious management of technical and operational team resources was a prime factor in the successful development of the Polaris A-1, A-2, and A-3 missiles.

He made numerous other contributions to engineering science.

While with the Los Alamos Scientific Laboratory, he served as director on important programs for weapon improvements, including research in the basic physical sciences concerning shock phenomena. This work resulted, in particular, in the design of experiments and instrumentation that led to reductions in the size and weight of fission weapons. As Test Director at Eniwetok Proving Grounds, he was in command of the scientific Task Group 132.1 for Operation Ivy, the first thermonuclear bomb test. He also served as Chief of Staff and Test Director for Operation Greenhouse. During this operation, he directed the development of a fast response interferometer device for measuring pressure versus time in the blast wave.

Stan Burriss made still other contributions during his Navy service as Tactical Evaluation Officer in the fields of radar, electronics, and communications. During Operation Crossroads at Bikini, he was assigned to Staff Commander Joint Task Force 1, in charge of instrumentation timing operations.

He had a wide range of interests outside his technical fields. He was a lifelong student of management and of people's roles and needs in the industrial process. He was quietly and deeply religious, and particularly interested in the application of Christian principles in the business setting.

He was an avid student of the oceans, their history, their ecosystems, and their mechanics. He enjoyed philosophy, and especially the transitional area where it approaches mathematics and the development of the sciences. He studied and enjoyed a wide range of music and worked with and for a number of community programs, especially the Boy Scouts of America.

When one reads the many comments of friends and associates who worked with him, two threads run through them. First, Stan Burriss was a gentleman, a friend, and a sincere man who pursued his work with thoroughness and strong conviction. Second, the world enjoys peace today because men like Stan Burriss lived and worked to deter war. Rear Admiral Robert Wertheim said, "None of our industrial teammates contributed more to the success of the Polaris program than Stan Burriss. The continuing deterrence to nuclear war provided by the Fleet Ballistic Missile System today is a living memorial to this dedicated American, businessman, and scientist."

Admiral Levering Smith said, "We mourn the loss of a teammate who was a pioneer in every field he entered. ... We honor the memory of a leader who played a major role in preventing nuclear war in his time and, we trust, for the future."

Henri Gaston Busignies

1905-1981

By Louis T. Rader

HENRI GASTON BUSIGNIES, an outstanding scientist, inventor, and engineer, died on June 20, 1981, in Antibes on the French Riviera at the age of seventy-six. In 1975 he retired from International Telephone and Telegraph Company (ITT) where he had been Senior Vice-President and Chief Scientist. His career, all with ITT, spanned a half century of major contributions to the field of telecommunications. He was responsible for more than 140 patented inventions, many of which were of major significance to commercial and military aerial navigation.

Dr. Busignies was born in 1905 at Sceaux near Paris, France, the son of a mechanical engineer. He showed a very early interest in radio and became a "ham" at age fourteen. Even as a teenager he soon discovered that he was more interested in experimenting with radio circuits to improve them than in receiving far-off stations, which was a prime interest in the early days of radio. He studied at the Jules Ferry College in Versailles, and in 1926, at the age of twenty-one, obtained a degree in electrical engineering from the Institute Normal Electro Technique in Paris. In 1926, before getting his degree, he obtained his first patent on a radio compass, a device that electronically pointed to the direction of the radio transmitter from which waves were being received. In that same year he received the first of his many awards, the Lakhovsky Award by the Radio Club of France.

In 1928 Dr. Busignies became an engineer with the ITT Paris

Laboratories. For the next twelve years he developed radio direction finders, airplane radio navigation systems, and early radars. In the first demonstration of an aircraft guidance system in 1936, his automatic direction finder dramatically guided a plane from Paris, France, to the Isle of Reunion off Madagascar. The equipment was demonstrated in the United States in 1937, and he continued to perfect it until World War II.

Dr. Busignies invented the world's first automatic direction finder, for which he received the Pioneer Award of the Aeronautical and Navigational Electronics Group of the Institute of Radio Engineers in 1958. The award also covered development programs including TACAN (tactical air navigation), the standard air navigation system used by U.S. and NATO military aircraft, and part of VORTAC (very high frequency omnidirectional range) in the Nation's common system for air navigation and traffic control on federal airways.

A model of the automatic radio direction finder resides in the Smithsonian Institution, where it was presented by the inventor and accepted in 1975.

One of Dr. Busignies' inventions was destined to make a vital contribution to the Allied war effort in the Battle of the Atlantic. At the time of the fall of Paris in World War II, much secret electronic work was being done in the ITT Paris Laboratory for the French military. One project, initiated by information supplied to the French by the British secret service, involved a method by which German U-boats could be located. The U-boats required periodic radio communications with each other and with Germany. To avoid being discovered by means of their radio transmitters, the Germans developed a technique of "burst" transmission, consisting of very short time intervals on the air, usually less than a second. During the years 1934 through 1945, Dr. Busignies received four patents on a high-frequency direction finder, later known as Huff-Duff, which was able to show instantaneously the direction from which the radio signals of the enemy submarines were coming and to indicate it on a cathode ray tube in a compass setting.

During the German occupation of Paris, Dr. and Mrs. Busignies along with two of their associates and their families (a party of ten) were able to escape from Paris with their working drawings and models under the eyes of the Gestapo and make their way first to Lyons, in unoccupied France, then by ship to North Africa, Portugal, and finally the United States. The invention was demonstrated to top U.S. military men, who immediately ordered that prototypes be built. Production followed rapidly.

A network of Huff-Duff stations was quickly established, first along the East Coast and later along both coasts. One thousand equipment stations were installed on destroyers and aircraft carriers, and 1,500 mobile ground stations were made for the U.S. Signal Corps. Another 30 to 40 stations were installed throughout the world.

German submarines were immediately located, as many as 150 in a single day during the peak period of the Battle of the Atlantic in 1943. This translated into raising Hitler's submarine losses to as high as forty in one month and decreasing Allied convoy ship losses to one-fiftieth of their worst figures. Hitler admitted that this was the "one single technical invention" that caused the German U-boats to lose the Battle of the Atlantic.

In recognition of these contributions, Dr. Busignies was awarded the U.S. Navy Certificate of Commendation for Outstanding Service to the Navy and the Presidential Certificate of Merit for his activities with the National Defense Research Council.

Another early wartime Busignies invention was the moving-target indicator (MTI) radar. This ingenious circuit scrubs off the radar screen every echo from objects that are stationary and displays only echoes from targets that are moving. In addition to military applications, the MTI radar is used in all airports of the world to eliminate the confusing echoes from cities and other stationary objects surrounding airports.

After the war Dr. Busignies elected to remain in the United States rather than to return to France, and he became a naturalized citizen in 1953. Since 1941, when he participated in the founding of ITT Laboratories, he played a major role in the growth of the corporation's U.S. activities. He became Technical Director of its laboratories (1949), Vice-President (1953), Executive Vice-President (1954), and President from 1956 until 1960, when he was advanced to Vice-President and General Technical Director of ITT. He later became

Senior Vice-President and Chief Scientist of the worldwide corporation.

After the war Dr. Busignies concentrated on the development of aids to navigation as well as on radio navigation. In addition to the two fields, noted above, of the radio compass and Huff-Duff, he made significant contributions in several areas. Inventions in the radar field in addition to the MTI were the IFF (Identification Friend or Foe), conical scanning radar, shell trajectory control, gunfire control, three-dimension radar, and a system to deceive and induce errors in enemy radar observations. The importance of the inventions to national defense is indicated by the fact that many of them were kept secret for periods ranging from seven years for gun control radar to twenty-six years for the IFF Some of his inventions are still in the secret category.

His inventions in the field of navigation systems included parts of ILS (instrument landing systems), TACAN, and VORTAC.

His inventions in the communications field cover the first use of Doppler effect in transmission and reception, the principle of phased-array antenna, and the use of metallic needles and ionized gases in orbit for communication when used as reflectors of radio waves.

Under his direction, some of the first pulse time modulation and pulse code modulation systems were developed, as well as the first commercial over-the-horizon link for television and telephone between Florida and Cuba in 1957-1958. He was also responsible for developing one of the first satellite antenna, 40 feet in diameter, in Nutley, New Jersey, in 1958.

In March 1959 Dr. Busignies presented to the Committee of Science and Astronautics of the U.S. Congress a project for international communication by synchronous satellites. This testimony contributed to legislation establishing the Communication Satellite Corporation.

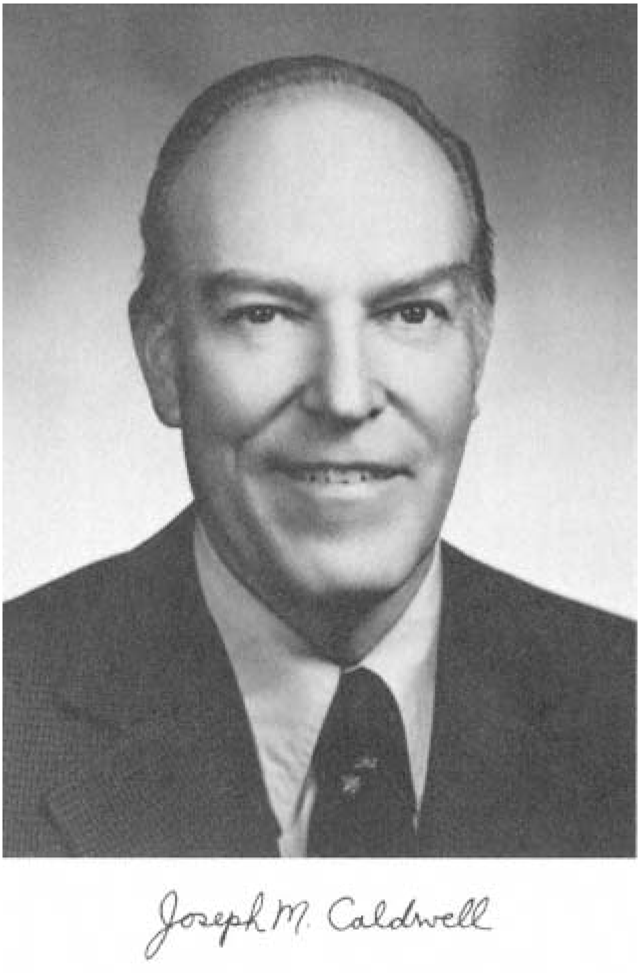
Fortunately, Dr. Busignies' genius was well recognized during his lifetime. In addition to the recognitions noted earlier—the Pioneer Award, the U.S. Navy Certificate of Commendation, and the Presidential Certificate of Merit—he was elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) in 1945, and in 1964 received the Institute's David Sarnoff Award for outstanding achievements in the field of electronics. In 1969 he received the IEEE Award in International Communications and in 1977 the Edison Award. In 1974 he was elected a Fellow of the Radio Club of America and in 1975 received their Armstrong Medal. He was awarded an honorary Doctor of Science degree in 1958 by Newark College of Engineering and an honorary Doctor of Engineering degree in 1970 by the Polytechnic Institute of Brooklyn. He received the Industrial Research Institute Medal in 1971 for his "outstanding leadership management ability, vision and wise counsel."

Dr. Busignies was the author of many technical publications, published both in the United States and in Europe. He was also invited to give many addresses, such as "Intercontinental Telecommunications by Artificial Satellites," which he presented at the Thirteenth International Congress of Communications in Genoa; "Industry Can Meet the Challenge of National Goals," presented at the National Security Industrial Association Symposium; "Science and Technological Changes: How to Survive Them," presented at the Governors' Conference on Science and Technology; and "Competing Internationally," the keynote address before the Thirteenth Annual Joint Engineering Management Conference—all presented in 1965.

Dr. Busignies was elected to the National Academy of Engineering (NAE) in 1966 and immediately began a long and distinguished service to the Academy. He was a member of the NAE Council from 1968 to 1971; Chairman of the NAE Project Committee from 1970 to 1973; a member of the Division of Engineering's Executive Committee from 1971 to 1973 and of its Committee on Space Applications. He served as Chairman of the NAE Committee on Telecommunications from 1973 until July 1974 when this committee was reorganized as the National Research Council's Committee on Telecommunication-Computer Applications. He continued to serve as Chairman until 1976 and also served as a member of a number of this committee's support panels.

Noted for his technical preeminence, Dr. Busignies was also an extremely courteous person who gave freely of his time to help others—from student to practitioner—and as a result he inspired very strong loyalties in all who came in contact with him. He was in truth one of "nature's gentlemen."

Dr. Busignies is survived by his wife, a daughter, and two grandchildren.



Joseph Morton Caldwell

1911-1980

By Jacob H. Douma

JOSEPH M. CALDWELL, formerly the top civilian engineering official in the Army Corps of Engineers, died in Arlington, Virginia, on December 21, 1980. His professional career began at the U.S. Waterways Experiment Station in Vicksburg, Mississippi, in 1933, and he retired as Chief of the Engineering Division of the Directorate of Civil Works, Office of the Chief of Engineers, in 1973, after forty years of federal service. He had a major impact on research and development of coastal engineering technology worldwide and was responsible for design or consulting work on every major commercial harbor in the United States and on major harbors in twenty foreign countries, largely under the Agency for International Development. He was recognized as one of the world's foremost coastal engineers.

Born on December 19, 1911, in Yazoo City, Mississippi, Mr. Caldwell received a B.S. degree in electrical engineering from Mississippi State University in 1932. During World War II, after graduating from the U.S. Army Command and General Staff School, he spent four years as an Engineer Intelligence Officer and was discharged with the rank of Major in 1946, when he returned to civilian service with the Corps of Engineers.

Mr. Caldwell was with the Coastal Engineering Research Center, formerly the Beach Erosion Board, from 1946 to 1971 and served as its Technical Director from 1963 to 1971. During this period he made innovations in the field of emergency shore protection and scale-model testing techniques, researched methods for predicting hurricane wave heights, and set standards for constructing deepwater ports for large oil tankers. Following the 1962 East Coast hurricane, he quickly developed the "Caldwell section," which formed the emergency shore protection fill placed along the U.S. seaboard; it formed the backbone for subsequent protective works.

In 1971 he was appointed Chief of the Engineering Division of the Directorate of Civil Works, Office of the Chief of Engineers. Mr. Caldwell was responsible for supervising the engineering and design of the Nation's largest water resource development program, with a design output covering over $1 billion of construction work annually in the areas of flood control, navigation improvement, harbor development, beach erosion control, hurricane protection, wastewater control, water quality improvement, and hydroelectric power plants.

Following a dam disaster in West Virginia, he was instrumental in drafting legislation for a national dam safety inspection program. As an engineering executive, he made great policy and management leadership contributions to the successful accomplishment of the Corps of Engineers' enormous annual construction program.

All during his long professional career, Joseph Caldwell devoted a significant amount of time to engineering society activities. He was a member of the American Society of Civil Engineers, International Association for Hydraulic Research, Coastal Engineering Council of the Engineering Foundation, Marine Technology Society, American Geophysical Union, International Union of Geodesy and Geophysics, and Washington Academy of Science.

He served on the Marine Science Advisory Committee for the Smithsonian Institution. After retiring in 1973, he practiced as a consulting engineer for private industry and the U.S. Government and was a consultant on coastal engineering in eight South American countries, four African nations, Canada, Portugal, India, Thailand, South Vietnam, and Bermuda.

During his career Mr. Caldwell's professional accomplishments were recognized by numerous honors, including the National Civil Service League Career Service Award, two Army Meritorious Civilian Service awards, and the Navy's Southeast Asia Civilian Service

Award for his work on port development in Vietnam. He was elected to the National Academy of Engineering in 1973.

Recognizing that a well-rounded man's total contributions to life involve more than a distinguished career in his occupational specialty, Joe, as he was called by everyone, gave unstintingly of himself to his fellow citizens in a number of religious, charitable, and civic activities. Among these were the local PTA, Boy Scouts, church visiting committees to alcoholic and penal institutions, teaching Sunday School for thirty-five years, and serving on the boards of directors for several church and benevolent institutions.

Throughout his career, Joe Caldwell combined the fundamental curiosity of the research scientist with the practical thinking of the engineer. His achievements exemplify the classic purpose of the engineer, that is, to understand nature and to modify and control nature's forces so as to meet the basic needs of mankind. His outstanding contributions in coastal engineering are well documented in his numerous writings in books, encyclopedias, and professional journals, but his influence on the prevention of coastal erosion is more far reaching than the publications indicate. It provides the basis for engineers to conserve and to improve our beaches and shorelines for use as recreational areas, as wildlife habitats, and as barriers to coastal flooding.

Joe Caldwell was a very friendly and informal man, revered by all his friends and associates. His sincere compassion and outstanding work have not reached their end. Both will continue to serve mankind on earth for many years to come.

Arthur Casagrande

1902-1981

By Stanley D. Wilson,

H. Bolton Seed, and Ralph B. Peck

ARTHUR CASAGRANDE, one of the great civ il engineers and teachers of this century, died peacefully in his sleep on September 6, 1981, at age seventy-nine. He had known for several years that the end was inevitable, yet with characteristic strength of will he actively participated in consulting and research activities until a few months before his death. He was the Gordon McKay Professor of Soil Mechanics and Foundation Engineering Emeritus at Harvard University.

Arthur Casagrande was born August 28, 1902, in Haidenschaft, Austria. He received his civil engineering degree in 1924 from the Technische Hochschule in Vienna, where he served as an assistant to Professor Schaffernak in the Hydraulics Laboratory. His father died in the same year, leaving the major burden of supporting the family on his shoulders. As the Austrian Empire had been dismembered after World War I and very little construction was in progress, Arthur Casagrande's strong desire to work on major civil engineering projects led him to emigrate to the United States, where he arrived on April 26, 1926. Shortly thereafter he met Karl Terzaghi, the founder of soil mechanics, who offered him the opportunity to work as his private assistant at the Massachusetts Institute of Technology (MIT) for the summer of 1926.

From 1926 to 1932 he was Research Assistant with the U.S. Bureau of Public Roads, assigned to MIT, where he assisted Terzaghi in numerous research projects directed toward improving apparatuses and techniques for soil testing. Arthur Casagrande developed the liquid limit apparatus, the hydrometer test, the horizontal capillarity test, the consolidation apparatus, and the direct shear apparatus. He also conducted field investigations on frost action in a cooperative project between the Bureau of Public Roads and the New Hampshire State Highway Department. His criteria for the frost susceptibility of soils, which resulted from this project, have been adopted by highway designers throughout the world.

In 1932 Arthur Casagrande began his long association with the Graduate School of Engineering at Harvard, where he developed a program of instruction that became the training ground for the majority of workers in soil mechanics and brought recognition to Harvard as the world's outstanding center of teaching and research in that field. He developed the triaxial test, now universally used as the basic technique for investigating strength and volume-change characteristics of earth materials, and entered into a lifelong study of the phenomenon of liquefaction, or loss in strength, of saturated cohesionless soils as a result of shock or earthquakes. He was an outstanding teacher, always thoroughly prepared, not dramatic, but completely at home in every detail. His students felt his personal interest, his genuine concern for their future, and the graciousness of his personality.

In 1936 he organized at Harvard the first International Conference on Soil Mechanics and Foundation Engineering. The success of this conference established the place of soil mechanics in engineering practice throughout the world.

During World War II, at the request of the U.S. Army Corps of Engineers, Professor Casagrande trained approximately 400 officers in the soil mechanics aspects of airfield construction. After the war the enrollment in his program of courses expanded to 80 or 90 students per year. In all, some 1,400 students studied soil mechanics at Harvard under Dr. Casagrande, and the roster of their names includes many of the outstanding professors, researchers, and practicing geotechnical engineers of the world. Few people have influenced the development of a branch of engineering as much as Arthur Casagrande by his own teaching and that of his former students.

Through long association with the Corps of Engineers, he strongly influenced the practice of soil mechanics and particularly the design and construction of earth dams. His association included studies of the failure of Fort Peck Dam, the stability of the banks of the Panama Canal and the possibilities for a sea-level canal, and consultation on the major dams constructed by the Corps including all those on the upper Missouri River. In addition, as a consultant on many of the highest and most difficult dams throughout the world, his experience and research had a dominant influence on the trend of development in this field. He engaged in such unusual problems as the foundations for the Liberty Mutual and John Hancock buildings in Boston, the construction of Logan Airport of soft dredged clay in Boston Harbor, the railroad fill across Great Salt Lake, and the foundations for the Synchrotron at the Brookhaven National Laboratories.

His last consulting assignments included the investigation of the failure of Teton Dam, design and construction of Itaipu Dam in Brazil (the largest concentrated hydro-development in the world), and Tarbela Dam across the Indus River in Pakistan (the largest of all embankment dams).

Professor Casagrande was the recipient of many awards and prizes, including the first Karl Terzaghi Award of the American Society of Civil Engineers in 1963, the Moles Non-Member Award in 1976, the Edmund Friedman Professional Recognition Award of the American Society of Civil Engineers in 1968, and a number of medals and prizes for papers before engineering societies. He received honorary doctorates from the Technical University of Vienna, the University of Liege, and the University of Mexico, and was awarded the Distinguished Civilian Service Award of the U.S. Army.

He was the first Rankine Lecturer of the British National Society of Soil Mechanics and Foundation Engineering and the First Nabor Carrillo Lecturer of the Mexican Society of Soil Mechanics.

He was elected to the National Academy of Engineering in 1966, served as President of the International Society of Soil Mechanics and Foundation Engineering from 1961 to 1965, and was an Honorary Member of the American and Boston Societies of Civil Engi neers, the Soil Mechanics Society of Venezuela, the National Academy of Exact Physical and Natural Sciences of Argentina, and the Mexican Soil Mechanics Society. He contributed more than 100 technical papers on soil mechanics and its applications.

He is survived by his wife, Erna (Maas) of Belmont, Massachusetts; his brother, Leo, of Winchester, Massachusetts; his sister, Alix Robinson; his daughters, Vivien and Sandra; and a grandson, James MacKanna, Jr.


V. T. Chow

Ven Te Chow

1919-1981

By William C. Ackermann

DR. VEN TE CHOW, noted engineer and educator, died on July 30, 1981. Dr. Chow was widely recognized throughout the world for his contributions to the science of hydrology and to water resources development. He was Professor of Civil and Hydrosystems Engineering at the University of Illinois at Urbana-Champaign.

Ven Te Chow was born in Hangchow, China, on August 14, 1919. He received his B.S. degree in civil engineering from the National Chiao Tung University in 1940, his M.S. degree in engineering mechanics from Pennsylvania State University in 1948, and his Ph.D. degree in hydraulic engineering from the University of Illinois in 1950. He became a naturalized U.S. citizen in 1962 and had been on the faculty of the University of Illinois in the Department of Civil Engineering since 1948.

Some of Dr. Chow's unusual contributions include his watershed experimentation system, which produced storms in the laboratory using sophisticated electronic, pneumatic, and sonar controls. It is the only instrument of such advanced sophistication in the world and has attracted worldwide attention and interest among scientists, engineers, and the public. It was the subject of an article that appeared in *Life* magazine on June 6, 1969, and was also addressed in the 1969 March issue of *Public Works* magazine. With this unique instrumentation, he introduced a new field of technology known as watershed hydraulics. He also developed a formula for hydrologic frequency drainage design, a method of backwater curve computa tion, and widely used theoretical approaches in the fields of stochastic hydrology and water resources systems analysis.

Among his many activities in hydrology and water resources, Dr. Chow was a founder and first President of the International Water Resources Association and was subsequently named Honorary President of that organization. He was also President of the American Geophysical Union's Section of Hydrology and a founder of and delegate to the Universities Council on Water Resources. He was a lecturing adviser to the Central Water and Power Commission of the Government of India and to the Power Resources Administration of the Government of Turkey; a member of the National Aeronautics and Space Administration (NASA) Study Group on Space Application of Earth Resources; an adviser to the United Nations Secretariat on water resources development in developing countries; a UNESCO/UNDP consultant to assist the establishment of a Centre of Applied Hydrology in Brazil and to plan a National Institute of Hydrology in Peru; the Director of the First International Seminar for Hydrology Professors; a consultant to the Commission Federal de Electricidad for the Government of Mexico; the United Nations Expert Adviser to the Government of Serbia, Yugoslavia; President of the First, Second, and Third World Congress on Water Resources held in Chicago (1973), New Delhi (1975), and Mexico City (1979); a member of the United States Water Resources Delegation to the People's Republic of China; and the Water Resources Expert of the World Health Organization to advise on Danube River projects in Hungary. In 1971 Governor Preston Smith commissioned Dr. Chow an Honorary Texas Citizen in recognition of his services as an adviser on implementation of the $10-billion Texas Water Plan. He was named an Honorary UNESCO Consultant in 1967.

He was elected to the National Academy of Engineering in 1973. Among his many activities was participation in National Research Council committees, including the U.S. National Committee for the International Hydrological Decade, the U.S. National Committee for the International Association of Hydrological Sciences, and the U.S. Committee for the International Institute of Applied Systems Analysis on Water Resources.

Dr. Chow became known throughout the world as a consultant and lecturer to many governmental, university, and private organizations, and he will also be long remembered for his writing and editing. He is the author of several well-known books, including the widely used *Handbook of Applied Hydrology* and *Open-Channel Hydraulics,* and more than 200 other technical publications. He was the Associate Editor of *Water Resources Research,* 1965-1967; Editorial Board Member of *Remote Sensing of Environment—An International Journal,* 1967-1971, and *Geophysical Survey—An International Journal of Geophysics,* 1971-1979; Editor of the Academic Press series of *Advances in Hydroscience* and *of Journal of Hydrology;* Advisory Board Member of *Fluid Mechanics—Soviet Research;* Editorial Board Member of *Water Supply and Management;* Advising Editor of Elsevier's series on *Developments in Water Sciences;* Consulting Editor of McGraw-Hill's *Water Resources and Environmental Engineering;* and Editor-in-Chief of *Water International* until 1980.

Dr. Chow received numerous awards and honors in recognition of his considerable achievements. He was elected to the American Academy of Arts and Sciences and the Academia Sinica, which is the Republic of China's highest award to a scientist or scholar. He was a Fellow of the American Association for the Advancement of Science, American Academy of Mechanics, and Diplomate of the American Academy of Environmental Engineers. He received honorary doctorates from Andhra University in India, Yeungnam University in Korea, Université Louis Pasteur de Strasbourg in France, and the University of Waterloo in Canada. His numerous awards include the Epstein Award; the American Society of Civil Engineers Research Prize; the Achievement Award of the Chinese Institute of Engineers, Inc.; the John R. Freeman Memorial Lecture Award; the Western Electric Fund Award; the Thompson-Ramo-Wooldridge Lectureship Award; the Fulbright-Hays Senior Scholarship Award; the Chinese Engineers and Scientists Association of Southern California Professional Achievement Award; the Silver Jubilee Commemorative Medal of the International Commission on Irrigation and Drainage; the Louis Pasteur Medal; the Vincent Bendix Award; and the Case Centennial Scholar Medallion. He was a National Science Foundation Distinguished Scholar and an Honorary Member of La Asociación Mexicana de Hidráulica.

Dr. Chow was most respected and loved by his close academic associates and a generation of students from throughout the world who came to study with him. It was in these associations that his warm personality, modesty, and his unfailing patience and good humor were most evident.

Ven Te Chow was certainly one of the "all-time greats" in water science and engineering.


William H. Corcoran

William Harrison Corcoran

1920-1982

By Cornelius J. Pings

WILLIAM H. CORCORAN, Institute Professor of Chemical Engineering, California Institute of Technology (Caltech), died on August 21, 1982, while vacationing in Hawaii with his wife, Martha. A scientist and engineer of extraordinary talent and achievements, he departed in the midst of a brilliantly productive career.

Dr. Corcoran attained great distinction as a research expert, educator, educational administrator and fund raiser, industrial consultant, and as the author or coauthor of more than ninety scientific papers and three books.

At Caltech he demonstrated his research virtuosity in a range of studies in biomedical engineering, chemical engineering kinetics, engineering design, process development of pharmaceuticals, rocketry, and transport processes.

Particular attention came to him from the international scientific community for his laboratory studies of the fluid mechanics of artificial heart valves. In these studies Dr. Corcoran and his research colleagues applied laser-Doppler anemometry (using laser beams to measure accurately the flow of fluid through the heart valves). He contributed significantly toward the development of improved artificial valve designs.

It was "in recognition of his outstanding scientific accomplishments and his great contributions of the past 27 years" that Caltech bestowed upon him the title of Institute Professor. Institute professorships are prestigious faculty positions and Caltech's highest honor for members of the faculty. When Dr. Corcoran was appointed to this position in 1979, he became the third person so honored in the history of the Institute.

As an Institute Professor, he took the leadership responsibility for developing a Caltech energy program to make a unique contribution to the Nation's energy needs.

As highly versatile as he was capable, Dr. Corcoran possessed fund-raising skills that had a tremendously beneficial impact upon the California Institute of Technology. In the decade 1969 through 1979, as First Vice-President for Institute Relations, he was responsible for all Caltech's fund-raising activity, including a $71-million campaign and a $130-million campaign, both completed with total success.

Dr. Corcoran was a most dedicated educator whose bright record clearly testifies to his total devotion to the cause of higher learning and especially to science and engineering. Dr. Harold Brown, Caltech President from 1969 to 1977 and later Secretary of Defense, said the following of Dr. Corcoran:

> Bill Corcoran displayed devotion to the institution and to chemical engineering as a professional discipline. He was an outstanding researcher, and remarkably talented at raising money as Vice-President for Development. But what impressed me most of all about Bill and Martha was how much they cared about Caltech students, undergraduate and graduate—not only as a group, but as individuals. Bill regarded his own research students as members of his family. He cared about their development as citizens, as caring people, as mature adults—as well as professional scientists and engineers. No wonder they, and all of us who knew him, miss him so much.

Born in Los Angeles on March 11, 1920, this long-time resident of San Gabriel, California, earned three degrees from Caltech: B.S. in applied chemistry, 1941; M.S. in chemical engineering, 1942; and Ph.D. in chemical engineering, 1948. He was one of the first two people to receive this doctorate from Caltech. In the course of his undergraduate years, he played four years of intercollegiate baseball.

His graduate work stopped temporarily for World War II, but in 1942 he was still on campus, at this point as a Research Supervisor and Development Engineer for the National Defense Research Committee for the Office of Scientific Research Development. His work focused on the interior ballistics and processing of propellant for artillery rockets and on the firing mechanism of the atomic bomb.

In 1948 he joined the Cutter Laboratories in Berkeley as Director of Technical Development. Caltech persuaded him to return to campus in 1952 as an Associate Professor, and five years later he was awarded a full professorship.

Many professional educational organizations were proud to claim Dr. Corcoran as one of their leaders. Among these were the American Institute of Chemical Engineers (which he served as President in 1979), American Chemical Society, American Institute of Chemists, American Society of Mechanical Engineers, American Society for Engineering Education, American Ordnance Association, Catalysis Society of California, American Association for the Advancement of Science, American Institute of Aeronautics and Astronautics, and National Society of Professional Engineers.

His scholarship and research contributions earned him an array of honors, including the Engineer of the Year Award from the Institute for the Advancement of Engineering in 1980, the same year he was elected to the National Academy of Engineering. Among his other honors were the Lamme Award of the American Society for Engineering Education for excellence in his profession, the Western Electric Fund Award for excellence in teaching, the Founders Award from the American Institute of Chemical Engineers for impact on his profession, and the Educational Achievement Award from the California Society of Professional Engineers. Dr. Lee A. DuBridge, President of Caltech from 1946 to 1969 and later Science Advisor to the President of the United States, reflected as follows:

> The characteristic which made Bill Corcoran such a highly valued member of the Caltech faculty was his versatility—his very broad range of interests and talents. He was a first-class chemical engineer, a superb teacher, a fine administrator and a valued friend and counsellor to both students and faculty. He was always an asset to each of the many Institute activities in which he engaged— academic, athletic, social or administrative. Above all, he was a man of high ideals, sterling character and a fine husband and father.

To win the enthusiastic accolades and discerning admiration of one's colleagues and contemporaries is a most meaningful triumph for a rigorous scholar and educator. Such was the recognition accorded William Corcoran in the many realms of higher learning that he inhabited and enriched.

His example is to be admired, certainly, emulated if possible, and looked to as a source of inspiration always.

Kurt H. Debus

1908-1983

BY Christopher C. Kraft, Jr.

KURT H. DEBUS, the outstanding twentieth-century pioneer in the field of space vehicle launch operations, died at Cocoa Beach, Florida, on October 10, 1983. Dr. Debus had retired in 1975 as Director of the National Aeronautics and Space Administration (NASA) John F Kennedy Space Center (KSC), the launch facility for the space vehicles that carried men to the first landing on the Moon, continued manned lunar explorations, delivered to orbit the first manned Space Workshop, and currently serves as launch and landing facility for the NASA Space Transportation System.

Dr. Debus devoted his life to advancing the technology of launch vehicle development and flight and to maintaining this Nation's leadership in space and aeronautics. During his lengthy career he achieved outstanding success in the innovation and application of new techniques in the design, development, and operation of missile and space vehicle launch facilities, equipment, and operations. His pioneering efforts profoundly influenced the progress of technology in national defense and space exploration. He was an inspiration to his colleagues, to members of the engineering and scientific communities, and to Space Age youth whom he strongly influenced in their careers.

Dr. Debus's contributions to the U.S. space program in launch vehicle development and flight are of historic significance. The leadership he provided in the development of launch concepts for space vehicles gained for him worldwide respect. He was personally responsible for many of the innovations in space vehicle preparations that led to the extremely high reliability of this Nation's manned launch vehicles. Dr. Debus forged a concept for the design of space vehicle assembly and launch facilities that could only be envisioned by an individual of stature far beyond the dreams and aspirations of many of his associates at the time. He had a keen grasp of the necessary and important and drove most directly for the best engineering solution. Dr. Debus was a true pioneer, unequaled as a technical innovator. His knowledge and expertise led to ideas, concepts, and, later, to applications that are continuing to assure this Nation of its leadership in large launch vehicle facility development and operations.

Dr. Debus was born in Frankfurt am Main, Germany, on November 29, 1908, and received all of his formal education in Germany. He attended Darmstadt University where he earned his initial and advanced degrees in mechanical and electrical engineering. He served as a Graduate Assistant on the faculty for electrical engineering and high-voltage engineering while studying for his master's degree. In 1939 he earned his engineering doctorate with a thesis on surge voltages and was appointed Assistant Professor of Electrical Theory at the university.

At this stage of his career, Dr. Debus joined the Wernher von Braun team on the Baltic coast in Germany and helped develop the V-2 rocket after the beginning of World War II. He came to the United States with Dr. von Braun's team in 1945 and committed his expertise in rocketry to the service of the embryonic American space program.

Dr. Debus was a central figure in the Redstone Ballistic Missile Program of the 1950s, the U.S. Army's first missile system equipped with a nuclear warhead. As a key member of the von Braun space team, located at the Redstone Arsenal in Alabama, he organized and directed the Missile Firing Laboratory and was responsible for the critical efforts in development of the Redstone, Jupiter, Pershing, Jupiter-C, and Juno vehicles. Dr. Debus was an essential member of the team that placed the *Explorer I* in Earth orbit, propelled by a Jupiter-C launch vehicle, inaugurating the Space Age for the United States. He supervised the development and construction of rocket launch facilities at Cape Canaveral, Florida, and led the launch operations team that sent the first American into space in 1961.

In 1962 Dr. Debus became Director of the Launch Operations Center in Florida, later to become NASA's John F Kennedy Space Center. Under his leadership more than 150 missiles and space vehicles were placed into orbit from KSC, including 31 manned flights from the Mercury, Gemini, Apollo, Apollo-Soyuz, and Skylab programs. The historic manned Apollo flights to the Moon, 1968-1972, utilizing the 363-foot, 7.5-million-pound thrust Saturn V launch vehicle, were all launched under his direction. As Director of the Kennedy Space Center, Dr. Debus guided development of the mobile concept applied to the preparation of the Saturn-class vehicles and transportation of the fully assembled space vehicle to the launch site. He developed KSC's Vertical Assembly Building, the largest spacecraft/launch system assembly building in the United States, and the extensive launch facilities that make up the Kennedy Space Center. He organized and directed the government-industry launch organization for the Nation's Apollo and Skylab programs. His last official act prior to retirement was to officiate in the ground breaking for the 18,000-foot KSC landing strip that the space shuttle used for the first time in returning to Earth from its successful mission in February 1984.

In recognition of his unique accomplishments, a number of honors were conferred upon Dr. Debus. He was given the U.S. Army's highest civilian decoration, the Exceptional Civilian Service Medal; the Scott Gold Medal of the American Ordnance Association's Missile and Aeronautics Division; and NASA's Outstanding Leadership Award. In July 1965 he was awarded the first Pioneer of Wind Rose Award, Order of the Diamond, by the International Committee of Aerospace Activities for his historical contributions to launch technology and science. In February 1967 he was awarded an honorary Doctor of Laws degree by Rollins College. He was also named co-winner of the American Astronautical Society's Space Flight Award for 1967. In January 1969 he received the NASA Distinguished Service Medal for his participation in the first manned lunar-orbit mission, *Apollo 8*. In September 1969 he received his second Distinguished Service Medal from NASA in recognition of his contribu tions to *Apollo 11* and man's first landing on the Moon. In December 1969 he was awarded an honorary Doctor of Engineering Science degree by Florida Technological University. He was elected to the National Space Hall of Fame in 1969. He received an honorary Doctor of Science degree from the Florida Institute of Technology in September 1970. He was awarded the Commander's Cross of the Order of Merit of the Federal Republic of Germany in 1971. In February 1974 he was signally honored as recipient of the Louis W Hill Space Transportation Award, presented by the American Institute of Aeronautics and Astronautics.

Dr. Debus was a Life Member of the American Ordnance Association; Fellow, American Institute of Aeronautics and Astronautics; Honorary Member, Instrument Society of America; Advisory Member, Marquis Biographical Library Society; Honorary Member, Herman-Oberth Gesellschaft; Honorary Member, Deutsche Gesellschaft für Raketentechnik und Raumfahrt, e. V.; Ex Officio Member, Florida Council of 100, from 1969 to 1971; and member of the Advisory Board of the British Interplanetary Society. He was elected to the National Academy of Engineering in 1975. He was a member of the Senior Advisory Council of the National Space Institute, and a member of the Council of Science and Technology of the Man and Space Committee.

Dr. Debus was truly a unique and special individual who was a warm friend and confidant to all who worked with him in those sparkling, adventurous days of the early space program. Many of the astronauts were particularly fond of Dr. Debus and knew full well of his concern for their safety. Dr. Debus was one of those sensitive human beings who possessed the qualities of leadership that motivated his employees to the highest levels of attainment. He was the expert in his field within the Free World. He pursued his responsibilities with a vigor and tenacity that sought out and overcame the most difficult management and engineering problems and provided solutions that ensured the utmost reliability of the spaceflight vehicles flown from the Nation's launch center. The facilities of the Kennedy Space Center, including the huge Vertical Assembly Building, the mobile crawler vehicle for transport of space vehicles to the launch site, and the efficient design of the total launch complex, serve as a monument to Dr. Debus and his illustrious career.

Raymond Louis Dickeman

1922-1983

By Fred W. Albaugh

RAYMOND L. DICKEMAN, perhaps one of the most brilliant engineering intellects that the nuclear industry has seen, died of a heart attack on March 12, 1983. Mr. Dickeman served for thirty years as an engineer and executive with the General Electric Company and Exxon Nuclear Company until ill health forced his retirement in 1978.

Born in Limeridge, Wisconsin, in 1922, Raymond Dickeman was awarded an M.S. degree in physics by the University of Wisconsin in 1948. He then joined the General Electric Company at the Hanford, Washington, nuclear complex, which the company operated for the U.S. Atomic Energy Commission. Over the next ten years Mr. Dickeman gained experience in all aspects of nuclear reactor technology, rapidly earning advancing responsibility in the general program of technology improvements at the Hanford plutonium production reactors, which increased reactor productivity severalfold during those years. In 1959 he was placed in charge of operations and maintenance at the eight production reactors and from 1960 to 1962 was General Manager of reactor fuel-manufacturing operations for the Hanford project.

Next came a new and quite different challenge, when he was charged with responsibility for the entire dual-purpose N-Reactor project. This included completion of a construction program that had not been going well, followed by plant start-up and then the ongoing operation of this $300-million complex. It was here that

Raymond Dickeman's ability to motivate his organization to an all-out effort was vividly demonstrated: over a two-year period they accomplished difficult construction goals without sacrificing quality, followed by an almost model start-up of the plant in spite of its radically new design. Today, after almost twenty years, the N-Reactor continues to produce electric power and special nuclear materials reliably and efficiently and is expected to do so for years to come. During the last two years of his stay at Hanford, Mr. Dickeman was General Manager of all General Electric Company operations at Hanford.

