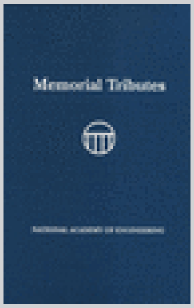

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OF THE
UNITED STATES OF AMERICA

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FOREWORD

THIS IS THE SIXTEENTH VOLUME in the series *Memorial Tributes* compiled by the National Academy of Engineering as a personal remembrance of the lives and outstanding achievements of its members and foreign associates. These volumes are intended to stand as an enduring record of the many contributions of engineers and engineering to the benefit of humankind. In most cases, the authors of the tributes are contemporaries or colleagues who had personal knowledge of the interests and the engineering accomplishments of the deceased.

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

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

Thomas F. Budinger
Home Secretary

Memorial Tributes

NATIONAL ACADEMY OF ENGINEERING

Irving Ashkinas

IRVING L. ASHKENAS

1916–2011

Elected in 1992

"For leadership in flying qualities theory and practice, and for contributions to flight control systems and aerospace vehicle system design."

BY TOM MYERS AND WADE ALLEN
SUBMITTED BY THE NAE HOME SECRETARY

IRVING L. ASHKENAS, distinguished aerospace engineer and cofounder of Systems Technology, Inc., passed away peacefully at his home in Los Angeles, California, on April 10, 2011. He was 94 years old. Ashkenas was born in New York City on September 3, 1916, the son of Max and Rose Ashkenas.

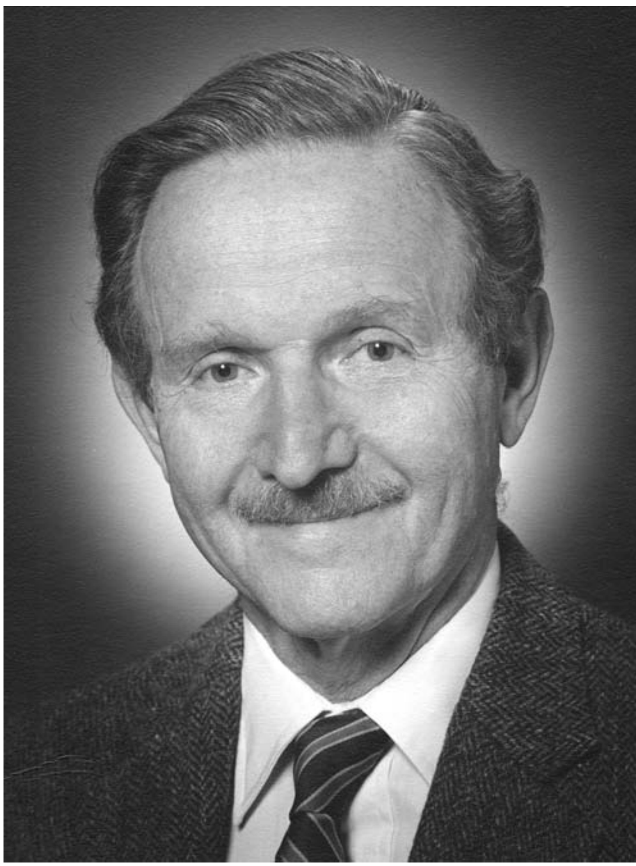
Irving Ashkenas attended the California Institute of Technology, where he earned his bachelor of science degree and two master's degrees and graduated with honors in 1939. His professional career began at North American Aviation, where he played a key role in the development of the P-51, one of the most famous aircraft of World War II. The original design was prone to overheating, and Ashkenas developed an air inlet design that overcame this problem. During his 14 years with Northrop Aircraft, he worked on the aerodynamics and control system design of such pioneering aircraft as the Northrop flying wings and the P-61 and F-89 fighters.

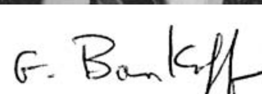
In 1957, Ashkenas cofounded Systems Technology, Inc., an internationally acclaimed company specializing in systems analysis of air, sea, and ground vehicles and human operator dynamics. Ashkenas had responsibility for and made significant and innovative contributions to over 30 aircraft and missiles. During his long and distinguished career he served on a number of investigative and governmental oversight committees, generated some 70 technical papers, wrote five books, and was awarded eight patents for various aircraft control systems and for a device for measuring the psychomotor capabilities of pilots and astronauts. Ashkenas coauthored the widely acclaimed *Aircraft Dynamics and Automatic Control* (Princeton University Press, 1973) along with his colleagues Duane McRuer and Dunstan Graham.

Ashkenas was a fellow of the American Institute of Aeronautics and Astronautics (AIAA) and a recipient of the institute's Mechanics and Control of Flight Award for 1970. He was cited in 1984 for his AIAA paper titled "25 Years of Handling Qualities Research." He directed and assembled a 1988 international lecture series sponsored by the Advisory Group for Aerospace Research and Development, the aeronautical research and development arm of the North American Treaty Organization. Ashkenas was AIAA's Distinguished Lecturer for 1990–1992 and in 1992 he was elected to membership in the National Academy of Engineering. He served as an independent consultant to Northrop Aircraft's stealth bomber project from 1982 to 1987, reflecting expertise derived from his early work on Northrop's XB-35 and YB-49 flying wing aircraft. In 1989 he reported on a National Aeronautics and Space Administration–sponsored study of performance improvements attainable through longitudinal automatic stabilization in tailless flying wing aircraft. After his retirement at age 77, Ashkenas remained an active member of the board of Systems Technology, Inc., and in 2007 was elected chairman.

Irving Ashkenas was a man of many interests and abilities. An avid sports enthusiast, he played handball, squash, badminton, tennis, and golf and also enjoyed horseback riding, swimming, surfing, snorkeling, and skiing. He was an active member of the PLATO Society of University of California, Los Angeles and took weekly singing classes through Santa Monica City College's emeritus program. Ashkenas and his wife, Shirley, loved to travel, and they enjoyed the cultural life of Los Angeles by attending concerts, operas, and dance and theater programs. They supported many Los Angeles–area charities and were longtime members of Temple Beth Am.

Irving Ashkenas is survived by his devoted and loving wife Shirley, son Adam, daughter Sharon Fabian, grandchildren Sara and Erin Fabian, and numerous nieces and nephews. Services were held on April 13, 2011, at Eden Memorial Park in Mission Hills, California.