In 1967 Mr. Dickeman moved to the commercial nuclear operations of the General Electric Company and became manager of an ambitious program of turnkey nuclear power plant construction aimed at early penetration of the utility market by a boiling-water reactor product line. Again he evidenced a mastery of the complex labor and procurement problems encountered in this pioneering field. He reorganized and staffed his component to a high level of effectiveness, with the result that each of seven large nuclear power stations was completed in less than four years and at a cost less than one-tenth of that being experienced today.

In 1968 ESSO, now Exxon Corporation, made a commitment to enter the nuclear fuel cycle field, and the following year, with only a skeleton staff and partially formulated business plan in place, it engaged Raymond Dickeman as Chief Executive of its newly formed subsidiary (now Exxon Nuclear Company). In this position he had the opportunity to prepare a business strategy and to structure an entire working team for the tasks ahead. The first and primary task was to organize a fuel-manufacturing business by putting a core professional group together to design the product, develop fabrication processes, and design and oversee the construction of a fabrication plant. This was articulated with the organization of an operational staff to produce the fuel and the marketing and administrative services. The effort was successful. Exxon Nuclear Corporation is today the leading independent fuel fabricator of the United States and enjoys an excellent industrywide reputation for both its people and its products.

Moving to enlarge the scope of Exxon Nuclear's fuel cycle services, Mr. Dickeman proceeded to assemble development teams for proposed fuel-reprocessing project, for a centrifuge uranium enrichment project, and for a laser isotope separation (enrichment) project. In each case the work of these teams was rated in peer reviews as being of the highest quality, although the projects themselves had to be halted when it became evident that the necessary governmental approvals to proceed commercially could not be obtained.

In recognition of these achievements, Raymond Dickeman was elected to the National Academy of Engineering in 1978. He also served as Director of the Atomic Industrial Forum, Director of the American Nuclear Energy Council, and was a Charter Member of the Tri-City Nuclear Industrial Council. He was a member of the American Nuclear Society and the American Physical Society and served on numerous national, regional, and local advisory groups. In 1970 he was awarded a Distinguished Service Citation by the University of Wisconsin.

The preceding factual and chronological review of Ray Dickeman's professional career can better be understood by a brief discussion of his personal characteristics, his motivations, and his methods for getting things done.

The secret of his success was an ability to analyze major technical problems and conceive solutions with such unassailable thoroughness and logic that even the most skeptical of his co-workers would nearly always be convinced and willingly commit themselves to tasks and objectives of extreme difficulty. They did this because they were convinced that the program was sound; they knew it would succeed and they wanted to be part of a winning team. To be part of a Dickeman team meant full acceptance of Ray Dickeman's characteristics of results-oriented drive and complete dedication to meeting all commitments that had been made with regard to time, cost, quality, safety, or other criteria. Some were willing, but unable to stand the pace.

Ray Dickeman's ability to assess a technical-economic problem had its roots in the intellectual intensity and diversity of the man. His formal training was only a starter to a lifelong program of intellectual growth whereby he became personally expert in every major aspect of the nuclear industry—reactor research, design, engineering and operation, nuclear fuels development and manufacturing, weapons materials production, chemical reprocessing, and waste treatment and enrichment processes. He augmented this technical expertise with an equally impressive grasp of political, institutional, and economic considerations important to the nuclear industry.

He was able to conceive the essential outlines of the solutions to major interdisciplinary problems that integrated all important interacting considerations. He could do this because he knew so well the limits of the state of the art for every major parameter of the problem. He knew which limits were hard and not worth the effort to change, and he knew which limits were soft and thus likely to yield to well-conceived, determined attack. Thus, he did not attempt to blindly extrapolate from the past; he could always show, specifically, how and why the past could be improved on and, to use one of his favorite terms, why some improvement program was "do-able." This came through to intelligent colleagues and accounted for their willingness to make all-out personal commitments to his programs.

Ray Dickeman was a brilliant man, and a favorite pastime seemed to be the intricate and subtle movements of his own mind and its competitive interplay with others. Almost any social or informal business occasion, whether playing golf or poker or conversing at the dinner table, was for him an opportunity for exercise of wits or for a carefully calculated wager; in his mind there was no opinion, no attitude, no position that was not somehow negotiable. One of the fondest memories of this observer is of occasional wide-ranging intellectual jousts with Ray Dickeman that, although seldom won, were always stimulating.

Those who have seen and heard Ray Dickeman perform in the board rooms and conference rooms of his life will not soon forget him. Characteristically, after a period of confused and contradictory expressions of opinions by others on some important and complex subject, he would rise and proceed to outline, in perfect order and without benefit of notes, the essential nature of the problem and the optimum approach to its solution. Among the Hanford technical community, and perhaps elsewhere as well, the Dickeman steel-trap mind is almost a legend. With Ray Dickeman's death, a vital intellect has passed on.

The last five years of his life were spent quietly as a part-time consultant. He is survived by his wife, Janice, and five daughters.

Joseph Robert Dietrich

1914-1982

By David Okrent

JOSEPH ROBERT DIETRICH, retired Chief Scientist, Nuclear Power Systems, Combustion Engineering, Inc., died in Newport News, Virginia, on November 4, 1982, at the age of sixty-eight, from amyotrophic lateral sclerosis, sometimes called Lou Gehrig's disease. Dr. Dietrich was internationally known for a pioneering career in nuclear power reactor development that spanned more than thirty years and included the nuclear design of the prototype power plant for the world's first nuclear submarine, the *Nautilus,* and the Atomic Energy Commission's first boiling-water reactors.

Joe Dietrich was a natural leader in a quiet, reflective way. At heart a scientist and a thinker who was moved more by the power of logic than the desire for power, he was widely respected for his judgment, for his ability to get to the technical heart of the matter, for his lack of bias, and for his knack of dealing with people who had opposing views and getting them to settle their differences. A pragmatic physicist, he combined an intimate knowledge of the theory of reactors and the engineering details of reactor design and construction that was rarely matched.

Dr. Dietrich was born in Miles City, Montana, on August 25, 1914, but grew up with his three brothers on the family farm on the banks of the James River outside of Newport News. During his teenage years he helped out both on the farm and in the family restaurant business, which prospered until his father's death and the onset of the Great Depression. Dr. Dietrich did his undergraduate college studies at the College of William and Mary in Williamsburg, Virginia, and received a B.S. in physics and chemistry in June 1935. He went on to earn his M.S. and Ph.D., both in physics, from the University of Virginia in June 1937 and June 1939, respectively.

Following a postdoctoral year at Yale University, Dr. Dietrich was employed by the National Advisory Committee for Aeronautics (NACA), the forerunner of the National Aeronautics and Space Administration (NASA), first at its Langley Field Laboratory and then at the new NACA laboratory in Cleveland, Ohio. As Head of the Rockets Section, he worked on jet-assisted take-off. During this time period he met Adelia Perkins of Newport News and they married in 1943. Joe and Dee had three children—Christine (Kit), David, and Joseph.

Dr. Dietrich became very interested in the potential for civilian application of the fission process, and in 1946 he arranged to have NACA send him on loan to Oak Ridge National Laboratory where he undertook a crash course in reactor physics together with then Captain Hyman Rickover of the Navy and John Simpson of Westinghouse, among others. Dr. Dietrich worked on the Daniels Pile, a very ambitious, gas-cooled reactor concept. However, it was dropped shortly after establishment of the Atomic Energy Commission.

Rickover set up a group to design a nuclear power plant for submarines, and Joe Dietrich was placed in charge of the physics design. This project was moved to Argonne National Laboratory in Illinois in 1948, where Dr. Dietrich worked under Harold Etherington and Walter Zinn, the Laboratory Director. The *Mark I* land-based prototype was designed and built as planned, beginning operation in 1953, in spite of the fact that they had only Marchant mechanical calculators on which to perform the needed analysis and were faced with the formidable constraints posed by submarine operational requirements as well as limits on the availability of highly enriched uranium-235. The *Nautilus* itself was launched the following summer.

In 1953 Dr. Dietrich formally joined Argonne National Laboratory as Associate Director of the Reactor Engineering Division with responsibility for the nuclear design and analysis of experimental power reactors. An Argonne scientist named Sam Untermyer had proposed an experiment designed to test two hypotheses. The first was that a water-moderated reactor would be self-limiting in the event of an accident involving a rapid increase in the neutron multiplication rate; the other idea was that one could design a boiling reactor that would really work. Walter Zinn approved the experiments, and Joe Dietrich headed up the theoretical work. Three separate experiments, which became known as the boiling reactor experiments (BORAX) series, were rapidly built and run, very successfully. They included the first experiment in which a watercooled reactor was subjected intentionally to large, rapid increases in multiplication rate well into the region where the reactor was critical on prompt neutrons alone, and demonstrated the inherent shutdown capability of the boiling process.

The final experiment on BORAX I involved deliberate destruction of the reactor by inducing a transient severe enough to melt the core. This experiment, which was run partly to introduce a sobering effect on those who prematurely thought nothing could go wrong, led, among other things, to much subsequent exploration of the "steam explosion," a rapid exchange of heat between the molten fuel and liquid water that led to damaging pressures. The BORAX experiments also represented the first instance of public use of nuclear-generated electricity in the United States, in 1955, although nuclear electricity was first generated in December 1951 at the liquid-metal-cooled, fast neutron Experimental Breeder Reactor (EBRI). The papers on the BORAX experiments were among the principal highlights of the First International Conference on Peaceful Uses of Atomic Energy held by the United Nations in Geneva in 1955, and represented an important beginning in establishing Dr. Dietrich's international recognition.

In 1956 Dr. Dietrich left Argonne to join Dr. Zinn in forming the General Nuclear Engineering Corporation in Dunedin, Florida. Dr. Dietrich served as Vice-President and Director of Physics for projects that included the ambitious Boiling Nuclear Superheater (BONUS) Power Station. General Nuclear Engineering became a part of Combustion Engineering (CE) in 1959, and in 1964, when the CE nuclear power efforts were consolidated in West Hartford, Connecticut, Dr. Dietrich took on the technical direction of the nuclear analytical and safety design and development of the CE pressurized water, nuclear steam supply systems. He retired from the position of Chief Scientist of Nuclear Power Systems a few years before his death and moved back to Newport News where, together with his wife, he built a new home on the old Dietrich family farm.

Dr. Dietrich was elected to the National Academy of Engineering in 1975. He was elected Vice-President of the American Nuclear Society in 1976 and served as President of that society from June 1977 to June 1978. Among his other professional activities was the position of Editor of the quarterly review, *Power Reactor Technology,* from 1958 to 1965.

Among the major publications by Dr. Dietrich are the chapter titled "The Reactor Core" in Volume I of the classic, *The Technology of Nuclear Reactor Safety;* the chapter on reactor calculations in the *Nuclear Engineering Handbook* edited by Etherington; and the book *Solid Fuel Reactors* (written with Walter Zinn), a presentational volume by the U.S. delegation at the Second International Conference on Peaceful Uses of Atomic Energy, Geneva, 1958.

Joe, as he was known to his many, many friends (or Bob as he was known to his family), was a remarkable person as well as a very able scientist. Warm, thoughtful, considerate, kind, fair, wise—these are all adjectives that could most properly be attributed to Joe. He was good to work with, to work for, or to have working for you. His steady, quiet, yet forthright approach to issues, both personal and technical, was a pleasure to behold. A real gentleman in the best sense of the word, Joe Dietrich will be truly missed.

Donald Wills Douglas

1892-1981

By Robert L. Johnson

DONALD WILLS DOUGLAS, aviation pioneer, founder of Douglas Aircraft Company, died on February 1, 1981, in Palm Springs, California. His leadership in the aviation/aerospace industry for more than fifty years contributed greatly to development of the world's air transport system and to the exploration of space.

Mr. Douglas established the company that carried his name in 1920, and he guided its growth to become one of America's largest aerospace firms. At the time of his death he was Honorary Chairman of the Board of Directors of McDonnell Douglas Corporation, formed with the merger of Douglas Aircraft and the McDonnell Company in 1967.

Born April 6, 1892, in Brooklyn, New York, he was the son of William E. and Dorothy Douglas. His father was a bank cashier. As a youth he attended the Trinity Chapel School in New York City, and entered the United States Naval Academy at Annapolis in 1909.

His interest in aviation had been sparked when, as a boy of twelve, he read the first accounts of the Wright brothers' successful flights at Kitty Hawk. He saw Orville Wright demonstrate an aircraft for the U.S. Army Signal Corps in 1908. By 1911, when the U.S. Navy based its first three float-equipped aircraft on the Severn River at Annapolis, young Midshipman Douglas was building and flying model planes in his spare hours.

In 1912, determined that aviation would be his vocation, he resigned from the Naval Academy just a year short of graduation to study aeronautical engineering at the Massachusetts Institute of Technology (MIT). He earned a B.S. degree in mechanical engineering (there was not yet an aeronautical degree) in 1914 and remained at MIT as an Assistant in Aeronautical Engineering. His assignment was to help build one of this country's first scientific wind tunnels.

"I think I can truly lay claim to being one of the very first aircraft engineers for the simple reason that up until that time there was no engineering," Mr. Douglas said more than fifty years later. "It was all done by judgment, mostly. If the airplane flew the judgment was good. If it didn't fly the judgment was bad."

In 1915 Mr. Douglas became a consultant to the Connecticut Aircraft Company, and then Chief Engineer for the Glenn L. Martin Company. After serving a year during World War I as Chief Civilian Aeronautical Engineer for the U.S. Signal Corps, he returned to Martin to design the Martin bomber. It was a giant—for its time—twin-engine biplane that did much to expand the concept of military air power.

With these achievements behind him, Mr. Douglas decided to go into business for himself. He moved his family to California and opened his enterprise equipped only with visionary ideas, engineering and business acumen, a desk in the back of a barber shop, and some $600 in assets.

His first project, in association with young sportsman David R. Davis, was an airplane designed to fly coast to coast over the United States, nonstop. That aircraft, the *Cloudster,* was the first of many Douglas engineering triumphs; it became the first airplane to take off with a useful load exceeding its own weight. Within months the U.S. Navy ordered torpedo bombers, drawing in part on the *Cloudster* design. Douglas Aircraft Company had completed its own takeoff.

Global recognition of Douglas design excellence came early. In 1924 U.S. Army pilots flew specially built Douglas World Cruisers more than 27,500 miles in the first flight around the world. The feat demonstrated that air travel was, in fact, limitless—and affirmed the Douglas slogan, "First around the world."

The Douglas reputation for outstanding military aircraft, mail planes, and flying boats grew as he assembled a design and production team that included many who gained fame in their own right; among them were John K. Northrop, James "Dutch" Kindelberger, Clifford Garrett, Ted Conant, Harry Wetzel, Arthur E. Raymond, and Thomas V. Jones.

In 1932 Mr. Douglas responded to a request from Transcontinental and Western Air for bids on design and production of a three-engine transport able to carry twelve passengers at speeds up to 145 miles per hour. Boldly he offered a twin-engine fourteen-passenger craft with a speed of 180 miles per hour. He won the contract, and the Douglas Commercial (DC) family of airliners was born.

The DC-1 prototype flew in July 1933. The improved DC-2 models delivered for airline service reduced transcontinental travel time to less than sixteen hours, and won for Douglas the 1935 Collier Trophy. The DC-3 story is a legend well known, with many hundreds still in service around the world. The four-engine DC-4 made transoceanic flight by land-based transports routine. The DC-6, DC-7, and jet-powered DC-8 were airliners that built the modern commercial air transport system. And today's DC-9 and DC-10 jetliners continue the tradition of design excellence, reliability, and technological leadership established by Donald Douglas.

Mr. Douglas threw himself and his company into the World War II aviation effort with typical vigor. His innovative B-19, laid down in 1937, was by far the largest land-based aircraft of the era. It provided knowledge that guided design of all the wartime heavy strategic bombers and expanded the concept of military air power. Six Douglas plants in the West and Midwest delivered nearly 30,000 planes—transports, bombers, and carrier-based attack aircraft—and Mr. Douglas presided over the War Production Council to coordinate efforts with other aircraft manufacturers.

After the war Mr. Douglas continued to press the advance of technology with improved commercial models, giant military transports, and jet- and rocket-powered research craft that explored supersonic flight.

He was a leader in developing guided missiles and, later, space vehicles. The Douglas series of Nike antiaircraft missiles provided the foundation for what evolved into the Nation's present ballistic missile defense technology program. The Thor intermediate-range ballistic missile of the 1950s became today's Delta space launch vehicle. The Douglas-designed S-IVB upper stage for the Saturn lunar launch vehicle became the *Skylab,* the world's first manned orbiting space station.

Donald Douglas's life coincided with the coming of the aviation and now aerospace—era. He must be credited with much of that epic development. His eminence as a creative engineer and head of a major industrial organization was recognized by countless honors and awards, including the Collier Trophy, the Daniel Guggenheim Medal, the Elmer A. Sperry Award, the French Legion of Honor, the Franklin Medal for creative engineering in aeronautical science, and the Wright Brothers Memorial Trophy. He was elected to the National Academy of Engineering in 1967.

Donald Wills Douglas, indeed "one of the very first aircraft engineers," earned a lasting place in history as he helped to make it. His friends and colleagues knew him as a peerless engineer and entrepreneur who prized his reputation for integrity above all else. They knew him as a sportsman who loved his dogs and his sailing and his friendships with the same intensity that he gave to his professional life. And they will remember him, always, as simply "Doug," with gratitude for having known him.

Charles Franklin Fogarty

1921-1981

By Albert P. Gagnebin

CHARLES F. FOGARTY, Chairman of the Board and Chief Executive Officer of Texasgulf Inc., died in a crash of his company aircraft on February 11, 1981, near White Plains, New York.

Dr. Charles F. Fogarty was truly an extraordinary man. He was born in Denver, Colorado, on May 27, 1921, grew up and was educated through high school in a Christian Brothers' orphanage, the J. K. Mullen Home for Boys in Fort Logan, Colorado. He then earned his way at the Colorado School of Mines with the help of a *Denver Post* scholarship and received an Engineer of Mines degree in 1942. His accomplishments in industry were as spectacular and impressive as his success in achieving an education. He was instrumental in transforming and expanding Texasgulf from a sulfur company into a broad-based mineral company in the space of a few years.

After receiving his degree from the Colorado School of Mines in 1942, Dr. Fogarty entered military service as a Second Lieutenant in the U.S. Corps of Engineers. He left the service as a Major in 1946 and took a position as Senior Geologist with the Sacony Vacuum Oil Company of Columbia where he stayed until 1950. Then he returned to the Colorado School of Mines to obtain a Doctor of Science degree in geology. He began his career with Texasgulf in 1952 in exploration and geology and advanced steadily to positions of increasing responsibility, becoming Director in 1962, President in 1968, and Chairman and Chief Executive Officer in 1973.

Dr. Fogarty had a deep interest in the earth, its formation and structure, and an affinity for natural resources. When he joined Texasgulf it produced one product—sulfur. Under his leadership and drive, exploration was expanded and, combined with his skill as a geologist, led to dramatic results. Texasgulf was transformed into a diversified natural resources company producing, in addition to sulfur, zinc, silver, phosphate, potash, copper, lead, cadmium, tin, iron ore, coal, forest products, and gas and oil. Dr. Fogarty was the driving force and the major instrument in achieving this expansion in products. In addressing the Newcomen Society in New York in 1975 he explained, "Perhaps one of our greatest rewards is being close to the earth and in direct contact with its variety, mystery, power and beauty." Perhaps the crowning achievement of the exploration effort was the discovery of the ore body in Timmins, Ontario, one of the most important mines in North America.

The objectives that shaped Texasgulf were articulated by Dr. Fogarty early in his career. In 1959 an attractive merger proposal being considered by the Board of Directors was viewed with dismay by him and his associates. To persuade the board to reject this proposal, Dr. Fogarty prepared a memorandum that stated in part: Our ultimate objective is to become a diversified natural resource company with sulphur contributing approximately 50 percent of the income and nonsulphur minerals (oil, gas, base metals, potash, phosphate, etc.) the balance. We feel that with our present cash generating ability, experienced and capable Board of Directors and management experience, we can achieve this within a reasonable time....

That these objectives were realized in the space of a few years testifies to his exceptional personal qualities. He was able not only to conceive of ambitious objectives, but to communicate his beliefs and enthusiasm to his associates with such conviction that they had no doubts of achieving what might have originally appeared to be unreachable goals. Charles Fogarty was able to inspire people, to stretch their capabilities, and to channel their work into a powerful team effort. He had exceptional intensity of purpose, that rare quality essential for any great achievement.

Dr. Fogarty was a compassionate, kind, thoughtful, and deeply religious man who loved his family and in a sense extended the warmth and understanding of a family relationship to all those associated with him. His life was replete with examples of the help rendered to many people. Under his leadership Texasgulf was one of the first companies to abolish hourly wages and make every employee salaried.

Besides being a corporate director of seven companies, he was a director of a number of mining and geological institutes, and a Trustee of the Colorado School of Mines. He received the Hal Williams Hardinge Award of the American Institute of Mining, Metallurgical and Petroleum Engineers; the Distinguished Achievement Medal of the Colorado School of Mines; and was elected to the National Academy of Engineering in 1976.

Dr. Charles F Fogarty's achievements both as a man and as a scientist and industrialist stand as an inspiration and example to all of us but especially to young people starting their careers. He left the world a better place than he found it and takes his place with the illustrious people who have individually contributed so much to the benefit of society.

John Chapman Frye

1912-1982

By William C. Ackermann

DR. JOHN CHAPMAN FRYE had recently retired as Executive Director of the Geological Society of America when he died on November 12, 1982, in Boulder, Colorado. His long and distinguished professional career was marked by both outstanding scientific contributions and exceptional managerial skill.

Perhaps the most lasting contributions of John Frye reside in more than 140 scientific papers and publications. Although these dealt with a wide range of subjects, including minerals, stratigraphy, and groundwater, they were predominantly concerned with the recent Pleistocene and Pliocene periods of the interior provinces and with the interpretation and applications of glacial materials.

As an outgrowth of his scientific studies, Dr. Frye can be credited with advancing the term and substance of environmental geology to its present well-recognized field among geologic specialities. This subject employs surficial geology in a systematic way to the solution of such important and practical matters as foundation conditions, landfill siting, availability of sand and gravel deposits, and land use planning.

John Frye was born in Marietta, Ohio, on July 25, 1912. He earned his B.S. degree at Marietta College in 1934 and his M.S. and Ph.D. in geology at the University of Iowa in 1937 and 1938, respectively. He was awarded an honorary Doctor of Science degree by Marietta College in 1955.

His professional career began at the University of Iowa and was followed by service in the Groundwater Division of the U.S. Geological Survey. He served as Assistant State Geologist and Assistant Director of the Kansas State Geological Survey from 1941 until 1945, at which time he was named the Executive Director of the Kansas State Geological Survey, a position he held until 1954. From 1952 to 1954 he served concurrently as State Geologist. He held appointments as Professor of Geology at the University of Kansas (1942-1954) and at the University of Illinois (1963-1974).

In 1954 Dr. Frye was named Chief of the prestigious Illinois State Geological Survey and held this position until he retired in 1974, at which time he accepted the position of Executive Director with the Geological Society of America until his second retirement in 1982.

John Frye was elected to the National Academy of Engineering in 1971. He was also a Fellow of the Geological Society of America and the American Association for the Advancement of Science; a member of the American Association of Petroleum Geologists; the Society of Economic Geologists; the American Geological Institute (President, 1966); the American Institute of Professional Geologists; the American Geophysical Union; the American Institute of Mining, Metallurgical, and Petroleum Engineers; the Association of American State Geologists (President, 1960); and the Society of Economic Paleontologists and Mineralogists (Vice-President, 1965-1966).

Dr. Frye was prominent in the activities of the National Research Council. This included service in the Division of Earth Sciences, the Geophysics Research Board, and a series of committees and panels dealing with remote sensing, mineral resources, energy, and radioactive waste management.

John Frye not only left a valuable record of basic and applied geological contributions, but he excelled as an administrator. His direction of the Illinois State Geological Survey from 1954 to 1974 was a golden age for that agency, based upon his scientific achievements, his administrative skills, and his personal qualities. Those same qualities were important during the subsequent eight years when he led the Geological Society of America (GSA) as its Executive Director. When he entered that position, the GSA faced financial crises that were effectively resolved. It was his leadership in organizing and managing the GSA Foundation that was successful in obtaining new funding that provided for important new Society endeavors. He stimulated greater participation in Society affairs by the membership with the resultant advancement of the geological sciences.

Those who knew John Frye best were his close professional associates who shared his extensive field exploration. He was particularly outstanding as a field geologist. He was a fine observer, systematic in recording his observations in the field and writing every evening a summary of the day's findings and their significance. Every day in the field was an adventure, and it never ended until the light faded.

John Frye was a warm and thoughtful man of good humor, a devotee of classical music, and deeply religious. He loved his family and was a valued friend and professional associate.

Edward John Gornowski

1918-1983

By Edward E. David, Jr.

EDWARD JOHN GORNOWSKI, retired Executive Vice-President of Exxon Research and Engineering Company, died at his home on December 19, 1983. We have lost a valued member and a trusted friend. Our sympathy goes out to the family he cherished and made a prime focus for his life. An engineer of great skill and the utmost integrity, he remains an inspiration to all who were privileged to work with him.

Ed Gornowski was born on February 27, 1918, in Wilmington, Delaware. He graduated with a bachelor's degree in chemical engineering from Villanova University in 1938 and went to work for Pyrites Co., Inc., in Wilmington. He soon decided that he would like a more thorough grounding in the fundamentals of his craft and enrolled in the Graduate School of the University of Pennsylvania where he obtained a Ph.D. in chemical engineering in 1943. His ties with both Villanova and Pennsylvania were strong and lasting. He provided both institutions with sound advice while serving on numerous committees and advisory boards, including an eight-year stint as a member of the Board of Overseers at Pennsylvania. His services and accomplishments were recognized by Villanova when it awarded him the J. Stanley Morehouse Award in 1979 and an honorary Doctor of Engineering degree in 1983.

As a freshly minted Ph.D., Ed Gornowski joined Exxon's Research Laboratories in Baton Rouge, Louisiana, at a time of intense activity during World War II. He was a member of the team that took the fluid catalytic cracking process through a rapid series of expansions, new designs, and innovations in response to wartime needs for aviation fuel. His contributions to the team effort were in the area of chemical process engineering and centered around the understanding of the intricate relationships among the many independent variables in this complex process.

At war's end Dr. Gornowski transferred to Exxon's R&D affiliate in New Jersey. From 1945 to 1964 he was involved in the development of a wide variety of new and improved petroleum processes. He guided the preparation of exploratory engineering designs and the programming and evaluation of laboratory/pilot plant operations. Specific accomplishments included advances in catalytic reforming, in gasification of carbon solids, and in the technology of fluidized solids. Dr. Gornowski's contributions in catalytic reforming are particularly worthy of note. This process, which converts saturated hydrocarbons into aromatics, has become a prime factor in petrochemicals manufacture and in the production of high-octane gasoline. It is of particular significance currently as the most economical means for obtaining high-octane gasoline without the use of tetraethyl lead. Dr. Gornowski's contributions in this area included a key technique for restoring the activity of the currently used noble metal catalysts. His steady rise in the organization during this period—from Engineer to Deputy to the Vice-President—was in recognition of his contributions to these and other pioneering activities. His technical contributions are exemplified by the fourteen patents granted in his name.

In 1964 Dr. Gornowski was appointed Manager of Chemical Products at Exxon's Bayway Refinery in Linden, New Jersey, where he was responsible for all aspects of the operation of a variety of plants in a major petrochemical complex. His success in handling that assignment led the following year to his appointment as Manager of the Coordination and Planning Department of the parent corporation in New York. In this post Dr. Gornowski was responsible for a number of critical corporate activities, including the development of long-range plans and the preparation of energy supply and demand forecasts.

From 1966 to 1969 Ed Gornowski served in London, England, as

Vice-President, Operations, of Esso Europe, Inc., and was responsible for coordination of the manufacturing, supply, transportation, and research activities of the fourteen national European operating organizations that comprise Esso Europe. During his tour of office in London, Dr. Gornowski handled superbly the drastic dislocations in petroleum supplies for Europe following the 1967 Arab-Israeli War and the subsequent closure of the Suez Canal.

In 1969 he returned to New Jersey as Executive Vice-President of Exxon Research and Engineering Company, a position he held until his retirement in 1981. Dr. Gornowski shared with the President full responsibility for directing the activities that provide research and engineering services for worldwide affiliates of Exxon Corporation. This involved leadership of some 2,000 scientists and engineers engaged in work ranging from basic research to management of construction projects. His background of personal technical contributions, his judgment and personal integrity, and his demonstrated skill in organizational leadership amply qualified him to lead one of the world's large organizations devoted to pioneering and applying technical developments.

In addition to his enormous contributions to Exxon's technology and operations, Ed Gornowski devoted substantial effort to the furtherance of his profession and of society in general. This was recognized by his election to the National Academy of Engineering in 1971 and his being elevated to the rank of Fellow in the American Institute of Chemical Engineers in 1973 and in the American Association for the Advancement of Science in 1978. He served on a large number of panels of the National Academy of Engineering, National Academy of Sciences, and National Research Council, and for five years was a guiding force on the Committee on Nuclear and Alternative Energy Systems (CONAES). He was an active member of the Office of Science and Technology's Energy R&D Overview Panel, the President's Energy R&D Advisory Council, the New Jersey Council of Graduate Education, of many committees of the Industrial Research Institute and of advisory boards for Caltech and the Institute of Gas Technology.

In 1983 Ed Gornowski served the State of New Jersey as a member of the Governor's Management Improvement Plan, acting as the principal industry consultant in an analysis of management and budget practices at Rutgers University. He received a citation from Governor Kean for his contributions.

Edward Gornowski was a superb engineer—and more. He was a superb human being, always ready to provide support and guidance, a man of loyalty and dedication, a man of great honesty. He faced life squarely, enjoying its successes and overcoming its unavoidable problems. He left us better for having known him.


Floyd L. Goss

Floyd L. Goss

1907-1980

By Arthur Hauspurg

FLOYD L. GOSS, former Chief Electrical Engineer and Assistant Manager of the Los Angeles Department of Water and Power (LADW&P), died at the age of seventy-three in Los Angeles, California, on December 25, 1980. Mr. Goss will be best known, remembered, and appreciated for his very significant work in the field of regional and national power supply planning and reliability, including operation and design. He was a man of great integrity who was also a powerful leader and supporter of the electric utility industry. He left his mark in many ways, not least of which was his continuing concern, appreciation, and willingness to support those responsible for the successful operation of electric utilities.

After a thirty-nine-year career with the LADW&P, Mr. Goss retired in September 1972, but continued in a consulting capacity in the electrical industry, particularly in the area of reliability. He participated in the formation of regional and national reliability organizations, the National Electric Reliability Council and the Western Systems Coordinating Council. He served as Founding Chairman of both organizations.

Floyd Goss was born on August 25, 1907, in Columbia, Missouri, and received a Bachelor of Science degree in electrical engineering from the University of California at Berkeley in 1931. As an undergraduate at Berkeley he worked as a student engineer for LADW&P during vacations.

During his professional career with LADW&P beginning in 1933, Mr. Goss ascended from his first position as an electrical tester to Chief Electrical Engineer and Assistant Manager. During the early years of his career, he did extensive work on transmission line vibration, corona loss, and lightning in connection with the design and operation of the Boulder transmission lines. After successfully meeting the challenges of several progressively higher positions of responsibility, he was promoted in September 1966 to Chief Electrical Engineer and Assistant Manager. He continued successfully to fulfill the demands of this position until his retirement in September 1972.

During his career Mr. Goss contributed to many professional groups. He was a member of the United States Electric Light and Power Utility Study Group as well as the Federal Power Commission's Advisory Commission on Reliability of Bulk Power Supply and its Advisory Group for Emergency Generating Facilities. He was a Past President of the Los Angeles Electric Club and served as a member of the Managerial Committee of the Western Energy Supply and Transmission Associates and the Policy Committee for the Pacific Northwest-Southwest Coordinating Council.

Mr. Goss was the former Chairman and a member of the Board of Directors of Western Systems Coordinating Council (WESTCON). He served on the Board of Governors of the California Municipal Utilities Association, was a member of the National Power Policy Subcommittee, and a member of the Industry Advisory Commission of the State Department of Industrial Relations. He was one of the founding fathers, in 1968, of the National Electric Reliability Council, working as its first Chairman and then its President until April 1975; he remained a close personal friend and adviser to many on the board until his death.

Mr. Goss was a fellow in the Institute for the Advancement of Engineering and a member of Theta Chi Fraternity, Tau Beta Pi, and Eta Kappa Nu honorary engineering societies. He was elected to the National Academy of Engineering in April 1979.

Floyd Goss's achievements included many articles published in trade magazines, including "Power Engineer at Work," which appeared in *Power Engineering* in 1967. A pioneer in the development of electric power facilities, he was granted a patent in 1940 for "Method of and Means for Damping Cable Vibration." Vibration dampers covered by this patent were used on a portion of the 287.5-kilovolt transmission line between Hoover Dam and Los Angeles.

For his outstanding leadership in developing an efficient and reliable power system for the City of Los Angeles and for his distinctive contributions to the power industry, Floyd Goss was the recipient of the James D. Donovan Personal Achievement Award presented by the American Public Power Association.

Because of his active engineering role in the development of major electric power facilities including the Harbor, Valley, Scattergood, and Haynes generating plants, the Pacific Intertie, Castaic Power Project, Mohave Power Plant, and the Navajo Power Plant, Mr. Goss was one of the three members of the Panel of Consultants commissioned by the Con Edison Board of Trustees to review the July 1977 blackout of New York City and Westchester County. His invaluable operating expertise contributed significantly to the understanding and delineation of the causes of the blackout. Further, all of his incisive corrective recommendations were accepted and implemented by the company.

Mr. Goss was active in church and community activities with Our Mother of Good Counsel Church and the Griffith Park Recreation Department, serving as coach for a variety of youth teams.

Survivors are his wife, Harriet; children, Richard, Janet, and Libby; grandchild, James; and brother, Glenn.


Patrick E. Haggerty

Patrick Eugene Haggerty

1914-1980

By J. Erik Jonsson

PATRICK EUGENE HAGGERTY died in Dallas, Texas, on October 1, 1980, following a brief illness. At that time he was Honorary Chairman and General Director of Texas Instruments Incorporated, which he led with vigor, technical skill, sensitivity, and wisdom and where his career developed for thirty-five years.

Pat Haggerty was widely known as a warm, kind, and gentle man, not without a touch of Irish temper when faced with obstacles to achievements or principles. He was a humanist, a moral and deeply religious man, an inquisitive scholar of keen intellect and extraordinary reasoning powers. He was an avid reader and a willing and perceptive listener, whose self-education was wide ranging and never waned or faltered. For example, when he decided to sail his 45-foot sloop, the *BAY BEA,* in a transatlantic ocean race, he studied into the wee morning hours to master the navigational knowledge required. This somehow is characteristic of his intensity in all matters as well as proof that even for relaxation, he chose a challenge.

Pat Haggerty was esteemed and respected by colleagues and competitors alike. From him and his example, thousands of men and women gained strength and inspiration to contribute in their own ways to society, its people, and its institutions. His influence was thus immeasurable. The stamp of his leadership, innovative mind, and disciplined application of energy and time on achievements beneficial to society is deep and enduring.

His sense of organization and his system approaches to management of difficult and complex problems were peerless. An engineer and scientist of broad vision, his leadership in bringing technological developments into practical application beneficial to mankind is indisputable, his record indelible.

He was a man whose interest in society as well as his corporation went deep, whose understanding of corporate, national, and international problems motivated him to make contributions beyond the reach of others less versatile, less daring, less disciplined, less focused, and less determined. In work and in leisure he chose to do only those things that would be productive.

The standards he set for himself and for others were of the highest order, and yet he was a realist. In a paper delivered in November 1979, entitled "The Corporation and The Individual," he closed with this statement: "We can overcome energy shortages, impersonal organizations, alienation. But we can only do it slowly, with persistence, with discipline, and, most of all, with wisdom."

He approached all endeavors in these ways, from attaining Eagle Scout rank in his youth, throughout his active life.

Pat Haggerty was born on March 17, 1914, in Harvey, North Dakota, and was the son of a railroad telegrapher. He received a B.S. degree in electrical engineering in 1936 from Marquette University, where his grade average was the highest ever attained at that time. During his senior year he served as a Cooperative Student Engineer with the Badger Carton Company, Milwaukee, which he joined full time upon graduating. At Badger he quickly progressed to become Assistant General Manager with full responsibility for all engineering, manufacturing, and administrative functions, except sales. He left Badger in 1942 to join the U.S. Naval Reserve, advancing to Lieutenant prior to his discharge in 1945. For most of those years he served the Electronics Production Branch of the Bureau of Aeronautics with responsibility for overseeing procurement and production of certain naval airborne electronic equipment.

In November 1945 he joined Geophysical Service Inc. (GSI), Dallas, Texas, as General Manager of its Laboratory and Manufacturing Division. GSI pioneered the use of the reflection seismograph for location of oil and gas reserves. It evolved into Texas Instruments Incorporated after deliberate goals were set—to diversify the business, initially via the design and manufacture of equipment for national defense, and to become a good, big company. Annual sales in 1946 totaled $2.8 million. In 1979 the company had net sales of $3.2 billion.

It was Pat Haggerty who recognized the way electronics would be revolutionized and proposed that the fledgling enterprise become a licensee of Bell Telephone Laboratories for manufacture of transistors. Always a team man as well as a leader, he selected, developed, and led the group of scientists and engineers whose work enabled Texas Instruments to manufacture germanium and silicon transistors, in commercial quantities and approximately two years ahead of other licensees. To create initial markets for the germanium devices, he called for the design of the first pocket radio. He led the Texas Instruments team that achieved its design and aided a company based in Indianapolis to manufacture and market it.

Since the commencement of its careful, deliberate goal setting, a principal Texas Instruments objective has been to be on the leading edge of technology. Its breakthrough in the transistor field led to other technological advances, via major investments in new technologies, innovations, and systems approaches to management. Included in its "firsts" were the invention of the integrated circuit; introduction of a new digital technique for geophysical exploration that now is the world standard; development of a clad metal system that helped solve both U.S. and foreign coinage problems in the mid-1960s; invention of the miniature electronic calculator; and the first "computer on a chip," which made possible today's generation of calculators, and computers, at popular prices. Mr. Haggerty was a pivotal leader in these efforts and those that shaped Texas Instruments growth choices for the future. Until his death, he articulated the potential of electronics and its benefits to mankind.

Mr. Haggerty was elected Executive Vice-President and Director of Texas Instruments in 1951, President in 1958, and Chairman of the Board of Directors in 1966. He served in the latter position until his retirement and election as Honorary Chairman and General Director in April 1976.

Pat Haggerty shared his capabilities, talents, and concerns widely—in business associations, in education, and in technical societies. He was a coleader in the merger of the Institute of Radio Engineers and the American Institute of Electrical and Electronics Engineers. Following their merger, he served two years as Director of the resultant Institute of Electrical and Electronics Engineers (IEEE) and was subsequently elected a Fellow of IEEE.

His leadership qualities and contributions to education were recognized by honorary degrees or distinguished service awards by The Catholic University, Marquette University, North Dakota State University, Polytechnic Institute of New York, Rensselaer Polytechnic Institute, University of Dallas, University of Notre Dame, and University of Wisconsin. For a number of years until shortly before his death, he was Chairman of the Board of Trustees of Rockefeller University. He was also a longtime Trustee and influential leader in the development of the University of Dallas, a twenty-five-year-old institution committed to excellence.

Other recognitions accorded his achievements include the Electronic Industries Association's Medal of Honor; Founder's Award, IEEE; Industrial Research Institute Medalist; John Fritz Medalist; WEMA Medal of Achievement; and the Henry Laurence Gantt Medal (ASME & AMA). He was a Fellow of the American Association for the Advancement of Science and a Knight Commander of the Equestrial Order of the Holy Sepulchre of Jerusalem.

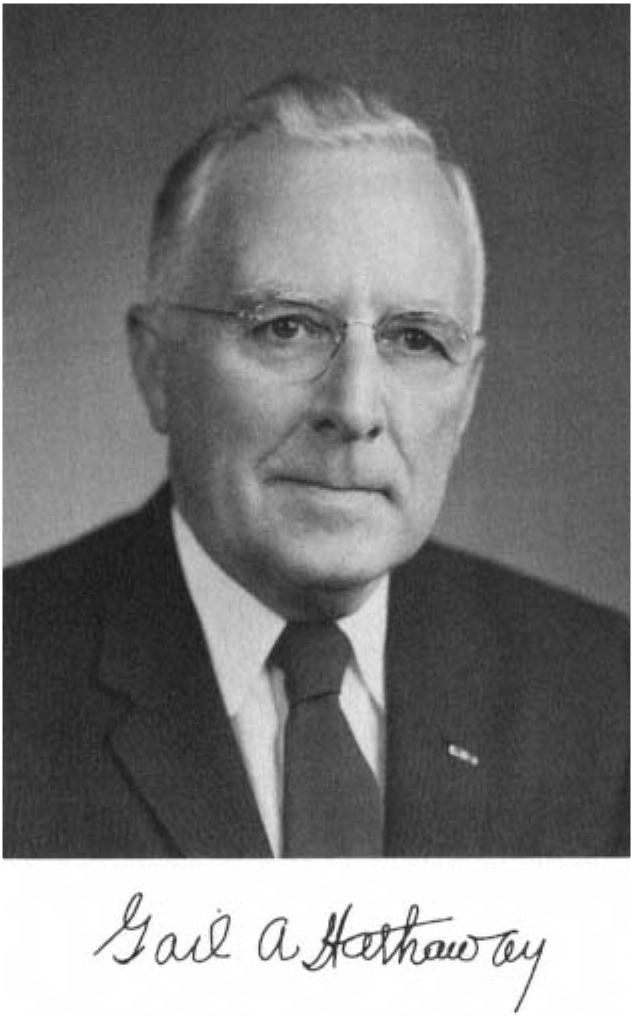
Mr. Haggerty was a member at various times of the Business Council; Defense Science Board; President's Science Advisory Committee; National Commission on Technology, Automation and Economic Progress; and President's Nuclear Safety Oversight Committee.

He was elected a member of the National Academy of Engineering (NAE) in 1965 and served various terms as a member of NAE Committees on Membership, Gifts, and Endowments, and one term as Chairman of the NAE Nominating Committee. He served three years each as a member of the NAE Committee on Public Engineering Policy and as a member of the NAE Council.

He wrote many papers for publication in managerial and technical society journals as well as for universities.

A man for all seasons, Pat Haggerty felt his own achievements resulted solely from commitments he perceived as his personal responsibilities. For himself he penned this prayer: "God, grant me the grace to fulfill with wisdom, justice, respect, humility and humanity my duties to all for whom and to whom I am responsible."

Pat Haggerty was a devoted family man. He is survived by his wife, Beatrice, their five children, and thirteen grandchildren. Clearly his prayer embraced them and his corporate family as well as a larger society of men, women, and children.



Gail Abner Hathaway

1895-1979

By Herbert H. Vogel

GAIL ABNER HATHAWAY, a distinguished civil engineer, died on October 1, 1979, in Washington, D.C. The great engineers of history are those who, blessed with breadth and depth of vision and introspective power of reason, have persevered to make the world a better and safer place to live. Among such, the name of Gail Abner Hathaway stands high, for his contributions to the technique of estimating the magnitude and frequency of floods led directly to the design of safer structures for the prevention of damages and established hydrologic engineering as an important discipline of civil engineering. Criteria developed by him during his long service with the Corps of Engineers have become bases for the design of spillways and have influenced to a marked extent the design of all large dams.

Born at Menomonie, Wisconsin, on October 11, 1895, Gail Hathaway lived there with his parents until going to Oregon State University for a baccalaureate degree in civil engineering. Following graduation and marriage to Mary Rosamund Peterson in 1917, World War I drew him to service with the Army in France. When the war was over, he went to work in the office of the Oregon State Engineer. After a few years there, he accepted a position as Hydraulic Engineer with the Corps of Engineers, United States Army, serving in several field offices until called to the Office of the Chief of Engineers in Washington, D.C., in 1938, where he served until retirement in 1957. For the next six years he held the position of Engineering Consultant to the Department of Technical Operations of the World Bank, retiring a second time in 1963.

The bare facts thus cited contain few clues to the full extent of Gail Hathaway's technical achievements or the leadership he exercised in so many fields. Nor does the summation contained in *International Who's Who,* although in addition to listing his membership and offices held in national and international technical societies, it points out that his hobbies embraced golf, fishing, hunting, and genealogy and thereby reveals more of the whole man. Much more is needed, however, to portray the remarkable career that served to change completely the theories that controlled the planning and design of flood control dams. Revolutionary as these seemed when first advanced and in spite of jibes about the "Hathaway Flood," time proved his theories and deductions to be correct, and the dams to which they were applied have stood the test of time.

So well had he become known as a flood forecaster that he was called to Europe on October 24, 1944, by General Eisenhower's Headquarters in Paris to organize a forecasting service to predict stages and other conditions of flow that would affect the planned crossings of the Rhine River. For this service he received the Bronze Star Medal and a Presidential Citation.

Important as were his individual and specific achievements, his lasting fame rests on the criteria and procedures he developed for the determination of spillway design floods while in the Office of the Chief of Engineers. The standards developed there by him, though meeting with initial resistance, became accepted by the Corps and then by other federal agencies. Ultimately they became standards for the country as a whole, and then for the rest of the world. Today it is not unusual for an engineer in some far part of the world to assert that his dam has been designed to accommodate the "Hathaway flood."

Following the spread and acceptance of his doctrines, Gail Hathaway became active in the work of several national and international technical societies. In particular, he was an ardent supporter of the American Society of Civil Engineers (ASCE) at both local and national levels, serving as President of the National Capital Section in 1942 and as National President from 1946 to 1948. He was presented with ASCE's ames . R. Croes Gold Medal in 1947.

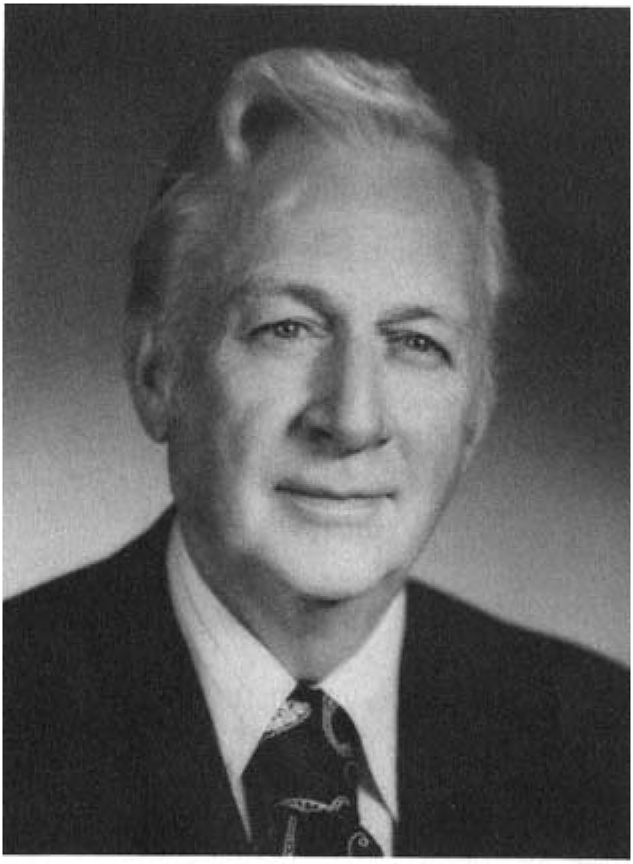
His postretirement activities kept him busy and productive over an extended period, during which he served as a consultant in con nection with the planning, design, and construction of Egypt's Aswan Dam and for the relocation of the Abu Simbel Temple, which would have been lost to the impounded waters. Other assignments included services as an engineering consultant to President Truman's Cabinet Committee on Palestine, as a consultant for the solution of Panama Canal problems, and as a consultant to the Venezuelan Government. He was Chairman of the U.S. Committee on Large Dams from 1948 to 1952 and then served as President of the International Commission on Large Dams until 1958. Other important assignments included a term as Chairman of the American Committee of the World Power Conference and as Vice-President of its International Executive Committee.

He wrote many technical papers during his long service with the Corps of Engineers, a number contained in special reports and sections of handbooks relating to flood control and water resource development. In recognition of his great contributions and achievements over the years, he was elected to the Corps' Gallery of Distinguished Employees. Other writings include:

- Determination of Spillway Requirements for High Dams," *Proceedings of the Fourth Congress on Large Dam,* 1951.
- Design of Drainage Facilities for Air Fields," *Transactions ASCE,* 1945.
- Application of Hydrology to Flood Control," *Proceedings,* Penn State College, Hydrology Conference, 1941.
- The Importance of Meteorological Studies in Design of Flood Control Structures," American Meteorological Society, 1939.

For his many contributions to the development of the Nation's natural resources he was honored with a Doctor of Engineering degree by Drexel Institute of Technology in 1951. He was a member of Sigma Tau and Tau Beta Pi honor societies, and a member of the Cosmos Club of Washington, D.C. (he resided in Washington, D.C., during his last years). Mr. Hathaway was elected a member of the National Academy of Engineering in 1979.

Wherever there stands a large dam built within the last twenty years, one may be sure that the downstream areas rest more safely and more securely because of the genius of Gail Abner Hathaway.



Alfred Hedefine

1906-1981

By Thomas R. Kuesel

ALFRED HEDEFINE, a distinguished bridge and structural engineer, died on January 26, 1981, in Englewood, New Jersey. For twenty years a partner and principal of Parsons Brinckerhoff Quade & Douglas of New York, he directed the design of many notable bridges, including the Newport suspension bridge in Rhode Island and the Fremont Bridge at Portland, Oregon, as well as New Jersey's Garden State Parkway.

Alfred Hedefine was born in Newport News, Virginia, on March 9, 1906. He studied civil engineering at Rutgers University (B.S. in civil engineering, 1929) and the University of Illinois (M.S. in civil engineering, 1931).

When he graduated in the midst of the Great Depression, the only job he could find in the construction industry was operating a pile driver on a power plant project in Brooklyn. After a year, he obtained a six-week temporary assignment with Waddell & Hardesty, checking calculations for a bridge design, during which he so impressed Dr. Shortridge Hardesty that he was given a full-time job, which was itself a major award in the 1930s. His job was to work on the design of the Mill Basin bascule bridge of the Belt Parkway in Brooklyn, and innovations that he developed on this project became the basis for a thesis on bascule bridges, which earned him a civil engineer's degree from the University of Illinois in 1942. This was followed by the design of the Marine Parkway vertical lift bridge in Brooklyn, the Rainbow Arch over Niagara Gorge, and the St.

George's tied arch over the Chesapeake and Delaware Canal, each of which established new standards for excellence in the bridge design for its type.

For the theme building of the 1939 New York World's Fair, the architects conceived a 700-foot-tall spike and a 200-foot-diameter hollow globe—the Trylon and Perisphere. Architecturally striking, they were structurally unprecedented. Alfred Hedefine was selected to prepare the structural design, which was accomplished entirely by hand calculation a generation before the development of electronic computers. His paper on the design of the Trylon and Perisphere earned the Thomas Fitch Rowland Prize of the American Society of Civil Engineers in 1942.

While with Waddell & Hardesty, he taught in the evening school at New York University and continued his own education with special studies at Columbia University in the then new discipline of soil mechanics, and at New York University in aviation engineering. At the outset of World War II, he was called as a special consultant to the Department of Defense and to the U.S. Air Force Strategic Air Command. He served from 1943 to 1945 in England with the Eighth Air Force on photoreconnaissance work.

In 1945 he returned to Hardesty & Hanover, the successors to Waddell & Hardesty, as an associate of the firm. Recognizing the changing climate of the design professions, he advocated the undertaking of professional business development. This was a departure from the traditional consulting engineer position whereby commissions come to an engineer solely because of his eminence. Disagreement on this philosophy led to a split with Hardesty & Hanover, and in 1948 Mr. Hedefine moved to Parsons Brinckerhoff Hall & Macdonald.

Starting as a Principal Associate and Head of the Bridge Department, he was admitted to the partnership in 1952. He became a Senior Vice-President of Parsons Brinckerhoff Quade & Douglas, and served as President from 1965 until his retirement in the early 1970s. In this second career he was responsible for pioneering efforts in the planning, design, and construction of bridges, tunnels, rapid transit systems, airfields, and marine terminals throughout the world.

His outstanding bridge project was the Newport Bridge in Rhode Island, which was the first major suspension bridge to use prefabricated, parallel-wire strands, a significant advance in bridge cable construction. This project also involved developing procedures for driving piles under water at depths up to 162 feet, the deepest ever attempted, and for placement of the largest amount of structural concrete ever placed under water (more than 90,000 cubic yards). The project received awards for excellence in engineering design from the New York Association of Consulting Engineers, the Consulting Engineers Council, the American Iron and Steel Institute, and the American Society of Civil Engineers. It also earned Mr. Hedefine a patent for a system of prestressed posttensioned suspension bridge cable anchorage.

An unexpected tribute to the soundness of the Newport Bridge design came in February 1981 when a 50,000-ton oil tanker collided with one of the main piers, scoring a direct hit in a dense fog. The bow of the ship was shortened 10 feet by the impact, but the bridge did not budge, and the only damage it suffered was an enormous blotch of gray paint spread over the end of the pier.

The Fremont Bridge in Portland, Oregon, is the third-longest arch bridge in the world, with a main span of 1,255 feet. It is a unique double-deck, three-span stiffened tied arch, which was selected for its clean architectural lines and its structural efficiency, after consideration of many alternatives. The analysis of this exceedingly complex space frame structure required development, under Mr. Hedefine's direction, of a new computer-aided analytic methodology. The Fremont Bridge design received awards from the American Institute of Steel Construction and the Lincoln Arc Welding Foundation.

Among Mr. Hedefine's many other bridge projects, the Arthur Kill Bridge between Staten Island and New Jersey still holds the record (558 feet) as the world's longest vertical lift span. His designs for the 62nd Street Bridge in Pittsburgh and the Martin Luther King, Jr., Memorial Bridge in Richmond won architectural and engineering awards. He was also involved in notable tunnel projects, including studies for a proposed immersed tube railway tunnel for the English Channel and an award-winning proposal for an immersed highway-rail tube supported on an underwater rock dike for the Straits of Messina international design competition in 1973.

In the fields of civil engineering, he personally directed the design and construction of the Garden State Parkway in New Jersey, prepared criteria for design and construction of military airfields that became a standard for the U.S. Air Force, and developed a unique concept for an automated vertical storage and retrieval system for handling large shipping containers.

Alfred Hedefine was active in many professional societies, including the International Association for Bridge and Structural Engineering, for which he served on the U.S. Council and the International Permanent Committee Policy-Making Body. For twenty years he was an active member of the Committee on Steel Structures of the American Railway Engineering Association and participated in the development of their standard specifications for fixed and movable bridges. He was a Fellow of the American Society of Civil Engineers, serving in various offices from 1942 to 1954, and of the American Institute of Consulting Engineers. His other professional memberships included those in the Society of American Military Engineers, National Society of Professional Engineers, Engineering Institute of Canada, and The Moles (the honorary tunneling fraternity).

His academic attainments earned him membership in Phi Beta Kappa, Tau Beta Pi, and Sigma Xi; he was one of the few individuals ever to receive high recognition in liberal arts, engineering, and science. He was elected to the National Academy of Engineering in 1973. In addition, he was a member of the New York Academy of Science and of the Cosmos Club. In 1975 he was awarded an honorary degree of Doctor of Science by Rutgers University. He was a member of the Board of Trustees of Rutgers and active in many of its committees.

In addition to his professional accomplishments, Alfred Hedefine was an accomplished musician. He served as President and Chairman of the Board of Trustees of the Guillmant Organ School, the oldest organ school in the country, founded in 1899. He was a Trustee of the Sussex County Music Foundation, and a member of the Board of Directors of the Bohemians, a New York musicians' club. He enjoyed playing the organ in his home at Lake Mohawk, New Jersey, and for some years served as host of a classical music radio program that he taped in the music room of his home.

He is survived by his wife, the former Julia Ann Fullagar, and a son, Alfred II, and three grandchildren, as well as by a generation of civil engineers who grew under his guidance, benefited from his wise counsel and from his personal and professional uniqueness.


Beatrice A Hicks

Beatrice Hicks

1919-1979

By Henri G. Busignies

THE BRILLIANT CAREER OF Beatrice Hicks ended on October 21, 1979, when she died at the age of sixty, but the effects of her contributions will be permanent. Early in her studies she developed a strong interest in technical matters and their impact on society. She pursued a successful education and started quickly to solve important, complex technical problems. She became the 1952 Woman of the Year, the Conference Director of the First International Conference of Women Engineers and Scientists in 1964, and served as first President and a member of the Board of Trustees of the Society of Women Engineers.

She was born on January 2, 1919, in Orange, New Jersey, and received a B.S. in chemical engineering in 1939 from the Newark College of Engineering, now New Jersey College of Engineering. She later received an M.S. in physics from the Stevens Institute of Technology in 1949, and in 1953 she enrolled at Columbia University's school of continuing education for the purpose of influencing women's involvement in engineering and management. Dr. Hicks was a registered engineer in New Jersey, New York, Pennsylvania, and the District of Columbia.

In the first years of her active engineering work, Dr. Hicks invented the gas density switch. She pioneered in the design, development, and manufacture of pressure and gas density controls for aircraft and missiles. She acted as a consultant to encourage women in engineering and sparked the local chapter of the Society of

Women Engineers into a very viable society. Under her stimulus, a 123 percent increase was achieved in eight years. In 1971 Dr. Hicks was invited to participate in the Old Masters Program at Purdue University. The response of faculty and students was enthusiastic. Dr. Hicks and her husband, Rodney D. Chipp, were selected by the National Society of Professional Engineers (NSPE) to represent the society as Project Ambassadors on a fact-finding and goodwill tour of South America. After her husband's death Dr. Hicks continued her worldwide tours to aid countries (including Brazil, Argentina, Uruguay, Chile, and Peru) with small business management problems.

Dr. Hicks received many honors and awards, which included the honorary Doctor of Science degree from Hobart and William Smith colleges, 1958; the honorary Doctor of Engineering from the Rensselaer Polytechnic Institute (RPI), 1965 (she was the first woman to receive an honorary degree from RPI); Woman of the Year in Business for 1952, *Mademoiselle* magazine; NSPE, member and corecipient of the Project Ambassador Award; Alumna of the Year, Newark College of Engineering, 1962; and invited guest to the Old Masters Program, Purdue University, 1971. She was elected a member of the National Academy of Engineering in 1978.

Her numerous technical papers included those on molecular density sensors; "Ingenieros de Sudamerica," written with Rodney D. Chipp, *American Engineer,* June 1960; "Sealed in Atmospheres," *Product Engineering,* February 29, 1960; "How to Specify and Apply Pressure and Gas Density Switches," *Space Aeronautics,* June 1960; "Density Switches Detect Leakage from Gas-Filled Transformers," *Power Engineering,* February 1961; "Great Expectations—The Science of Choice As It Affects Humanity's Future," *PE. Lex et Scientia,* Volume 9, Number 2, April-June 1971. In addition, Dr. Hicks served as U.S. Delegate to the International Management Congress, Sao Paulo, Brazil, 1954; Paris, 1957; Australia, 1960; and New York, 1963. She was a member of the Defense Advisory Committee on Women in Services, 1960-1963, and Director of the First International Conference of Women Engineers and Scientists, Carnegie Institute of Technology.

Dr. Hicks was thirty-one years old and the Vice-President and

Chief Engineer of Newark Controls Company in Bloomfield, New Jersey, when she was elected the first President of the Society of Women Engineers. The society itself consisted of sixty persons, a number that doubled by the next year. In 1963 the society honored her with its highest award, the Achievement Award, presented "in recognition of her significant contributions to the theoretical study and analysis of sensing devices under extreme environmental conditions, and her substantial achievements in international technical understanding, professional guidance and engineering education." In addition to the Society of Women Engineers, she participated actively in professional societies such as the Institute of Electrical and Electronics Engineers; Eta Kappa Nu; National Society of Professional Engineers; American Society of Mechanical Engineers; American Society of Heating, Refrigerating, and Air-Conditioning Engineers; and Women's Engineering Society.

In 1966 Dr. Hicks became President of the firm that her father had founded, and a dozen years later found herself also the owner of the consulting firm operated by her late husband, Rodney D. Chipp.

Dr. Hicks knew how to be effective in advising small business and also was an able adviser to larger organizations as well as international operations. She could design complex systems and keep them operating. In spite of the positions of strength and value that she attained, Dr. Hicks retained her charming personality and was always helpful and understanding of others; she had a heart of gold.

All her friends deeply miss her.

Solomon Cady Hollister

1891-1982

By Richard N. White

SOLOMON CADY HOLLISTER, retired Dean of Engineering and Professor Emeritus of Civil and Environmental Engineering at Cornell University, died on July 6, 1982, at the age of ninety. Dean Hollister's remarkable career as an engineer and educator spanned more than six decades. Among his many contributions to American engineering were pioneering developments in structural welding and in concrete technology. As an educator and administrator, his career showed bold innovation, with continuous emphasis on the needs of the engineering profession and how the engineering curriculum should respond to these needs.

Solomon C. Hollister was born in Crystal Falls, Michigan, on August 4, 1891, and grew up in the Pacific Northwest. He enrolled at Washington State University in 1909 and worked his way through college, taking considerable time off to earn money as a surveyor and engineer. He transferred to the University of Wisconsin, where he completed his final year and a half and received the Bachelor of Science degree in 1916 (and later, in 1932, the Civil Engineering degree). He entered engineering practice in 1916 and also taught at the University of Illinois for one year.

In 1918, at the age of twenty-six, he was appointed Chief Designer and Head of the Research Branch of the Concrete Ship Section of the U.S. Shipping Board. In this capacity he was responsible for several major innovations in reinforced concrete that led to the construction of the world's first practical seagoing concrete ves sels. In the 1920s he had a consulting practice in Philadelphia, designing mainly in reinforced concrete; in 1929 he received the first Wason Research Medal from the American Concrete Institute (ACI) for his innovative design, construction, and testing of a skewarch bridge built in Chester, Pennsylvania. His other contributions to concrete technology included development of transit-mixed concrete and being a leader in developing standard specifications that helped evolve this engineering area from empiricism to structural science.

Dean Hollister had a major role in the design of the 30-foot-diameter welded steel penstocks for Hoover Dam. Through his extensive research and consulting activities, he helped produce many advanced designs for welded steel bridges, boilers, and pressure vessels.

After four years on the faculty at Purdue University, Solomon Hollister came to Cornell as Professor and Director of the School of Civil Engineering in 1934. He became Associate Dean and then Dean of the College of Engineering in 1937, a position he held for twenty-two years, until his retirement in 1959. He physically and intellectually rebuilt the College of Engineering and thrust Cornell into the top echelons of engineering education in the United States. One major step he initiated was to move the college into a five-year undergraduate curriculum, strengthening scientific course content as well as the engineering design and liberal arts electives. He brought the School of Chemical Engineering into the college and initiated a new School of Engineering Physics and a Graduate School of Aeronautical Engineering.

Much of his work in strengthening engineering education at the national level was done through his chairmanship of various committees of the Engineers' Joint Council for Professional Development. While leading the American Society for Engineering Education (ASEE), he established a committee that in 1955 produced a major study, known as the Grinter Report, which outlined future innovations in engineering education.

As a development officer at Cornell, Solomon Hollister was an outstanding success; he raised funds to build an entire new engineering campus during his tenure as Dean of Engineering. For a period after World War II he was Vice-President of Development as well as Dean. After his retirement in 1959, he maintained an active role in professional and educational affairs, particularly at Cornell as a University Trustee (1959-1964) and as a member of the Engineering College Council until his death.

Dean Hollister had a unique capability to undertake difficult problems that impacted on the public sector. This breadth of interest and capability was recognized by requests for his assistance throughout his life, such as service on the Second Hoover Commission on the reorganization of the Executive Branch of the U.S. Government; chairmanship of the Board of Consultants on the Isthmian Canal Study; member of a Defense Department committee of business and scientific leaders to advise the National Security Council on defense systems; and a member of the Steering Committee for the study of Africa south of the Sahara undertaken by the National Academy of Sciences. He also served as a member of many other professional and public commissions, giving freely of his precious time for these important national activities. Of these experiences, he especially treasured the friendship he developed with Herbert Hoover during and after their work on the Second Commission. He admired Hoover particularly as an engineer-become-public-servant. The admiration was reciprocal; as Hoover wrote for an event honoring Solomon Hollister, "He is a great engineer, he is a superb teacher, and he knows more about our government than any engineer I know."

Solomon Hollister was elected to the National Academy of Engineering in 1973. He was also named to the Hall of Fame of Engineering Education of the ASEE. He served as President of the American Concrete Institute in the early 1930s, President of ASEE in 1951, and was the recipient of the Lamme Award of ASEE in 1952.

Solomon Hollister was awarded honorary Doctor of Engineering degrees from Stevens Institute of Technology, Purdue University, and Lehigh University, and an honorary Doctor of Science degree from the University of Wisconsin. He was elected to honorary membership in no fewer than six national professional societies: American Society of Civil Engineers, American Society for Mechanical

Engineers, American Concrete Institute, American Institute of Architects, American Society for Engineering Education, and American Association for the Advancement of Science. To be so honored by civil engineers, mechanical engineers, and architects reflects the unique breadth of this man. He received the Turner Medal of ACI in 1979, and his last award came in the spring of 1982, when he received Washington State University's Alumni Achievement Award for "brilliance and boldness in pioneering the field of reinforced concrete, and in bringing prominence to his profession."

Dean Hollister contributed articles to several handbooks and texts and wrote many technical papers and articles on structural mechanics, structural engineering, construction materials, and educational matters. He consulted with numerous companies and was a Director of Raymond International, Inc. In one of his many and varied hobbies, paleontology, he achieved professional status. He was a Research Associate and President of the Paleontological Research Institute in Ithaca and contributed scientific papers and one book to the literature of this field.

Solomon Cady Hollister was a famous man, a distinguished man, a good man, a man of great achievements; to those who knew him well, he was a Renaissance man. He was an artist, a paleontologist, a musician, an analyst, an avid reader and collector of rare books, a creative designer, a visionary educator, a most effective promoter, and a great engineer of truly uncommon breadth. We have lost a good friend and a patient adviser.

Dean Hollister is survived by Ada, his wife of sixty-three years; by three children, ten grandchildren, and six great-grandchildren.

Goro Inouye

1899-1981

By Walker L. Cisler

GORO INOUYE, elected in 1977 as a Foreign Associate of the National Academy of Engineering, died in Tokyo on November 18, 1981, at the age of eighty-two. He was an internationally known and highly respected Japanese electric power engineer and executive. He had been Chairman of the Japanese National Committee of the World Energy Conference and, at the time of his death, was Honorary Vice-Chairman of the International Executive Council of the World Energy Conference. He was tireless in his efforts to improve the standard of living not only of the Japanese, but of peoples of all the world through the efficient generation of electric power and its effective application and use.

Goro Inouye was born on August 16, 1899, in Tokyo, Japan. He received a degree in electrical engineering, graduating from the Faculty of Technology at the Imperial University of Tokyo in 1923. He then joined the Toho Electric Power Company, predecessor of the present Chubu Electric Power Company, Inc., in Nagoya. He became President in 1951 and was Chairman of the Board from 1961 to 1967. Among many other assignments related to the field of electric power, he became Vice-President of the Federation of Electric Power Companies of Japan, President of the Japan Electric Association, and President of the Chubu Economic Federation of Nagoya.

He was instrumental in the development of a 500-kilovolt high-voltage transmission system and facilities in the Nagoya area, in the development of the Hatshagi pump storage plant, including one of the largest hollow gravity dams in the Far East, and in the 30-electrical-megawatt gas turbine power supply in the Japanese system. He was a pioneer in Japan in research and development of the fast breeder reactor, advanced test reactor and in nuclear fuel cycle technology. He contributed greatly to international cooperation by his participation in consummating agreements on fast reactors between the Power Reactor and Nuclear Fuel Development Corporation (PNC) and the U.S. Atomic Energy Commission (1969), Gesellschaft für Kernforschung (1971), the French Atomic Energy Commission (CEA) (1970), and also with Atomic Energy of Canada Ltd. (AECL) on heavy-water reactors (1971).

His close relationship with the World Energy Conference began in 1962 when he visited Melbourne as the leader of the Japanese Delegation to the Sixth World Power Conference to propose having a sectional meeting of the conference in Japan in 1966. In the next ten years he was very active internationally in energy and economic fields. In 1964 he was appointed Vice-Chairman of the International Executive Council of the World Energy Conference in recognition of his responsibilities as Chairman of the Japanese National Committee. The Tokyo Sectional Meeting in 1966, over which he presided, was considered a great success. After that meeting, he took part in organizing another world event, the 1970 World Exposition in Osaka, Japan, which also was most successful. He served as Vice-Chairman of the Japan Association for the 1970 Exposition. After having served two successive terms of six years as Vice-Chairman of the International Executive Council of the World Energy Conference, he became Honorary Vice-Chairman in 1970.

Mr. Inouye received many special honors. In 1956 the Japanese Government presented him the Blue Ribbon Medal. In 1969 the Emperor of Japan presented him with the First Class Order of the Sacred Treasure. In 1970 he became an officer of the French Legion d'Honneur, and in 1979 the Emperor of Japan awarded him the First Class Order of the Rising Sun.

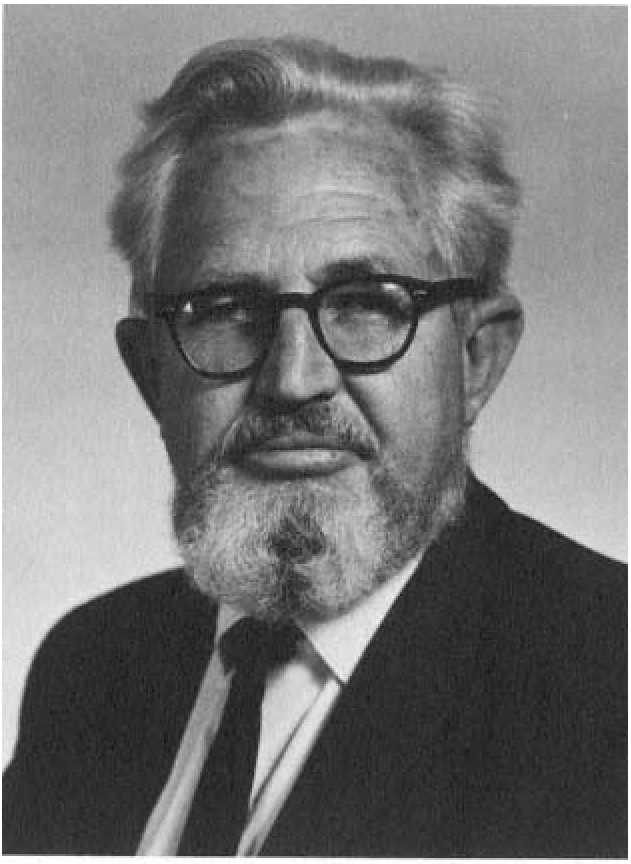
The diversity of his interests is exemplified by the positions that he held, among them the following:

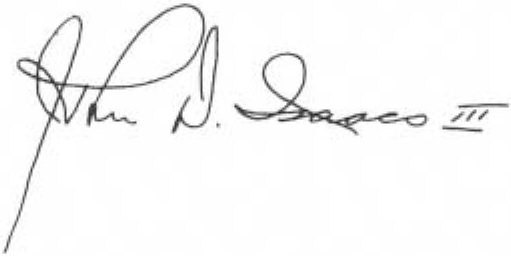
President, Institute of Electrical Engineers of Japan
Trustee, Thomas Alva Edison Foundation
Vice-Chairman, Japan Science Foundation
Director, Overseas Technical Cooperation Agency
President, Japan Meteorological Association
Director, Japanese National Committee on Large Dams
Director, Japan Atomic Industrial Forum
Director, Chubu Nippon Broadcasting Co., Ltd.

He was truly a man for all seasons!

But, perhaps most remarkable of all was the versatility in engineering capabilities exhibited by Mr. Inouye when, relatively late in life, he recognized the great advantage to Japan that nuclear energy offered to an energy-poor country. He became most knowledgeable in the new technology and led his country to an advanced position in nuclear power production. He retired as Chairman of the Board of Chubu Electric Power Company in 1976. He had been appointed President of the Power Reactor and Nuclear Fuel Development Corporation by the Japanese Government and held the office until 1972 when he was appointed Acting Chairman of the Japanese Atomic Energy Committee. He held this position until he resigned in November 1978.

Goro Inouye was a gifted leader and exceptional technological counsellor, and his contributions to the improvement of the daily lives of people everywhere will leave a goal to be sought by all of us. He was a man of deep human instinct. His energetic encouragement of international cooperation and goodwill should serve as an inspiration to achieve understanding and to promote a spirit of helpfulness among all nations.





John Dove Isaacs III

1913-1980

By Elmer P. Wheaton

JOHN ISAACS, world-renowned oceanographer and pioneer in man's conquest of the oceans, died June 6, 1980, at his home in Rancho Santa Fe, California. John Isaacs was a professor at the Scripps Institution of Oceanography and since 1971 was also Director of the University of California's statewide Institute of Marine Resources.

Professor Isaacs was often described as a Renaissance man: scientist, engineer, physical oceanographer, biologist, author, inventor, and his favorite of all, teacher. His colleagues and students were energized by the enthusiasm and unfettered imagination of this large and warm man, who was thrilled with the challenge of the natural universe. He was troubled at the unproductive ways in which politics could influence scientific progress and wrote, "I wonder at the deep and unbridged gulf in communication that now cleaves our vast fund of knowledge and understanding from those who create policy and lead events. ..."

In recent years his innovative developments had included tidal-mediated harbor channel control, a dynamic breakwater, a search system for underwater thermal and freshwater springs, a wave-powered generator, and research on salinity gradient power. His theories on the oceanic food web and chemical uptake are broadly influencing pollution research and waste disposal design, as were his findings in past levels of marine populations and chemical concentrations as recorded in sea-bottom sediments.

John Isaacs contributed broadly to the fields of marine biology, fisheries, physical oceanography, climatology, and other marine sciences. His contributions to engineering were considerable. He developed new and important approaches to oceanic problems, including deep-sea moorings, deep-sea free instruments, wave refraction plotting systems, current meters and cameras, undersea communication and signaling devices, trawls, and dredges. These were novel, first-time accomplishments. Now they are in general worldwide use.

Elected to the National Academy of Engineering in 1977, he was a rarity in academe, having achieved the status of Professor, Head of a University of California institute, and election to membership in the most prestigious scientific organizations: the National Academy of Sciences, National Academy of Engineering, American Academy of Arts and Sciences, and World Academy of Art and Science—the highest recognitions accorded a scientist by his peers—and he received all of this without a Ph.D. He was a prolific author and could have converted many of his research projects into Ph.D. theses, but he was too busy moving on to new challenges.

John Isaacs was born into a prominent Oregon pioneer family, in Spokane, Washington, on March 28, 1913. He attended Oregon State University in 1930-1931 and worked as a chemistry lab assistant until a serious leg injury forced him to stop school. The mysteries of the deep sea were irresistible to John, and in 1939 and 1940 he went to sea as a commercial fisherman. From 1941 until 1943 he worked for the Austin Company, and with no previous education in engineering he worked out basic equations for stress in structures and became Chief Project Engineer for the construction of the Tongue Point Naval Air Station at Astoria, Oregon. He stopped work to attend the University of California (UC) at Berkeley, where he received his Bachelor of Science degree in civil engineering in 1944. Until 1948 he worked as a Research Engineer at UC on the waves, beaches, and amphibious landings, this work being directed by Morrough P. O'Brien. Willard Bascom was John's assistant.

In 1948 John Isaacs went to the Scripps Institution of Oceanography as an Associate Oceanographer in charge of the photography program for Project Crossroads. He served as Assistant to the Direc tor, Roger Revelle, until 1955, when he became an Associate Professor. From 1958 to 1974 John Isaacs directed the activities of the Marine Life Research Group, which is the university's portion of the California Cooperative Oceanic Fisheries Investigations, a longterm study of the ecology of the eastern North Pacific, the California current, and its living resources. He became a full professor in 1961, and in 1971 became Director of the Institute of Marine Resources (IMR). During his years as Director, IMR expanded its programs in scope and service to society, and under IMR the California Sea Grant College Program became the largest of its kind in the Nation.

Scripps Director William A. Nierenberg said:

> John Isaacs' life and career are coincident in what will be recognized as the greatest era in oceanography. Isaacs is one of a handful of postwar pioneers in man's conquest of the oceans. In his early years at the University of California at Berkeley and his many years at the Scripps Institution of Oceanography, he was one of the small group who built the Scripps Institution to what it is today. He was a world leader in his field. Isaacs' contributions were always a mixture of the orthodox and unorthodox. He was involved with all aspects of man's interventions in the oceans—his favorite description of our many activities. John Isaacs' passing represents a great loss to our community and will leave an unfillable void.

John Isaacs served in consulting, advisory, and editorial positions for a variety of government committees, private businesses, foundations, and societies. Since 1970 he had been Chairman of the Consulting Board of the Southern California Coastal Water Research Project, and in 1976 he became President and Chairman of the Board of Trustees of the Foundation for Ocean Research in San Diego. He also served as Chairman of the National Academy of Sciences/National Research Council (NAS/NRC) Panel on Ocean Engineering and was a member of the Mine Advisory Committee, the President's Science Advisory Committee, and many other committees of national and international scope. More recently, he served on the NRC Commission on Natural Resources, the Assembly of Engineering, and the Marine Board.

In addition to the organizations already mentioned, Professor Isaacs was a Fellow of the American Geophysical Union and the California Academy of Sciences, a past President of the Pacific Divi sion of the American Association for the Advancement of Science, and a member of the New York Academy of Sciences, Sigma Xi, Challenger Society, Cosmos Club, Pi Mu Epsilon, American Society of Limnology and Oceanography, and the Western Society of Naturalists.

Dr. Roger Revelle, Director Emeritus of Scripps, said:

> John Isaacs had more original scientific ideas every month than most scientists have in a lifetime. His incredible creativity was famous among oceanographers throughout the world, but its sources were perhaps not as well known. John's ideas didn't simply spring full blown out of his subconscious, but rather out of perceptive observations of the ocean and its creatures and out of a profound, almost intuitive, knowledge of the laws of physics and chemistry. John was one of the very small number of marine scientists who can be called true oceanographers, in the sense that they are interested in everything about the ocean—the motions of the waters, the ways of life in the sea, the use of an ocean's resources, and the meaning of the oceans for human history and for mankind's future. He was cut off in his intellectural prime before he had a chance to make a grand synthesis of his ideas into a wholly new way of looking at the ocean.

Dr. George Shor, Jr., Associate Director at Scripps and Professor of Marine Geophysics, has said that "the most remarkable thing about John was his constant flow of ideas—enough to have kept him busy for a hundred lifetimes. The ones he carried to completion have impacted almost every branch of ocean science. He was a great man—larger in many ways than the rest of us—but also a wonderful person to know and to work with. He will be missed. It is as if a mountain had disappeared."

John and Mary Carol's home reflects their broad range of interest in music, the arts, and horticulture. Their patio contains a sunken fireplace surrounded by circular stone steps arranged for lively conversations with students and colleagues. Friends from all over the world will miss those conversations around the crackling fire.

John Isaacs is survived by his wife, Mary Carol; his four children: Dr. Ann Katherine Isaacs, Professor of Renaissance History in Italy; Dr. Caroline Isaacs, geologist for the U.S. Geological Survey; Jon Berkeley Isaacs, mechanic; Dr. Kenneth Isaacs, resident neurologist at the University of California San Diego Medical School; and one grandson, Allesandro Marcello Isaacs of Pisa, Italy.

Wendell Eugene Johnson

1910-1982

By Jacob H. Douma

WENDELL E. JOHNSON died in Arlington, Virginia, on February 26, 1982. Before his retirement in 1970 he had been Chief of the Civil Works Program of the Army Corps of Engineers for the last ten years of a distinguished thirty-seven years with the Corps. He was recognized universally for competence, leadership, and vision in directing the largest water resource program in history.