G. Bankoff

S. GEORGE BANKOFF

1921–2011

Elected to NAE in 1996

"For contributions to the field of two-phase flow and heat transfer and its application to nuclear-reactor thermohydraulics."

BY JULIO M. OTTINO AND STEPHEN DAVIS

S. GEORGE BANKOFF, professor emeritus of chemical engineering at Northwestern University, whose research into the fundamentals of heat transfer and two-phase flow won him recognition in the fields of chemical and nuclear engineering, died July 13, 2011. He was 89.

George was born on October 7, 1921, in Brooklyn. Three years later his father was killed in a robbery, leaving his mother to raise him and his siblings alone. Nevertheless, he excelled in academics, finishing high school with honors and entering Columbia University at age 16. He went on to receive his B.S. and M.S. degrees in mineral dressing in 1940 and 1941, respectively.

George worked briefly for DuPont before becoming a subleader team member on the Manhattan Project, where he worked on pile heat transfer and fluid flow. He eventually returned to DuPont, where his work on plastics, specifically his patent on polytetrafluoroethylene suspensoids, made commercial production of Teflon feasible at the time.

George began his academic career at Rose Polytechnic Institute (now Rose-Hulman) as an assistant professor while he commuted twice a week to simultaneously pursue his Ph.D. at Purdue University, which he received in 1952. He became department chair at Rose before spending a year at the California Institute of Technology as a National Science Foundation fellow. In 1959 he became a faculty member at Northwestern University.

During his 33 years at Northwestern, George conducted research on a wide variety of topics in multiphase heat transfer and fluid mechanics, many of which are related to nuclear reactor safety, including bubble nucleation and growth in boiling, heat conduction and diffusion with phase changes, vapor explosions, and stability of thin liquid films under heating. He established that surface cavities, rather than projections, were the sites for bubble nucleation in boiling, and he developed the necessary conditions for their stability. His variable-density single-fluid model was the first to consider radial distribution effects in gas-liquid flow and was the forerunner of the drift flux model.

He was elected to the National Academy of Engineering in 1996 for his "contributions to the field of two-phase flow and heat transfer and its application to nuclear-reactor thermohydraulics."

George published more than 200 papers and served as thesis adviser to more than 70 graduate students. He took his research around the world, as a visiting scientist at Technion (Israel Institute of Technology) in Haifa, Israel; at CENG (Centre d'Études Nucléaires de Grenoble), in France; and as a visiting scholar at Imperial College in London. He was a member of the U.S. team for the Japan-U.S. Seminar on Two-Phase Flow Dynamics in Kobe, Japan, in 1979 and again in Kyoto in 1988.

George received many awards, including the Ernest W. Thiele Award in 1999, the Heat Transfer and Energy Conversion Division Award from the American Institute of Chemical Engineers in 1995, and the Institute's Robert E. Wilson Award in Nuclear Chemical Engineering in 1994. He was also named an Outstanding Chemical Engineer by Purdue University in 1993. In 1987 he was awarded the Max Jakob Memorial Award, given in recognition of eminent achievement in the area of heat transfer.

In addition, he was a fellow of the American Institute of Chemical Engineers, the American Society of Mechanical Engineers, and the International Centre for Heat and Mass Transfer, in Belgrade. He served as chairman of the advisory committee of Oak Ridge National Laboratory, Engineering Technology Division, and as a member of the U.S.-USSR Cooperative Program in Heat and Mass Transfer.

George's children said that they first learned about their father's work in "boiling heat transfer" when they spent a summer in Pasadena when he was working at the Jet Propulsion Laboratory, but it was not until 10 years later that they learned he had worked on the design of the reentry heat shield on the Mercury space capsule. They also spent time with him at Oak Ridge National Laboratory but again did not know that their father was working on nuclear power.

In fact, nuclear power as an alternative energy source was one of George's passions. In a letter published in the *Chicago Tribune* in November 1993, he wrote: "This nation cannot afford to burden itself with high energy costs; too many jobs are lost as a result. It is up to the media to initiate a realistic re-examination of nuclear energy, which is, in fact, the least environmentally damaging and most reliable of all energy sources."

George Bankoff is survived by his wife, Elaine Bankoff; his three children—Joseph Bankoff, Elizabeth Bankoff, and Jay Bankoff; his six grandchildren; and a sister, Eleanor Stein.

PAUL BARAN

1926–2011

Elected in 1996

"For the concept of packet-switching and for its technical development and utilization."

BY VINTON G. CERF

PAUL BARAN was born in Grodno, Poland (which is now in Belarus), on April 29, 1926. He was the youngest of three children. His family moved to the United States on May 11, 1928, settling in Boston. Later, in Philadelphia, his father, Morris Baran (1884–1979), opened a grocery store. Paul graduated from the Institute of Technology (now Drexel University) in 1949 with a degree in electrical engineering. He received an M.S. in engineering from the University of California in 1959 and honorary doctorates from Drexel University in 1997 and the Pardee RAND Graduate School in 2000. He passed away on March 26, 2011.

Baran joined the Eckert-Mauchly Computer Company upon graduation from Drexel. There he did technical work on UNIVAC models, the first brand of commercial computers in the United States. He moved on to Raymond Rosen Engineering Products in 1950. There he designed circuits to correct tape speed errors for FM telemetry recording. In 1955 he moved to Los Angeles to work for the Hughes Aircraft Company on radar systems.

Baran joined the RAND Corporation in 1960, two years after the invention of the integrated circuit. There he blazed a new trail in digital communication systems, with a broad exploration of the problem of maintaining command-and-control capability in the event of a nuclear attack. Baran explored the possibility of digital communication in hostile environments by using "addressed message blocks" and a "hot potato" routing method. He envisioned the use of omni-directional antennas, such as those provided by existing AM radio stations, to construct a highly resilient, distributed communications network. His seminal work, first published in a series of RAND studies from 1960 to 1962, was documented in a multivolume study entitled "On Distributed Communications," published in 1964.[1,2] Baran's ideas were considered radical at the time and were met with resistance from proponents of conventional circuit switching, which was used in the telephone network.

The basic idea of such communications networks was also explored in independent research on queuing systems by Leonard Kleinrock, whose doctoral dissertation considered the mathematical properties of such systems.[3,4] At the National Physical Laboratory (NPL) in Teddington, England, Donald W. Davies pursued similar ideas in the mid-1960s, ultimately christening the switching method "packet switching" and building a one-node local network at NPL to prove the idea.[5] Subsequently, packet switching was the switching technique used in the development of ARPANET and many other computer communications networks, such as Ethernet. Today, the Internet enables the interconnection of such networks with myriad computer systems and services in use worldwide.