Outstanding among his many significant accomplishments during his federal career were his work on (1) development and design of the multiple-use reservoir system in the Missouri River, one of the world's largest water resource developments, costing approximately $200 million per year; (2) design of the Third Locks Project in Panama and the Atlantic-Pacific Interoceanic Canal Study, involving pioneering in the use of nuclear explosives for canal excavation, a new field of engineering technology; (3) research and development of techniques and criteria for design of massive earth dams on foundation conditions unprecedented in engineering technology; and (4) leadership in fostering worldwide recognition of greater concern for the safety aspects of major dams.

Mr. Johnson was born on September 23, 1910, in Minneapolis, Minnesota, and received a B.S. degree in civil engineering in 1931 from the University of Minnesota. After working briefly with that state's highway department, he joined the Corps of Engineers in 1933 and continued his career with the Corps until retirement, only interrupted by two years of military service during World War II.

To describe Mr. Johnson's responsibilities as Chief of the Engineering Division of the Directorate of Civil Works of the Corps of Engineers, an understanding of that program is required. The program was composed of more than 3,600 authorized projects having a total estimated construction cost of more than $23 billion and annual expenditures of $1 billion. It was the major federal program for development of the Nation's water resources, providing many benefits to the American people, such as flood control, navigation improvement, hydroelectric power development, water supply, water quality control, hurricane protection, beach erosion control, and recreation and conservation of land and water resources.

The technical problems—the social, economic, and aesthetic factors that had to be considered—all challenged the engineer executive. He directly supervised sixty top-level engineering specialists and was responsible for providing technical direction for several thousand engineers working throughout the Nation in eleven regional supervisory offices and thirty-seven districts of the Corps of Engineers. In addition, he was responsible for technical direction and review of the work of private firms whose services were required, annual costs being typically $15 million.

For many years Mr. Johnson represented the United States at international conferences, assemblies of engineering organizations, and advisory boards for major engineering projects. As a federal administrator and engineer, he furnished advice to the Congress on numerous occasions. One example of such service was his work as a consultant to the State Department in connection with the preservation of the Abu Simbel temples in Egypt from inundation by the reservoir behind the high Aswan Dam. He provided advice on the engineering feasibility of the several plans proposed for preservation of the temples, and it was on his advice that the United States made its commitment to participate in the preservation work.

After his retirement from the Corps of Engineers, Mr. Johnson continued as a consultant on major dam projects until he suffered a stroke. With great courage and eagerness he kept informed of ongoing problems and progress on projects with which he was actively involved before his illness, often contributing valuable suggestions by letters dictated to his devoted wife, Margaret, or by telephone.

He also prepared, by dictation, a significant technical paper on construction inspection of dams, which was published by the American Society of Civil Engineers.

In addition to his distinguished service as a federal employee and private consultant, Mr. Johnson served his profession in an exemplary manner through his activities with professional engineering societies. He served in many positions as an officer or committee member of the American Society of Civil Engineers, the International Commission and U.S. Committee on Large Dams (USCOLD), the World Power Conference, and the Society of American Military Engineers. He was Chairman of USCOLD in 1968 and had a major influence in USCOLD actions to promote dam safety, including development of a model law for licensing and inspection of privately owned dams in the United States.

He was recognized by his peers and received a number of honorary awards, including the Department of the Army Exceptional Civil Service Award. He was a Fellow of both the American Society of Civil Engineers and the Society of American Military Engineers and was elected to the National Academy of Engineering in 1970.

Mr. Johnson was a very effective catalyst in human relationships that required the resolution of differing engineering opinions. He was able to conceive of ambitious objectives and to communicate his beliefs and enthusiasm so articulately that there was little doubt about achieving what may have appeared to be unreasonable goals. He inspired people to stretch their capabilities and channel their work into a powerful team effort.

Wendell Johnson was a warm, perceptive man, a true friend of many and admired by all who knew him. It was an inspiration to work with him; younger engineers found his support and encouragement particularly valuable to their career development. His achievements both as a human being and as an engineer leave a rich heritage indeed.


Thomas F. Jones

Thomas Franklin Jones

1916-1981

By Mildred S. Dresselhaus, Walter A. Rosenblith, Myron Tribus, and Henry Zimmermann

THOMAS F. JONES, a brilliant leader in engineering education, died on July 14, 1981. At the time, he was a teacher and Vice-President for Research at Massachusetts Institute of Technology (MIT).

Tom Jones was born in Henderson, Tennessee, July 9, 1916. He earned his Bachelor of Science degree at Mississippi State University in 1939 and a master's degree in electrical engineering at MIT in 1940. From 1941 to 1947 he served as a research physicist at the Naval Research Laboratory. His outstanding contributions to the war effort, including design of harbor defense systems, were recognized by the Meritorious Civilian Award.

In 1947 he returned to MIT where he did research on computers, nuclear instrumentation, and missile systems prior to receiving his Sc. D. in 1952. He then joined the Electrical Engineering faculty and began a lifetime career in education. He continued to do research, to publish technical papers, to obtain patents, and to contribute to the burgeoning field of electronics. His interests expanded to encompass education, and it is as a leader in engineering education that he will be remembered best.

Tom Jones was a graduate teaching assistant in the Electrical Measurements Laboratory at MIT in 1940. That experience may have nurtured his innovative revitalization of the introductory laboratory in electronic circuits, for when he returned as a faculty member, he succeeded (where numerous others had failed) in devising a laboratory that students regarded as an enjoyable learning experi ence rather than a necessary requirement for graduation. His ideas and methods spread to the other undergraduate laboratory subjects in electrical engineering.

What made his approach to the lab appeal to students? He had each student design a meter to measure voltage and current. The student then built, calibrated, and used this meter. When the crude instrument was eventually replaced by a commercial instrument, the mystique surrounding the instrument was replaced by the confidence that comes from understanding.

In 1958, while he was still an Associate Professor at MIT, Purdue chose him to be the Head of its School of Electrical Engineering. As one of his faculty colleagues at Purdue recently wrote, "Dr. Jones came to Purdue at a time when the School of Electrical Engineering was in great need of a capable and understanding Head." In the brief span of four years he revised and updated the curriculum, he enlarged and upgraded the faculty, he enlisted the collaboration and cooperation of industry, and he initiated the development of an industrial park around Purdue, much like those existing near MIT and Stanford.

In 1962 when he was selected to be the twenty-third President of the University of South Carolina, his staff at Purdue felt a deep sense of loss. Again, quoting his colleague, "his training was deep-rooted and kept all of us on the path of excellence."

His appointment to the presidency of South Carolina's oldest university coincided with a period of social turmoil in the United States. Dr. Jones was faced with problems of explosive growth, social change, and unprecedented national student activism. Integration, Vietnam, Watergate—these were the words that then disturbed the sleep of college presidents across the United States.

Growth alone was a challenge of substantial proportions. In a period of about ten years the student population rose from about 5,000 to 27,000. During that period of rapid growth, Dr. Jones succeeded in markedly improving the quality of the education being provided and in improving the quality of life for the students. He established an Instructional Services Center, integrated technical and liberal education, and fostered interdisciplinary studies. His influence was felt at all levels, from undergraduate to graduate to continuing education, and in all disciplines from library science to engineering to general studies. In 1974, when he decided to step down from the presidency, he was honored by expressions of appreciation and affection by the trustees and the faculty, who awarded him an honorary Doctor of Laws degree for "having brought the University into the mainstream of educational innovation and development." He was also appointed a Distinguished Professor at the university.

Dr. Jones decided to explore some of his innovative ideas at MIT where he accepted, in 1974, a visiting professorship of engineering and education. The fit between him and MIT was so natural that he was made Vice-President for Research upon the retirement of Vice-President Albert G. Hill.

He was active in national affairs and his profession of engineering. He never hesitated to give his time and energies for public service. He was elected to the National Academy of Engineering in 1969. He served as an Editor and a Director of the Institute of Electrical and Electronics Engineers, Inc., and as its Vice-President for Educational Activities. He served as an officer of the American Society for Engineering Education. He served on the National Science Board and on the Advisory Council of the National Science Foundation and on many of its committees and panels. He gave his talents to many causes. He served on the Council on Higher Education in the American Republics and made visits to Peru, Colombia, Argentina, Mexico, and Brazil to assist in the development of higher education in those countries.

These are the facts that appear on the written record. They show an effective engineering educator, respected and admired by many. But the written record does not reveal the messages Tom Jones left in the hearts and minds of all who knew him.

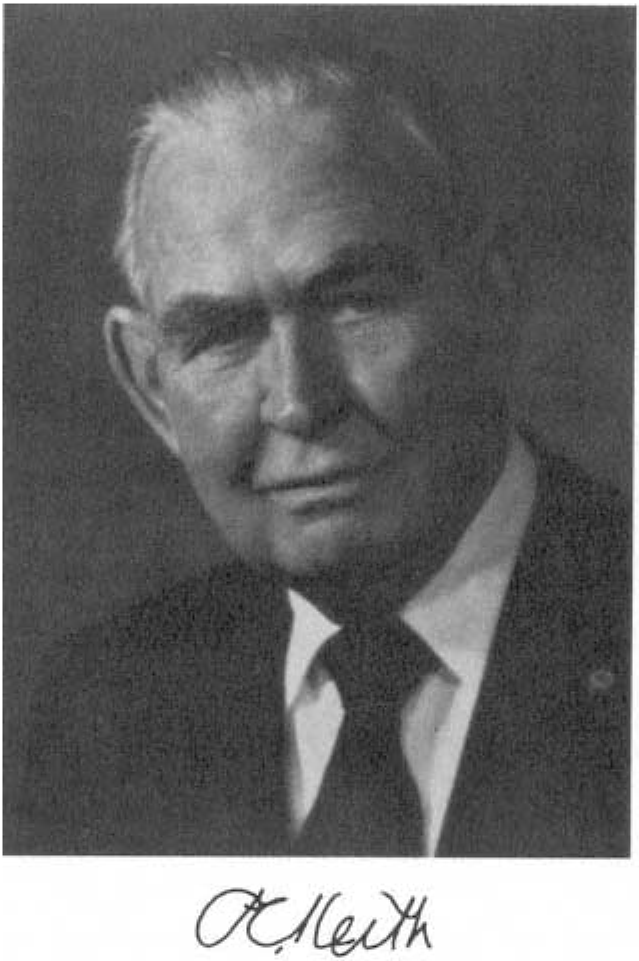
In the words of MIT President Paul Gray, who was one of his students,

> Tom was the consummate teacher. He taught throughout his life, in all his activities, effortlessly, but oh so individually.... His teaching was the most effective and engaging I had seen anywhere. And it was evident that he was interested in each student as an individual, and that his insistence that we concentrate on "learning how to learn" rather than on the facts and theories was

> a personalized prescription. It was education over the whole spectrum, for it was Tom who first urged me to read Herodotus, Whitehead and Tocqueville; it was he who told me where to look, just north of Scollay Square, for a used set of Harvard Classics. It was he who insisted that all relationships and all actions respect the humanity of those who were involved.

Tom Jones was a caring man. All who met him felt his interest and concern. It was genuine, and touched each and every one of us. And he taught to the end of his days. In the words of Paul Gray again, "Now he was teaching about organization and administration, about leadership and persuasion, but the lessons were couched in the same earthy and personal terms which had captured my interest and heart twenty years before." He made his points with humor: "Friends may come and friends may go, but enemies go on forever." "You must pat a person on the back ten times before you are permitted to swat him on the behind once."

His doctor told him, two years before he died, that he was terminally ill. He insisted on working up to the very last day. Those of us who were privileged to see him in this period will never forget his loving concern for others and for the future of MIT and its students. He taught us how to learn and how to teach. He taught us how to live. And in the end, he taught us how to die, with courage and dignity.



Courtesy of *The National Cyclopaedia of American Biography*

Percival Cleveland Keith, Jr.

1900-1976

By Manson Benedict

PERCIVAL CLEVELAND KEITH, JR., retired Founder and President of Hydrocarbon Research, Inc., died in Peapack, New Jersey, on July 9, 1976. Throughout his long professional career, he was a brilliant engineering innovator. He pioneered in the development of petroleum refining processes, first thermal cracking and reforming, then, in the years just preceding and during World War II, in catalytic processes for converting petroleum to aviation and automotive fuels and to chemicals such as ammonia, methanol, and butadiene. Later he did original work on synthetic fuels and the use of hydrogen for improvement of petroleum derivatives and reduction of ores to metals. His most notable engineering achievement was the inspiring leadership he gave to development and engineering of the K-25 Gaseous Diffusion Plant for production of uranium-235, whose successful operation did so much to bring victory in World War II.

Percival C. Keith, Jr., was born in Tyler, Texas, on December 24, 1900. His father was a well-to-do pharmacist, born in Scotland. His mother wrote poetry in her free moments. Both parents were determined that their precocious son should have the best education obtainable in Sherman, Texas, where the family had moved. A local retired French engineering officer, Captain LeTellier, who had been a French military attache in Washington and later taught in Sherman, was engaged as young Keith's tutor. LeTellier instilled in Percival Keith his lifelong interest in history, philosophy, and science. Many of Mr. Keith's professional associates remember the quotation from Heraclitus framed on his office wall: "There is nothing permanent but change." Without formal schooling, Percival Keith entered Austin College in Sherman at age sixteen and graduated in three years with an A.B. degree in English.

His interest in engineering was kindled by the growing oil production of Texas. He entered Massachusetts Institute of Technology (MIT) in 1919 and spent three exciting years there taking all the courses he could manage in mathematics, chemistry, and engineering. He was greatly influenced by MIT's legendary chemical engineer, Warren K. Lewis, whose dynamic personality so closely matched his own. It was at MIT that Percival Keith acquired the nickname "Dobie," which he was called for the rest of his life.

Mr. Keith's professional advancement was rapid. He worked in the research laboratory of the Texas Company for a year and in the field for Universal Oil Products Company for two years. From 1925 to 1927 he was Vice-President for Operations for the Cross Engineering Company. In 1927 he joined the M. W Kellogg Company, one of the leading U.S. engineering firms, as Chief Engineer. In 1929 he left Kellogg to form his own company, Refinery Engineers, in Kansas City. In 1932 he returned to Kellogg in New York as Vice President for Research and Engineering. The early 1930s was the period of rapid growth for petroleum refining, and Keith and Kellogg pioneered in the development of thermal cracking and reforming and delayed coking. Later, with other companies, Keith and Kellogg contributed to the development of catalytic cracking, catalytic reforming, and catalytic polymerization of olefins. Kellogg's catalytic reforming process, under the trademark Hydroforming, was a major source of toluene for production of TNT during the early years of World War II. Prior to 1946 Mr. Keith was issued more than forty patents on petroleum refining processes.

Mr. Keith's involvement with uranium-235 began immediately after Pearl Harbor, late in 1941. At that time he was invited to join the planning board of the S-1 Committee of the Office of Scientific Research and Development, headed by Eger V. Murphree, Vice President for Research of Standard Oil Company (New Jersey), who had worked with Mr. Keith on petroleum refining projects. Mr. Keith was asked to evaluate and undertake engineering develop ment of the gaseous diffusion process for separating uranium-235, one of the several processes being considered for production of materials for an atomic bomb.

The work of Mr. Keith and his associates at Kellogg in 1942 was reviewed in December of that year by a committee, headed by W. K. Lewis, which had been appointed by Leslie R. Groves, Commanding General of the Manhattan Project. Mr. Keith convinced first Lewis and then Groves that the gaseous diffusion process could succeed. Kellogg was asked to form a subsidiary company, the Kellex Corporation, to complete development and engineering of a full scale diffusion plant to produce uranium-235. Mr. Keith served as Vice-President and Technical Director.

The task was monumental. The only compound of uranium that could be used was the hexafluoride, a corrosive gas that reacted with water and attacked steel. Although gaseous diffusion appeared to be the best process, it was very inefficient. A plant to produce useful amounts of uranium-235 would have several thousand stages and would use enormous amounts of electric power. It would be necessary to develop a special diffusion barrier with ultrafine holes made of material that would not react with uranium hexafluoride. Pumps, valves, heat exchangers, and instruments of novel design would have to be developed. And a smoothly operating plant with thousands of stages of such novel equipment would have to be designed, built, and put into operation in two years.

The success of this unprecedented engineering venture would have been impossible without Mr. Keith's dynamic leadership. He understood the exacting requirements of the process. His personal conviction that the plant would be successful and the example he gave of determination to overcome enormous difficulties persuaded some of the best chemical, electrical, and mechanical engineers of the country to join the Kellex Corporation and, with him, to solve the many technical problems of the Oak Ridge diffusion plant. He led this team of expert engineers with consummate skill, setting overall objectives, making key decisions, and contributing many original ideas.

To this day, the gaseous diffusion process that he pioneered is the process most widely used for enriching uranium-235.

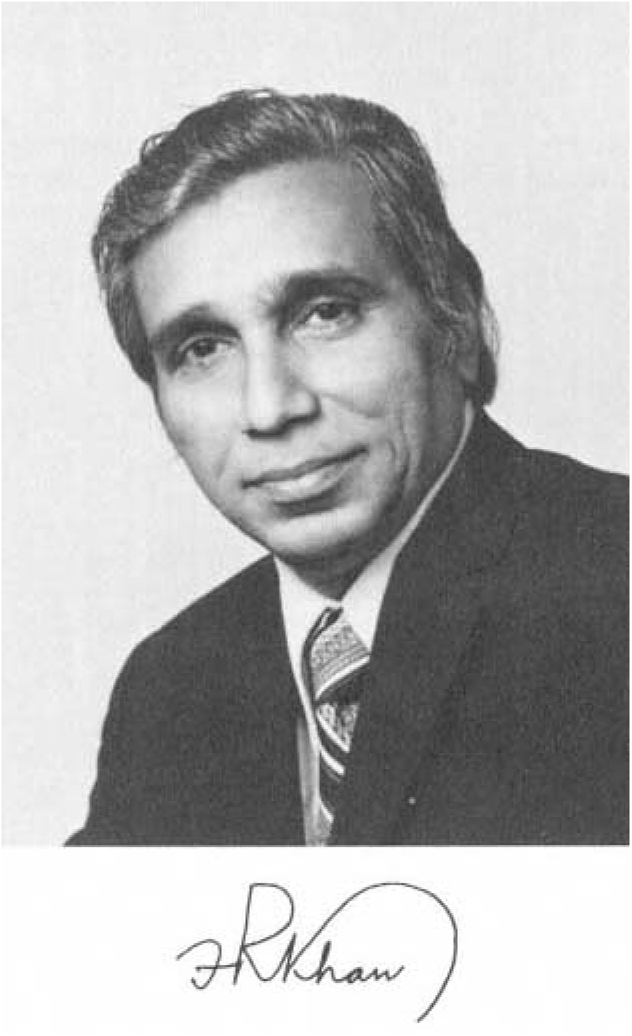
Even while he was leading the Kellex team, Mr. Keith was planning his postwar activities. In 1943 he formed a new company, Hydrocarbon Research, Inc. (HRI), to develop new processes for synthesizing liquid fuels from natural gas or coal. He served as President of this company from 1943 until his retirement in 1964. The Carthage Hydrocol plant, built by Hydrocarbon Research at Brownsville, Texas, in the 1950s to convert natural gas to gasoline by the Fischer-Tropsch process, proved uneconomical. But the partial oxidation process, originally developed for production of synthesis gas (carbon monoxide plus hydrogen) at Brownsville, was adapted to make synthesis gas from residual oil or coal and was licensed by HRI and its partner, Texaco, in more than seventy plants throughout the world. The principal use has been to make hydrogen for ammonia synthesis and other commercial purposes. Another offshoot from Brownsville was the H-Iron direct reduction process for making powdered iron from iron oxides in a fluid bed.

Two other processes utilizing hydrogen were commercialized during Mr. Keith's later years as President of HRI. One of these was the H-Oil process for hydrodesulfurization and hydrocracking of heavy and residual oils. The other was the HDA process, jointly developed with Atlantic-Richfield, for the manufacture of benzene from toluene by hydrodealkylation. After retirement in 1964, Mr. Keith remained active in engineering through work on projects for secondary recovery of petroleum by injection of carbon dioxide.

He was elected to the National Academy of Engineering in 1968. He was also a member of the American Institute of Chemical Engineers, American Chemical Society, American Gas Association, Society for Chemical Industry (American Section), and American Association for the Advancement of Science. He obtained more than seventy patents and wrote several articles on petroleum refining, the Manhattan Project, oxygen production, and synthetic fuels. He received honorary Ph.D. degrees from Austin College in 1946 and from Colby College in 1947.

Mr. Keith was an extraordinarily dynamic man, with a restless, far-reaching mind. He worked long hours and expected similar dedication from his associates. Stories of his absorption in his work are legend. He once gave a design problem to one of his mechanical engineers. Two days later Mr. Keith called and asked for the solution. The engineer told him that he had been too busy to work on it. Said Keith, "God bless you my friend. What do you think about when you shave in the morning?"

Despite his absorption in his work, he had a full personal life. The Keith family home, Windfall, was a small farm with an apple orchard, where sheep, cattle, chickens, and turkeys were raised. He kept horses and rode with the Essex fox hounds. He was a gourmet cook, and a very proud possession was a rare original edition of the classic cookbook written by the legendary French chef, Escoffier. He is survived by his wife, Elizabeth, and by his children, Percival III, Christopher, and Martha (by his wife Martha, who died in 1939) and Mac and Dennis (by his wife Ann, who died in 1974.)



Fazlur Rahman Khan

1929-1982

By Lynn S. Beedle

FAZLUR RAHMAN KHAN, prominent partner and Chief Structural Engineer of Skidmore, Owings and Merrill in Chicago, died March 27, 1982, during a business trip to the Middle East. The sudden passing of Dr. Khan—guiding structural engineering force of the Sears Tower, the world's tallest building, and other significant projects—has left a great void in the ranks of engineers of tall buildings. In the span of his career he achieved international distinction for his unparalleled work in structural systems.

Dr. Khan was a pioneer in tall-building engineering design, best known for the creation of the "bundled tube" system first used in the Sears Tower. The innovative concept calls for the use of groups of narrow tubelike structures joined together to form a tower of great height, yet with sufficient stiffness to meet lateral sway limitations. It was created as a means of reducing the amount of structural steel or concrete necessary to support a huge skyscraper, and thus making large towers economically feasible.

He was born April 3, 1929, in Dacca, Bangladesh. In 1950 he received a Bachelor of Engineering degree from the University of Dacca. He continued his education in the United States, attending the University of Illinois at Urbana. There he earned an M.S. degree in structural engineering in 1952. Three years later he completed both his M.S. degree in theoretical and applied mechanics and his Ph.D. in structural engineering.

Dr. Khan decided to make his home in Chicago and joined the international architectural firm of Skidmore, Owings and Merrill in 1955. He remained with them until his death at age fifty-two. Becoming Senior Designer his first year there, he rose through Senior Project Engineer, to Associate Partner, to Head of the Structural/ Civil Division, and finally to Partner in 1970.

Dr. Khan had been responsible for the engineering design of many major architectural projects. He developed a number of new structural systems for tall buildings, both for reinforced concrete and for structural steel. Among many of the significant tall structures he designed, three special buildings that stand out are the 714-foot-tall One Shell Plaza Building in Houston; the 100-story John Hancock Center in Chicago, the world's tallest multiuse building; and the 110-story Sears Tower in Chicago, the world's tallest building, at 1,454 feet.

Dr. Khan was also an active designer of other kinds of structures. His work in long-span structural systems made possible the design for the Haj Terminal of the King Abdul Aziz International Airport in Jidda, Saudi Arabia, an immense, tentlike structure of stretched fabric and concrete completed in 1981. He was also the engineer for the Hubert H. Humphrey Metrodome, a stadium in Minneapolis, and the Baxter Travenel Laboratories, a structure with a roof suspended from cables, in Deerfield, Illinois. Among other major projects were the engineering designs for the solar telescope at Kitt Peak, Arizona, designed by Myron Goldsmith, and the United States Air Force Academy in Colorado Springs, designed by Walter Netsch.

Though he was not an architect, Dr. Khan worked easily with architects and prided himself on his collaborative role with them. In particular, he worked closely with two of his partners in Skidmore, Owings and Merrill's Chicago office: Bruce Graham, with whom he worked on his major skyscraper designs, and Myron Goldsmith, with whom he taught in the Architecture Department of the Illinois Institute of Technology. Together, Dr. Khan and Mr. Graham devised the design for the John Hancock Center. The pattern of the huge X-braces on the exterior of the tower made it clear that the structural system was an important aspect of the building's aesthetics, and the dramatic form brought both Dr. Khan and Mr. Graham considerable public notice. For the Sears Tower, nine tubes were used. They were of different heights, both to express their separate natures and to give the building a lively profile on the Chicago skyline. Most other bundled tube designs have used tubes of uniform height, making these buildings appear somewhat more conventional.

In addition to his work with Skidmore, Owings and Merrill, Dr. Khan also participated actively in many professional organizations. He was elected to the National Academy of Engineering in 1973. From 1976 to 1979 he was Vice-Chairman of the International Council on Tall Buildings and Urban Habitat and was elected Chairman in 1979, a post he held until his death.

The American Society of Civil Engineers (ASCE), the American Concrete Institute (ACI), the American Welding Society, and the IABSE, to name a few, all listed his name on their rosters. He achieved distinction among their ranks, receiving many awards and honors. Some of the most notable include Fulbright Scholar, Chicagoan of the Year in Architecture and Engineering, American Institute of Steel Construction Special Award, Chicago Civil Engineer of the Year (ASCE), Alumni Honor Award of the University of Illinois, Middlebrooks Award (ASCE), Alfred E. Lindau Award (ACI), State Service Award (Illinois Council of the American Institute of Architects), Ernest E. Howard Award (ASCE), and G. Brooks Earnest Award (ASCE Cleveland Section).

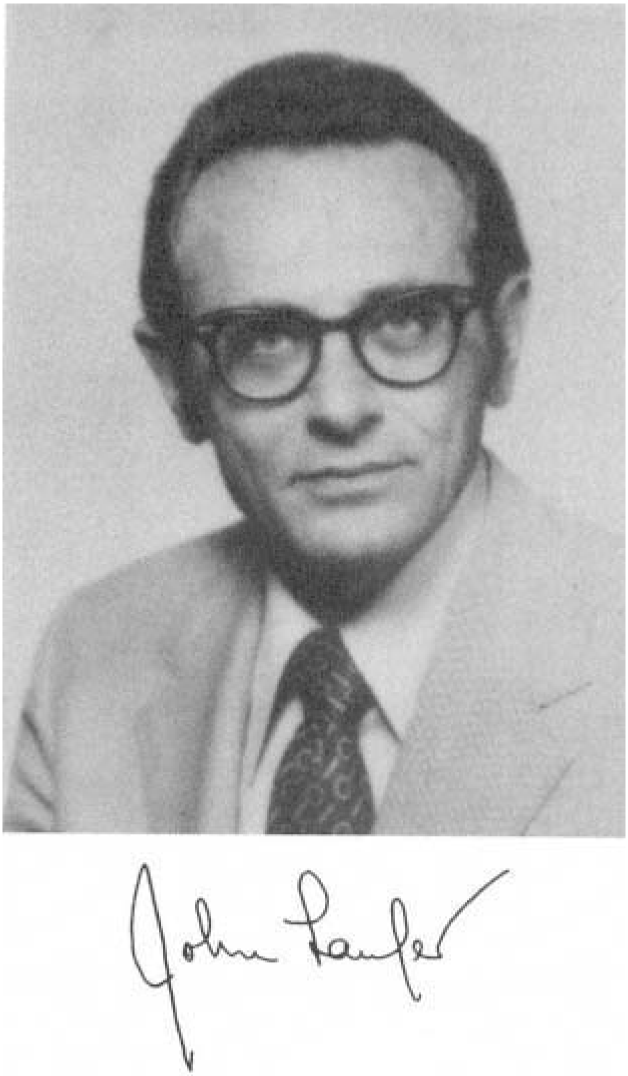
He was also cited among the Men Who Served the Best Interests of the Construction Industry, in 1966, 1969, and 1971, and was voted Construction's Man of the Year in 1972, by *Engineering News Record.* Many medals, such as the Wason Medal for most meritorious paper from ACI (1971), the Lloyd Kimbrough Medal from AISC (1973), and the Oscar Farber Medal from the Institute of Structural Engineers in London (1973), were bestowed upon this engineering giant.

His untiring devotion to his field included the belief that it was not enough just to keep his many theories, discoveries, and "school of hard knocks" knowledge to himself. He published more than seventy-five technical papers in engineering and architectural journals on topics relating to the analysis, design, and construction of complex structures. He also gave freely of his time as an Adjunct Profes sor of Architecture at the Illinois Institute of Technology in Chicago where he taught from 1961 until the time of his death.

As a professional, Dr. Khan gave every fiber of his talent, energy, and creativity to the development of new and innovative concepts, all the while preserving what was essential in the tried and true solutions.

As a person, he felt that structures should serve mankind, not the other way around. He was keenly interested in a union of architectural and engineering expertise, with the common goal of functional, economical, and yet beautiful tall buildings. As was so aptly stated by *Engineering News Record,* "The consoling facts are that his structures will stand for years, and his ideas will never die."

He is survived by his wife, Liselotte; his daughter, Yasmin; and his stepson, Martin Reifschneider.


John Laufer

John Laufer

1921-1983

By Hans W. Liepmann

JOHN LAUFER, Chairman of the Department of Aerospace Engineering at the University of Southern California (USC), died on July 9, 1983. He was sixty-one years old. John Laufer is internationally known for his work in fluid mechanics. In particular, several of his contributions to the literature of turbulence are classics in the field. He founded and led the Aerospace Engineering Department at USC to its present state of preeminence. This contribution today almost overshadows his technical work.

Janos Laufer was born in Szekesfehervar, Hungary, on September 22, 1921. In the ominous political atmosphere of the late 1930s, his parents chose to send him to live with relatives in Baton Rouge, where he obtained a B.S. degree in mechanical engineering at Louisiana State University in 1942. Subsequently he was accepted for graduate study in aeronautics at the California Institute of Technology (Caltech). He obtained M.S., A.E., and Ph.D. degrees at Caltech in 1943, 1944, and 1948, respectively.

John Laufer, as he was called in this country, arrived at Caltech at a time when intense research activity in turbulence, stimulated by Theodore von Karman, was just beginning. Dr. Laufer kept up his interest in this field to the end of his days. His thesis on turbulent channel flow and his early work on turbulent mixing layers and on isotropic turbulence are still read and used today. He remained at Caltech as a research fellow until 1949, when he joined the National Bureau of Standards (NBS). There, in the fluid physics group led by

Hugh Dryden and Galen Schubauer, Dr. Laufer had the opportunity to develop his experimental skills to an exceptional level. His research at NBS on turbulent pipe flow remains the definitive work on the subject, a true classic. In 1952 he moved to the Jet Propulsion Laboratory where he remained until 1964, first as a Senior Research Engineer and then as Chief of the Gas Dynamics Section. In 1964 he accepted a position as Professor and Chairman of the Aerospace Engineering Department at the University of Southern California, posts that he held until his death in 1983.

John Laufer served on a number of national and international committees. As a consultant for the Advisory Group for Aeronautical Research and Development (AGARD), he lectured on turbulence in France, Italy, Germany, and Holland in 1958-1959. He was a member of the National Aeronautics and Space Administration's Advisory Committee on Fluid Mechanics from 1960 to 1964. He was a member of the Board of Editors of the *Physics of Fluids* from 1965 to 1967 and again from 1970 to 1972. He served as Associate Editor *of Applied Mechanics Reviews* beginning in 1969. As a Fellow of the American Physical Society, Dr. Laufer was a member of the Executive Committee of the Division of Fluid Dynamics. As a Fellow of the American Institute of Aeronautics and Astronautics, he was a member of the Aeroacoustic Technical Committee. He was elected to the National Academy of Engineering in 1977 for his contributions to fluid mechanics and for leadership of his academic department.

The accomplishments, honors, and published papers of John Laufer fail to measure the total impact that he had on his co-workers, students, and the engineering community. His combination of ability and charming personality left a lasting impression on everyone who came in contact with him. This combination, together with a quiet tenacity of purpose, was the key to his success in developing his department at USC to its present state as one of the leading centers of turbulence research in the country.

John Laufer's tenacity of purpose became apparent early in 1945 while he was still a student in the last stages of his Ph.D. research. He managed to return to Europe and find and marry his childhood love, Susan Ullman, who had just been freed from a concentration camp. It was little short of miraculous for a student with few resources to succeed in such a nearly impossible task in war-torn Europe at that time. The marriage thus begun was a lasting and happy one.

In spite of his history and background—both of his parents died as victims of Hitler—John Laufer was able to live without prejudice or bitterness. He was at peace with himself, a gentle man. He died too young, but he died on the tennis court, painlessly, enjoying a game that he loved: a harmonious end to a full and happy life.

Photograph by Fabian Bachrach.

Joseph C. Lawler, Jr.

1920-1982

By Martin Lang

JOSEPH C. LAWLER, JR., Chairman of the Board of Camp, Dresser and McKee, Inc. (CDM), one of the Nation's major consulting firms in the environmental engineering field, died on November 18, 1982, at his home in North Reading, Massachusetts.

Mr. Lawler was widely recognized for his contributions to the environmental engineering profession, for his dedication to high ethical standards, and for his involvement in furthering the consulting engineering profession.

He received a B.S. in civil engineering, with honors, from Northeastern University in 1943. He served with distinction as a Navy Lieutenant in the Civil Engineering Corps stationed in the Pacific during World War II. He then attended Harvard University and received a master's degree in sanitary engineering in 1947. He was also awarded an honorary Doctor of Engineering degree from Northeastern University in 1972.

Mr. Lawler had been with Camp, Dresser and McKee since its inception in 1947 and played a significant role in guiding the firm to its position as one of the largest consulting firms in the country. He became a Partner in 1952, President of the international subsidiary in 1968, and President and Chairman of the Board when the firm was incorporated in 1970. Thomas R. Camp, the firm's founder, once characterized him as the "backbone of CDM." Under his leadership the firm expanded its national and international markets and became a leading force in the environmental engineering field.

He was recognized as an untiring worker for the international advancement of environmental engineering and for the training of engineering personnel of developing countries.

Some of his many international projects included water treatment works for Sydney, Australia; development of water and sewerage systems for eighty communities in Bangladesh; water supply, sewerage, drainage, and flood protection for metropolitan Bangkok, Thailand; water supply and sewerage projects for Ankara, Turkey; and sewerage and wastewater treatment for metropolitan Taipei, Taiwan.

Major projects in the United States included expansion of Tallman's Island wastewater treatment plant, New York City; sewerage and joint wastewater treatment works for Pittsfield and Dalton, Massachusetts; a waterworks improvement program for Troy, New York; the nineteen-community water pollution abatement report in the Merrimack River Basin; and the study for pollution control works for Lawrence and adjacent towns in Massachusetts.

Joseph Lawler was elected to the National Academy of Engineering (NAE) in April 1973. He was cited for his innovative contributions to water supply and wastewater treatment plant design and to the advancement of the engineering profession. In 1981 he chaired the NAE-sponsored round table on the Clean Water Act.

He was very active in many engineering and professional societies, serving as President of the New England Water Pollution Control Association in 1970 and as President of the Engineering Societies of New England in 1962-1963. He was a Diplomate of the American Academy of Environmental Engineers and a Fellow of both the American Society of Civil Engineers and the American Consulting Engineers Council.

The Engineering Societies of New England cited Mr. Lawler's ability as an administrator, his contributions to the international advancement of environmental engineering, and his dedication to maintaining the ethical standards of his profession when they gave him the New England Award in 1972. In April 1981 he received the Civil Engineering Management Award from the American Society of Civil Engineers and delivered the Parcel-Sverdrup management lecture at the society's national meeting.

Joseph Lawler was an avid big-game hunter and wildlife conservationist. A founder and first President of the New England Chapter of the Safari Club International, he was active in both the club's local and national affairs. He was a Vice-President of the Safari Club's International Conservation Fund, sponsor of a broad range of conservation activities, including the American Wilderness Leadership School, and recipient of the Arthur Sullivan Memorial Award for New England outdoor journalists.

At Northeastern University he served as Director of the Alumni Association from 1958 to 1960 and as Vice-President from 1960 to 1962; in 1964 he was made a Director of its National Council. He was an active member of the university's Board of Trustees at the time of his death. As a graduate of Northeastern's cooperative education program, Mr. Lawler had been recognized for his efforts in promoting cooperative education nationwide. The Cooperative Education Association posthumously awarded him the Charles F Kettering Award.

Speaking for his associates, Joseph E. Heney, President of Camp, Dresser and McKee, said:

> We all share a deep sense of loss at the passing of our Chairman and Chief Executive Officer. Joe was the driving force behind CDM's spectacular growth over the past two decades. He leaves behind a strong organization, a management philosophy, and a set of professional ideals that will serve us well in the years ahead.

Donald Percy Ling

1912-1981

By Brockway Mcmillan

DONALD P. LING died at his home in Albuquerque, New Mexico, on July 14, 1981. Dr. Ling retired as Vice-President of Bell Laboratories in 1971. Because of his expertise, his thoughtful judgment, and his selfless willingness to probe into questions brought before him, he was widely known and highly respected in government and military circles and among his engineering colleagues. He had been a member of the National Academy of Engineering since 1967.

Educated in languages, music, and mathematics, Dr. Ling spent much of his professional life either working as an engineer or working with engineers. His practice centered on the large, real-time control system. He combined his knowledge of the diverse technologies at issue with the attitude and instincts of a systems engineer. He left his mark on the structure as well as on the details of most systems with which he dealt—this was possible because of his understanding of the complex interactive effects that govern the performance and plague the design of large systems. His best-known work was with guided missile systems, and many of his important contributions are therefore scattered in classified memorandums and reports that have not been published.

During his career Dr. Ling served on literally dozens of committees and advisory panels to the U.S. Government—ten panels alone of the President's Science Advisory Committee during the first half of the 1960s. During the same period he served on other groups that advised the Department of Defense, National Aeronautics and

Space Administration, Central Intelligence Agency, and Arms Control and Disarmament Agency.

Dr. Ling's most extensive involvement was with the Nike series of antiaircraft and antimissile systems. None of these systems was without critics, and the antimissile systems were focuses of controversy. It reflects on the respect in which Dr. Ling was held that he, almost alone among employees working on these projects, frequently served on advisory groups convened to review the projects.

Donald Percy Ling was born January 2, 1912, in Albany, New York, and he attended the public schools of Albany. He entered Amherst College in 1928 and later studied piano at the Eastman School of Music in Rochester, returning to graduate from Amherst in 1933 with a B.A. in mathematics. For the next year he studied classical applied mathematics in Cambridge, England. He taught in private schools in New England for three years and then entered Columbia, where he received M.A. and Ph.D. degrees in mathematics, and also taught part of the time.

In 1944 and 1945 he worked on aerial gunnery problems with the Applied Mathematics Panel of the National Defense Research Committee. In 1945 Dr. Ling was hired by Bell Laboratories as a research mathematician and was a member of the (then) Mathematical Research Department headed by H. W. Bode. He immediately joined a team that included fellow mathematicians Bode and John W. Tukey and other physicists and engineers, who prepared a detailed study of a possible antiaircraft guided missile system for the Army. The study broke new technical ground in analyzing the aerodynamic control of supersonic vehicles, and it challenged conventional wisdom about sensors and about where the control loops should be closed. It also broke new ground among military "systems analyses" of the period in the scope of issues covered and in its penetration of these issues. From this study came the Nike series of guided missile systems.

Dr. Ling remained a member of the mathematical research organization at Bell Laboratories for the next thirteen years. During much of that time he consulted with Nike projects. He himself did the first design of a warhead for Nike Ajax, a controlled fragmentation device. During the flight tests of Ajax, he spent weeks at a time at the

White Sands missile test range with engineers from both Bell Labs and Douglas Aircraft Company, the subcontractor. It was in the camaraderie of this field assignment, where everyone was learning, that Don Ling the mathematician formed bonds of friendship and respect, not only with the engineers of his own company but also with their friendly rivals, whom they called "plumbers," from the aircraft industry. He served as liaison between these two communities for the rest of his career.

The mathematical research organization at Bell Laboratories grew in size and in the early 1950s was split into several units under one director. Dr. Ling headed one of the research units. In his group were Sydney Darlington, J. W Tukey, and R. B. Blackman. The guidance algorithms for Nike Ajax and Nike Hercules were designed there, and the programs were written there for the first digital (and solid-state) bombing and navigation computer (Tradic).

In 1958 Dr. Ling left the research organization to become Director of Military Analysis, building up a group within a newly formed organization for military systems engineering. Another promotion in 1959 saw him reporting to the Vice-President for Military Systems Engineering, to which post he himself succeeded in 1967.

In 1959 studies began that led ultimately to the setting up of a program, called Nike-X, to demonstrate an antimissile system that used as a primary sensor a phased-array radar, tracking both intruders (targets) and interceptors. Into 1962, under Dr. Ling's direction, these studies were continued and compiled into a formal report. The report, in several volumes, outlined the basic plan and proportions of an antimissile system, detailed the development problems, and described a program to address them. The program thus outlined was formally proposed by the Army to the Department of Defense and was approved for initiation. For the next five years Dr. Ling's organization pursued its analyses and consulted in developing detailed objectives for the design of the demonstration system and the conduct of its test. At the same time Dr. Ling was a principal spokesman for Bell Laboratories and Western Electric, the prime contractors, in reporting progress on Nike-X. He appeared regularly in this role before the Secretary of Defense. He also appeared as a spokesman for the Army and the Department of Defense before the President's Science Advisory Committee and other groups. It speaks well of the objective quality of his reports that this record of advocacy was not a bar to Dr. Ling's participation at other times in reviews and critiques of the program.

Neither the inventor (there was none) nor, in any detailed sense, the designer of Nike-X, Don Ling probably did as much to preserve a sound balance among the many objectives of the demonstration program as any individual. That these objectives were technically defensible and that they remained the governing factors in the conduct of the program are important facts for which Dr. Ling and his organization must be given much credit. In addition, Don Ling's personal efforts as a detached and articulate spokesman did much to keep the technical issues clear and separate from the often heated and diffuse arguments about defense policies.

Dr. Ling left his mark on Bell Laboratories. His Military Analysis group, handpicked from the start, grew to a vigorous and productive unit. Its alumni have found their way into influential posts throughout the company. He early recognized the need for a company-wide computing organization and was instrumental in the early decisions that set it up and staffed it with competent people. As Chairman of his company's influential Committee on Education, he initiated a major expansion in the extent and variety of educational opportunities that the company offered to its employees.

Increasingly troubled by a weakening heart, Dr. Ling retired in October 1971. At retirement he was concurrently the Vice-President for Systems Research at Bell Laboratories and President of Bell Comm, Inc. He moved to Albuquerque in the desert country that he loved. He briefly undertook some consulting work for the University of New Mexico but not, as he had hoped, in matters related to education.

Dr. Ling was a private man. Cultured, urbane, elegantly articulate, and gifted with a perceptive sense of humor, he met everyone with courtesy and respect. He was gracious, almost courtly, in social gatherings. But he reserved a private self that was rarely glimpsed. His one marriage lasted only a few years. Alone in retirement, as his health allowed he explored the desert, expanded his mineral collection, and spent time each day at his piano. Scholar and mathemati cian, he completed a project begun before retirement: the writing of a serious technical book on modern mathematics for the nonmathematical reader. His final draft manuscript was completed in 1980.

I last saw Donald Ling in March 1981. I called him from Socorro, New Mexico, to ask if my wife and I could drop in. With characteristic detachment and tact, he referred obliquely to his failing strength and urged that we visit for a short while. In the event, the short while stretched to three hours. We talked of his book, of his hopes for its publication, of his music—he had strength only for short periods at the piano—of his mineral collection, of his health, of his daughter and infant grandson. At our parting, we all knew it was our last. Ever the gracious host, he saw us to the door, instructed us in finding the highway, and bade us a cordial good-bye, just as he would have done thirty years before.

Edwin Albert Link

1904-1981

By Harold E. Edgerton

EDWIN A. LINK died on Labor Day, September 7, 1981. He held thirty-three patents for his inventions in aviation, navigation, and ocean engineering. His reputation spans heaven, earth, and ocean; he was best known for his 1929 development of the Link Flight Trainer and his developments of lock-out submersibles of the Johnson-Sea-Link type.

Born in Huntington, Indiana, on July 26, 1904, he soon moved to Binghamton, New York, where his father manufactured organs. The young Link worked with the organ controls and began a lifetime as the quintessential Yankee tinkerer. He saw the beauty in tools—in wrenches and drills and lathes—and what they could fix and fashion. He loved working alone, late at night, gnawing at a problem until he had mastered it. Not for him the committee approach; he was guided by the light of a singular flame, burning brightly within his head.

Ed Link barnstormed with the aces of the Lafayette Escadrille and passed the time of day with Orville Wright. He will always be famous for the Link Trainer, which he developed in the 1920s when he was determined to learn to fly but lacked funds for the airborne hours flying required. The first Link Trainer was built in his father's basement. With this device an aviator can be trained in instrument flying without the complications introduced by an actual airplane.

There were few customers for the Link Trainer until 1934, when the U.S. Army Air Corps was abruptly given the task of carrying airmail. The Corps pilots, trained to fly by watching the ground, could not handle the job. After ten pilots crashed, the Air Corps turned to Link's invention.

During World War II the Link Trainer was used to teach more than half a million airmen. Today Link Trainers are produced for pilots, astronauts, and maritime vessel operators. A sophisticated offspring, controlled by computers, rehearsed men for the Moon. Visitors to the Smithsonian's National Air and Space Museum can take a five-minute simulated flight in one of three Link General Aviation Trainers that are on display there.

Ed Link was two men: one with a tool box in his fist, the other with dreams in his head. He never forgot his dreams. Even while he was putting together the company that would build the Link Trainer—Link Aviation, Inc.—and then guiding its expansion into a large corporation that became General Precision Equipment Corporation and eventually part of the Singer Company, he never forgot one of the dreams of his youth—to go to sea.

A vagabond at heart, he took off into the Caribbean with his wife, Marion—the pillar of his life—and his two young sons. He loved the act of diving, of descending to marvel at the ocean's innermost secrets. Like most visionaries, Ed Link had the capacity to hitch his dreams to a purpose: He would design and build things so that men could work beneath the sea—to salvage sunken ships and survey drowned seaports, to weld pipelines and study sea life.

He designed and built an oceanographic research vessel, *Sea Diver,* which he used for many archaeological research expeditions in the Aegean and Caribbean seas. In 1960 he commenced the task of developing equipment that would "put man in the sea." In 1962 he built the world's first submersible decompression chamber for marine science. Lightweight and able to lock onto a deck decompression chamber, it would become the forerunner of the hundreds of diving bells currently working in the Far East, North Sea, and Gulf of Mexico.

Shortly after it was built, he took to the water to test it himself. "The final test of a man's beliefs, . . ." he said as he settled into its aluminum shell and closed the hatch behind him. In the clear blue waters of the Mediterranean off the coast of France, he stayed at 60 feet for eight hours, swimming outside while breathing a mixture of oxygen and helium. Not bad for a fifty-eight-year-old man.

Over the years Ed Link did more than any other individual in building the diving systems that would support man under water. He designed pressure chambers, small manned stations, and a pair of lock-out submarines known as the Johnson-Sea-Link class. Into the last he incorporated a brilliant concept—a transparent acrylic shell. Scientists could sit on the seafloor at a thousand feet and have a panoramic view.

Much of the world was unaware of his tremendous contributions. Unlike Jacques-Yves Cousteau, whose fame was burning with its own brilliance, Ed Link was shy in public and not deft with films or self-publicity.

His younger son, Clayton, died in a diving accident when strong currents swept the minisub into a tangle of cable and debris. Ed Link led rescue efforts from the deck for thirty-one hours, but the acrylic bubble was freed too late. He gathered himself up as best he could and pressed on with his work. "We're not going to stop," he vowed, and two years later he developed a submersible that would prevent the kind of accident that took his son's life. The Cabled Observation and Rescue Device (CORD) is an unmanned submersible equipped with television cameras, hydraulically powered claws, and cutters to rescue divers trapped under water. A man is measured not only by his successes but by how he handles his tragedies.

Ed Link had a residence in Binghamton, New York, and at the Harbor Branch Foundation near Fort Pierce, Florida. It was at this latter location that he carried forth his remarkable developments of underwater research projects. He helped direct a staff of 150 scientists, engineers, and support personnel at Harbor Branch Foundation, Inc., a unique oceanographic center where research and engineering have united to create the hardware needed to explore and study marine life.

His interest in technical education led to the establishment in 1953 of the Link Foundation to support research and education in the fields of aeronautics and oceanography. Link Foundation grants have been awarded to more than 120 universities and nonprofit organizations. Its first Ocean Engineering Fellowships were established in 1962.

He received honorary doctorates from Tufts University, Hamilton College, Syracuse University, and Florida Institute of Technology. Numerous honors include the Franklin Institute's Howard N. Potts Medal; Wakefield Gold Medal from the Royal Aeronautical Society of London; Underwater Society of America NOGI Award for Science; Matthew Fontaine Maury Medal from the Smithsonian Institution; and International Oceanographic Foundation Gold Medal Award. He was elected to the National Academy of Engineering in 1965.

The 1980 Lindbergh Award was presented to Edwin Link with this citation: "A truly Renaissance man: engineer, inventor, explorer, philanthropist, businessman, pilot, archeologist, oceanographer, conservationist." Dr. Joseph MacInnis, President of Undersea Research, Ltd., of Toronto, Canada, and a recipient of a Link Foundation Fellowship, said, "Some of us were fortunate enough to work for him. Whatever task, he would bend his back to it, toiling alongside us ... he made us feel like we were young men on a young frontier. Looking back, decades later, it was an apprenticeship to genius."

William K. Linvill

1919-1980

By David C. White

WILLIAM K. LINVILL died suddenly on August 7, 1980. Bill Linvill combined in one personality an unusual number of rare human gifts. With his passing, engineering loses one of its most thoughtful social philosophers. He combined a simple, direct, and manifold concern for his fellow human beings with brilliance as a teacher, faithfulness to methodology as a scholar of engineering, and the breadth of vision of a true social generalist.

William K. Linvill was born in Kansas City, Missouri, on August 8, 1919. He and his identical twin John were the sons of Thomas Grimes Linvill and Emma Crayne Linvill. The twin sons were both scientifically inclined, and they studied math and physics at William Jewell College in Missouri. Then they entered the Massachusetts Institute of Technology (MIT) where they both did graduate work in electrical engineering. Bill Linvill worked in the Servomechanisms Laboratory at MIT, where feedback control systems concepts were in the very early state of development. His Sc. D. thesis, "Analysis and Design of Sampled-Data Control Systems," was a pioneering contribution to the use of sampling techniques applied to intermittent noisy data used for systems control. He was an early leader in this now highly developed field of electronic signals and computers used in interactive control systems. After completing his Sc. D. in 1949, Dr. Linvill joined the faculty of MIT as an Assistant Professor of Electrical Engineering. Promoted to Associate Professor in 1953, he continued his research and teaching in sam pled-data computer control systems, making contributions to the successful design of the SAGE defense system developed by MIT's Lincoln Laboratory. In 1956 he resigned his MIT associate professorship to lead systems analysis work, first at the Institute for Defense Analyses and later at the Rand Corporation.

In 1960 Dr. Linvill joined the Electrical Engineering faculty of Stanford University. It was at Stanford that he brought to fruition the concepts he had been developing for applying systems and decision analysis to large-scale engineering and social systems. He concerned himself with developing ways to meet society's need to utilize technology and adapt to implications of technological applications. He was a visionary in perceiving the pressures that rapidly advancing technology places on human beings and the difficulties created by the necessity for technological choices to be made by the whole society rather than by a few specialists. He applied his vision to creation of an interdisciplinary academic program that would broaden the perception and enhance the systems analysis skills of his graduate students. In 1967 he became the Founding Chairman of the Department of Engineering-Economic Systems with a program emphasizing rational analysis of complex socioeconomic engineering systems.

Dr. Linvill's work in the philosophical aspects of problem solving and the issues of how technology can better serve society made him a pioneer of a new engineering discipline. As a leading scholar and teacher in this emerging field, he recognized early the critical need for practical internships in such an applied field. He encouraged more than 150 of his doctoral candidates over the next twelve years to take full-time field training of at least one year in government or industry. His focus was always on those hard, complex problems that should be the real concerns of our society. He believed that an educated mind needed highly developed skills of both quantification and qualification. He emphasized to his students that good common sense in applying words and numbers in analysis was a great asset. Demanding, yet gentle, with a ready wit and winning smile, he attracted many bright students and colleagues who shared his interest in technology policy. He was a true humanitarian who sought always to develop fully the human potential in those about him.

In the last years of his life he perceived an intensifying need for those educated in technology policy analysis and development to take a more entrepreneurial role. Toward this end, his last project was to begin creation of a prototype Technology Policy Exploratory Center embodying close interaction among several universities and private corporations. Through this new institution he hoped to facilitate the formation of critical masses of human resources around needed new policy initiatives that could be implemented by private entrepreneurship. Full development of this pioneering concept falls to others as an intellectual legacy from Bill Linvill.

In addition to being a member of the National Academy of Engineering, Dr. Linvill was honored by appointment as a Fellow of the Institute of Electrical and Electronics Engineers and the American Association for the Advancement of Science. He served as a member of the National Research Council's Commission on Sociotechnical Systems, the National Aeronautics and Space Administration's Advisory Council for Space and Terrestrial Applications, the Westinghouse Electronic Research Advisory Council, and the National Bureau of Standards Visiting Committee. He was a consultant to a number of organizations including Stanford Research Institute International and the National Science Foundation. He was a Visiting Professor, "Chair of Free Enterprise," at the University of Texas.

He is survived by his wife, the former Bessie Blythe Burkhardt; his children, Barbara, Mary Lou, Thomas, Anne, and Carl; his twin brother John, also a member of the National Academy of Engineering; and his brother James of Kansas City, Missouri.

Heinrich Mandel

1919-1979

By Walker L. Cisler

HEINRICH MANDEL, elected in 1976 as a Foreign Associate of the National Academy of Engineering, died on January 24, 1979. He was a Professor, Doctor of Engineering, Doctor of Philosophy, and Chairman of the Management Board of Rheinisch Westfälisches Elektrizitätswerk AG (RWE). He will long be remembered not only for his outstanding leadership of a great electric utility system but, more particularly, for his incisive analysis of the current world energy crisis. Professor Mandel saw clearly the developing shortages of petroleum and gas and the potential dangers from intensified competition for diminishing supplies. He was convinced that the future well-being of many countries was closely linked with an adequate supply of energy at favorable prices, that a substitute must be found for the failing contribution of oil and gas, and that the substitute must be nuclear fission.

Heinrich Mandel was born on August 11, 1919, in Prague, Czechoslovakia, where his family had lived for several generations. He studied mechanical engineering at the local Institute of Technology and received his Doctor of Engineering degree in 1943. After military service during the war, he joined the RWE organization in 1948. In 1950 he entered the University of Cologne to study physics and was granted a Doctor of Philosophy degree in 1952. He accepted a professorship at Technische Hochschule Aachen in 1963, a post he held for the rest of his life.

After completing his studies at Cologne, Heinrich Mandel devoted himself to the prognosis of electric power demand and total energy requirements. After 1955 the German Federal Republic again was allowed to work on nuclear power plant technology, and from then on, Professor Mandel had a key role in its development. He recognized that, in the long run, a dependable energy supply was impossible without it. Largely as a result of his drive and leadership, a small, 15-megawatt nuclear power plant was built at Kahl/Main in 1958. Experience acquired there and at the demonstration plant at Gundremmingen/Danube provided an important background for the further development of nuclear power in the Federal Republic, culminating in the construction and successful operation of two 1,200-megawatt nuclear units at Bilbis. He was cofounder of the German Society for the Regeneration of Nuclear Fuels, a constant supporter of German centrifuge technology and of a European enrichment industry. He was President of the German Atomic Forum.

In 1961 Heinrich Mandel was elected to the Board of Management of RWE with principal responsibilities for construction and operation of power plants. In addition to the successful introduction of nuclear power, spoken of above, he had a key role in the development of power plants burning brown coal. These plants, using progressively larger units up to today's 600-megawatt machines, were an important factor in controlling electric power costs and thus contributing to the favorable development of the German economy.

Heinrich Mandel's ideas concerning energy policies reached far beyond the boundaries of West Germany. He ably represented his country on many international energy bodies. He was constantly sought after as a participant in conferences and forums. He presented many papers on the basic importance of conservation, on the environmental impact of energy, and on the need to find a substitute for the dwindling reserves of oil and gas.

In 1977 he was elected Chairman of the Executive Council of the World Energy Conference, a position he held until his death. In the same year an honorary Doctorate of Engineering was conferred upon Heinrich Mandel by Michigan Technological University.

Heinrich Mandel was deeply concerned with the substantial differences between nations in economic development. He believed that an important factor in the past development of industrialized nations had been a supply of energy at favorable costs and in adequate amounts. He also believed that the gap between industrialized nations and developing countries can be narrowed only if adequate supplies of energy are available to developing nations. He therefore urged that the industrialized nations push ahead with the development of nuclear power so that a greater share of the diminishing supply of oil and gas would be available to the developing countries.

He was well aware of the worldwide concern with the proliferation of nuclear weapons, but he nevertheless insisted that the breeder reactor was an essential part of the nuclear program and that the long-term potential of nuclear power could only be reached with a balanced program including the breeder reactor. He was convinced that the proliferation problem could be solved through International Atomic Energy Association controls and cooperative agreements.

Heinrich Mandel's untimely death is a great loss to the entire world. He will long be remembered for his early recognition of the developing energy crisis and, most particularly, for his constant readiness to support his ideas on how the crisis might be met with well-considered reasons. His life philosophy is probably best reflected by his statement to the graduating class at Michigan Technological University on May 21, 1977: "I fully believe that it is possible to make our world a better place to live in. ..."

Photograph by Fabian Bachrach.

John William Mauchly

1907-1980

By Isaac L. Auerbach

JOHN WILLIAM MAUCHLY, one of the visionaries who pioneered the era of the electronic digital computer, died on January 8, 1980, in suburban Philadelphia at the age of seventy-two. John Mauchly was a pioneer of automatic computing, particularly in the design and construction of the Electronic Numerical Integrator and Computer (ENIAC), the world's first all-electronic computer, and of the Binary Automatic Computer (BINAC) and the Universal Automatic Computer (UNIVAC). His efforts in the application of electronic computers to the solution of scientific and business problems were outstanding.

Dr. Mauchly was born August 30, 1907, in Cincinnati, Ohio, and grew up in Chevy Chase, Maryland. He attended John's Hopkins University on a scholarship, and received a Ph.D. in physics in 1932.

While Head of the Physics Department at Ursinus College, he became interested in the problem of weather prediction. Realizing the magnitude of the calculations involved, he began to experiment with different techniques to achieve the high speed required. In the summer of 1941 he attended a war training course at the Moore School of Electrical Engineering of the University of Pennsylvania. Realizing that both short- and long-range weather forecasting techniques could only be improved by faster, cheaper, and more sophisticated computational means, he turned his efforts to the development of electronic computing devices at the Moore School.

In a memorandum prepared for the Army Ordnance Department, Dr. Mauchly proposed the basic ideas for an electronic computer. On April 9, 1942, in collaboration with J. Presper Eckert, he completed a more extensive proposal, which included more detailed specifications of a computing machine. These specifications were submitted to the Army Station at the Aberdeen Proving Grounds in Maryland. Within a month a contract was awarded for the first all-electronic computer, ENIAC. Development of ENIAC was completed in 1946.

In the fall of 1944 the Moore School was awarded a contract to study the design of a stored program computer called the Electronic Discrete Variable Automatic Computer (EDVAC). Early progress reports written by Drs. Mauchly and Eckert included the first disclosure of the stored-program concept.

A dispute over the patent rights to the ENIAC caused Drs. Mauchly and Eckert to leave the university in late 1946. The two men formed the Electronic Computer Company in order to further develop their ideas. The company was eventually to change its name to the Eckert-Mauchly Computer Corporation, with John Mauchly as President. Under study contracts from the National Bureau of Standards, Prudential Life Insurance Company, and A. C. Neilsen Company, they developed models of an acoustic memory system, an advanced arithmetic unit, and a magnetic tape device. This research led to a contract from the Northrop Company to design the BINAC for missile steering. The BINAC was completed in 1949.

This was an extraordinarily creative period for Drs. Mauchly and Eckert; not only was the concept for UNIVAC I being developed, but John Mauchly also proposed the idea for a small scientific computer, a slower version of the BINAC. Inadequate funding required that they dedicate themselves to the development of only one computer at a time. The result was UNIVAC I, completed in March 1951, for the Census Bureau. UNIVAC I was the first general purpose commercial computer capable of handling alphabetic and numeric symbols and suited to a wide variety of applications.

In the late 1930s and early 1940s the electronic computer was an idea whose time had come. Dr. John V. Atanasoff was developing ideas at Iowa State College. Dr. Konrad Zuse was developing ideas in Bad Hersfeld, Germany. It was, however, Drs. Mauchly and Eckert in 1946 who developed the first operational all-electronic computer, the ENIAC, the precursor of all that was to follow.

Following the work on UNIVAC, John Mauchly returned to statistical analysis of solar and geophysical data, and under his guidance the first Fortran-like programming system was produced. John Mauchly headed the UNIVAC Applications and Research Center from 1953 to 1959, and among other applications developed was the network method of project analysis, now known as the critical path method.

John Mauchly shares, with J. Presper Eckert, awards of the Potts Medal of the Franklin Institute, the Philadelphia Scott Award, the Modern Pioneers in Creative Industry Award from the National Association of Manufacturers, and the Henry Goode Memorial Award of the American Federation of Information Processing Societies. He was one of the founders and an early President of the Association of Computing Machinery (ACM) and the Society of Industrial and Applied Mathematics (SIAM). He became a member of the National Academy of Engineering in 1967, was a Fellow of the Institute of Electrical and Electronics Engineers and the American Statistical Association, and was a Life Member of the Franklin Institute.

John Mauchly was an idea man of tremendously good instincts. He was a conceptualizer, a catalyst, a warm human being, and a pioneer who championed ideas before their time. He was certainly the prime mover in securing the contract for the first electronic computer. A brilliant innovator with a tremendous capacity to listen, he was perpetually stimulating and influencing other people.

Dr. Mauchly always saw to it that anyone who worked for him was encouraged to grow and to get more training. He was an ideal person to be in charge of self-motivated people because he could stimulate them to think and to rethink an idea without discouraging their creativity.

Dr. J. Presper Eckert says of him, "He inspired me and he inspired many others. He was not tied down by inhibitions or traditions. He had an interdisciplinary skill to get things done."

Dr. Grace Hopper remembers him as "one of the brightest people

I ever met and one of the nicest. He was a charming person and a pleasure to work with. He not only got the work done, but he cared for the growth of the people he worked with and was the finest boss anyone ever had."

Kay Mauchly, his wife, said, "John was a family man who loved stimulating his children and grandchildren. He felt that an open mind is like a fresh plot of ground to put something into. He was eternally the teacher. He had a great sense of humor and loved puns."

John Mauchly was a warm human being with an incredibly wide range of interests and achievements. We will all remember his leadership and pioneering achievements, for which we will be forever indebted.


Warren L McCabe

Warren Lee McCabe

1899-1982

By Ralph E. Fadum

WARREN LEE McCABE, recognized as one of the founders of the profession of chemical engineering, and a legend in engineering education for his textbooks and innovative ideas, died in retirement at Black Mountain, North Carolina, on August 24, 1982, just seventeen days after his eighty-third birthday. At that time he was R. J. Reynolds Professor Emeritus of Chemical Engineering at North Carolina State University.

The name "McCabe" is significantly entwined in the history of chemical engineering. A colleague once said, "Ask a junior or senior chemical engineering student, or a process design engineer, to identify the name 'McCabe' and they will invariably call to mind one of the co-authors of the McCabe-Thiele graphical methods for design of distillation columns. Ask another member of our profession the same question and he might recall that McCabe was among the first to call attention to the usefulness of an enthalpy—concentration diagram for binary solutions—or the first to enunciate the ΔL law of crystal growth. Ask a contemporary and he will without doubt associate the name with one of the most distinguished chemical engineering educators, researchers, authors, and administrators of the last generation."

Another colleague described Warren McCabe's students and colleagues as "fortunate beneficiaries of his influence through his wisdom, sensitivity, good humor and creativeness."

Born in Bay City, Michigan, on August 7, 1899, Warren Lee

McCabe was drawn to a career in chemical engineering when, just out of high school, he became a chemist's assistant in a wood distillation plant. It was at this time that his interest was aroused in the evolving concept of unit operations—an area with which his name is now synonymous.

This interest led him to the University of Michigan at Ann Arbor where he earned his B.S. degree in chemical engineering in 1922 and his M.S. degree in chemical engineering in 1923. After a period of teaching in the East, he returned to the University of Michigan for his Ph.D. degree in chemical engineering in 1928.

His teaching career included faculty appointments at the Massachusetts Institute of Technology (1923-1925); Worcester Polytechnic Institute (1925); the University of Michigan (1925-1936); Carnegie Institute of Technology (1936-1947), where he served as Head of the Department of Chemical Engineering from 1938 to 1947; Polytechnic Institute of Brooklyn (1953-1964), where he was Administration Dean; and North Carolina State University (1964-1972). He also served as a member of the Chemical Engineering Advisory Council of Princeton University (1949-1955).

His professional and industrial experience included consulting associations with several industries. From 1947 to 1953 he was Director of Research and Vice-President of the Flintkote Company, Whippany, New Jersey.

Among his war activities, he served from 1944 to 1945 as Director of the Central Engineering Laboratory, University of Pennsylvania.

It was during his tenure at Michigan that he and W. L. Badger wrote the textbook *Elements of Chemical Engineering*. This book, published in 1930, has been used by colleges and universities throughout the world. In 1956 he and Professor J. C. Smith of Cornell University wrote a successor text, *Unit Operations of Chemical Engineering*. These landmark publications have strongly influenced the development of chemical engineering.

Throughout his teaching career, Professor McCabe exhibited the highest concern for his students. This was exemplified by the development of the McCabe-Thiele calculation technique for the analysis of distillation columns. This development was motivated by his conviction that much simpler methods of teaching the subject of distilla tion to chemical engineers were needed. His rapport with students for more than half a century was legendary among his colleagues. One of them once explained, "A significant effect of his presence was a calming influence on the turbulent times of the late sixties and early seventies in which most technology was under fire and out of favor with a generation of disillusioned students."

At sixty-five, Professor McCabe retired from the Polytechnic Institute of Brooklyn and moved to Chapel Hill, North Carolina, with his devoted wife, Lillian. After he moved South, he was approached by his long-time friend and colleague, the late E. M. Schoenborn, who headed the Department of Chemical Engineering at North Carolina State University, to join his chemical engineering faculty as a Visiting Professor. Warren McCabe's "retirement" turned into a vigorous twelve-year period of productive teaching, research, and writing. He supervised graduate research in crystallization and elucidated the phenomenon of contact nucleation hailed by those in the field as a piece of work of "great significance in describing the crystallization process." During this time he also worked on the third edition of his book on unit operations that was published in 1976.

He frequently joined the Dean of Engineering at North Carolina State University for discussions of engineering education—where it was headed, how it could be improved. He was regarded as the elder statesman of the School of Engineering during his tenure there.

Professor McCabe was very active in the affairs of the American Institute of Chemical Engineers, and he was elected a Fellow in 1971. He served the institute in many capacities, chairing engineering education committees, conducting special assignments, and leading the institute as Director, Vice-President, and President. He was a member of Tau Beta Pi, Sigma Xi, and Pi Tau Alpha; the American Chemical Society, the American Society of Engineering Education, the Association of Engineering Colleges, and the American Society of Mechanical Engineers.

In 1977 Warren McCabe was elected to the National Academy of Engineering and was cited for his "contribution as an educator, researcher, and industrial manager to the understanding and design of chemical separation processes."

Among his many awards are the William H. Walker Award, Founders Award, Warren K. Lewis Award, and Tyler Award from the American Institute of Chemical Engineers; the U.S. Presidential Certificate of Merit (1948); the University of Michigan Distinguished Alumnus Award (1953); the Sesquicentennial Award (1967); and the Golden Key Award of the American Society for Engineering Education.

Perhaps the following words of one of his warmest admirers, Dr. Ronald Rousseau of North Carolina State University, best sum up the life of Dr. Warren Lee McCabe:

> Dates, places, titles do not adequately describe the contributions Warren has made as one of the important and distinguished educators during the middle part of the 20th Century.... As an engineer and administrator in industry and academics, Warren has interacted with his times, and as a result, he has been a part of historical events in which many of us would like to have participated .... It is impossible to measure all that Warren's career has meant to the field of chemical engineering education and to chemical engineering and to society in general.


J. S. McDonnell

James Smith McDonnell

1899-1980

By Arthur E. Raymond

JAMES SMITH McDONNELL was an aeronautical engineer and businessman whose foresight and dynamic leadership created one of the world's great aerospace manufacturing organizations.

He was born in Denver, Colorado, on April 9, 1899, and died on August 22, 1980, in St. Louis, Missouri. Educated in the schools of Little Rock, Arkansas, he entered Princeton in 1917 and graduated in 1921 with a Bachelor of Science degree and honors in physics.

Deciding upon a career in aviation, he joined the Army Air Corps for flight training at San Antonio, Texas, and was given his wings as a Reserve Second Lieutenant in January 1924. Meanwhile, he had enrolled in the Massachusetts Institute of Technology, the only university offering graduate courses in aeronautics at that time, from which he received a master's degree in aeronautics in 1925, one of a class of four.

For the next four years he worked in various aircraft companies in a number of positions, including that of Assistant Chief Engineer with the Stout Metal Airplane Company of Dearborn, Michigan, designer of the Ford Trimotor.

Starting out on his own in Milwaukee, Wisconsin, Mr. McDonnell and his associates built a two-place low-wing airplane to compete in the $100,000 Guggenheim Safe Airplane competition in 1929. Though this airplane, which he called the "Doodlebug," was unsuccessful in that effort, he spent a year making demonstration flights around the United States in the hope of finding a market for it as a popular, inexpensive flying "flivver." The Depression was against him, and after abandoning this effort he became an engineer and test pilot with Great Lakes Aircraft in Cleveland, Ohio, moving on to the Glenn L. Martin Company of Baltimore, Maryland, as a Project Engineer. In five years with Martin he had become Chief Project Engineer for land planes, but he decided the time had come for him to form his own firm.

Starting with $165,000 from savings, family, friends, and businessmen, the McDonnell Aircraft Corporation of St. Louis, Missouri, was incorporated in 1939. At first it was a struggle and, while the company was developing its own products, it depended largely on subcontracts from other aircraft companies to survive. But by 1943 McDonnell had begun to establish itself as a major long-time source of fighters for the military services, from the FH-1 Phantom to the F-18 Hornet.

In the 1950s the company expanded its work in missiles to cover spacecraft and in 1959 obtained a contract for *Mercury,* this country's first orbital vehicle, following with one for *Gemini.*

In 1967 the McDonnell Douglas Corporation was formed through merger with Douglas Aircraft Company of Santa Monica, California, noted for its famous DC series of commercial airliners as well as numerous Army and Navy combat aircraft and missiles such as Thor and Nike. This merger fulfilled a long-held desire of Mr. McDonnell, who held a high regard for Donald Douglas, because subcontracts from Douglas had played a major part in enabling his company to survive its early years and because each company supplied strength the other needed.

In his business life Mr. McDonnell was noted for his attention to and knowledge of detail, his careful handling of funds, his willingness to speak his mind forcefully and effectively, and his high sense of ethics. He looked upon company products as a result of team effort, insisting that his employees be called teammates and that they think of him as Mr. Mac—or, in his later years, as Old Mac. Unconventionality never bothered him.

Anyone who worked closely with him soon learned he would accept no vague thinking or incomplete preparation. A slight, bespectacled man with piercing eyes, he had the ability to concentrate totally on the subject at hand and would brook no distractions.

Nobody could listen long (and sometimes it had to be long) to Mr. Mac without sensing his enthusiasm and being stimulated to participate in it. He operated in a large area but was also intensely personal. His family meant much to him and he enjoyed family life.

Combined with his strong interest in and contribution to national defense was a conviction that peace is two-sided: armed strength and an effective international peace-keeping organization. He said, "There is nothing contradictory about supporting preparedness as the surest safeguard against war and at the same time supporting the United Nations. On the contrary, these are complementary concepts. They mark the surest road to peace."

Mr. McDonnell devoted much of his life to fostering the United Nations and the North Atlantic Treaty Organization. From 1965 until his death he actively served the United Nations Association of the United States as a member of its Board and was National Chairman from 1975 to 1977. He was a pioneer in granting all his employees a paid vacation on United Nations Day.

His interest in the probing of space was also strong, arising from curiosity about the nature and meaning of the universe and life. He was intensely interested in the human mind, brain, and genetic makeup and in how to realize the human potential. He was at heart profoundly religious in this quest, seeking a better personal contribution toward making the world more peaceful and a better setting for mankind.

Through the McDonnell Foundation and the McDonnell Aerospace Foundation, family and company philanthropic funds, Mr. McDonnell oversaw the distribution of millions of dollars for charity and support of medical and scientific research. His philanthropy was in the McDonnell style of holding to large visions, and the major part of it was directed to the Washington University in St. Louis in such projects as the McDonnell Center for the Space Sciences as part of the Department of Earth and Planetary Sciences, the McDonnell Medical Sciences Building, and the McDonnell Department of Genetics. His most recent contribution was $5.5 million in May 1980 to establish the McDonnell Center for Studies of Higher Brain Function. A grant also helped make possible the construction of the McDonnell Planetarium in St. Louis's Forest Park.

Mr. McDonnell was elected to the National Academy of Engi neering in 1967. He served on many community, state, and national committees. He was a member of the Advisory Board of the Center for Strategic and International Studies; the Industry Advisory Council of the Department of Defense; President Nixon's Aviation Advisory Committee; the National Alliance of Businessmen; President Johnson's Citizens' Committee; and the Atlantic Council of the United States, to name a few. He actively served on the Board of Trustees of the U.S. Naval Academy Foundation, Washington University, and Washington University Medical School and Associated Hospitals, among others.

He was the recipient of six honorary degrees and many honors and awards, including the 1963 Daniel Guggenheim Medal, the 1966 Collier Trophy, the 1972 Forrestal Memorial Award, and the 1980 National Academy of Sciences Hunsaker Award. He was an Honorary Fellow of the American Institute of Aeronautics and Astronautics and the Royal Aeronautical Society and an Enshrinee in the Aviation Hall of Fame.

The McDonnell Douglas Corporation today is a diversified company with 1979 sales of more than $5 billion, about equally divided between commercial and government business, facilities in numerous locations within the United States and Canada, and 83,000 personnel.

In accepting the Forrestal Award Mr. McDonnell said:

> As I cast my mind back over fifty years, what impresses me the most? It is very clearcut. It is the rapid pace of creative evolution that has been going on, the rapid pace at which the human mind is delving deeper and deeper into the mysteries of this fantastic fairyland universe in which we find ourselves consciously existing. Not only is the human mind using the methods of basic science, technology, and engineering. Man is reworking the evanescent stuff of nature into new patterns and combinations that can be developed into things useful to mankind, and the rate at which it is occurring is pyramiding.


Jack E. McKee

Jack Edward McKee

1914-1979

By Edward J. Cleary

JACK EDWARD McKEE, Professor of Environmental Health Engineering at the California Institute of Technology, died October 22, 1979, at his home in Newport Beach, California. In addition to his academic pursuits, he was a Partner in Camp, Dresser and McKee, Inc., a Boston-based firm of sanitary engineering consultants.

Dr. McKee was distinguished as an inspired teacher, a creative conductor of research, and an innovative practitioner in devising engineering solutions for environmental problems. His influence, which was international in scope, was enhanced by a generous disposition to share his time and talents for the advancement of professional objectives. Toward the end he was indefatigable in generating support of colleagues and promoting recognition of their contributions.

If time and place of birth have a conditioning influence on the choice of career, it becomes apparent why Jack McKee became a specialist in matters associated with pollution of air and water resources. He was born in Pittsburgh, Pennsylvania, on November 9, 1914. At that period and throughout his youth, his environment was what then was known as the Smokey City, surrounded on two sides by rivers fouled by indiscriminate discharge of industrial wastes and sewage from a million inhabitants of the region.

Undoubtedly his sensitivity for control of environmental degradation was reinforced during his undergraduate training at the Carnegie Institute of Technology, where he received a bachelor's degree in civil engineering in 1936. For a year thereafter he found a more agreeable environment as a flood forecaster with the Tennessee Valley Authority. Scholastic aspirations then led him to Harvard University. There he attained his master's degree and doctorate under the tutelage of the late Gordon M. Fair, Professor of Sanitary Engineering and a member of the National Academy of Engineering.

After completion of graduate studies in 1941, he married Ruth Yeaton, by whom he had two sons and a daughter. Following a short period of service with the U.S. Public Health Service, Dr. McKee transferred to the U.S. Army Corps of Engineers and attained the rank of Major prior to demobilization in 1946. As a Sanitary Engineer Officer he participated in the Normandy campaign and was later assigned to the civil affairs and military government in the European theater.

Returning from war service, he joined Thomas Camp, former Professor of Sanitary Engineering at Massachusetts Institute of Technology, and Herman Dresser in establishing a consulting firm. All of the founding partners of Camp, Dresser and McKee are now dead, but the organization they nurtured has grown to include some 1,400 employees engaged in the design of sanitary engineering projects throughout the world.

Within a few years an even greater personal challenge began to assert itself to Dr. McKee. He was possessed with the notion that teaching and research in sanitary engineering should be broadened to embrace a more holistic approach to newly emerging environmental problems. Thus, in 1949 he eagerly accepted an appointment to the faculty of the California Institute of Technology. According to Fred Lindvall, then Chairman of the Department of Civil Engineering, "Dr. McKee was not invited to fill a staff vacancy but given carte blanche to create a new program."

Displaying missionary zeal, Dr. McKee's efforts gradually added a new dimension to the otherwise well-established excellence of the university. Its physical manifestation is the W. M. Keck Laboratory of Environmental Health Engineering. Its contribution to society has been the training of some 200 engineers, more than half of whom attained master's and doctoral degrees and who today may be counted among the leaders in the environmental affairs of government, industry, and universities.

Additionally, Dr. McKee's research endeavors continued to offer new insights into scientific and engineering aspects of environmental quality management. These included the application of molecular filter techniques for the bacterial assay of sewage, the reclamation of wastewater by pressurized recharge of aquifers, an assessment of the impact of nuclear power production on the quality of natural waters, and the stabilization of wastes in space environments. This is but a sampling of the provocative questions that were probed by Dr. McKee and his colleagues and which have richly contributed to advancement of environmental health management.

One of his crowning achievements was the assembly, condensation, and evaluation of all the available technical and legal literature pertaining to water quality and its effects upon the beneficial uses of water. Titled *Water Quality Criteria,* this compendium was completed in 1952 for the California Water Pollution Control Board. It is regarded as a definitive text for all those who seek to exercise judgment in the administration of rational decisions for the management of pollution control.

Widely honored for his professional accomplishments, Jack Edward McKee was elected to the National Academy of Engineering (NAE) in 1969. In 1970 he was appointed Chairman of the National Research Council Committee on Air Quality Management as well as a member of the NAE Committee on Engineering Aspects of Environmental Quality. His many public service activities included chairmanship of the Sanitary Engineering and Occupational Health Council of the National Institutes of Health, membership on the Reactor Safeguards Committee of the Atomic Energy Commission and, more recently, on the California Council for Environmental and Economic Balance. He was a member of twelve scientific and professional organizations.

Dr. McKee's honors included the Clemens Herschel Award in hydraulics from Harvard University and the Desmond Fitzgerald Medal of the Boston Society of Civil Engineers. He also received the Rudolf Hering Medal in sanitary engineering, the Karl Emil Hilgard Prize, as well as the Edmund Friedman Award, all bestowed by the American Society of Civil Engineers.

In 1960 Dr. McKee was President of the Los Angeles section of the American Society of Civil Engineers, and in 1963-1965 he served as a National Director of the society. In 1962-1963 he was President of the Water Pollution Control Federation.