It is illustrative of Baran's wide-ranging interests that he created many other innovations, such as a "doorway gun detector," and that he developed an early working model to discriminate between guns and other metal objects that might be carried on one's person.

In 1968, Baran left RAND to help found, with RAND colleagues, the Institute for the Future. The focus of this nonprofit institute, which began with a grant from the Ford Foundation, was to facilitate the transition of various research results into public and business sectors. That Baran resonated strongly with this idea is evident from the 10 companies that he founded or cofounded over the years. In surveying his remarkable ability to sense when technology might support new ways to design products and services, one is struck by his "readiness radar." He seemed to have a keen awareness of the ripeness of technology to be exploited.

In 1972, Baran founded CableData to explore the idea of moving data on conventional cable television networks. CableData spawned multiple companies, including Comprint (computer printers); Equatorial Communications Company (using Baran's small dish satellite transceiver and one of the first nonmilitary spread spectrum applications); Telebit (manufacturer of high-speed modems for impaired dial-up telephone lines); Packet Technologies (interactive cable TV and fast packet switching for voice and data on T1 lines); and Com21, an early producer of cable modems. In 1986, Baran cofounded Metricom, Inc. (electric/utility industry remote metering and distribution automation), which led to the Ricochet wireless data communications system. In 1989 he founded InterFax, Inc. (interactive facsimile). Eventually, Packet Technologies was acquired by StrataCom, and its ideas were used in the design of asynchronous transfer mode (ATM) systems.

In a classic Baran sequence, when he founded Packet Technologies to explore the possibility of achieving interactive television, a new and radical idea of his led him to found Telebit Corporation (across the street!). The Telebit TrailBlazer modem took advantage of the decreasing cost and increasing speed of digital processing, extracting data rates on the order of 18 kilobits per second when contemporary modems were delivering 2400 bits per second. The design was particularly audacious: it divided the 3000-Hz telephone bandwidth into 512 six-baud channels and modulated each at 0, 2, 4, or 6 bits per Hertz, depending on their measured signal-to-noise ratio. The TrailBlazer was succeeded by a number of ambitious Telebit devices with greater speed and functionality using the OFDM (orthogonal frequency-division multiplexing) methods pioneered at Telebit.

Following the founding of Com21, Baran founded and was chairman of GoBackTV, which specializes in personal TV and cable IPTV infrastructure equipment for television operators. Most recently, he founded Plaster Networks, which provides an advanced solution for connecting networked devices in a home or small office through existing wiring.

Baran never sought the limelight, but his remarkable contributions were recognized in many ways. He received the

Silver Medal for Product Excellence (for the Telebit TrailBlazer Modem) from *PC WORLD* (1986); the Edwin H. Armstrong Award from the Institute of Electrical and Electronics Engineers (IEEE) Communications Society (1987); the UCLA Advanced Computing Technologies Act One Pioneer Award (1989); the Alexander Graham Bell Medal of the IEEE (1990); the Electronic Freedom Foundation Award (1993); the Nippon Electronics Corporation's Computers & Communications Award (1996); the Franklin Institute Bower Award for Science (2001); and the National Medal of Technology and Innovation (2007) and was named UCLA Engineering Alumnus of the Year in 2009. Baran was also a fellow of the Marconi Society (1991), the IEEE (1993), the American Association for the Advancement of Science (1994), the American Academy of Arts and Sciences (2003), and the Computer History Museum (2005). Baran was inducted into the National Academy of Engineering in 1996. In 2007 he was inducted into the National Inventors Hall of Fame.

Baran obtained his master's degree in engineering in 1959 (with Professor Gerald Estrin as his adviser) after taking night classes. His thesis was on character recognition. Estrin said that Baran was the only student of his who actually went to the Patent and Trademark Office in Washington, D.C., to see whether his master's thesis was patentable! "From that day on, my expectations of him changed," Dr. Estrin said. "He wasn't just a serious student, but a young man who was looking to have an effect on the world."

In a remembrance of Bill Houser, Paul Baran related these stories:

> Many, many years later, Bill and I started a new company in the cable TV space called Com21, Communications for the 21st Century. At this time in the mid-1990s Bill and I were quite old but still active. Bill was living in Alexandria [Virginia] at the time. I was living in Silicon Valley and we would meet at different places in the country depending on who we were visiting. Both of us were frugal with company money so we traveled by Delta Airline senior citizen tickets. These tickets were $99, allowing senior citizens to fly anywhere in the US for $99. The kicker was that standby was risky

to travel because you never knew if there would be a seat for you or not. Your cheap choice was to either make a reservation weeks in advance or gamble on standby.

Bill's only known character defect was that he liked desserts and could eat them without ever gaining weight. Once on the airplane and seated, Bill would suggest to the stewardess that if she had trouble with too many unserved chocolate desserts in First Class, he was willing to do his part to help. It always worked for Bill. By the end of the meal a stewardess invariably appeared with an extra dessert for Bill. I couldn't take the calories so always I took a pass, but Bill invariably would suggest two spoons so that I could take a taste. I always said "no" but would usually weaken for a few calories.

I learned a lot from Bill. I remember a late connecting flight from San Francisco by way of Denver. The last plane was leaving and there was a screaming crowd of passengers wanting to go on the flight rather than have to spend the night at the airport. Rather than wading into the angry crowd, Bill smiled and motioned to me to come with him as he took off down the empty airport corridors until he found a single agent at an empty counter closing up for the evening. Bill then turned on the Houser charm that came on so naturally, asking if there were any closed flights that hadn't yet left. "Yes, but you can't make it." Bill responded, "Well, I sure would love to give it a try posed as a bet."

I never ran so hard in my life following old Bill with suitcase in hand until we reached the closed gate. As this was in the days before "security," Bill got to the closed airplane door and pounded. It opened and we were let in and the plane immediately took off. As we caught our breath, Bill smiled at the stewardess with his offer to take the extra unserved chocolate dessert in First Class off her hands. Damn, it worked every time. Bill sure taught me a lot about people.

Baran himself recalled:

Jerry Estrin convinced me that since I had so many courses out of the way, why not go on for a Ph.D.? RAND allowed me to take time off during the day, but business travel was increasing at the time, causing me to have to miss more and more lectures. But the final decision was made one day when I drove in to UCLA from RAND and couldn't find a single parking spot in all of UCLA and the entire adjacent town of Westwood. At that instant I concluded that it was God's will that I should discontinue school. Why else would He have found it necessary to fill up all the parking lots at that exact instant?