This commentary on the professional achievements of Jack McKee cannot overshadow another distinction that he highly prized. He was the organizer, leader, and banjo virtuoso of the Caltech Dixieland Jazz Band. This aggregation of about ten musicians (said to be the most harmonious interdisciplinary group on the faculty) favored their listeners with joie de vivre, particularly at the annual garden party for engineers that he hosted at his home. But probably their best-remembered performance will be that at the memorial services for Dr. McKee. Shortly before his death he prepared a written request that the band be included at the services and that they play, among other songs, "Please Don't Talk About Me When I'm Gone." This offers another glimpse of the personality of Jack McKee, whose wit made him beloved by all his peers and students.

Dr. McKee is survived by his second wife, Dorothy, and three children, Douglas Edward, Richard C., and Katherine Alice.

Alexander Crawford Monteith

1902-1979

By Edwin L. Harder

ALEXANDER C. MONTEITH, retired Senior Vice-President of the Westinghouse Electric Corporation, and for more than forty years an outstanding leader in the development of electric power systems, died at his home in Orleans, Massachusetts, on September 17, 1979. "Monty" had been retired since 1967, following a brilliant career of outstanding achievements in engineering, technical education, and corporate management.

Everyone who knew him will agree that Alexander C. Monteith was a superb and gifted leader of men. The engineering profession particularly can be proud of his achievements and thankful for his example. His father, of Scotch-English heritage, was a lumber "boss" in the woods of Canada, and Monty Monteith came naturally by the sterling qualities of personal leadership. He accepted the responsibility. He had both the self-confidence and the unusual technical talents to provide much-needed leadership in the early development of electric power systems. He inspired confidence in others by his strong personality, his infectious enthusiasm, and his wise and steady course.

Mr. Monteith's judgment and advice were eagerly sought after and followed in an ever-increasing sector of the industry and of society with which he came in contact. He progressed from Central Station Engineer to Senior Vice-President of Westinghouse, to President of his primary professional society, now the Institute of Electrical and Electronics Engineers (IEEE), and to President of the National Electrical Manufacturers Association.

Gifted with an excellent memory, Monty Monteith never had to make decisions twice. The people that worked for him, or with him, could be sure that his direction and policies would be the same at the next encounter. This made him an ideal superior and a trusted coworker. The engineers working under him were well aware of his keen interest in their progress. One of the younger engineers, upon receiving a professional award, wrote regarding his own success, "It requires superiors who have the understanding to support efforts into untried fields, and who can find ways to provide encouragement along the way. It requires leaders who encourage the professional advancement of their engineers, help with their education, and lead the way in their professional activities." He was referring specifically to A. C. Monteith.

Born in Brucefield, Ontario, Canada, on April 10, 1902, Mr. Monteith received his formal education in electrical engineering at Queens University, Kingston, Ontario, where his natural engineering talents won him the Governor General's Medal for highest grades. He was also elected to both engineering and electrical honor societies, Tau Beta Pi and Eta Kappa Nu.

Queens University was later to bestow on him a Doctor of Laws degree, one of many recognitions of his outstanding contributions to engineering and to society. In the course of his career he received the Westinghouse Order of Merit; the Washington Award, given by six engineering societies combined, for major engineering accomplishments contributing to the well-being of society; the Edison Medal, top career award in electrical engineering; the American Society for Testing and Materials Award to Executives; he was an Honorary Member of the American Society of Mechanical Engineers (ASME) and a Fellow of the IEEE; and he received honorary degrees from Drexel Institute of Technology, Lafayette College, and Carnegie Mellon University. He was elected to the National Academy of Engineering in 1965, the year after its founding.

After joining the Westinghouse Central Station Engineering group in 1924, Mr. Monteith became an expert in power station auxiliaries and in power transmission and distribution, an activity that culminated in the preparation of the *Transmission and Distribution Reference Book* in 1942 by fourteen authors under his direction and co-authorship. Periodically revised since that time, the book is still, in 1980, the most authoritative reference book covering the entire electrical system. It is widely used by college students and practicing engineers throughout the world.

The "direct stroke theory" of lightning protection of transmission lines, originally set forth by C. L. Fortescue, a famous Westinghouse engineer, was brought to practical use by Mr. Monteith. His paper, "Lightning Protection of Transmission Lines," later became the "Transmission Line Design" chapter of the *Transmission and Distribution Reference Book* and evolved into the accepted industry method for designing transmission lines to withstand lightning.

Under Mr. Monteith's direction, Westinghouse was the principal manufacturing participant in the "Tidd" field experimental study, with American Gas and Electric and others, that provided the fundamental basis for 345-kilovolt transmission. Following this, the Apple Grove Project, with the same major participants, including Mr. Monteith's active participation, provided the fundamental basis for 500-kilovolt and 765-kilovolt transmission.

After World War II, when thoughts were turning to use of the atom for power production, A. C. Monteith was a key adviser in the Westinghouse entry into this field, first with the nuclear-powered submarine development and later with the development of atomic power stations for electric utilities. From these beginnings came the power plant for the *Nautilus,* the world's first atomic-powered submarine; Shipping-port, the first U.S. electric utility atomic power plant; Yankee, the first economically viable power station using the pressurized-water reactor; and all their progeny.

As Vice-President of Engineering and Research in 1948, Mr. Monteith was instrumental in forming the initial Westinghouse organization for nuclear development. Later, as Vice-President of the Electric Utility and Marine Divisions, he actively directed the Westinghouse development and manufacture of nuclear power systems for electric utilities.

Always strongly interested in the education of young engineers, Mr. Monteith became Director of Education for Westinghouse in 1945, in addition to managing the Headquarters Engineering Department of the company. His contributions were immediate and effective. The Education Center for graduate students was planned and built under his direction. He also headed the Westinghouse Educational Foundation, which sponsors a broad range of scholarships, fellowships, professorships, and many other education programs, including the Westinghouse Science Talent Search. Arrangements for graduate study were made for all employees at nearby universities.

Later he spearheaded the industrywide report, *The First Five Years of Professional Development,* a program for the professional development of all young engineers, which has been widely used. His later articles on the human relations of management, industry, and engineers again stressed the need for maximum development of potential in young professional people, an endeavor that marked his whole career with outstanding success.

Mr. Monteith's remarkable leadership qualities were recognized both inside and outside the Westinghouse Company. He became, in turn, Manager of Central Station Engineering; Manager of Industry Engineering, the application engineering for all industries; and then Manager of Headquarters Engineering. This included all of the centralized engineering operations of the company, dealing with the full range of products and services, both domestically and with foreign licensees. This was the start of an extensive acquaintance with prominent engineers and executives in electrical utilities and electrical manufacturing throughout the world, a rapport that grew with his later business and professional society activities. He was held in the highest esteem in these associations.

In 1948 he was elected Vice-President of Engineering and Research of Westinghouse and made very substantial contributions in these areas of vital importance. Research was strengthened and the present Westinghouse Research and Development Center was planned and the central core of it built during this period.

In 1955 he was made Vice-President and General Manager of the Apparatus Division, including the heavy apparatuses for electrical utilities and industries as well as aviation gas turbines. In this capacity he directed a large part of the Westinghouse operations. With a reorganization of the company he became Manager of the Electric

Utility and Marine Group from 1962 until 1963, then Senior Vice-President until his retirement in 1967.

Mr. Monteith was usually found in the leading role in the many professional society activities in which he was engaged. In the IEEE he was Chairman of the Pittsburgh Section and of several of the national committees, and in 1954-1955 he was President of the institute. In the mechanical society, ASME, his contributions were recognized by the highest award, Honorary Member. He headed standards committees and was a leader in the Engineers' Council for Professional Development. He was an active member of the Engineers' Joint Council and of CIGRE, the international professional organization dealing with large electrical systems.

Throughout his busy career, Monty Monteith was ably supported by his charming and gracious wife, Evelyn. His two sons and his daughter, of whom he was justifiably proud, inherited his spirit of self-reliance and goodwill. One of his sons confided, "He was really something." After Evelyn's death, Mr. Monteith was happily married to Paula, who shared his busy retirement activities.

Monty Monteith shares, in large measure, credit for the splendid electrical systems of today, the wonderful heritage of professional cooperation, and the excellent development opportunities for young engineers. His career was one of the finest examples of service to one's profession and to society. But despite all of the justly deserved honors that came his way, he was never adversely affected by them. To spend any time with him was an exhilarating experience. He never lost his ability to enjoy life to the fullest, and he was infectious in this characteristic. As Shakespeare wrote in *Hamlet,* "He was a man, take him for all in all, I shall not look upon his like again."

Nathan Mortimore Newmark

1910-1981

By William J. Hall

NATHAN M. NEWMARK, internationally known educator and engineer, died January 25, 1981, in Urbana, Illinois. Dr. Newmark was widely known for his research in structural engineering and structural dynamics at the University of Illinois at Urbana-Champaign and for his contributions to the design of earthquake-resistant structures, including the Latino Americana Tower in Mexico City, and most recently for his work on the design of the trans-Alaska pipeline.

Nathan M. Newmark was born in Plainfield, New Jersey, on September 22, 1910, to Abraham S. and Mollie (Nathanson) Newmark. After receiving his early education in North Carolina and New Jersey, he attended Rutgers University. There he accumulated a number of prizes as an undergraduate and graduated with High Honors and Special Honors in Civil Engineering in 1930, thereby giving evidence of his unusual skills and talents at a young age. He then enrolled as a graduate student at the University of Illinois in Urbana where he worked under the late Professors Hardy Cross, Harold M. Westergaard, and Frank E. Richart, and received his M.S. and Ph.D. degrees in 1932 and 1934, respectively.

Beginning in 1930 as a graduate research assistant, Nate Newmark held a succession of positions for over half a century at the University of Illinois. He was appointed Research Professor of Civil Engineering in 1943, skipping the intermediate rank of Associate Professor. Early in his career he contributed significantly to the fields of structural analysis and structural materials and received national and international recognition for his work pertaining to highway bridges. His contributions in the area of structural dynamics, including consideration of impact, wave action, wind, blast, and earthquakes, influenced greatly structural and mechanical design throughout the world. In 1956 he was appointed Head of the Department of Civil Engineering, a position he held until 1973; he retired from his university position in 1976. Although the reputation of the department had been great almost since its founding, under Professor Newmark's leadership its stature rose to new heights.

From 1947 to 1957 he was Chairman of the Digital Computer Laboratory at the university; during this period he had a major hand in development of one of the first modern large-scale digital computers (ILLIAC II). This activity led to the university's eminent status in developing computer science in engineering. He served in many important leadership capacities in the university; he has the distinction of having held the longest appointment to date on the University Research Board, the organization that was in large part responsible for placing the university among the great research institutions of the world. Nate Newmark's vision and foresight played no small role in the success of this effort.

During World War II Dr. Newmark was a consultant to the National Defense Research Committee and to the Office of Scientific Research and Development. Part of his national service time was spent in the Pacific war zone. He was awarded the President's Certificate of Merit in 1948. In addition to serving on numerous Department of Defense boards and panels, he made major contributions to the development of the Minute Man missile system as well as the MX missile system currently under development.

Dr. Newmark played a major role in many of the most important technical activities of the American Society of Civil Engineers. He was one of the founding members of the Engineering Mechanics Division and was also a prime mover in the development of the computer application activities of the society. He has been granted almost every major award that can be bestowed by the American Society of Civil Engineers and the founder society groups. He was an honorary member of most of the many societies to which he belonged.

As a practicing engineer he was instrumental in developing the design criteria for many of the largest and most complex projects of the world. These include the earthquake design of the forty-three-story Latino Americana Tower in Mexico City, for which he was the earthquake consultant in the late 1940s and early 1950s. In 1957 the building was subjected to a strong earthquake and withstood it without damage. A plaque is mounted on that building attesting to his design accomplishment. He also was responsible for developing the seismic design criteria for many other large projects such as the Bay Area Rapid Transit System and the Trans-Alaska Oil Pipeline System, which is now the largest privately financed project in the history of the world. He held similar responsibility for the Alaska-Canada gas pipeline at the time of his death. He carried major responsibility over the seventeen years before his death for development of the earthquake design and review criteria for about seventy nuclear power plants as well as for proposed liquid natural gas facilities on the West Coast.

Dr. Newmark was elected a Fellow of the American Academy of Arts and Sciences in 1962, Founding Member of the National Academy of Engineering (NAE) in 1964, and member of the National Academy of Sciences (NAS) in 1966. Among his many NAE/NAS/ NRC (National Research Council) activities were the following: NAE Council, 1964-1968; NAS/NAE Engineering Joint Board, 1966-1968; NAE Committee on Earthquake Engineering Research, 1965-1970; NAS/NAE Committee on Scientific and Technical Communication, 1966-1969; and NAE/NRC Committee on Natural Disasters, 1971-1977 (Member and Chairman).

In 1968 Dr. Newmark received the National Medal of Science from President Lyndon B. Johnson, and in 1969 he received the Washington Award—a joint award given annually by the major engineering societies of the United States. In 1979 Dr. Newmark was presented the John Fritz Medal, an all-engineering society award, and in 1980 he was awarded the sixteenth Gold Medal in the fifty-seven-year history of the Institution of Structural Engineers of Great Britain, the second American engineer to be so honored. Dr. Newmark received honorary degrees from his alma mater, Rutgers University, in 1955, from the University of Liege in 1957, from the

University of Notre Dame in 1969, and from the University of Illinois in 1978.

Dr. Newmark's publications include more than 200 papers, books, and chapters in books. He is the coauthor of the following books on earthquake engineering: *Design of Multi-Story Reinforced Concrete Buildings for Earthquake Motion,* with John A. Blume and Leo Corning (published by the Portland Cement Association, Chicago, 1961), and *Fundamentals of Earthquake Engineering,* with Emilio Rosenblueth (published by Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1971).

Nate Newmark carried his own university with him wherever he went, even into professional practice. Engineers, young and old, who came into contact with this man sensed the intellectual and educational challenge. His penetrating insight, his keen engineering judgment, and his genuine interest in people have been a constant source of inspiration to all who have had the privilege of working with him.

Dr. Newmark possessed an unusual ability to attract young people to the field of civil engineering, to inspire them with the confidence for undertaking new and varied tasks, and to guide but not direct their thinking. He insisted that as individuals they receive appropriate recognition for their accomplishments. His unceasing devotion to research, his noteworthy and continuing contributions to the betterment of structural design practice, and his leadership in engineering education, teaching, and professional activities have had a profound influence on civil engineering. It is no accident that there grew up around him one of the most active research centers in civil engineering in the country or that the alumni of this group have assumed broad leadership in education, industry, and government throughout the world.

On February 19, 1981, the Board of Trustees of the University of Illinois renamed the Civil Engineering Building as the Nathan M. Newmark Civil Engineering Laboratory in commemoration of Dr. Newmark's contributions to the university.

He is survived by his wife, Anne, and three children, Richard, Linda (Mrs. James Bylander), and Susan (Mrs. Paul Mayfield).

Daniel Earl Noble

1901-1980

By C. Lester Hogan

DANIEL E. NOBLE, retired Vice-Chairman of the Board of Directors and active Chairman of the Science Advisory Board of Motorola, Inc., died in Scottsdale, Arizona, on February 16, 1980. He is best known for his pioneering efforts in FM mobile communications, contributing directly to Motorola's strong technical and marketing capabilities in this field. But, by those who knew him best, he is at once scientist, engineer, scholar, philosopher, artist, writer, and friend. His uncanny vision of the future was clearly evidenced by the fact that he personally founded Motorola's Communications, Government Electronics, and Semiconductor divisions. In so doing he often stood alone in Motorola's Board Room but always prevailed as a result of the depth of his conviction and the persuasiveness of his argument. The industry will certainly miss this man. He has been both an accurate prophet and a practical and effective builder for the past fifty years of our art.

Dan Noble was born in Naugatuck, Connecticut, on October 4, 1901, and received a bachelor's degree in engineering from the University of Connecticut in 1929. He remained at the University of Connecticut after receiving this degree and rose in rank to Assistant Professor of Mathematics, Electrical and Radio Engineering. It was during this period that he did much of his pioneering in FM broadcasting, but more than this, he demonstrated to the entire world that he was a generalist rather than a specialist during these early years.

The station became such a success that in 1936, stations WTIC and WDRC asked him to build a relay station so they could receive certain of the programs originating at the university for rebroadcast from their stations in Hartford. He had read Major Armstrong's pioneering paper on FM and, while many others in this era believed that it had no practical advantages, Dan Noble knew otherwise, and used this opportunity to design and build a 100-megahertz FM relay station linking the University of Connecticut with these two stations in Hartford. This system worked so well that the owner of WDRC asked him to design and supervise the construction of an FM broadcast station for them in Hartford. This was one of the first commercial FM broadcast stations in the world.

By this time Professor Noble's reputation as a brilliant scientist and capable, practical engineer was well known, at least in the state of Connecticut. As a result, State Police Commissioner Edward J. Hickey came to him in 1938 and asked him to design a statewide police broadcast system so that all police cars in Connecticut could be contacted wherever they were. The proposal, as made by the Police Commissioner, was for one-way transmission only from fixed broadcast stations to the cars. At this point Dan Noble made a very daring and visionary proposal to Commissioner Hickey. He was to design and supervise the construction of mobile units for the police cars that would use frequency modulation in the 30- to 40-megahertz band. This was a first. No such statewide system existed any place in the world. He not only had to break new ground in design but also in manufacture in order to ensure the reliable operation of this ambitious system.

As with every other system that he had built, this one worked extremely well, and he established a worldwide reputation as both a brilliant designer and a superb engineer.

It was at this point that Paul Galvin, who had founded Motorola just ten years before, got to know Dan Noble and began to try to pry him loose from the university to come to work for him. At first he did not want to leave the university. However, in 1940, Galvin convinced him to use his sabbatical leave to try industry life at Motorola.

Paul Galvin had a strong personality, but he had the wisdom to give Dan Noble the freedom he needed to guide Motorola's begin nings in mobile communications. World War II had just begun, and Dan Noble was the only person in the United States who had the expertise to develop and build the famous SCR-300 FM Walkie-Talkie for the Armed Forces. By 1942 Paul Galvin had Dan Noble in his camp, and a great love and respect developed and existed between them until Galvin passed away in 1959. Those were years when Dan Noble established Motorola as the dominant force in mobile communications.

At the end of the war, Dan Noble recognized that the company should be a part of the research and development needed by the U.S. defense establishment to maintain its lead in electronics systems. Galvin had faith in Dan Noble and convinced the Board of Directors that this was a wise decision.

In 1952 Professor Noble established a department within the Military Electronics Division that was charged with the responsibility of developing and building transistors. With this development a reality, he then split out this department and founded the Semiconductor Products Division in 1954. Under his leadership the company became Arizona's largest industrial employer. And it was his pioneering research work that helped make Motorola an international household name in the industry.

He held nine patents on electronics and communication circuitry. His many awards included the 1966 Greater Arizonan Award; the 1974 Arizona Association of Industries Leadership Award; the 1978 Edison Medal from the Institute of Electrical and Electronics Engineers, of which he was a Fellow; and the Franklin Institute's 1972 Stuart Ballantine Medal. He was elected to the National Academy of Engineering in 1968.

Dan Noble was an artist as well as an engineer, and he took personal charge of the architectural design of all of Motorola's buildings in Phoenix. To this day they are a credit to his artistic eye. He once commented that he would like to write a blistering essay on abstract art; he found it to be fraudulent. Until 1965 all of his paintings were of the classical type. But when he became involved in abstract art at age sixty-four, he talked eloquently about the fact that to do something entirely new in abstract art required patience, hard work, great originality, and maybe even some talent. At age sixty-four he still had the vigor and the ability to change his mind when he learned the facts.

He was always full of vitality, always experimenting, always learning something new, and when he learned that his original conception had to be modified, changed, or even totally cast out, he was the first to admit it. It was this vitality, this honesty, that made him loved by all who knew him well.

He is survived by his wife, Mary; daughter, Anne Lynch; sons, Tryson Noble, Talboy Noble, and Richard E. Lynch; and three grandchildren.

John Knudsen Northrop

1895-1981

By William R. Sears

JOHN KNUDSEN NORTHROP, pioneer designer and manufacturer of aircraft, died at the age of eighty-five on February 18, 1981. He was an engineer in the finest tradition of the profession: innovator, inventor, leader and organizer of engineering teams, industrialist, and master of the art and science of design. He was one of the great pioneers of aviation and founder of the major aerospace company that bears his name.

Born in Newark, New Jersey, on November 10, 1895, Mr. Northrop attended high school in Santa Barbara, California. He never attended college, but received an honorary doctorate and founded a technical university. He began his engineering career in 1916 as a mechanical draftsman-engineer in the Loughead Aircraft Company. He learned structural design on the job, was called to Army service during World War I, and was sent back to Loughead by the Army for work on a flying-boat contract. In 1923 he joined Donald Douglas in the engineering design of the Douglas Aircraft Company's famous round-the-world biplanes. The engineering team that produced those airplanes was said to be a formidable one, with Jack Northrop responsible for structural details.

Later he rejoined Allen Lockheed (Loughead) in the new Lockheed Aircraft Company. Here he designed the remarkable *Vega* series of airplanes, characterized by monocoque fuselage and unusual aerodynamic refinement. A long series of record-breaking flights was made by many famous aviators in the Lockheed *Vega* and its derivatives. He was "the designer" in days when that terminology was realistic.

In 1928 he founded the first of his own aircraft companies. Originally called the Avion Corporation, it became the Northrop Aircraft Corporation, a division of United Aircraft and Transport Corporation, in 1930. Here the Northrop *Alpha* and *Beta* were designed and built; they possessed the same kind of aerodynamic refinement as the *Vega,* but Jack Northrop was now working with stressed-skin metal structures instead of plywood. He originated many elements of the multicellular, stiffened-skin, metal wings that have become standard throughout the aeronautical world. The original *Alpha* now hangs in the National Air and Space Museum. The Northrop *Gamma* and *Delta,* which carried on these trends, were products of Mr. Northrop's second company, founded in partnership with Douglas Aircraft in 1932. This was the company that later became the El Segundo Division of Douglas. Under Mr. Northrop's direction until 1939, this division produced a long series of efficient and successful military aircraft.

In 1939 the present Northrop Corporation was founded. Its products were principally military aircraft, including the P-61 *Black Widow,* F-89 *Scorpion,* the giant XB-35 and YB-49 *Flying Wings,* and a number of other sophisticated and imaginative research aircraft. Donald Douglas, Sr., has said, "Every major airplane in the skies today has some Jack Northrop in it." Mr. Northrop retired from active direction of the company in 1952 and was Honorary Board Member until his death.

John K. Northrop, the inventor, was awarded more than thirty patents during his career. His ingenuity was not limited to aircraft and aeronautics. In 1944 he became interested in the design of prosthetic devices for amputees, shocked by what he saw as the primitive and awkward products then available. He and his company were awarded a series of U.S. patents in this area. He invented a popular, lightweight anchor widely adopted by yachtsmen and is also given credit for the "hill-holder" device for automobiles and for techniques of welded-magnesium-alloy construction based on the helium-shielded arc.

Mr. Northrop was an Honorary Fellow of the American Institute of Aeronautics and Astronautics, Fellow of the Royal Aeronautical Society of Great Britain, and was President of the Institute of Aeronautical Sciences in 1948. He was awarded the President's Certificate of Merit of the U.S.A., the *Spirit of St. Louis* Medal of the American Society of Mechanical Engineers, and the honorary degree Doctor of Science by Occidental College. He was elected to the International Aerospace Hall of Fame and the Aviation Hall of Fame. He was one of only three people to receive the Wings of Man Award of the Society of Experimental Test Pilots. He was Founder and Chairman of the Board of Trustees of Northrop Institute of Technology, accredited as Northrop University since 1976. He was elected to the National Academy of Engineering in 1979.

Mr. Northrop, as a Chief Engineer and company President, was clearly a co-worker with his fellow employees: cheerful, cooperative, respectful of their skills and their sensibilities, and always ready to shoulder his share of work. He was a gentleman of the highest personal and intellectual standards, courteous and quiet voiced. To all who worked with him, including several generations of military leaders, he stood as a symbol of character, modesty, ingenuity, and originality—an engineer's engineer.

William Prager

1903-1980

By Daniel C. Drucker

WILLIAM PRAGER, University Professor Emeritus of Engineering and Applied Mechanics, Brown University, died on March 16, 1980, in Zurich. He had retired to Savognin, Switzerland, in 1973 with his wife Ann but maintained an extensive research activity in his many complex fields of interest and continued to lecture on the progress he made in his remarkably simple and clearly organized manner. At the same time he served as Editor of *Computer Methods in Applied Mechanics and Engineering.*

Born on May 23, 1903, in Karlsruhe, Germany, Dr. Prager received his Dipl. Ing. degree from the Institute of Technology in Darmstadt in 1925 and his Dr. Ing. the next year. At the age of twenty-six he was appointed Acting Director of the Institute of Applied Mechanics in Göttingen and three years later was made Professor of Technical Mechanics in Karlsruhe. Before leaving Germany in protest in 1934, he had established an international reputation as an engineer and applied mathematician in the statics and dynamics of structures and in the theories of elasticity and plasticity. His subsequent research at the University of Istanbul enhanced his reputation still further, so that on his arrival at Brown University in 1941 he was a key member of the world-famous group that was brought together at that time to place applied mechanics in the United States at a firm high level of applied mathematics. The first issue of the *Quarterly of Applied Mathematics,* which he edited continuously from the time he founded it until 1965, appeared in April 1943.

Dr. Prager established the Division of Applied Mathematics at Brown in 1946, served as its first Chairman, and guided its research and teaching by gathering around him younger people in a wide variety of fields of applied mechanics, applied mathematics, physics, and engineering. His own research during this period covered an enormous diversity of topics in the mechanics of continue of all types, problems of traffic flow, and application of computers to problems in economics and engineering. A small sampling of this pioneering work in applied mechanics includes his illuminating representations in function space developed with Professor Synge, variational principles for stability, stress-strain relations in the plastic range including the effects of temperature, the theorems of limit analysis and design, minimum weight structures, geometric representation of the slip-line field in the stress plane and hodograph plane, solutions with stress discontinuities, dynamic plasticity, and his inventive models of material behavior as kinematic hardening and ideal locking.

Brown University recognized his scientific and administrative abilities by designating him as the first Chairman of the Physical Sciences Council and then as L. Herbert Ballou University Professor. Industrial concerns as well as universities and professional societies valued his advice and counsel. National Academy of Engineering and National Research Council committees and panels were the beneficiaries of his thoughtful input.

Professor Prager's awards and honors predate and postdate his election to the National Academy of Engineering in 1965. They include foreign membership in the Polish Academy of Science, fellowship in the American Academy of Arts and Sciences, and honorary membership in the Groupe Française de Rhéologie, the Groupe pour l'Avancement des Méthodes Numériques de l'Ingénieur, Paris. The American Society of Mechanical Engineers awarded him the Worcester Reed Warner and Timoshenko medals, and the American Society of Civil Engineering presented him with the von Karman Medal. Honorary degrees were bestowed by the University of Liege, Poitiers, the Politecnico di Milano, Case Institute of Technology, Waterloo, Stuttgart, Hannover, Brown, Manchester, and Bruxelles. The Institution of Mechanical Engineers invited him to be their James Clayton Lecturer. Membership in the National Academy of Sciences came in 1968 and Correspondent, Academie des Sciences de l'Institut de France in 1974.

His almost 20 books and many of his more than 200 papers have appeared or have been translated into several languages. They have had a tremendous worldwide influence on those not fortunate enough to have direct contact with this truly unusual person who was always willing to share ideas and credit. Dr. Prager's many former students and junior colleagues, whom he encouraged so warmly and helped so unselfishly to develop, now occupy key positions in research and teaching in many countries. He could and did converse with them in fluent French or Turkish as well as in German or English. Whenever possible, an hour of classical music very early in the morning began each busy day of his innovative research, teaching, and service to the profession.


Perry W. Pratt

Perry W. Pratt

1914-1981

By Edward H. Heinemann and Edward R. Cowles

PERRY W. PRATT, a leading aircraft engine designer who made key contributions to the development of jet propulsion, died on January 6, 1981, at his home in Jupiter, Florida. He spent his entire career, spanning more than three decades, with Pratt and Whitney Aircraft and its corporate parent, United Technologies.

When he retired in 1971, he was the company's Chief Scientist and directed the advanced study and planning group of scientists and engineers who were responsible for searching out and investigating new fields of activity for the corporation, its operating divisions, and its subsidiaries.

Mr. Pratt was born January 10, 1914, in Lompoc, California. He graduated from Oregon State University and did graduate work at Yale and New York University.

Mr. Pratt joined Pratt and Whitney Aircraft (no relation) as a Test Engineer in 1939, and was Project Engineer for the R-2800 Double Wasp engine, which powered a wide array of Allied fighters, bombers, and transports during World War II.

When Pratt and Whitney Aircraft went into the jet engine field, Mr. Pratt was chosen to head the Technical and Research Section of the Gas Turbine Department. In this capacity he had a key part in the development of Pratt and Whitney Aircraft's family of gas turbine engines, which today power a large number of the Nation's front-line military aircraft and three-quarters of the free world's commercial jetliners.

Mr. Pratt was named Assistant Chief Engineer of the Pratt and Whitney Aircraft Division in 1950, Chief Engineer in 1952, Assistant Engineering Manager in February 1957, and Engineering Manager later that same year. During this period he was granted patents for inventions of induction apparatuses and ignition controls for aircraft engines.

In 1958 United Technologies created the position of Vice-President and Chief Scientist for the corporation, and Mr. Pratt was elected to that post, which he held until his retirement.

During his career Mr. Pratt was recognized by several technical and engineering organizations for his outstanding contributions. He was elected to the National Academy of Engineering in 1967. The American Society of Mechanical Engineers (ASME) presented him the George Washington ASME Award in 1956 in recognition of his contributions to the engineering profession. He received the American Society of Mechanical Engineers' Gas Turbine Division Award for 1967 for his leadership and technical contributions in the development of aircraft turbojet and turbofan engines.

In 1968 the Institute of Aeronautics and Astronautics selected Mr. Pratt to share the Goddard Award, given to "a person who has made a brilliant discovery or a series of outstanding contributions over a period of time, in the engineering science of propulsion or energy conversion." The citation accompanying the award read: "For their independent and sustained major contributions, each in his own country, to the development of the aircraft gas turbine; and for their imagination, competence and persistence which have made these engines outstanding in human transportation."

In 1972 Mr. Pratt was chosen to receive the Elmer A. Sperry Award of the American Institute of Aeronautics and Astronautics for his role in the development of the JT3 turbojet, the power plant for America's first commercial jetliners, the Boeing 707 and McDonnell Douglas DC-8.

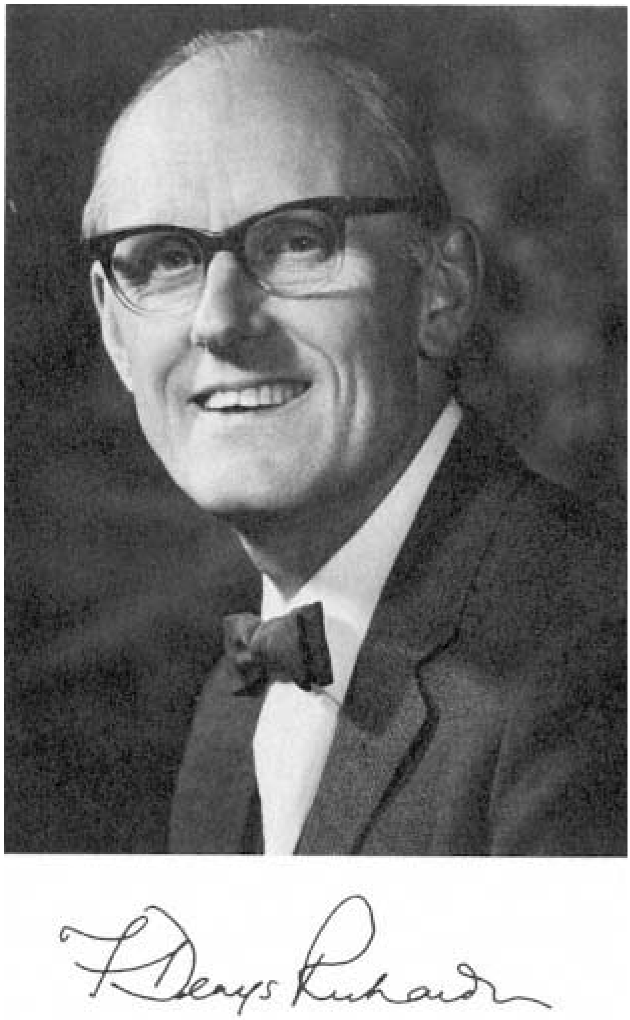
It was the first turbojet engine in the Western world to produce 10,000 pounds of takeoff thrust, and the first to power a production aircraft, the F-100, at supersonic speeds in level flight. More than 21,000 of the engines were produced for such commercial and military aircraft as the Boeing 707, B-52, and KC-135; the McDonnell

Douglas DC-8, F-101, and A-3; North American Rockwell F-100; General Dynamics F-102; and the LTV Aerospace F-8.

Perry Pratt and Luke Hobbs (also of United Technologies), who shared the Sperry Award, were recognized "for their leadership, vision and engineering skill in directing the design and development of the JT3 turbojet engine ... which by its performance and reliability was an essential element in the initiation and rapid growth of the jet age in commercial air transportation."

During his career Mr. Pratt served in a variety of capacities. He was a member of the Advisory Council of the Department of Aeronautical Engineering, Princeton University; a member of the Aeronautics and Space Engineering Board of the National Academy of Engineering; a member of the Industrial and Professional Advisory Council, Department of Aerospace Engineering, Pennsylvania State University; and a member of the Board of Directors of the Coordinating Research Council.

Mr. Pratt is survived by his wife, Edith Abraham Pratt of Jupiter, Florida; a son, Spencer Pratt, and a daughter, Mrs. Albert Phillips, both of Glastonbury, Connecticut; his mother, Ruth Pratt of Corvallis, Oregon; a brother, Edwin Pratt of Bellevue, Washington; and three grandchildren.



Frederick Denys Richardson

1913-1983

By Michael Tenenbaum

FREDERICK DENYS RICHARDSON, elected in 1976 as a Foreign Associate of the National Academy of Engineering (NAE), died on September 8, 1983. He was Emeritus Professor of Extraction Metallurgy at the Imperial College of Science and Technology. His death has been described by one of his peers as the passing of "the last of the four apostles of Chemical Metallurgy." This group— Denys Richardson, John Chipman, Carl Wagner, and Lawrence Darken—shaped the field of chemical metallurgy into an exact and rigorous science. In his lifetime Professor Richardson became recognized for his scientific and practical mind, as well as his unique ability to generate basic data and to apply such fundamental knowledge to large-scale industrial systems.

Denys Richardson (his friends generally omitted the "Frederick") was born in London, England, on September 17, 1913. He was orphaned at the age of six with two older brothers and one younger sister. He received his early education at a small, independent, boys' boarding school. What this small school lacked in size it made up in its work-ethic beliefs. Its teaching schedule started with a preparatory session before breakfast and then proceeded through a day-long rigorous academic program. During holidays students were exposed to more practical activities, ranging from carpentry to nature works, with ample time devoted to encouraging hobbies. Throughout his busy career Denys Richardson exploited this early training by using his wonderful mind not only to generate new knowledge, but also to work creatively with his hands.

He received his B.Sc. (chemistry) in 1933, his Ph.D. in 1936 from University College, and his D.Sc. (metallurgy) in 1955 from London University. In 1937 he went to America as a Commonwealth Fellow, and returned to England shortly before the outbreak of World War II. Shortly after his return he entered the Royal Naval Volunteer Reserve, and in 1943 he became Deputy Director of the Department of Miscellaneous Weapons Development, Admiralty England. Among other things, it was here that he contributed notably to the development of countermeasures to the magnetic mines that were infesting the waters surrounding the British Isles. His work in the Admiralty concerned the degaussing of ships and the sweeping of magnetic mines. He also invented the two-pounder star shell used by the British Coastal Command. He rose to the rank of Commander in the Royal Navy Voluntary Reserve (RNVR). His coworkers in the Royal Navy describe the "cheerfully unorthodox style, with which he tackled difficult problems connected with the war at sea, as almost legendary."

Denys Richardson's achievements in the Admiralty brought him scientific recognition which, after the war, led to his selection to join the newly established British Iron and Steel Research Association (BISRA). At BISRA he supervised the development of an outstanding chemistry department. In 1950 he made the permanent transition to academia by accepting the post of Nuffield Fellow at Imperial College. In 1957 he was appointed Professor of Extraction Metallurgy, a chair that he occupied for more than twenty years. It was during this period that he formed the John Percy Group in Process Metallurgy with support from industry and the Nuffield Foundation. He retired in 1976 but remained very active in the posts of Senior Research Fellow and Emeritus Professor of Extraction Metallurgy.

Throughout his teaching career Professor Richardson dedicated himself to seeking out promising students with inquiring minds and took pride in his ability to help them fulfill their potential. He was an inspiring teacher to those who were fortunate enough to hear his lectures or collaborate in his research. He would say, "Give me a student who asks questions—not one with his head crammed with second hand information." He obtained great satisfaction when the steady flow of young men emerging from his classroom occupied important posts in academic institutions and leadership positions in industries all over the world.

Professor Richardson published extensively in the field of chemical metallurgy, contributing basic information on thermodynamic properties of metals and slag solutions, explaining the thermodynamic aspects that control large-scale smelting and refining processes, clarifying the factors that govern the kinetics of gas-metal reactions, and identifying the characteristics that influence mass transfer in high-temperature metallurgical processes. His classic two-volume work, *The Physical Chemistry of Melts in Metallurgy,* published in 1974, is regarded as a standard text on the subject. These volumes, along with many of his 125 or so major technical papers, are outstanding references for those engaged in high-temperature metallurgical chemistry research, development, and teaching.

In his lifetime, Professor Richardson received special recognition from learned societies and institutions in Great Britain, the United States, France, Germany, Austria, Belgium, and Japan. In addition to his election as a Foreign Associate of the NAE in 1976, he was a Charter Fellow of the American Institute of Mining and Metallurgical Engineers; Fellow of the Royal Society, London; Fellow of the Metals Society, London; Fellow of the Institute of Mining and Metallurgy, London; Fellow of the Institution of Chemical Engineers, London; Fellow of University College, London; and Fellow of the Fellowship of Engineering, London.

Other awards received were the Sir George Bielby Memorial Award from the Royal Institute of Chemistry and Society of Chemical Industry; the Bessemer Gold Medal Award from the Iron and Steel Institute, London; the Gold Medal from the Institute of Mining and Metallurgy, London; the Gold Medal from the American Society of Metals; the Peter Tunner Medal from Eisenhutten Oesterreich, Austria; the Grande Medaille from Société Française de Metallurgie; and the Carl Lueg Medal from Verein Deutsche Eisenhuttenleute. He was an Honorary Member of the Japan Institute of Metals, an Honorary Doctor of the Université de Liège in Belgium, and received the Dr. Ing. h.c. from the R. W. Technische Hochschule in Germany.

Shortly before his death, Denys Richardson was awarded the Kelvin Medal for application of science to industry. He was the first metallurgist to receive this great honor.

It might seem from his many accomplishments that Denys Richardson was preoccupied with research and teaching, but the opposite is true. He had a great love for beautiful objects, which he not only admired but also created. He was an ardent gardener, and those of us who were fortunate enough to visit his home derived great pleasure from the results of his aesthetic talents. He shared his warmth, charm, humor, and love with a gracious wife, Irene, and two sons, Hugh and Rodney, each of whom reflect his wonderful disposition, intelligence, and quick wit. His wife describes him fondly as an "exceptionally clear-headed person with a keen and observant eye, who could concentrate exclusively on the work before him, as the surrounding tumult passed over his head." He took great pains over details and pruned and pruned again whatever he wrote. His speeches were always carefully timed. Yet within this rigid framework he could flash out a quip or a play on words that delighted his audiences. His colleagues admired him for his brilliance, and his family loved him for being the wonderful husband and father they were so fortunate to share with all of us.

His death creates a void in the field of metallurgical chemistry. But a great tribute to this man will be the ongoing contributions to the understanding of chemical metallurgy that will be made by the students and colleagues who have benefited from the scientific foundation that was his legacy to them. His reward would be the satisfaction of knowing that the generation he guided and inspired has demonstrated some measure of the rare vision and talent that was Frederick Denys Richardson.

Hubert Rüsch

1903-1979

By Anton Tedesko

HUBERT RÜSCH was born December 13, 1903, in Dornbirn, Austria, and died October 17, 1979, in Munich, Germany. He was elected a Foreign Associate of the National Academy of Engineering in 1977. At the time of his death he was Professor Emeritus of the Technological University of Munich, an author of books and articles, and a consultant in many branches of civil engineering. He was considered the elder statesman in the fields of prestressed concrete, in the theory of reinforced concrete, as well as in the knowledge of concrete material properties and phenomena such as creep—areas in which he made contributions of fundamental importance over a span of several decades.

A practical engineer with a solid theoretical foundation, Professor Rusch had the gift for finding simple solutions when problems became deadlocked among professional colleagues. He was fluent in five languages, could express his ideas effectively, and had countless friends among engineers, scholars, researchers, and builders throughout the world. As a member of numerous engineering groups, he combined great technical ability with charm and an outstanding diplomatic performance on an international level. Innumerable publications have shown his innovative ideas, described his new theories and concepts, and proved him an engineer of unusual creativity and productivity.

Hubert Rüsch came from an engineer's family. His grandfather and father managed the family-owned Rüsch Works, a machine factory in Dornbirn, Austria, which existed until World War II. Turbines built there are still in operation in Austria. His parents, Karl and Anna Winder Rüsch, had three sons, all of whom became engineers. Hubert was the youngest, and he went to school in Dornbirn, spending a great deal of time in the Austrian mountains. By the time he went to college he had become a well-known mountain climber.

He studied civil engineering at the Institute of Technology in Munich, received his engineer's diploma in 1926, and thereafter joined Dyckerhoff and Widmann AG, Engineers and Contractors, at Wiesbaden, Germany. They were pioneers in reinforced concrete construction. There he worked under Franz Dischinger and Ulrich Finsterwalder, the inventors of concrete shell construction. He soon made a name for himself contributing to the design, model testing, and execution of significant structures, such as the record span domes for the Great Market Halls at Leipzig, Frankfurt, and Budapest. In 1930 he received a Doctor of Engineering degree from the Munich Institute of Technology, based on a thesis on the theory of narrow unsymmetrical cylindrical shells.

In 1931 his company sent him to its Buenos Aires office where he introduced modern construction techniques and other innovations. During the three years in Argentina he was Chief Designer and Planner of industrial shell structures. In the mid-1930s Dyckerhoff and Widmann transferred him to Berlin where he directed the design and the economical planning of complex European structures: industrial plants, waterfront construction, domes, aircraft hangars, prestressed concrete trusses (System Rüsch), and precast concrete construction. He was the engineer in charge of the planning, design, and construction of the Volkswagen plant, the largest single-story factory in Europe, a shell structure built in a planned manufacturing cycle.

In 1935 Hubert Rüsch was married to Trude Kate Maria Meier, and they had three children. Bombed out in Berlin at the end of World War II, they escaped unharmed before the advancing armies of the USSR. Having lost all their possessions, they walked with their children to Austria where they were taken in by relatives. Not many months later, Hubert Rüsch became active in the rebuilding of the Dyckerhoff and Widmann organization in Munich.

In 1948 Hubert Rüsch accepted a professorship of civil engineering at his alma mater, renamed the Technological University of Munich. There he specialized in reinforced concrete and the new field of prestressed concrete construction. He conceived, created, and was appointed the Head of the new government materials testing, research, and development laboratory that was attached to the university. The laboratory soon became known worldwide, and he served as its Head until 1969. Fifty to sixty research programs were usually in progress with about eighty researchers under his direction in the field of metals and reinforced and prestressed concrete.

The prestressed concrete codes of many countries are based on Professor Rüsch's ideas, and numerous international standards are the product of his influence and skillful guidance. Hubert Rüsch's impact internationally was aided by the fact that he was a citizen of Austria, a nonaligned country. More than 150 publications, including books, reflect his activities in research and as a practicing consultant. He was a rare example of perfect balance between scientific rigor and awareness of the needs of practical application. Moreover, he was adept in bringing clarity to many problem areas. His name is connected with contributions in many fields: the structural behavior of concrete, creep, shrinkage, bond, crack formation, bending theory, safety theory, and probabilistic approach. His work in general led to a better understanding of basic relationships, principles, and the behavior of structural components. For many of his students and collaborators he was the model of creative activity. It is safe to say that he influenced progress in his field more than any other engineer. At the same time he was interested in music and literature and contributed articles in the field of education and liberal arts.

Hubert Rüsch was a well-known lecturer in many countries, including the United States. He was a Visiting Professor at Cornell University and at the University of Texas. He was also active in many engineering societies, where he was extraordinarily able in creating a spirit of constructive collaboration.

He left his mark on the American Concrete Institute, which elected him an Honorary Member; on the Comité Euro-International du Beton, which made him its Honorary President; and on the Réunion Internationale des Laboratoires et Matériaux, which made him an Honorary Member. He was a past Vice-President of the International Association for Bridge and Structural Engineering, as well as an Honorary Member of the Associazione Italiana Cemento Armato e Precompresso, and a Founding Member of the Fédération Internationale de la Précontrainte.

Hubert Rüsch held an honorary doctorate from the University of Dresden, East Germany; received the Longstreth Medal of the Franklin Institute of Pennsylvania; and the Alfred E. Lindau Award and the Wason Medal of the American Concrete Institute. In Germany he was honored as a recipient of the Carl Friedrich Gauss Medal and of the Emil Mörsch Medal.

Hubert Rüsch was a giant of a man with an unusual gift for human understanding and relationships. He is survived by a son living in Munich and two daughters, who live with their families in the United States and with whom he was able to enjoy skiing as late as the winter before his death.


Otto H. Schade

Otto H. Schade, Sr.

1903-1981

By William M. Webster

OTTO H. SCHADE, SR., died in West Caldwell, New Jersey, on April 28, 1981, following his seventy-eighth birthday. He was an eminent authority on image evaluation in motion picture and television systems. He is best known for developing the concept of the modulation transfer function, which is widely applied to the evaluation of optical, photographic, and electronic image systems and to studies of the eye.

Otto H. Schade, Sr., was born in Schmalkalden, Germany, in 1903 and was educated in Germany. He came to the United States in 1926 and worked with the firm of Atwater Kent in Philadelphia.

Five years later he joined the Radio Corporation of America (RCA) Tube Department in Harrison, New Jersey, the start of a lifetime career. Mr. Schade retired from RCA in 1968 as Staff Engineer, a position first created for him. He continued as a consultant to RCA until 1974. In the course of this career, Otto Schade presented or published more than thirty papers and received eighty-five patents and numerous awards, including an honorary Doctorate of Engineering from Rensselaer Polytechnic Institute.

The first widely recognized achievement of Mr. Schade was the subject of his presentation in 1936 before the Institute of Radio Engineers on the electron optics behind the beam power tube, typified by the well-known 6L6. Many of his colleagues can recall that this history-making vacuum tube was not the first important new product developed at RCA's Harrison plant. Years before, the

Harrison building complex was known as the Edison Lamp Works; Mr. Schade's laboratory in Building 17-3 had also been used by Thomas Edison. The burn marks on the wooden lab floor bore testimony to the molten glass and vacuum technology practiced by Edison—a technology later used by Mr. Schade and his co-workers in electronic developments dimly, if at all, envisioned by Edison when he discovered the diode effect that today bears his name.

Other landmark accomplishments in electron tube design resulted in Mr. Schade's "Analysis of Rectifier Operation" and "R-F Operated High-Voltage Supplies," both published in 1943. In 1958 he began a study that resulted in successful manufacture of the Nuvistor line of low-noise tubes for TV receiver tuners, designed to supplement the emerging semiconductor products in "hybrid" equipment.

In 1938 he began specialized studies of television circuits, camera tubes, picture tubes, and the analysis of television systems performance. From 1944 to 1957 he worked on a unified general method of image analysis and specification, including practical methods for measuring the modulation transfer function and noise in optical, photographic, and electronic imaging systems. In the August 1976 *Scientific American,* William H. Price of Kodak wrote: "Much of the mystery surrounding lens 'quality' was cleared up in 1951 when Otto H. Schade, Sr., of the Radio Corporation of America, described his investigation of lenses used in the entire chain of information transmission represented by a television system." He adds that with Otto Schade's concepts and a computer, "[now] we can mathematically model the entire photographic system, beginning with the subject and ending with the transfer function of the viewer's eye."

Mr. Schade subsequently developed an accurate method for calculating the resolving power of photographic and television systems to assist in the evaluation of high-definition TV systems for the Air Force. He developed new electron optics that provided uniform resolution in TV camera tubes with larger formats (50 x 50 millimeters) and special high-resolution electron guns to realize resolutions on the order of 100 line pairs per millimeter.

After his retirement from RCA in 1968, he continued his valuable affiliation as a consultant for six more years.

In 1946 he received RCA's highest citation, the RCA Victor Award of Merit, for his contributions in the field of television. Mr. Schade, a Fellow of the Institute of Electrical and Electronics Engineers and the Society of Motion Picture and Television Engineers (SMPTE), also received numerous other honors, including the Modern Pioneer Award of the National Association of Manufacturers (1940) and the Morris N. Liebman Memorial Prize of the Institute of Radio Engineers (1950). He was the first recipient of the David Sarnoff Gold Medal Award of the SMPTE (1951).

In June 1953 Otto Schade, Sr., was invested with the honorary degree of Doctor of Engineering by Rensselaer Polytechnic Institute. In 1960 he received the Progress Medal Award of the SMPTE for his outstanding contribution in the engineering phases of the motion picture and television industries, and in 1965 he received the Journal Award of the SMPTE for his paper entitled "An Evaluation of Photographic Image Quality and Resolving Power," published in February 1964. In 1968 he received the David Sarnoff Outstanding Achievement Award from RCA for the conception of electronic techniques to determine accurately the response of the total television system, including lenses and photographic films. In 1969 he received the Technical Achievement Award from the American Society of Magazine Photographers for "effecting a marriage of electronics and optics making possible sophisticated designs of lenses." In 1969 he received the Vladimir K. Zworykin Award for outstanding technical contribution to electronic television from the Institute of Electrical and Electronics Engineers.

Otto Schade, Sr., received two additional awards: "The Karl Fairbanks Memorial Award to Dr. Otto H. Schade, Sr., who through his work in industry has contributed significantly to the advancement of photo-optical instrumentation engineering" (1974), and the Special Recognition Award in 1975 "for the pioneering application of frequency response concepts to the analysis and optimization of electro-optic systems" by the Society for Information Display (SID). He was elected to the National Academy of Engineering in 1977.

His acclaimed television accomplishments are perhaps best represented by his formal treatises, "Electro-Optical Characteristics of

Television Systems," published in the *RCA Review* in 1948, and "Image Gradation, Graininess and Sharpness in Television and Motion Picture Systems," published in the *Journal of the SMPTE* in four parts, from 1951 to 1955.

In 1975 RCA published "Image Quality: A Comparison of Photographic and Television Systems" as a definitive treatise and also as a tribute to Mr. Schade.

By those who had the good fortune to work with Otto Schade, Sr., or even to know him in a passing fashion, he would be characterized as a gentle, unassuming, thoughtful man who combined the Old World ideals of perfection with understanding of the real world's deficiencies. He was a superb teacher of the younger engineers who worked with him and, often, of the older managers he worked for.

Ernest Edwin Sechler

1905-1979

By Hans W. Liepmann

ERNEST E. SECHLER, Professor of Aeronautics Emeritus at the California Institute of Technology (Caltech), died on August 14, 1979.

Born in Pueblo, Colorado, on November 17, 1905, Dr. Sechler entered Caltech as a freshman in 1924 and remained there all his life. He obtained his B.S. and M.S. in mechanical engineering and joined the small group of students and faculty who helped Theodore von Karman build an aeronautics institute at Caltech, which became world famous under the acronym GALCIT. Ernest Sechler was the first recipient of an M.S. in aeronautics at Caltech and one of von Karman's first Ph.D.'s, with a thesis on the ultimate compressive strength of thin sheet metal panels. Much of his later research direction was set in this early, now classical, work and in his subsequent study of shell structures.

The impact of aeronautics on engineering in those early days was remarkable. Suddenly a field was opened where large safety, or rather ignorance, factors could not be tolerated. Structures had to be light but fail-safe, and the aerodynamic forces had to be predicted with great accuracy. Dr. Sechler chose the first path, and the development of light, fail-safe structures became the main theme of his professional life.

It became evident that thin-shell structures were not restricted to airplanes; the design of the Palomar Observatory to house the new 200-inch mirror called for a large, movable dome. The cooperation of Theodore von Karman and Ernest Sechler, with their experience and knowledge of thin shells, resulted in the first monocoque observ atory dome, a thin-shell structure of remarkable resistance. Needless to say, the development of missiles and, in particular, large booster rockets called for thin-walled structures as well.

His two books, *Airplane Structural Analysis and Design,* written with L. G. Dunn, and *Elasticity in Engineering,* were published in 1942 and 1952, respectively. Both were republished as Dover paperbacks in the 1960s and currently retain their place on engineering shelves.

While Dr. Sechler's research contributions to lightweight structures are well known, only the more intimate circle of colleagues and students at GALCIT know of his contributions to education. During most of his academic career he was largely responsible for the admission of students to GALCIT and, in addition, was influential in student affairs throughout Caltech. He had an unbelievably intuitive understanding of the potential of an incoming student. In the forty years or so of my own recollection, I cannot remember a single case where his predictions were wrong. This unusual gift was most important in the development of the graduate school of aeronautics at Caltech.

Dr. Sechler's impact on engineering construction at Caltech is also noteworthy. He had a hand in the design of both the 10-foot wind tunnel and the cooperative wind tunnel. He influenced the construction of most experimental facilities in the institute and was well known for his commonsense approach to technical design problems, both at Caltech and in industry. Indeed, his consulting services for the aerospace industry, as well as for the National Aeronautics and Space Administration and other government agencies, will be remembered for a long time.

Ernest Sechler was a Fellow of the American Institute of Aeronautics and Astronautics and held memberships in the American Association for the Advancement of Science and the California Academy of Sciences. He was elected to the National Academy of Engineering in 1979.

Dr. Sechler's work will continue for a long time through the GALCIT students he influenced, many of whom are now leaders in industry and education.

He is survived by his wife, Margaret Nelson Sechler; his daughter, Lorraine Sechler Emery; and two grandsons, Jeff and Brett Emery.

William Earl Shoupp

1908-1981

By Donald C. Burnham

WILLIAM E. SHOUPP, a pioneer in the development of nuclear power for naval propulsion and electrical generation and the retired Vice-President for Research of the Westinghouse Electric Corporation, died on November 21, 1981. At the time, he was in his office at the Westinghouse Research Center in Pittsburgh, Pennsylvania, where he had continued to serve as a consultant after his retirement.

Dr. Shoupp was a leader in the technical development of nuclear power. Early in his career he directed work on the world's first industrial atom smasher. He was responsible for the development of the nuclear power plant for the first nuclear-powered submarinethe USS *Nautilus—for* which he won Westinghouse Corporation's highest achievement award, The Order of Merit, in 1953. He was in charge of research and development for the Shipping-port Atomic Power Plant, which was the first commercial nuclear power plant in the United States. He provided leadership and inspiration to the entire Westinghouse Electric Research Laboratories which he managed, as Vice-President for Research, from 1962 until his retirement in 1973. He served on numerous government advisory committees and contributed greatly to the work of many professional societies and to the National Academy of Engineering. He was noted for his optimism, his sense of humor, and his ability to inspire the young people in engineering and science to give more of themselves—to do better.

Born October 12, 1908, in Troy, Ohio, he received a Bachelor of

Science degree from Miami University of Ohio in 1931 and master's and doctor's degrees in science from the University of Illinois in 1933 and 1938, respectively. He received honorary Doctor of Science degrees from Miami University and the Indiana Institute of Technology.

Dr. Shoupp had a long and distinguished career with the Westinghouse Electric Corporation. From 1938 until 1943 he was a Research Fellow at the Westinghouse Research Laboratories, where he was Section Head of Electronics and Nuclear Physics. He was the inventor of many nuclear particle detector systems and has been called the father of the industrial nucleonics field because of his developments in nuclear gauging techniques. In 1943 he was made Manager of the Electronics and Nuclear Physics Department. From 1948 to 1954 he served as Director of Research, Director of Development, and Assistant Manager of Development for the Bettis Atomic Power Laboratory where he was in charge of research and development for atomic-powered submarines and the Shipping-port Atomic Power Plant. In 1954 he was made Technical Director of the Atomic Power Division of Westinghouse. He directed the research and development and engineering of various commercial atomic power plants, including the Yankee Atomic Electric Plant in Rowe, Massachusetts. In 1961 Dr. Shoupp was appointed Technical Director of the Westinghouse Electric Corporation Astronuclear Laboratory where he was in charge of research and development of space propulsion and life support and associated activities.

In 1962 he was appointed Vice-President for Research in charge of the Research Laboratories of Westinghouse. He was responsible for basic, applied, and developmental research conducted at the Research Laboratories in support of the company's sixty-four manufacturing plants and for various federal agencies. He directed the scientific and engineering activities of more than 700 employees, many of whom are world-renowned authorities in their fields. As Director of one of the pioneering industrial research laboratories of the world, Dr. Shoupp was charged with guiding investigations in disciplines as varied as molecular electronics, magnetohydrodynamics, cryogenics, life sciences, laser research, mechanics, and scores of other scientific and technological areas. In 1973, at the age of sixty-five, Dr. Shoupp retired from Westinghouse, but he continued to work as a consultant for Westinghouse, the Office of Coal Research, the Electric Power Research Institute, and a number of other organizations interested in energy.

Dr. Shoupp was elected to the National Academy of Engineering in 1967 and was active in Academy affairs for the rest of his life. He was Vice-President of the Academy from 1973 to 1978 and was also Acting President of the Academy from December 1974 until April 1975. He was Chairman of the National Research Council's Marine Board from 1970 to 1974.

He belonged to numerous professional and honor societies; he was a Fellow of the American Society of Mechanical Engineers, the American Nuclear Society, the American Physical Society, and the Institute of Electrical and Electronics Engineers. In 1964 he served as President of the American Nuclear Society and was awarded the Industrial Research Institute Medal in 1973. He was awarded nine patents for inventions ranging from a thickness gauge for rolling mills to a method of measuring neutron intensity. Dr. Shoupp published many scientific papers and articles, most of which addressed the subject of nuclear power. Illustrative of his broad interests are those entitled "Organizing Engineers to Meet the Challenge of New Technology" and "Bringing R&D to the Market Place."

Dr. Shoupp was an engineer and scientist who took great pleasure in the results of his work. He was justifiably proud when the USS *Nautilus* cruised successfully under the North Pole. He was interested in people as well as things, and he even set up a training course for the *Nautilus* crew.

Dr. Shoupp did not limit his interests to engineering and technical matters; he was an excellent tennis player and also had a hobby of fixing watches. When anybody had a watch to fix, Bill was the man to do it. Oftentimes, even as a meeting in his office was in progress, he would sit there studying watch parts through a magnifying glass. He had all the necessary tools in his desk to make the repairs.

Dr. Shoupp had many friends who enjoyed his brilliant engineering and scientific knowledge, his sense of humor, and his interest in people.

Carl Richard Soderberg

1895-1979

By Ascher H. Shapiro

ON OCTOBER 17, 1979, the full life of C. Richard Soderberg, Institute Professor Emeritus at the Massachusetts Institute of Technology, came to an end. He was eighty-four years of age. With roots in the simple realities of a boyhood in a fishing family on a remote Swedish island, his qualities of mind and character led him first into a distinguished industrial career as an engineer in his adopted country; then, after refusing advancement to a high managerial position, he went on to an even more illustrious career in education and as a consultant, and finally to a vigorous professional and intellectual life in his retirement. His years were marked by an expansive and seemingly unlimited passion to learn and by a capacity to teach, by a superb intuitive sense of design and rightness, by an unflagging breadth of intellectual interest, by a deep understanding of the social and historical forces set in motion by technology, and by a warmth and nobility of spirit that endeared him to his colleagues and friends.

C. Richard Soderberg was born on February 3, 1895, in Ulvohamm, Sweden, one of eight children, and grew up on the sea. He studied with the one teacher of a small, one-room school, but the future pattern of his intellectual life was even then foreshadowed by wide reading from books. With assistance from various places, he went to the technical gymnasium on the mainland and subsequently to the Chalmers Institute of Technology in Göteborg, where he graduated as a Naval Architect in 1919. Then, in one of life's fateful turns, he came to the Massachusetts Institute of Technology (MIT) on a fellowship from the American Scandinavian Foundation, where he earned a bachelor's degree in naval architecture in 1920. Although his life afterward was centered in the United States, he never gave up close associations with his homeland.

In 1921 Dick Soderberg married Sigrid Kristina Löfstedt of Boston, and theirs was a lifelong companionship. He was acutely lonely when she died in 1975. Their three children are C. Richard Soderberg, Jr.; Lars O. Soderberg; and Barbro K. (Mrs. Sven O.) Dirke.

Professor Soderberg's career in its several phases marks him as a towering figure in that transformation of American engineering that took place during the decades from the 1920s to the 1960s. At the Westinghouse Electric and Manufacturing Company, where he worked from 1922 to 1938 except for a two-year hiatus at ASEA in Sweden, he rose in 1933 to the position of Manager of the Turbine Division. During those years he was involved with various aspects of power production: railroad electrification, electric motors, and, most importantly, steam-turbine-driven electric generators. An authority on the engineering design of steam turbines, he made long-lasting contributions in two areas of applied mechanics: the dynamics, vibrations, and balancing of rotating machinery; and the development of design criteria for safe working stresses under oscillatory applied loads.

Professor Soderberg's deep interest in engineering education was awakened through his activities in the 1920s and 1930s at what was known as the Westinghouse Design School. This was an in-house training program for young engineers to enable them to deal with the demanding problems of steam turbines and electric generators operating at high speeds and temperatures, problems for which they were ill prepared scientifically by the type of education then in vogue at schools of engineering in the United States.

The years at Westinghouse were of great significance when Dick Soderberg came to MIT as a Professor of Mechanical Engineering in 1938. Reflective and philosophical by nature, he foresaw the face of things to come and became one of those contributory to the revolution in U.S. engineering education that was beginning then and which, accelerated by World War II, wholly changed engineering schools by the end of the 1950s.

At MIT Professor Soderberg taught applied mechanics. During the war years he became Graduate Registration Officer of the Mechanical Engineering Department. Graduate programs in engineering were then burgeoning and there was ample opportunity to shape the future. When Jerome Hunsaker became heavily occupied in Washington as Chairman of the National Advisory Committee for Aeronautics (NACA), predecessor of the National Aeronautics and Space Administration, Dick Soderberg ran the department. In 1947 he succeeded Hunsaker formally as Head of the department, and led the department through the critical years of postwar growth and development. In 1954 (sixteen years after his arrival at MIT) when he was appointed Dean of the School of Engineering, the Department of Mechanical Engineering had acquired a form and style that made it renowned the world over.

Both as Head of the department and as Dean of the school, Professor Soderberg was concerned with the broader issues of engineering education—with general aims, with philosophical background, and with the development of character and professional style. He constantly stressed as a philosophical premise the dignity of useful work and the value of preparing for such a career.

A year after appointment to the illustrious position of Institute Professor, Dick Soderberg in 1960, at age sixty-five, went on so-called half-time service, but of course he remained fully active. So much so, indeed, that after mandatory full retirement at age seventy, he was recalled to serve for a half year as Acting Head of two departments, Mechanical Engineering, and Naval Architecture and Marine Engineering.

During his busy years at MIT, Professor Soderberg maintained remarkable associations with industry. The three mentioned below are particularly notable, for he did what few consultants with limited time can accomplish: he was the catalyzing agent and provided the intellectual leadership for developments of far-reaching consequence.

His efforts at the Elliott Company toward the development of a gas turbine for ship propulsion led to development of the first marine gas turbine power plant in the United States.

For forty years Dick Soderberg maintained a close association with his native country through periodic consulting trips to Stal-Laval Turbin AB, a manufacturer of power station turbines, industrial steam and gas turbines, and marine turbines; he was highly instrumental in the progress of the company.

His long consulting association with United Aircraft Corporation was a major factor in the development of the now-famous J-57 aircraft turbine engine. The manner in which Dick Soderberg led the company from the reciprocating engine era to the rotary gas turbine, and in so doing revolutionized air travel, is remarkable: he guided and inspired the newly formed group of young engineers who, starting from scratch, developed the dramatically new series of engines that made Pratt and Whitney the leading manufacturer of jet engines in the world.

During the several phases of his career, Professor Soderberg was the author of fifty-two technical articles, and he received eighteen patents. He served on many government committees for the Department of Defense, NACA, the U.S. Air Force, and the National Defense Research Committee. He was honored by election to membership in illustrious scientific academies: the National Academy of Engineering (NAE), National Academy of Sciences (NAS), American Academy of Arts and Sciences, and the Royal Swedish Academy of Engineering Sciences. He participated heavily in the activities of the NAS, the NAE, and the National Research Council and was active in professional activities of the American Society of Mechanical Engineers.

Many other honors were bestowed upon him. In 1958 Professor Soderberg was made Knight of the Royal Order of the North Star (Sweden), and in 1968 the King of Sweden named him Commander of the Royal Order of the North Star. His medals include the John Ericsson Gold Medal of the American Society of Swedish Engineers, 1952; the Medal of the American Society of Mechanical Engineers, their highest award, 1960; the DeLaval Medal of the (Swedish) Royal Academy of Engineering Sciences, 1968; and the Gustav Dalen Medal of Chalmers Institute of Technology, Sweden, 1970. He received the honorary degree of Doctor of Technology from Chalmers Institute of Technology in 1951, and the Doctor of Engineering from Tufts University in 1958. In 1975 MIT established in his honor the Carl Richard Soderberg Professorship of Power Engineering.

Finally, a personal note: When Dick Soderberg started at MIT as a full Professor, I started as a lowly lab assistant, fresh with a bachelor's degree. It was my good luck to be close to him for forty years. He was my teacher, guide, friend, boss, and colleague. He was wonderfully well read and intellectually stimulating; for this his chronic insomnia may have been a blessing, for he read in the middle of the night. He was unfailingly attentive to and respectful of junior colleagues and students. I never knew him to have an enemy or heard that anyone felt unkindly or unfairly treated by him. A bear of a man, he sometimes blustered when pushed, but he was never less than open minded. He was truly a remarkable man.

Frederick Emmons Terman

1900-1982

Joseph M. Pettit

FREDERICK EMMONS TERMAN, one of the twenty-five founders of the National Academy of Engineering, died at Stanford University on December 19, 1982, at the age of eighty-two. He will long be remembered as one of the outstanding teachers, textbook authors, and educational leaders of his generation. His organizational leadership left a permanent mark on the history of Stanford University and its surrounding industrial complex.

Frederick Terman was born on June 7, 1900, in English, Indiana, but moved with his family in 1910 to the Stanford University campus where his father, Lewis M. Terman, became Professor and Head of the Psychology Department. His father was coauthor of the Stanford-Binet IQ test, a landmark in educational testing. Both father and son were to become famous, and both were elected to the National Academy of Sciences.

Frederick Terman entered Stanford and graduated in 1920 in industrial chemistry. In his graduate work he shifted to electrical engineering, receiving the degree of Engineer at Stanford in 1922. He continued his studies at the Massachusetts Institute of Technology, where he received his doctorate in 1924 under Vannevar Bush.

He became an instructor at Stanford in 1925, and except for a leave of absence during World War II, his career at Stanford was continuous until his retirement in 1965. He advanced through the ranks in electrical engineering, becoming Professor and Head of the department in 1937. He went on leave in 1942 to head the Radio

Research Laboratory at Harvard University, a wartime research and development laboratory that specialized in radar countermeasures and had a staff of more than 800 persons. The work at this laboratory had great significance in the detection, analysis, and jamming of German and Japanese radar. Dr. Terman was decorated by the British Government and by our own, receiving our Presidential Medal of Merit in 1948.

After World War II Dr. Terman returned to Stanford as Dean of the School of Engineering, a position he held until 1958. Stanford appointed him to the post of Provost in 1955 and in 1959 added the title of Vice-President.

Dr. Terman's early fame came through his textbook, *Radio Engineering,* first published in 1932; there were four editions of the book, which became the bible of the profession. Its success was due to a blend of conventional radio theory and advanced electric circuit analysis that Dr. Terman learned from Vannevar Bush. His technique for updating this book was interesting. He subscribed to about five journals and religiously scanned every article, preparing an abstract on a file card for each one. These he cataloged according to the chapters of his book. In later editions of the book, he called in several of his younger colleagues, including this writer, to take over certain of the newer fields. The book finally had to be set to rest because radio engineering as a field melted into the broader landscape of electronics.

He was a diligent writer, and when his younger colleagues had trouble producing intended books, he would advise them to write one page a day—that way one would have a 365-page book at the end of the year. He was so disciplined that he did produce something on each day of the year.

Dr. Terman certainly qualified as a leading educator, although one would have to say that he was not a good lecturer—he was warm, but shy, and no orator. But he believed in learning, and his students were obliged to learn as he drilled each class in the contents of his book. He had good contacts with industry, and he brought various of his engineer friends in industry into his classes to have them narrate new developments in which they were involved.

Perhaps his best contribution to education was institution building at Stanford University. He had the highest standards for new faculty, and participated in building up Stanford University from a good regional institution to one of distinction. He advocated the "steeples of excellence" theory, saying that a city skyline is noted for its high steeples rather than for the average height of all its buildings. He also urged his "mainstream" theory, saying that even the best university cannot be outstanding in everything, but that it is important that its chosen fields lie along the mainstream of intellectual development. A major contribution was to build up Stanford as a strong research university. As Gene Bylinsky wrote in *Fortune* magazine: "While training a whole generation of scientist-entrepreneurs, Terman had built up the prestige and quality of Stanford's engineering school to a level that attracted outstanding graduate students from all over the country. For more than a decade, Stanford has awarded more Ph.D.'s in electrical engineering than any other school, including M.I.T."

Finally, he was recognized in later years as a region builder, receiving much of the credit for the evolution of "Silicon Valley." He encouraged Stanford graduates like William Hewlett and David Packard to start companies in the Palo Alto area. Gene Bylinsky further wrote in the *Fortune* article that the concentration of 800 technology companies along the southwestern shore of San Francisco Bay "has created an innovative ferment on a scale without precedent in industrial history. No other center of advanced technology in the U.S. can match Santa Clara County's performance—and the buildup of creative technology in Santa Clara County was almost wholly the handiwork of Frederick Terman, an enthusiastic and inspiring teacher at Stanford."

Dr. Terman described the ideal relationship, which was achieved in the Stanford area, as a "modern community of scholars" whereby, through continuous cooperation and interchange of ideas between the university and its surrounding industry, an important intellectual community could arise that would encourage the growth of industry. He persuaded the university to create the Stanford Industrial Park, in which many of these firms were ultimately located.

He was active in national technical societies, including the Ameri can Institute of Electrical Engineers (AIEE) and the Institute of Radio Engineers (IRE), the two forerunners of the present Institute of Electrical and Electronics Engineers.

He was also elected to the top honorary societies. He was elected to the National Academy of Sciences (NAS) in 1946, and helped found the National Academy of Engineering in 1964. He was Chairman of the NAS Engineering Division during 1953-1956 and served on the NAS Council during 1956-1959. His other honorary memberships included Tau Beta Pi, Phi Beta Kappa, Eta Kappa Nu, and Sigma Xi. His social fraternity was Theta Xi, and he was a longtime member of the Bohemian Club in San Francisco.

He served as adviser to the U.S. Government in many important positions. During World War II he served the National Defense Research Committee and in Division 14 (Radar) and Division 25 (Electronic Countermeasures) of the Office of Scientific Research Development. In the important postwar period when the federal role in research and development was taking form as a continuing national commitment, he served as an adviser to the Department of Commerce (1946-1947), in the Department of Defense Special Technical Advisory Group (1950-1953), and in the Research and Development Advisory Committee of the U.S. Army Signal Corps (1954-1962). He was a member of the Naval Research Advisory Committee in 1956-1964, serving as Chairman in 1957-1958. He was a member of the Defense Science Board in 1957-1958. He served the National Science Foundation as a member of the Advisory Committee for the Division of Mathematical, Physical, and Engineering Sciences during 1955-1959 and as Chairman during 1958-1959. He served as a consultant to the President's Science Advisory Committee and was a Trustee of the Institute for Defense Analysis.

Dr. Terman's honors were many. He received honorary doctorates from Harvard, the University of British Columbia, and Syracuse University. Stanford University, which does not give honorary degrees, honored him in equivalent ways: the Herbert Hoover Medal in 1970 and the special designation of "Uncommon Man" in 1979. In 1956 the AIEE awarded him its first Education Medal. The IRE gave him the Medal of Honor in 1950 and the Founders Award in 1962. The ASEE awarded him the Lamme Medal and elected him in 1966 to the special grade of Honorary Member. Eta Kappa Nu made him an Eminent Member in 1951. For his service in Korea in founding a new graduate school in engineering and science, the government gave him the medal of the Order of Civil Merit in 1975. Finally, in 1976, President Ford conferred upon him the National Medal of Science.

As this writer can attest, having succeeded Frederick Terman at Stanford, it can truly be said that he erected a high platform upon which his successors could stand and from which they could see and reach farther than had been possible before.

Charles Allen Thomas

1900-1982

By Ralph Landau

CHARLES ALLEN THOMAS, Founding Member of the National Academy of Engineering (NAE), Life Member Emeritus of the Corporation of the Massachusetts Institute of Technology, and retired Chairman and President of Monsanto Company, died at the age of eighty-two at his winter home near Albany, Georgia, on March 29, 1982. In his passing, the Nation has lost one of its most distinguished scientists, a leader of the chemical industry, and a prominent figure in the development of atomic energy. We at the NAE have lost a towering member and staunch friend who had participated in the affairs of the Academy for twenty years.

Dr. Thomas was an articulate spokesman for basic research, higher education, and advanced technology, who gave generously of his time and talent to a variety of civic, medical, and educational organizations. In the mid-1960s, to broaden educational opportunities for residents of the St. Louis area, he led an unconventional campaign that persuaded area taxpayers to give over $47 million for the construction of a new junior college. In the years following his retirement from Monsanto in 1970, Dr. Thomas served as Chairman of the Board of Trustees of Washington University in St. Louis and led that university's fund-raising efforts for a decade.

Charles Allen Thomas was born in the bluegrass country of Kentucky on February 15, 1900. His father, whose name was also Charles Allen Thomas, was of Welsh descent and had come to America from Australia as a minister of the Disciples of Christ. He died when young Charles Allen was only six months old. The infant grew up with his mother, Frances Carrick Thomas, who was descended from Scotch-Irish forebears of early American stock and who lived to be ninety-four years of age.

The young Charles went with his mother to Lexington, Kentucky, to stay at his grandmother's home, which was across the street from Transylvania College. Charles Thomas's fascination with chemistry began at an early age. When a large explosion in his boyhood laboratory in a room back of the kitchen almost blew out the end of the house, Transylvania College professors invited the prodigy to use their laboratories. He was then thirteen years old.

Following his graduation from Transylvania College in 1920, the young man went to Massachusetts Institute of Technology (MIT) for graduate study, where he earned his master's degree in chemistry in 1924. He helped work his way through graduate school by singing professionally, and he seriously considered a career in music. He received a D.Sc. degree in organic chemistry from Transylvania College in 1933. He achieved fame in the scientific world when he was a young researcher for General Motors: he and Dr. Carroll A. (Ted) Hochwalt, another scientist who was later to achieve a leadership position in Monsanto, were part of a team credited with a significant role in the development of tetraethyl lead additive for gasoline. Later, Dr. Thomas helped develop a process that extracted bromine from seawater, thereby cutting the price of that product in half on world markets. He also made important contributions to the development of synthetic resins, synthetic styrene and rubber, and rocket propellants.

In 1926 the two men formed Thomas and Hochwalt Laboratories in Dayton, Ohio, where they conducted research for leading corporations. Their work there came to the attention of the late Edgar M. Queeny of Monsanto, who decided he wanted them in his firm. He bought their company and brought Dr. Thomas to St. Louis to direct Monsanto's research, while Dr. Hochwalt remained for a time in Dayton to spearhead the research that led to the development of Acrilan, Monsanto's man-made fiber.

When the two scientists joined Monsanto in 1936, the St. Louis chemical company was doing $34 million in annual sales. When Dr.

Thomas retired as Chairman in 1970, sales at Monsanto had reached $1.9 billion. "Now don't credit Ted and me with all the growth," Dr. Thomas once said. "Thousands of dedicated people at Monsanto share in the credit. And the same thing applies to the money raised during my chairmanship at Washington University."

Under Dr. Thomas's presidency, which began in 1951, Monsanto's investment in research rose from $6.2 million a year to $101.4 million. Asked about his approach to problem solving, Dr. Thomas commented, "I've made it a habit to listen to intelligent young people. It has been my experience you can learn as much from them as they can from you." An affable, gregarious man with a fine sense of humor but with penetrating insight into people, Dr. Thomas had a knack for communicating a genuine concern for others. This easy nature belied his inner drive and capacity for concurrent detailed projects. He was an effective bridge between the idea generators in the laboratory and the practical needs of the marketing organization of Monsanto. He held ninety-five U.S. and foreign patents. There is no doubt that he and Dr. Hochwalt made Monsanto into one of the true high-technology companies of the world. It is interesting to speculate whether an American corporation today would, should, or could make so fruitful and so long-range an acquisition as Edgar Queeny did for Monsanto.

Before and during World War II, Dr. Thomas was involved in the top-secret Manhattan Project that developed the atomic bomb. He was a member of the group that developed the final processes to purify plutonium, an essential radioactive element in the bomb. He spent considerable time shuttling from one secret scientific base to another, resolving differences and keeping the vital project in high gear. He was in the exclusive group of top scientists under Dr. Vannevar Bush and including others from MIT at Alamogordo, New Mexico, on July 16, 1945, when the new bomb was tested. He later deplored the U.S. resistance, in the face of vigorous growth of nuclear plants abroad, to the development of nuclear-powered electric-generating plants.

After World War II Dr. Thomas was one of the five coauthors of *A Report on the International Control of Atomic Energy,* prepared at the direction of the Secretary of State's Committee on Atomic Energy, and commonly known as the Acheson-Lilienthal Report. It proposed a master plan for the international control of atomic energy. The plan, however, was never universally accepted. He also wrote an important book, titled *Anhydrous Aluminum Chloride in Organic Chemistry,* a treatise that became the bible of chemists working with aluminum chloride reactions.

In 1951 he was appointed a member of the President's Science Advisory Committee by President Truman. This committee was later reactivated by President Eisenhower to report directly to him after the Sputnik episode. He was also a member of a group that advised Secretary Neil McElroy to establish an office associated with the Secretary of Defense to undertake advanced research projects. This came to be known as the Advanced Research Projects Agency (ARPA).

Dr. Thomas devoted the later years of his retirement to managing Magnolia Plantation, a 15,000-acre family farm near Albany, Georgia. The farm employed a staff of fifty people. As a long-time successful businessman, he made certain the farm operated profitably while producing peanuts, pecans, corn, soybeans, and an annual harvest of timber.

A major project financed by Dr. Thomas and some farming friends was a study at Washington University designed to boost the yield of food and oil from peanuts. Nearly half the world uses peanut oil for cooking and food. Thus, Dr. Thomas rationalized that anything that improves peanut growing not only aids this country's exports but also helps food and cooking oil supplies, particularly in Asia and Africa.

Dr. Thomas maintained that America did not spend enough money on basic research to keep abreast of other leading industrialized countries. To promote such research in his own field of chemistry, he donated $600,000 to Washington University to endow the Charles Allen Thomas Professorship of Chemistry.

In addition to having farming interests, Dr. Thomas was an avid hunter and superb marksman. He and his first wife, Margaret, were distinguished skeet shooters and raised and trained hunting dogs, especially Labrador retrievers. Dr. Thomas was also an airplane pilot.