Baran also said:

My experience with innovations is that everything has a predecessor event or events. Generally when the next generation of ideas and effort comes along, what has gone before becomes irrelevant. Then the following generation comes along and there is the same shift of focus. The process of technological developments is like building a cathedral. Over the course of several hundred years, new people come along and each lays down a block on top of the old foundations, each saying, "I built a cathedral." Next month another block is placed atop the previous one. Then comes along an historian who asks, "Well, who built the cathedral?" Peter added some stones here, and Paul added a few more. If you are not careful you can con yourself into believing that you did the most important part. But the reality is that each contribution has to follow onto previous work. Everything is tied to everything else.[6]

Mike Cassidy wrote in the *Mercury News:*

Baran wasn't interested in fame. And he apparently wasn't afraid of death. When I first met him in 2008, he mentioned that his wife had died the year before. I offered my condolences. "It's a perfectly normal part of life," Baran said. "You're only around for a fixed time. I think people make entirely too much of it."[7]

Mike Malone writes of Baran in *Forbes*:

He remained audacity personified right up to the very last day of his life, when he was simultaneously

> working on a new invention and preparing for a business presentation to one of the world's biggest companies.... In the end, he also taught us how to live our own lives, from beginning to end, in the Internet age.[8]

Ever modest, Baran never failed to minimize his own credit and gave much to others. He was at his best working in partnership with creative, smart, and adventurous colleagues, overcoming obstacles with a calm panache that made him unique. Bob Kahn sums it up in an elegant way: "Paul was one of the finest gentlemen I ever met and creative to the very end." He will be missed but long remembered.

Paul Baran married Evelyn Murphy in 1955 and moved to Los Angeles. Sans Ph.D. himself, Baran often remarked that Evelyn (with her Harvard Ph.D. in economics) was the better educated but, thankfully, she did not remind him of this. Another favorite tale of his was that when someone phoned asking for "Dr. Baran," he would say, "Just a moment, I'll get my wife." Evelyn passed away in 2007, after their 52 years of marriage. Baran is survived by his son David, three grandchildren, and his companion of recent years, Ruth Rothman. Of Ruth, Baran confided that she had been his prom date many years ago.

Notes

1 Reliable Digital Communications Systems Using Unreliable Network Repeater Nodes, P. Baran, Report P-1995, The RAND Corporation, 1960.

2 On distribution communications: Introduction to distributed communications networks, P. Baran, Report RM-3420, The RAND Corporation, 1964.

3 L. Kleinrock, "Message delay in communication nets with storage," Ph.D. dissertation, MIT, Cambridge, MA, 1962.

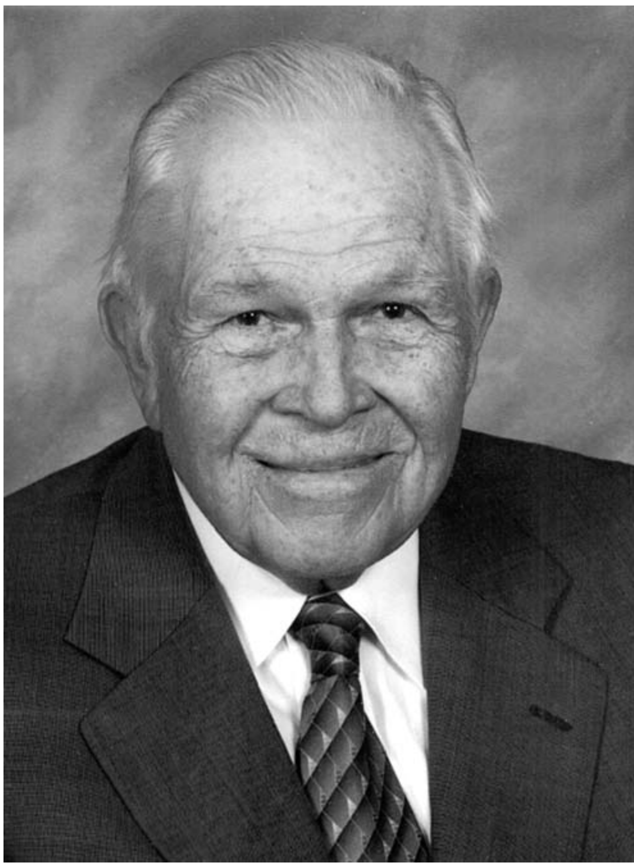
4 L. Kleinrock, Communication Nets: Stochastic Message Flow and Delay, McGraw-Hill (New York: 1964).

5 D. W. Davies, K. A. Bartlett, R. A. Scantlebury, and P. T. Wilkinson, "A Digital Communications Network for Computers Giving Rapid Response at Remote Terminals," unpublished paper presented at the ACM Symposium, Operating Systems Problems, Oct. 1967.

6 http://www.cbi.umn.edu/oh/pdf.phtml?id=295.

7 http://www.mercurynews.com/mike-cassidy/ci_17719914?nclick_check=1.

8 http://blogs.forbes.com/mikemalone/2011/03/30/entrepreneur-for-life/.



THOMAS D. BARROW

1924–2011

Elected in 1974

"For leadership in the development of geologic analysis and methods contributing to worldwide petroleum resource discoveries."

BY ROLAND N. HORNE

THOMAS BARROW passed away on January 27, 2011. He had a long and influential career in the energy and resources industries, having served as vice chairman of Sohio (Standard Oil Company of Ohio), chairman and chief executive officer of the Kennecott Corporation, and senior vice president of Exxon Corporation.

Thomas Barrow was a Texan, born in San Antonio and raised in Houston. His father was a petroleum geologist and, eventually, served as chairman of the board of the Humble Oil and Refining Company (now Exxon). His mother was the daughter of a turn-of-the-century California gold miner. Thomas attended the University of Texas at Austin, where he earned a B.S. in petroleum engineering in 1945 and an M.S. in geology in 1948, and Stanford University, where he earned his Ph.D. in geology in 1953. He served on active duty with the U.S. Navy from 1943 to 1946 and was a member of the Naval Reserve from 1946 to 1961.

He began his career as a geologist in California, joining Humble Oil and Refining Company in 1952. He rose quickly in the company, to become Southeastern Region Exploration Manager by 1962 and ultimately its president in 1970. He was elected to the Board of Directors of Exxon Corporation in 1972 and also became senior vice president of the corporation, in charge of Exxon's worldwide exploration and production activities. He was also contact director for Exxon Exploration, Inc., and Esso Eastern, Inc., as well as corporate planning, mining, and synthetic fuels. He was responsible for Exxon Research and Engineering Company, Imperial Oil Limited, Exxon Enterprises, Inc., and production, science, and technology. Dr. Barrow retired from Exxon in November 1978 and joined Kennecott. When Kennecott was acquired by Sohio in June 1981, Dr. Barrow was Kennecott's chairman of the board and chief executive officer, posts to which he had been elected in December 1978. He was responsible for Sohio's oil and natural gas exploration and production activities, the worldwide minerals business of Kennecott (an indirect wholly owned subsidiary of Sohio), and corporate planning, research and development, and engineering and technology functions. Dr. Barrow retired as vice chairman of Sohio in June 1985.

Dr. Barrow was a board member of Tobin International (chairman) and GX Technology Corporation (chairman). He was a member of the Board of Trustees of Baylor College of Medicine (vice chairman, 1991–1999), Texas Medical Center, and the Houston Grand Opera (president, 1985–1987, chairman 1987–1991). He was a trustee of Stanford University (1980–1990), the American Museum of Natural History, the Geological Society of America Foundation, and Woods Hole Oceanographic Institute, as well as president of both the American Society for Oceanography and the National Oceanography Association.

Dr. Barrow was a member of the American Association of Petroleum Geologists, the American Geophysical Union, and the Society of Mining Engineers. He was elected a fellow of the American Association for the Advancement of Science, the Geologic Society of America, and the New York Academy of Sciences. As a member of the National Academy of Engineering, he served on the Commission on Physical Sciences, Mathematics, and Resources of the National Academy of Sciences.

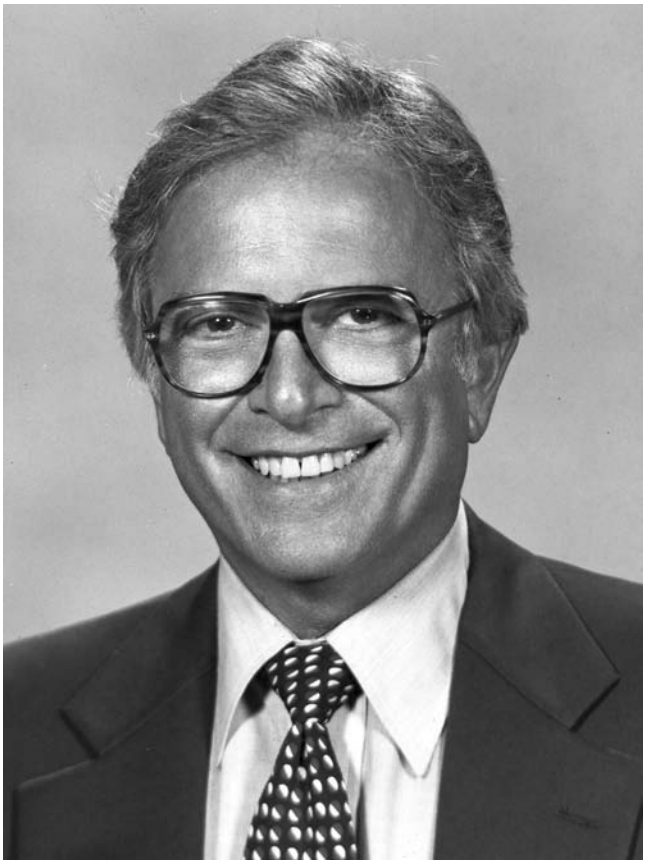
Dr. Barrow received many honors from the University of Texas at Austin: Distinguished Graduate in Engineering

(1970), Distinguished Alumnus Award (1982), Distinguished Graduate in Geology in (1985), and Distinguished Graduate from the College of Natural Sciences (1991). He was a life member and former chairman of the Geology Foundation, a life member of the Ex-Students Association, a life member of the University of Texas Development Board, and a member of the Centennial Commission.

At Stanford University, Dr. Barrow's name is memorialized in perpetuity in the Thomas Davies Barrow Professorship in Earth Sciences.

The Offshore Technology Conference awarded Dr. Barrow the Distinguished Achievement Award in 1973, and the National Ocean Industries Association gave him the same honor in 1974. He was named chief executive of the year for the metals and mining industry in 1979 by *Chief Executive* magazine. In 2010 he received the Pioneer Award from the American Association of Petroleum Geologists.

Dr. Barrow and his wife Janice met at Stanford University and married in 1950. He is survived by his wife and their four children and nine grandchildren.



JORDAN BARUCH

1923–2011

Elected in 1974

"For contributions to technology transfer to industry, noise control systems, and application of computer technology."

BY LEO L. BERANEK

JORDAN JAY BARUCH was born August 21, 1923, in New York City and grew up in Brooklyn. Both his father and grandfather were in the wholesale fur business until the collapse of that business in the 1940s. Jordan's father then sought other opportunities, becoming a stockbroker in a small Wall Street firm. Jordan already knew how to read when he entered Midwood Elementary School (PS 99) and graduated eighth grade as an honor student in January 1936. At James Madison High School he participated in the after-school activities of the Microscope Club. One of his projects on hydroponics was selected to be exhibited in the New York World's Fair. A talk of his, based on another high school project, "On the Action of Ions on Cardiac Muscles—A Home Made Kymograph," was named "Best of the Session" by the Science Congress of the American Institute. The kymograph was made up of parts that Jordan bought from junk pushcarts. During these years, Jordan was an enthusiastic Boy Scout, becoming an Eagle Scout. Later in life he was a Boy Scout leader.

In 1940 he entered Brooklyn College. In his freshman physics class, Jordan's professor announced there would be gender-segregated seating in alphabetical order. Jordan Baruch, the first male, sat next to Rhoda Wasserman, the last female. Jordan invited Rhoda to the BioMed Society Dance. Four years later, in June 1944, when he was a private first class in the U.S. Army, they were married. Their marriage lasted 67 years.