An active member of the National Academy of Sciences and the National Academy of Engineering, Dr. Thomas received numerous academic, civic, and professional awards, including the Perkin Medal for the highest achievement in American industrial chemistry; the Palladium Medal of the Société de Chimie Industrielle; the Priestley Medal, the highest honor given by the American Chemical Society; the Industrial Research Institute Medal for outstanding achievement in administration of industrial research; the Deeds-Kettering Memorial Award; the Missouri Award for Distinguished Service in Engineering; the Golden Plate Award of the American Academy of Achievement; the American Institute of Chemists' annual Gold Medal in recognition of work in research administration; and the Eliot Society Award for distinguished service to Washington University. He served as President of the American Chemical Society in 1948. In addition, Dr. Thomas was named the *St. Louis Globe-Democrat's* Man of the Year in 1966. He received the Medal of Merit from President Truman, the highest civilian award bestowed by the United States, for his work on the Manhattan Project. He was also engaged in a number of other governmental activities. At various times he served as the Chairman of the Scientific Manpower Advisory Committee of the National Security Resources Board, a consultant to the National Security Council during the Eisenhower Administration, and U.S. Representative to the United Nations Atomic Energy Commission.

Dr. Thomas was a member of the American Philosophical Society, American Institute of Chemists, American Institute of Chemical Engineers, Chemical Society of London, National Citizens' Commission for the Public Schools, Washington Academy of Sciences, American Academy of Arts and Sciences, Electrochemical Society, American Chemical Society, Chemists Club of New York, Phi Beta Kappa, Sigma Xi, Alpha Chi Sigma, and the Cosmos Club of Washington, D.C.

He was a curator of Transylvania College, a Fellow of the American Association for the Advancement of Science, and a member of the Board of Governors of the National Farm Chemurgic Council. He served as a Board Member of the First National Bank of St. Louis, Metropolitan Life Insurance Company, Rand Corpora tion, St. Louis Union Trust Company, Southwestern Bell Telephone Company, and the Civic Center Redevelopment Corporation of St. Louis. He was a Trustee of the Universities Research Association, was a Founding Member of the National Academy of Engineering, and served as the first Vice-Chairman of the St. Louis Research Council.

Dr. Thomas was active on behalf of such organizations as Radio Free Europe, Boy Scouts of America, United Fund and United Community Campaigns of America, and, in St. Louis, the Herbert Hoover Boys' Club and the *St. Louis Globe-Democrat* Fund for Children. He was a long-time enthusiast and dedicated worker for the greater St. Louis United Fund. In the year during which he served as President—1963—the fund exceeded its quota and set a new collection record of $9,740,000.

Dr. Thomas held fourteen honorary degrees from the following U.S. colleges and universities: Washington University, St. Louis University, Princeton University, Brown University, University of Alabama, Ohio Wesleyan University, Lehigh University, University of Missouri at Rolla, Hobart College, Kenyon College, Transylvania College, Simpson College, Brooklyn Polytechnic Institute, and Westminster University in Fulton, Missouri.

Charles Allen Thomas inspired all who came in contact with him. He was a selfless man of great stature—a giant in the field of applied science and technology in the service of the people and the Government of the United States.

Dr. Thomas is survived by his wife, Margaret Porter Thomas, whom he married in 1980; one son, Dr. Charles Allen Thomas, Jr.; and three daughters, Mrs. Stephen O'Neil, Mrs. Theodore R. P. Martin, and Mrs. James A. Walsh. His first wife, Margaret Talbott, died in 1975.

Arthur Henry Waynick

1905-1982

By Eric A. Walker

ARTHUR H. WAYNICK, an internationally known scientist, engineer, and educator, died in London on August 31, 1982. He had retired in 1971 as Director and Founder of the Ionosphere Research Laboratory and Head of the Department of Electrical Engineering at the Pennsylvania State University. He had also been the first individual there to hold the A. Robert Noll Distinguished Chair in Electrical Engineering.

His long interest in communications engineering won him distinction in the field of the ionosphere. He may not have discovered the ionosphere (Kennelly and Heaviside guessed it was there about the time Arthur Waynick was born), but he and Appleton and Radcliffe, at the Cavendish Laboratory in Cambridge, first measured it, described it, and taught us how to use it. In 1948 he organized the Ionosphere Research Laboratory, which brought together a large group of experts to study the ionosphere. His expertise in the field led to involvement in the basic science aspects of the U.S. space program from its inception. Prior to his appointment to the Pennsylvania State University, Dr. Waynick served on the faculties of Wayne State, Harvard, and Cambridge universities.

He was born in Spokane, Washington, on November 9, 1905. His father's small hardware store was bringing slim returns in the 1921 depression, so the family pulled up stakes and moved to Detroit, answering an ad by Henry Ford offering jobs to mechanics at $5 per day. Art Waynick developed an interest in radio while he was still in grade school; he got his amateur license, 8AW, when he was only twelve years old. He was in contact with the airship *Shenandoah* as she was going down in the Pacific, and also communicated with the *Hindenburg,* which caught fire at Lakewood, New Jersey.

However, radio was expensive; he could ill afford the resistors, condensers, and those new vacuum tubes with which a transmitter could be built. Money was in such short supply that his uncle gave him some for a new suit for high school graduation. On that memorable day, however, his mother found him sitting in the audience instead of on the graduation platform—he had spent the suit money on a couple of UX 11s for his receiver!

He tried to save money for a college education by building radio receivers for a small manufacturer, but his money evaporated in the bank closings of the Depression. It took thirteen years, with his employer allowing him to work after classes from 3:00 P.M. to 11:00 PM., for him to put together enough credits to earn a B.S. in physics from Wayne State University in 1935. It is alleged that his knowledge far exceeded that of his instructors, and he was quickly signed on as an instructor in physics. At this time he met and married Lillian Wait, with whom he raised a family of three, two boys and a girl.

He was at Wayne State for two years, during which time he became interested in the propagation of high-frequency radio waves in the atmosphere. He received a Guggenheim Fellowship to study physics at Cambridge, and he went with great enthusiasm, anticipating that his studies would lead to a doctor's degree. His love of science was fulfilled by his study of the ionosphere in the Cavendish Laboratory with Appleton and Radcliffe, but all was interrupted by the start of World War II. His plans had to be changed, and he returned to the United States in 1939 and became an Assistant Professor of Physics at Wayne State University.

Another good opportunity appeared in 1940 when Ted Hunt was putting together what later became the Harvard Underwater Sound Laboratory, formed to do work on underwater sound for submarine detection. Joining that group allowed Arthur Waynick to have connections with the Cruft Laboratory and Professors Chaffee and Pierce and Mimno, who were also interested in radio propagation.

While at Harvard, he also received his Sc.D. in communications engineering in 1943.

The Harvard Underwater Sound Laboratory was asked to work on the development of an acoustic homing torpedo, and Art's electronic knowledge was extremely valuable. He devised a biaural listening system and a servomechanism that would allow the torpedo to steer toward an acoustic target. This later led to the first of the acoustic torpedoes, which was launched from an airplane to drop into the water and then, turning on its steering and propulsion mechanisms, pursue a rapidly moving submarine. This was one of the devices that broke the back of the submarine menace in World War II and led to the formation of the Ordnance Research Laboratory, which still serves the Navy from Pennsylvania State University. Dr. Waynick became the Assistant Director in charge of electronics at that laboratory.

In 1945 he was able to establish the Ionosphere Research Laboratory at Penn State, dealing with his original interests. This laboratory, still in existence, deals with the propagation of radio waves through the ionosphere. Its organization and scientific objectives were laid out by Dr. Waynick in the late 1940s, and they are still being followed. The laboratory is a source of much valuable scientific information and has proved to be the educational vehicle by which many scholars have obtained their doctor's degrees.

Some of his important contributions included participation in the design, construction, and operation of numerous ground-based and rocket systems for the exploration of the Earth's upper atmosphere, particularly in the ionospheric D-region (50-90 kilometers in altitude). These studies resulted in the first definitive models of Dregion ionization and provided a new basis for the prediction of long-distance radio propagation by the National Bureau of Standards. They have also greatly improved the understanding of radio blackouts associated with solar flares and nuclear explosions, to mention a few.

Work also included the design and construction of facilities for the first long-wave pulse sounding of the lower ionosphere; planning and construction of the only combined phase and amplitude wave-interaction facility in the world for D-region studies; the first rocket experiments involving radio propagation measurements between the rocket and a separating capsule; and the development of parachute-borne blunt probes released from ARCAS rockets for the study of the D-region. The laboratory has also been prolific in presenting papers throughout the world, in publishing papers, and in issuing engineering and scientific reports.

While this was the mainstream of his career, there were many side tracks. He was the Program Director for Engineering Science in the National Science Foundation for two years, and because of his international connections, it was natural for him to finish his active career by serving as a Liaison Scientist with the Office of Naval Research in London, England.

Possibly the most important work he did was as a Delegate from the United States to the conferences of the International Scientific Radio Union. He attended conferences in The Hague, Sydney, London, and Tokyo and was made an Honorary Member of the U.S. National Committee of the International Scientific Radio Union.

He served on a number of committees for the National Science Foundation and the National Research Council. He was invited by the Space Science Board of the National Academy of Sciences to assist the National Aeronautics and Space Administration in reviewing the applications of candidates for science astronauts. He did committee work for the Institute of Radio Engineers and was a Director of the Institute of Electrical and Electronics Engineers.

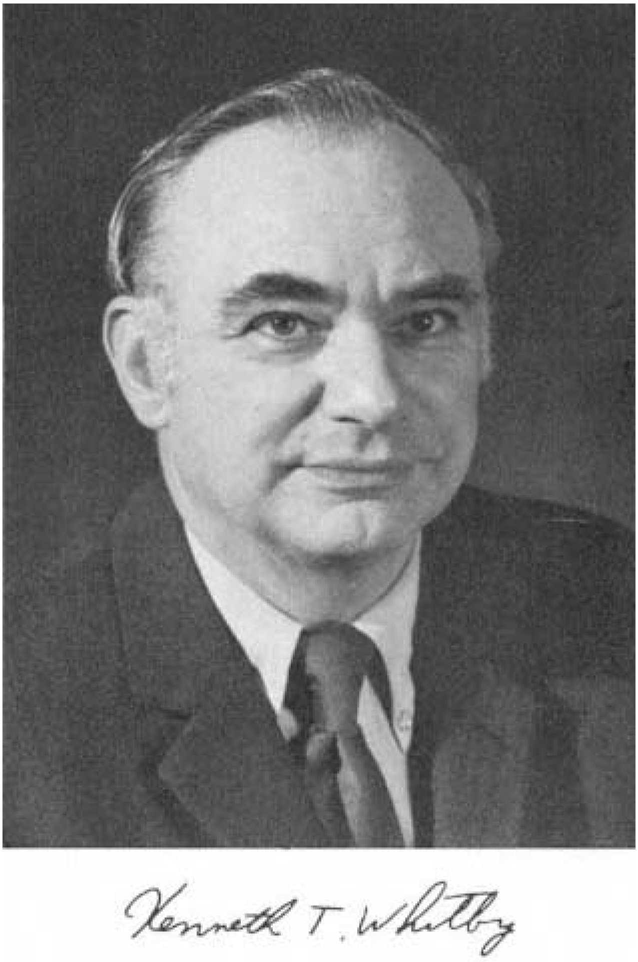
He was a writer on a wide range of subjects, including articles on engineering education as well as technical papers on the ionosphere in both the technical press and in more popular magazines. He served as the Associate Editor of *the Journal of Geophysical Research* as well as *the Journal of Research* of the National Bureau of Standards.

He received many honors and was a Fellow of both the Institute of Electrical and Electronics Engineers and the American Geophysical Union. He became a member of the National Academy of Engineering in 1969.

Although Arthur Waynick was a native-born American and a very loyal one, his years in England made a great impression on him. To most of his friends he was the epitome of a true English gentleman, speaking like an Englishman and gradually falling into the ways of the English. Much of his time in retirement years was spent in a cottage he owned in Cambridge, England.

None of his friends will forget his courtly bow on being introduced, or his smile and inquiring nod, which said that to him you were an important person. Who will ever forget his pipe, always being lighted but never lit? He was the personification of Mr. Chips, the thoughtful, kindly, studious professor, surely not of science, one might think, but rather of English literature or some other gentlemanly discipline. But his quiet penetrating questions on the facts opened windows that showed the correct way to even the most belligerent adversary.

He takes his place with the illustrious people who have individually contributed so much to the benefit of society. His friends and former students are establishing an annual Waynick Lecture Series on the ionosphere in his memory.


Kenneth T. Whitby

Kenneth T. Whitby

1925-1983

By Sheldon K. Friedlander

KENNETH T. WHITBY died at the University of Minnesota Hospital on November 14, 1983. At the time of his death he was Professor and Chief of the Environmental Division, Department of Mechanical Engineering, University of Minnesota. The Particle Technology Laboratory, which he established at the University of Minnesota, is an internationally known center for research on aerosols.

Professor Whitby's experimental skills, remarkable physical intuition, and knack with instrument design played a key role in making the study of the behavior of particles in gases (aerosols) into a science. Before his pioneering work little was known of aerosol particle size distributions in the range below a few micrometers. The instruments that he developed made it possible for the first time to measure particle size distributions from 0.01 to 3 micrometers on a continuous, almost real-time basis. He applied the instruments to the study of atmospheric aerosols, where they have become standard. Later, similar instrumentation was applied to the study of gasoline and diesel exhausts, power plant plumes, and coal combustion gases by Professor Whitby and co-workers and by other groups. The results of these studies have had much influence on air quality and emission standards for particulate matter.

Kenneth Whitby was born in Fond du Lac, Wisconsin, on February 6, 1925. He received his B.S. in naval technology in 1946 and his Ph.D. in mechanical engineering in 1954, both from the University of Minnesota. After a period as Research Associate, he was appointed Assistant Professor of Mechanical Engineering in 1958, Associate Professor in 1962, and Professor in 1966. He became Chief of the Environmental Division in Mechanical Engineering in 1971.

Kenneth Whitby's interests in airborne particles were stimulated through contacts with local milling companies in Minneapolis in the late 1940s. His first archival publication was entitled "Measurement of Particle Size Distributions of Flour," and his interest in aerosol size distributions continued throughout his research career.

During the mid- to late 1950s he worked with other researchers in the Environmental Division of the Department of Mechanical Engineering on aerosol problems important in heating, ventilation, and air conditioning systems. Techniques for evaluating the performance of air cleaners and filters were developed. During this period he also completed a study of indoor aerosols.

During the 1960s Professor Whitby became interested in extending the measurement of aerosol size distributions into the submicrometer range. Studies on electrical charging and classification of aerosols were initiated, and this led to the development of the Whitby Aerosol Analyzer (the forerunner of a widely used commercial electrical aerosol analyzer).

The last major research effort in his career was a series of pioneering studies of atmospheric aerosols. He was a key participant in the 1969 Los Angeles Aerosol Characterization Study—the definitive study of photochemical smog aerosols. Innovations in this project involved the organization of an interdisciplinary team for an intensive smog aerosol study and the application of state-of-the-art instrumentation to measurements of ambient aerosols. This study served as a model for similar air pollution studies throughout the 1970s, in many of which Professor Whitby and his colleagues and students participated. Using the electrical aerosol analyzer in combination with other instruments, he and his students discovered the characteristic trimodal nature of ambient aerosols. The concepts of nuclei, accumulation, and coarse particle modes that he introduced have been adopted by many workers in the field.

Professor Whitby published widely. He held four patents and served on many national committees, including the Advisory Com mittee for the Chemistry and Physics Division of the U.S. Environmental Protection Agency (1974-1976), the Working Group 1 of a Bilateral Environmental Agreement between the United States and the USSR (1973-1976), among others. He was elected to membership in the National Academy of Engineering in 1978 and was a member of the National Research Council Committee on Chemical and Biological Sensor Technology at the time of his death.

Professor Whitby was deeply committed to his family and to his church activities. He had numerous personal interests and skills, including photography, woodworking, canoeing, and model airplane building. He lived a fruitful, happy life and will be missed by his many friends and colleagues here and throughout the world.

Warren E. Winsche

1917-1983

By Herbert J. C. Kouts

WARREN E WINSCHE died on June 19, 1983, at his home in Bellport, New York. At the time of his death, Dr. Winsche was Deputy Director of Brookhaven National Laboratory, a position that he had occupied for four years.

Dr. Winsche had a constantly inquiring mind that found new challenges and discovered fresh solutions in technical problems ranging over a wide variety of fields. He was a chemist by training, and he made important contributions to chemistry and chemical engineering. He also developed new approaches that influenced many other fields of science and engineering—he was led into these fields by his curiosity and his evolving technical and managerial responsibilities.

At the same time he had a penetrating insight into the human side of the people with whom he worked, and he was sensitive to the needs of individuals as human beings. He found special pleasure in solutions to complex blends of technical and personal problems, solving at once both kinds of difficulty. He was especially interested in assisting women and members of minority groups into careers in science from which they might otherwise have been barred by cultural influences.

Warren Winsche was born in Brooklyn, New York, on January 26, 1917. He grew up in Brooklyn and received his B.S. in chemical engineering in 1939 from the Polytechnic Institute of Brooklyn. He then continued at the University of Rochester where he was awarded an M.S. in 1940 and at the University of Illinois where he was awarded a Ph.D. in chemical engineering in 1943.

From 1943 to 1945 he was a member of the National Defense Research Council. He worked at the University of Illinois and at the Edgewood Arsenal on problems in chemical warfare. In 1945 he went to the Clinton Laboratories of the Manhattan Project, now the Oak Ridge complex of laboratories of the U.S. Department of Energy. There he was Group Leader for Chemical Processes, a position that permitted him to apply deep insight into the value of modern countercurrent chemical processes to the development of new, efficient methods of reprocessing spent fuel from nuclear reactors.

In 1946, seeing new challenges in the design of the world's first peacetime nuclear research reactor at Brookhaven National Laboratory, he joined the staff of that infant institution. He profoundly influenced the design of this new graphite-moderated reactor through his unique ability to see novel solutions to technical problems. His principal innovations were a fuel element design and a split-flow cooling circuit that were important in raising the power and the available neutron flux by an order of magnitude over those previously achieved in research reactors.

During this period he also conceived of a method of generating short-lived radionuclides by separation from their long-lived parents. This principle is the basis for an array of generators of active isotopes, particularly the Te-I generators of 1-132, which today are the backbone of nuclear medicine. About 80 percent of radioisotope patient administrations (about 10 million per year) are made with pharmaceuticals using radioiodine from these generators.

In 1951 he joined the Atomic Energy Division of E. I. duPont de Nemours. He became a Senior Research Supervisor and, later, Research Manager of the Chemical Separations Division for the Savannah River production facilities. There he originated an ion exchange process using stirred bed ion exchange equipment that became the basis for large-scale production of Pu-238 by remote control methods, requiring only limited shielded space. Later this made possible the wide use of Pu-238 in electrical power generators used for space missions. He also developed centrifugal extractors that reduced the in-process time required for chemical treatment of spent nuclear fuel from the Savannah River operations. This sub stantially reduced irradiation of the solvent, the key feature of successful Savannah River use of the Purex process.

Dr. Winsche returned to Brookhaven National Laboratory in 1962 and became Chairman of the Department of Nuclear Engineering. In this broader capacity his inventive mind found scope in many directions at once. He conceived of several possible new versions of plutonium-fueled breeder reactors based on the potential for high breeding gain that might be offered by carbide or metallic fuels. These concepts opened the possibility of reducing or eliminating the need for intermediate fuel reprocessing. He was a pioneer in focusing attention on hydrogen as a fuel of the future, and he developed a simple means of storing large amounts of hydrogen in small spaces at low pressures, based on use of metal hydrides. He developed an early interest in surface chemistry with applications to new catalysts and to biological processes.

In 1975 he became Associate Director of Brookhaven for Energy Programs, and in 1979 he became Deputy Director of the laboratory, a position he held at his death.

Dr. Winsche wrote numerous unclassified and classified publications based on his innovative ideas, including a description in *Nucleonics* (March 1951) of his I-132 generator and an article in *Science* (June 29, 1973) laying out his views on use of hydrogen as a future fuel in the Nation's energy economy. He held ten unclassified patents and a number of classified ones.

He was a Fellow of the American Nuclear Society, a member of the American Association for the Advancement of Science, Director of the Long Island Forum for Technology, a member of the editorial board of *Annals of Nuclear Energy* (Pergamon Press), and a member of the Energy Committee of the Long Island Association. He was elected to the National Academy of Engineering in 1982.

One of Warren Winsche's most distinctive characteristics was his constant questioning of problems and solutions to find out if questions had better answers or if conditions affecting old answers had changed enough to merit reconsideration.

He was a pioneer in the development of nuclear energy and left his mark on many aspects of the technology in this field. Because he was constantly looking to the future and addressing problems that he anticipated, his influence will continue to be felt in future years.

Richard L. Woodward

1913-1981

By Gordon G. Robeck

RICHARD L. WOODWARD, consulting engineer and a former Vice-President of Camp, Dresser and McKee, Inc., of Boston, died at the age of sixty-seven on March 15, 1981. He had served for many years as a highly effective leader of government environmental engineering research and as a private consultant throughout the world. Because of his total dedication to knowledge and to its practical application to solving water supply problems, his influence will continue for many years among researchers and designers.

Born in Kansas City, Missouri, on December 11, 1913, Dr. Woodward received his B.S. degree in civil engineering from Washington University, St. Louis, in 1935; his M.S. degree in sanitary engineering from Harvard University in 1948; and his Ph.D. in nuclear physics from Ohio State University in 1952.

After working briefly with a consulting firm in St. Louis, Dr. Woodward joined the U.S. Public Health Service in 1937, where he served with distinction for twenty-six years. His assignments took him to Washington, D.C., Atlanta, and Cincinnati, and they usually emphasized engineering problems associated with water quality and resources. Analysis and interpretation of data plus the writing of clear, concise reports were his strong points in these early days of his career. The famous *Ohio River Water Pollution Investigation Report* is just one example of a major contribution that he made to the understanding of stream sanitation. Later, in the 1950s, after he finished a special study period in nuclear physics, he became a national leader in the research designed to help form the scientific and technical basis for the revised U.S. Drinking Water Standards. To accomplish this he effectively developed a staff of researchers of various disciplines that worked harmoniously as a team mainly because of his quiet devotion to knowledge and his openness to suggestions from all staff members.

The revised Drinking Water Standards were issued in 1962, and he then retired from the U.S. Public Health Service as a Sanitary Engineer Director in 1963. After a few years as a Senior Research Associate at the Harvard School of Public Health, he joined the consulting firm of Camp, Dresser and McKee in Boston for the next fifteen years, spending much of the time as Vice-President of International Affairs. While he was there, some of his most notable work included the water treatment plant in Bangkok, one of the world's largest; the advanced wastewater treatment plant for Greater Chicago; a water supply and sewerage master plan for Alexandria, Egypt; and water treatment plants for Taipei, Singapore, Manila, Bogota, and Istanbul.

Dr. Woodward was an active member of nine professional societies and a dozen prominent technical committees. He became a member of the National Academy of Engineering in 1977. He served as a Representative of the American Society of Civil Engineers to the U.S. Environmental Protection Agency's Committee on Federal Drinking Water Standards. He was a Diplomate of the American Academy of Engineering. He served on the panel on Public Water Supplies for the Committee on Water Quality Criteria of the National Academy of Sciences. He was also a member of the Subcommittee on Water Supply of the Committee on Sanitary Engineering of the National Research Council from 1955 to 1964.

The author of more than forty papers on water and wastewater in professional journals, he received the Thomas R. Camp Medal of the Water Pollution Control Federation, the Research Award of the American Water Works Association, the Clemens Herschel Award of Harvard University, and the Meritorious Service Medal of the U.S. Public Health Service. Some of his prize-winning papers involved unique treatment of water to control organic contaminants, algae, viruses, and other pathogens. He and his team members enriched the literature on the subject of better public health through the application of engineering principles to waste and water quality control.

Dr. Woodward was able to do this quietly because of a unique ability to lead a multidisciplinary group of scientists and engineers by the force of his intellect and knowledge rather than by virtue of rank or position. He truly opened the gates for staff members to contribute their own ideas and then arranged for their professional involvement and growth outside the organization. The team spirit was outstanding. Although occasionally ill in recent years, Dr. Woodward continued his search for recent research findings and their application into designs wherever it was practical throughout the world.

Many of the suggestions he made for understanding and correcting environmental problems are still being followed, so his pace setting will remain of great influence in public health practice. No person could be expected to do more: He served his country and profession with distinction.

Photograph by Fabian Bachrach.

James Frederick Young

1917-1980

By Francis K. McCune and Arthur M. Bueche

JAMES F. YOUNG, Vice-President of Technical Resources for the General Electric Company, died in Greenwich, Connecticut, on November 22, 1980. His entire professional career was spent at General Electric, and he was personally involved in the design and manufacture of many company products. He influenced the education and professional development of many students and engineers and, by his own example, demonstrated his conviction that an engineer should participate in technical society and government affairs.

Born on January 4, 1917, in Philadelphia, Pennsylvania, he received his B.S. degree in mechanical engineering from Lafayette College in 1937. He graduated with honors and was a member of Tau Beta Pi, Phi Beta Kappa, and Alpha Phi Omega fraternities. That same year he was hired by General Electric and enrolled in its three-year Advanced Engineering Program, which he later supervised. He developed a broad interest in education and, in particular, in ways to aid the transition of young graduates from an academic environment to the application of engineering to solve real problems.

In 1940 he started the Creative Engineering Course, which emphasized innovative, ingenious, but practical approaches to design as a supplement to other classes in mathematical analysis; this was probably the first such course in the country. He edited *Materials and Processes,* published in 1944, which was based on the background information developed for that course, and demand justified a revised edition in 1954. Prior to his death he had been assisting in the preparation of the third edition of this book.

After several years of administering and developing educational programs, Jim Young transferred to the Appliance and Merchandise Department. When consumer goods work was cut back during the war in favor of defense work, he was the engineer responsible for rocket launchers and torpedo gyroscopes. Postwar design of washing machines, refrigerators, freezers, and air conditioners gave him a lasting appreciation of the importance of recognizing and fulfilling the needs of customers. It was during this period that he obtained most of the twenty patents granted him.

In 1953, in his new position as Consultant to the Vice-President of Engineering, Jim Young had his first opportunity to become acquainted with the technology requirements for all of General Electric. Another broadening experience occurred in 1958 when he was appointed General Manager of the General Engineering Laboratory, which worked on critical technical problems throughout the company.

Although he later enjoyed a very wide scope of technical business responsibilities, energy became his dominant personal interest. In 1960 his work as General Manager, Electric Utility Systems Engineering, familiarized him with utility requirements both domestically and abroad. In 1963 he was appointed General Manager of the Nuclear Energy Division during a critical and exciting time in the history of nuclear energy. Feasibility had been demonstrated by plants such as Dresden I, and the next phase, and Jim Young's job, was the implementation of a technical and business program that would lead to a line of practical, commercially competitive nuclear plants by the late 1960s. The variety of new considerations was formidable: soundness of concepts, need for new techniques and procedures, understanding of behavior of materials and fastenings under intense radiation, safety and reliability assurance, control, and integration with utility systems—all of these, coupled with the long time required to verify critical hypotheses, presented a succession of unique challenges. During this period, he became, and remained, convinced of the practicality, safety, and need for nuclear power in this country and worldwide.

After election as Vice-President and with the nuclear development well under way, Jim Young became Vice-President of Engineering for General Electric in 1966. With an opportunity for broad corporate long-range thinking and planning, he encouraged developments in the fields of gas turbines, aircraft jet engines, diesel engines, steam turbines, combined cycles, and solar power. He emphasized energy conservation in the design of more efficient energy-using equipment and also in more efficient generation. He continued his previous interests in less conventional methods of energy conversion, such as magnetohydrodynamics, thermoelectrics, thermionics, wind, and tides.

Jim Young was often asked to testify to congressional committees and government and state agencies on various aspects of energy. In his words, he felt an obligation, as a good corporate citizen, to share with them his experience and judgment and to do so as completely and thoroughly as possible. In addition to his knowledge and competence, two other factors were said to be important in establishing his reputation as a credible, expert witness: he never talked down to his audience, and he showed his sincere desire to help. These were not qualities he adopted for such occasions; they were inherent in his character.

Other aspects of his broad responsibilities included company policies on product quality, product safety, and product service. Still others were standardization, metrification, and environmental protection. When he was asked to give testimony to committees and agencies on these subjects, he especially tried to present balanced judgments on the wisdom and practicality of regulations and codes.

In 1963 he was granted an honorary doctorate by Lafayette College. In 1967 he was elected to membership in the National Academy of Engineering and served on several committees. He was President of the Atomic Industrial Forum, 1966-1968, and was an honorary Director at the time of his death. He served on the Materials Advisory Board of the National Research Council, he was Chairman of the National Research Council's Committee on Mate rial Requirements Criteria for Advanced Design, and he was a Board Member of the National Safety Council. Additionally, he was a member of the Institute of Electrical and Electronics Engineers, a member of the National Society of Professional Engineers, and a Fellow of the American Society of Mechanical Engineers.

His early interests in education continued with service as a member of the Board of Trustees of Lafayette College, a member of the Corporation of the Polytechnic Institute of New York, and a Trustee of Clarkson College of Technology. He enjoyed direct involvement with young people, guiding, stimulating, and aiding them in their own professional development. One of his great contributions to engineering was his encouragement of young engineers to think and act like professionals and his discouragement of unionism as a restraint on the scope and depth of an engineer's activities.

The advancement and application of technology were Jim Young's life work, but privately, architecture fascinated him, and he developed real competence in that field. He designed homes for his family and for several friends. He was always happy to discuss and improve house plans for his acquaintances and, because of his typical high enthusiasm, some friends learned more about architecture than they had thought they needed to know.

He had outstanding engineering and management capabilities, as shown by the numerous important positions he held within the General Electric Company. However, in many ways he was much more than a competent engineer and manager. He combined the generation of innovative ideas, a great depth of engineering knowledge, and an understanding of customer requirements with the ability to apply them to practical ends. He had a unique ability to analyze complex problems and present ideas for their solutions. He could communicate with others in such a way as to stimulate their enthusiasm and help them to apply their creative ideas to the manufacture of products and systems. His major contributions were made through others and were often unknown to his associates and to the engineering community at large. And he was quite happy to have it that way.

An illuminating image of Jim Young was revealed during the preparation of this tribute. When former co-workers were asked about him, their replies invariably emphasized him as a person. Typical descriptions were that he understood engineers' concerns; that he was always ready to listen, accessible, and fair; that he developed people and stimulated associates; that he knew what he was talking about; and that, as a General Manager, he emphasized good engineering.

The more tangible accomplishments were remembered and recognized, but his friends remembered more vividly his genuine and deep personal relationships, his stimulating personality, his emphasis on integrity, his desire to help, and above all, his great warmth.

Vladimir Kosma Zworykin

1889-1982

By James Hillier

VLADIMIR K. ZWORYKIN, often called the father of television, died in Princeton, New Jersey, on July 29, 1982. At the time of his death, Dr. Zworykin held the special title of Honorary Vice-President of the Radio Corporation of America (RCA), having officially retired in 1954 as Vice-President and Technical Consultant to RCA Laboratories.

Dr. Zworykin was one of the giants among the early architects of our electronic age. While he always shrugged off his designation as the father of television, nevertheless his inventions and developments during the 1920s brought the concept of electronic television within the range of practicality and provided the technical foundations for all modern television systems. His "flash of genius" was the combination of electron beam scanning and the concept of signal storage at the picture element level in an image sensor he named the "iconoscope." His signal storage concept made it possible for the level of illumination required on the subject to be reduced by several orders of magnitude and, for the first time, to be brought within a practical range.

Dr. Zworykin was much more than an inventor. He was a visionary who dedicated much of his career to using technology to extend the human senses. He was a leader with an extraordinary ability to select competent research workers and then to inspire them to perform at levels far beyond their own expectations. While he never assumed the role of entrepreneur, he was a very persuasive exponent of the value of electronics technology to the entrepreneurs of his time.

Born in Mourom, Russia, in 1889, Dr. Zworykin received his undergraduate education at the Petrograd Institute of Technology, graduating with the degree of electrical engineer in 1912. At the institute he met and worked with Professor Boris Rosing, who, as early as 1906, believed that cathode-ray tubes would ultimately provide the solution to practical television. By the time Dr. Zworykin left the institute, he took with him an intense conviction that Rosing's thesis was the one to pursue.

In 1912 Dr. Zworykin entered the College de France in Paris, where he engaged in X-ray research under Paul Langevin. These studies were interrupted by World War I when he had to return to Russia to serve as an officer in the radio communications branch of the Russian Army. The disruption and confusion caused by the Russian Revolution ultimately resulted in his arriving in the United States in 1919.

Soon after arriving here, he joined the research staff of the Westinghouse Electric and Manufacturing Company where he undertook research on photoelectricity. In reality, and largely on his own initiative, he was continuing the development of electronic television. While he appears to have had the freedom to do this, it also seems clear that the management had little enthusiasm for the future of the work. While at Westinghouse he was also a graduate student at the University of Pittsburgh, where he acquired his Ph.D. in 1926.

His association with RCA came as the result of a corporate rearrangement. It began in 1929 when he was transferred to RCA as Director of the Electronic Research Laboratory in Camden, New Jersey.

By the time of his transfer to RCA, Dr. Zworykin had developed working versions of his iconoscope and had demonstrated a television receiver incorporating his "kinescope," a cathode-ray display tube embodying the concepts that are still fundamental to all modern picture tubes. At RCA he found a kindred spirit in David Sarnoff, who could provide both the entrepreneurial expertise and the financial support that were needed to complement his technical achievements and bring television to the general public.

Throughout his working career Dr. Zworykin never lost interest in the key elements of the television system. His laboratory was the source of a stream of major developments that continually enhanced the performance of both the pickup tubes and picture tubes. Of particular note among these were the "Image Orthicon" that provided another major improvement in the sensitivity of the pickup tube; the "Vidicon" that led to compact, portable, and inexpensive television cameras for all purposes; and the "shadow-mask" concept that is fundamental to the operation of every type of picture tube used in present-day color television receivers.

As Dr. Zworykin's influence and staff grew, his interests also broadened, but they always did so within his central theme of using technology to extend or aid human senses. Among the diverse products of his laboratory in this facet of his career were infrared image tubes that became the key elements in "Snooperscopes" and "Sniperscopes," used primarily in military operations; television systems for the remote guidance of aerial torpedoes; secondary emission photomultipliers that were ultrasensitive photocells with a multitude of applications; and the electron microscope. Each was a major contribution in its field.

Dr. Zworykin's recognition of the potential of the electron microscope led to his support of its development from a laboratory demonstration to a readily available commercial instrument. Also, his observation of the impact of the electron microscope on biological and medical research inspired him to dedicate his retirement years to developing interdisciplinary cooperation between physical and life scientists.

As a by-product of such extensive technical achievements, Dr. Zworykin was the holder of more than 120 patents, the author or coauthor of 4 monographs and innumerable technical papers, a fellow or member of all the relevant technical societies, and the recipient of a large number of significant awards, only a few of which are mentioned here. He was a member of the National Academy of Sciences and was among the earliest group to be elected to the National Academy of Engineering in 1965. Among his more outstanding awards were Chevalier of the French Legion of Honor (1948), the Faraday Medal of the British Institution of Electrical Engineers (1965), the U.S. National Medal of Science (1966), the

Founders Medal of the National Academy of Engineering (1968), and induction into the National Inventors Hall of Fame (1977).

In his professional career his dedication to technical work and to the future was exclusive and absolute. Invitations to serve on committees were invariably refused, but his response was usually accompanied by an offer of the services of a very appropriate member of his staff. His climb through the management ranks at RCA was more honorific than real. He never allowed his management responsibilities to grow to the point where he could no longer give individual, personal attention to the members of his staff. At the same time, he was a very human and compassionate individual, always ready to help members of his staff solve their personal problems.

In his personal life Dr. Zworykin was one of those rare individuals who truly "left his job at the office." He was a thoughtful and considerate husband and father and a frequent and gracious host. He enjoyed a wide range of nontechnical personal interests and had numerous friends who paralleled those interests: writers, artists, musicians, philosophers, and politicians. Many were leaders from the immigrant Russian community. Then there were hunting companions, tennis partners, and more. He was a dedicated hunter, and at home he was always accompanied by a well-trained bird dog. To be his friend was an enlightening and exhilarating experience.

Dr. Zworykin has passed on. He died a happy man, having lived long enough to see the realization of his early great vision—to have technology take our eyes where our bodies cannot follow. While the profuse ramifications of the technology he initiated are still unfolding, it is clear that the whole world is already much richer for his having lived.

Appendix

Members	Elected	Born	Deceased
Turner Alfrey, Jr.	1977	May 7, 1918	August 10, 1981
Benjamin B. Bauer	1974	June 26, 1913	March 31, 1979
Samuel S. Baxter	1970	February 6, 1905	February 7, 1982
Arthur M. Bueche	1974	November 14, 1920	October 22, 1981
Stanley W. Burriss	1968	July 15, 1910	March 22, 1979
Henri G. Busignies	1966	December 29, 1905	June 20, 1981
Joseph M. Caldwell	1973	December 19, 1911	December 21, 1980
Arthur Casagrande	1966	August 28, 1902	September 6, 1981
Ven T. Chow	1973	August 14, 1919	July 30, 1981
William H. Corcoran	1980	March 11, 1920	August 21, 1982
Kurt H. Debus	1975	November 29, 1908	October 10, 1983
Raymond L. Dickeman	1978	August 9, 1922	March 12, 1983
Joseph R. Dietrich	1975	August 25, 1914	November 4, 1982
Donald W. Douglas	1967	April 6, 1892	February 1, 1981
Charles F. Fogarty	1976	May 27, 1921	February 11, 1981
John C. Frye	1971	July 25, 1912	November 12, 1982
Edward J. Gornowski	1971	February 27, 1918	December 19, 1983
Floyd L. Goss	1979	August 25, 1907	December 25, 1980
Patrick E. Haggerty	1965	March 17, 1914	October 1, 1980
Gail A. Hathaway	1979	October 11, 1895	October 1, 1979
Alfred Hedefine	1973	March 9, 1906	January 26, 1981
Beatrice Hicks	1978	January 2, 1919	October 21, 1979
Solomon C. Hollister	1973	August 4, 1891	July 6, 1982
Goro Inouye	1977	August 16, 1899	November 18, 1981
John D. Isaacs III	1977	March 28, 1913	June 6, 1980
Wendell E. Johnson	1970	September 23, 1910	February 26, 1982
Thomas F. Jones	1969	July 9, 1916	July 14, 1981
Percival C. Keith, Jr.	1968	December 24, 1900	July 9, 1976
Fazlur R. Khan	1973	April 3, 1929	March 27, 1982
John Laufer	1977	September 22, 1921	July 9, 1983
Joseph C. Lawler, Jr.	1973	May 3, 1920	November 18, 1982
Donald P. Ling	1967	January 2, 1912	July 14, 1981
Edwin A. Link	1965	July 26, 1904	September 7, 1981
William K. Linvill	1979	August 8, 1919	August 17, 1980
Heinrich Mandel	1976	August 11, 1919	January 24, 1979
John W. Mauchly	1967	August 30, 1907	January 8, 1980
Warren L. McCabe	1977	August 7, 1899	August 24, 1982
James S. McDonnell	1967	April 9, 1899	August 22, 1980

Members	Elected	Born	Deceased
Jack E. McKee	1969	November 9, 1914	October 22, 1979
Alexander C. Monteith	1965	April 10, 1902	September 17, 1979
Nathan M. Newmark	1964	September 22, 1910	January 25, 1981
Ianiel E. Noble	1968	October 4, 1901	February 16, 1980
John K. Northrop	1979	November 10, 1895	February 18, 1981
William Prager	1965	May 23, 1903	March 16, 1980
Perry W. Pratt	1967	January 10, 1914	January 6, 1981
Frederick D. Richardson	1976	September 17, 1913	September 8, 1983
Hubert Rüsch	1977	December 13, 1903	October 17, 1979
Otto H. Schade, Sr.	1977	April 27, 1903	April 28, 1981
Ernest E. Sechler	1979	November 17, 1905	August 14, 1979
William E. Shoupp	1967	October 12, 1908	November 21, 1981
Carl R. Soderberg	1974	February 3, 1895	October 17, 1979
Frederick E. 'Irman	1964	June 7, 1900	December 19, 1982
Charles A. Thomas	1964	February 15, 1900	March 29, 1982
Arthur H. Waynick	1969	November 9, 1905	August 31, 1982
Kenneth T. Whitby	1978	February 6, 1925	November 14, 1983
Warren E. Winsche	1982	January 26, 1917	June 19, 1983
Richard L. Woodward	1977	December 11, 1913	March 15, 1981
James F. Young	1967	January 4, 1917	November 22, 1980
Vladimir K. Zworykin	1965	July 30, 1889	July 29, 1982

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