In December 1942, at the age of 19, Jordan enlisted in the U.S. Army, dropping out of Brooklyn College in his junior year. He was offered a place in the Army Specialized Training Program (ASTP) at the Massachusetts Institute of Technology. He enjoyed MIT until the program came to an end. Fortunately, the participants were assured they would be welcomed back at the end of the war. Jordan did reenter MIT in February 1946, immediately after he was discharged from the Army.

When the ASTP came to an end, Jordan was assigned to the Army Signal Corps. He served in both the European and Pacific theaters of operation. When the war ended in Europe, he was sent to Japan. He became very seasick on the long ocean voyage. He wrote home to his young wife Rhoda that, when he returned, he would have nothing in the house that moved—neither a rocking chair nor a porch glider. It is surprising that after his discharge in February 1946, he became an avid sailor, first learning in a tech dinghy and later owning a sequence of sailboats, each bigger than the previous. He taught many of his friends to sail, as well as his children and grandchildren. Favorite vacations involved charters in the Caribbean with friends and "bumping into" old Cambridge friends on some sparsely populated island.

Jordan's prize war story was during the Battle of the Bulge. One of the repeater amplifiers along the line failed. He drove at top speed to the nearest Army supply depot to obtain a replacement, only to learn that they did not have the part. A Marine supply depot was not far away. Jordan went there, learned they had the part, but they refused to give it to him without a written request. He threatened and, by hook or by crook, got the part. Communications were quickly restored to General Patton's headquarters to announce the end of the war in Europe. Jordan received a medal. There were other brave exploits, and Jordan ended his service with a box of medals and the rank of technical sergeant. One of his most memorable and nightmarish experiences in the war was to witness the liberation of the Buchenwald concentration camp in 1945.

After the war, under the G.I. Bill, Jordan attended MIT as an electrical engineering student, beginning in his junior year. He received his bachelor's and master's degrees in 1948. For his master's thesis he designed a high-speed polariscope for analysis of dynamic stresses, while a co-op student at General Radio Company. When he took Professor Leo Beranek's course, "Acoustics 101," in the electrical engineering department, he became very interested in the subject and asked so many questions during class that he had to be told to give the others a chance.

With his master's degree, his G.I. Bill money would run out and he was prepared, reluctantly, to leave MIT. Jordan was forever grateful for Beranek's help. Professor Beranek encouraged him to go for his doctorate and arranged for him to get the Armstrong Cork fellowship and other assistance. He received scholarships in the MIT Acoustics Laboratory during the next two years. Jordan had already taken most of the courses in the electrical engineering department, so he chose to register jointly in three departments: electrical engineering, mechanical engineering, and physics. He became Beranek's first doctoral student. His thesis work was in the Acoustics Laboratory, where he set up a novel means for measuring the sound isolation of building partitions. Defense of his thesis exam involved a committee with members from all three departments. One committee member said that Jordan was a stellar candidate and answered questions in all three fields, not responding incorrectly to any. Jordan was appointed an assistant professor of electrical engineering at MIT the next year. During that year he invented what became known as the Baruch-Lang loudspeaker, which he patented. It was a corner loudspeaker, with 4-inch loudspeakers in a vented half-a-cubic-foot box. It received much acclaim, and several thousand were sold.

The firm Bolt and Beranek was formed in 1948 and was subsequently renamed Bolt Beranek and Newman (BBN). The business grew rapidly, and in the summer of 1951 Jordan became a full-time employee. He seemed to know everything and was quick to offer help to anyone on an eclectic array of subjects, from health and gardening to automobiles and electronics equipment. He assisted in carrying out a number of consulting jobs. This led to his invention of a structure for reducing noise in ventilating ducts, called SOUNDSTREAM. This patented design was licensed to two manufacturers. In 1952, Jordan and Sam Labate were admitted into the partnership, although the firm's name was not changed. In December 1953, with 39 employees, the company was incorporated. Bolt was named chairman, Beranek president, Labate vice president, and Baruch treasurer. Government contracts started to pour in from the U.S. Army, Navy, National Institutes of Health (NIH), National Science Foundation, and U.S. Department of Defense. BBN grew quickly. The U.S. government decided to make the BBN contracts uniform and set up a contract conference at BBN. Government procurement regulations involved a number of volumes that occupied a 3-foot shelf. Jordan, with his photographic memory, sat down and read the entire set. When the contract negotiators arrived, they found him to be better informed than they were. At the end of the second day, the government people came out of the meeting obviously overwhelmed by Jordan's proficiency. Soon BBN had more government contracts than any other firm in New England.

In 1961 it became apparent that BBN needed cash for expansion. As treasurer, Jordan worked with the auditors to produce a prospectus. An investment banker had to be selected, and Jordan and Beranek interviewed several candidates. On June 27, BBN made its initial public offering with Hemphill Noyes as the winner, taking BBN public at $12 a share.

While at BBN, Jordan was a consultant to NIH. In addition to acoustical consulting for the new clinical center, he designed a colorimeter for monitoring blood during cardiac surgery and developed a novel lighting system used in neurosurgery. He designed other instruments for the medical fields. His friend at NIH and director of the clinical center, Dr. Jack Mazur, persuaded him to work on a computer system for medical records.

Jordan took an interest in the new computer field that BBN was pioneering and that was called "time sharing." With time sharing, many operators could use a single computer, sharing data as needed. Baruch soon envisioned this as a means of bringing computer technology to bear on medical practice. In 1962, contracts were obtained from NIH and the American Hospital Association to install a demonstration computer system for the information processing needs of Massachusetts General Hospital (MGH) in Boston. As Professor Octo Barnett, director of computer science at MGH, has written: "BBN's time-sharing technology was at the cutting edge of computer science, and its use at MGH was one of the first demonstrations of the potential power of remote access to a real, online data base." With Baruch as parent, the system allowed nurses and doctors to create and access patients' records at a number of hospital stations, all connected to a central station. When Jordan was installed as a regent of the National Library of Medicine, he was introduced as the father of medical informatics.

Hospital use of computers looked so promising that in 1966 General Electric set up a new department to merchandise hospital computer systems, called MEDINET. G.E. hired Baruch as department general manager, and he left BBN to go to the new building in Watertown, Massachusetts. Unfortunately, after a period of time, G.E. mandated that a Digital Equipment Corporation computer could no longer be used (like the one in use at MGH). Instead, Jordan was required to adapt a midrange G.E. computer system for the project. This was a computer that G.E. had been unable to sell. Jordan and the staff members he had hired tried desperately to modify it in a reasonable length of time but found it impossible. Baruch developed, specifically for MEDINET, a computer programming language called FILECOMP. In 1968, Jordan left General Electric.

From 1968 to 1970, Jordan was president of Educom, a consortium of 100 colleges and universities. Educom's goal was to help institutions adopt networking, computation, and storage in the four principal college and university application areas: administrative systems, teaching and learning, research, and community services. Jordan was particularly interested in a system for sharing library resources, using microfiche technology. The universities were not ready to enter this cooperative venture. In 1970 he resigned so that he could work full time as an independent consultant.

From 1971 to 1974, Baruch was a lecturer in business administration at the Harvard School of Business Administration, where he could develop his ideas about the management of technological innovation. His success there led him to Dartmouth College, where he held a joint professorship at the Tuck School of Business and the Thayer School of Engineering from 1974 to 1977.

In 1963, Jordan had joined a group of 30 leading citizens from the Boston area who applied for a license to operate a television station on Channel 5 in Boston. They were successful, and the station went on the air in 1972. It was featured in a two-page article in the *New York Times* as "probably the best television station in the U.S." In 1982 the station was sold to MetroMedia, and Jordan's share in the receipts made him well off. Afterward, he joined with his longtime friends Isaac Auerbach and William Poorvu, as well as Howard Stevenson from the Harvard Business School, to form an investment firm—The Baupost Group. Under the leadership of Seth Klarman, it has been highly successful. Jordan remained a partner until he died.

While Jordan was at Dartmouth, he was invited, along with other experts from around the country, by Under Secretary of Commerce Sidney Harman to participate in a seminar in Washington, D.C., to discuss the federal government's role in fostering innovation. As Harman relates in his memoir, *Mind Your Own Business* (Crown Business, 2003), Baruch stood out above the others, and Harman invited him to join the Carter administration as assistant secretary of commerce for science and technology. He moved to D.C. in 1977.

In his new position, Baruch aimed to foster innovations and competitiveness in the United States. He led efforts to modernize the Patent and Trademark Office, to transfer and expand the Bureau of Standards into the National Institute for Standards and Technology, and to examine industrial innovation. While at the Commerce Department, he worked with eminent industry leaders to establish the Commerce Technical Advisory Board, and they provided President Carter with an "Innovation Study" useful for that and subsequent administrations.

Early in the administration, Baruch went on an Institute of Electrical and Electronics Engineers (IEEE) mission to China to visit business fairs and factories. When, shortly after that trip, the United States and China were about to sign an agreement about transfer of science and technology, Baruch voiced his concern that without management reform there would be little advancement in productivity and the standard of living of the Chinese people. His concern was based on observations he and his colleagues had made on the IEEE visit. The Chinese were very responsive and followed Baruch's recommendation to establish a school of management jointly with the United States. Baruch was authorized to help hire staff, including American professors and case writers for the new school in Dalien, China. It was the first example of management education in the People's Republic of China.

Professor Bill Dill, first dean of the faculty at the National Center at Dalien University of Technology, as it came to be called, wrote of how the programs had grown, "built solidly on the conceptual foundation and guidelines for implementation that Jordan provided" (letter to Rhoda Baruch, Nov. 29, 2011). He recalled that Jordan had negotiated for a computer from Control Data Corporation and for a Xerox copier to be provided for the Dalien campus, the first such machines for that part of the world. In writing about Baruch's 1979 mission to China, Bruce Merrifield, who followed Jordan in the same position at the Commerce Department, referred to it as a "critical turning point for the country" (letter to Rhoda Baruch, Nov. 18, 2011). Merrifield wrote that "most of China's leaders are graduates of that school."

Another major achievement of Baruch while at the Commerce Department was the establishment of the Binational Research and Development Foundation (BIRD-F) in Israel, which Merrifield stated "may have been of even greater significance" than the Chinese management school. In addition to being a primary engine for the remarkable Israeli economy, BIRD-F became the model for similar programs in India, Chile, Finland, Ireland, and Iceland. Much of this was done under Merrifield, but the initial model was Baruch's. Merrifield wrote: "BIRD-F has now become the primary model which incrementally will be assisting some 80% of the world's 7 billion population, living in underdeveloped countries, to develop their economies as well! What a legacy!"

After leaving Commerce, Jordan established a consulting firm in Washington, D.C., called Jordan Baruch Associates. The firm has served industry and government in the planning, management, and integration of strategy and technology. Jordan also served on the Board of Regents of the National Library of Medicine. He was involved in efforts to develop industry strategies and to increase innovation in India, Indonesia, and Israel. Baruch told of a humorous incident: "I was involved in starting another management school in the country Jordan despite the fact that 'Baruch' is a Hebrew word well known in the Arab world. At the end of the conference program, Crown Prince Hassan asked me, 'Dr. Baruch, this has been wonderful. What can we do for you?' I responded, 'I'd like the school named for me.' There was dead silence. Before anyone's heart could stop I said, 'Yes, I would like it called the Jordan Institute.' Crown Prince Hassan just smiled and said, 'Done.' And that is what it is called."

Baruch was associated with many organizations. In 1956 he was awarded the Outstanding Young Electrical Engineer Award from Eta Kappa Nu. He was a fellow of the Acoustical Society of America, the IEEE, the American Academy of Arts and Sciences, the American Association for the Advancement of Science, and the New York Academy of Sciences. His greatest interest was the National Academy of Engineering (NAE) to which he was elected in 1974 and served on 24 committees after 1982. Of these he chaired the following: General Engineering Peer Committee, Subcommittee on Educational Systems, Board on Telecommunications/Computer Applications, and Panel on Techniques for Affordable Housing. In 2007 he received the NAE's Arthur M. Bueche Award for "the promotion of innovation and managing of science and technology nationally and internationally, thereby enhancing the economy of the U.S. and developing nations."

Finally, Jordan worked in Africa, India, Indonesia, and Jordan, and he was honored by China and Israel. He founded the Transatlantic Institute of the American Jewish Committee and was a member of the American boards of Ben-Gurion University and the Israel Oceanographic and Limnological Research Foundation. In 2005 he established at MIT the Jordan J. Baruch Fund to support undergraduates conducting research for the Undergraduate Research Opportunities Program in the School of Engineering and the School of Science. Recipients of the fund are known as Baruch Undergraduate Researchers. Jordan held 12 patents and authored many articles. He coauthored the book *The Innovation Explosion* (Free Press, 1997) with James Brian Quinn and Karen A. Zien. He served as president of his synagogue, Adas Israel, in Washington, D.C., and was appreciated as a member of his neighborhood book club in Chevy Chase, Maryland. He was also a member of the Cosmos Club for many years.

Jordan was a loving husband and partner for 67 years to Rhoda Wasserman Baruch; an active and caring father to Roberta Baruch (Bethesda Maryland), Marjory Baruch (Fayetteville, New York), and Lawrence Baruch (Parsippany, New Jersey). He passed on to his grandchildren a joy for life, a curiosity for understanding, a passion for tinkering, and an appreciation of art, science, and nature, while endowing them with a sense of responsibility for family and the world. His grandchildren (Mina, Solomon, and Sabrina Hsiang; Rebecca, Max, and Julia Ostrov; and Benjamin, Alexander, and Rachel Baruch) treasured their relationship with Grandpa.

KENNETH B. BISCHOFF

1936–2006

Elected in 1988

"For excellence in research and education in chemical reaction engineering and in biomedical engineering."

BY MARK A. BARTEAU

KENNETH B. BISCHOFF died on August 27, 2006. Ken was born in Chicago on February 29, 1936, obviously a leap-year baby. Ken was proud of this accidental distinction, and when a leap-year day occurred, a special birthday celebration was held. Ken also described himself in his leap-year age; at the time of his death he was 17.373 (70 in conventional terms).

Ken enjoyed a distinguished academic and industrial career, both in the United States and internationally. He earned his B.S. in chemical engineering in 1957 at Illinois Institute of Technology (IIT) and remained there for his Ph.D. (1961) under the direction of Octave Levenspiel. His dissertation was on backmixing in chemical reactors. His 1960–1961 postdoctoral work was with Gilbert Froment at the Rijksuniversiteit Gent. This marked the beginning of a long collaboration and friendship. Ken was an assistant professor and an associate professor at the University of Texas at Austin from 1961 to 1967, where he was mentored by and collaborated with David Himmelblau. This collaboration produced a textbook, *Process Analysis and Simulation* (John Wiley & Sons, 1968). Ken then served as an associate professor and as a full professor at the University of Maryland from 1967 to 1970. There he enjoyed a very productive collaboration with Bob Dedrick of the National Institutes of Health (NIH), and together they founded the topical area of pharmacokinetics. At age 34, Ken became the youngest person ever to hold an endowed chair at Cornell University—the Walter R. Read Professorship of Chemical Engineering. There he also was director of the School of Chemical Engineering (1970–1975). In 1976, Ken joined the University of Delaware as the Unidel Professor of Biomedical and Chemical Engineering. He remained at Delaware until, owing to health issues, he retired in 1997. He served as department chairman of chemical engineering (1978–1982) and as acting director of the Center for Catalytic Science and Technology (1983–1984).

Ken's primary research interests were in the areas of chemical reaction engineering and applications to pharmacology and toxicology, resulting in more than 100 journal articles and two textbooks. His scholarly productivity was recognized with many awards, including the IIT Distinguished Alumni Award (1996) and several American Institute of Chemical Engineers (AIChE) awards: fellow (1987), Professional Progress (1976), Institute Lecture (1982), and Wilhelm Award (1987). He received the Ebert Prize from the Academy of Pharmaceutical Sciences (1972), became a fellow of the American Association for the Advancement of Science (AAAS; 1980), and was elected to the National Academy of Engineering (1988). Ken was also active in professional service for the AIChE: he was elected director (1972–1974), selected as program committee chairman (1978), and was session chairman for many sessions. For the American Chemical Society he was on the Awards Committee and the editorial board of the Industrial & Engineering Chemistry Annual Research Review and was an associate editor of the Advances in Chemistry series. He also was associate editor of *Advances in Chemical Engineering* (Elsevier), volumes 12 (1982) through 23 (1996). He was chairman of the First and cochairman of the Ninth International Symposium on Reactor Engineering. He also served as chairman of the Council for Chemical Research (1985).

Ken's skills in mathematical model building led to significant and enduring consulting collaborations, particularly with Bob Dedrick at NIH and with many individuals at Exxon. His consulting with Exxon was unique: Each summer he would stay at Exxon Research and Engineering for one month. At the beginning of the month he was given a loosely defined topic. He then read and mastered an assembly of open-literature and related company reports. By the end of the month he had this material cogently organized and broken into problems to be solved in collaboration with engineers at Exxon. At Ken's retirement Exxon honored his many consulting contributions with a plaque placed in the lobby of the Research and Engineering Center. He also had conventional consulting contracts with many other firms.

Ken's research neatly divided into two general areas: pharmacokinetics and reaction engineering. His pharmacokinetics work is exemplified by publications such as "Methotrexate Pharmacokinetics" (*Journal of Pharmaceutical Sciences*, 60, (*1128*) 1971), "Species Similarities in Pharmacokinetics" (Federation Proceedings, 39, (*54*) 1980), "Pharmacokinetics and Cancer Chemotherapy" (*Journal of Pharmacokinetics and Biopharmaceutics*, 1, (*465*) 1973), and many other specialized papers. This list of representative titles shows how Ken's efforts spanned the topic of pharmacokinetics—indeed, founded the topic and defined its scope.

Similarly, his work in reaction engineering was very broad. He began writing the book *Chemical Reactor Analysis and Design* in 1961; the first edition appeared in 1979 and the second in 1989. Ken's first publication modeled axial dispersion in reactors, and he continued writing about this topic through much of his career. He was concerned with the difficult topic of parameter identification in reacting systems and later with the implications of lumping the kinetics of systems with a large number of species into more easily understood blocks. He developed a generalized model for estimating the catalyst effectiveness factor in complex systems and on coke formation with catalyst deactivation.

DONALD J. BLICKWEDE

1920–2011

Elected in 1976

"For leadership in engineering advancement in the steel industry."

SUBMITTED BY THE NAE HOME SECRETARY

DONALD JOHNSON BLICKWEDE, retired steel executive and resident of Houston, Texas, passed away peacefully on Easter Sunday, April 24, 2011, at the age of 90.

Blickwede was born in Detroit, Michigan, on July 20, 1920, the only child of Frederick Herman Blickwede and Laura Louise Johnson Blickwede. After attending primary and secondary schools in Detroit, he enrolled in the College of Engineering at Wayne State University, graduating with a B.S. in chemical engineering in 1943. At Wayne State he also served as editor of *The Wayne Engineer.*

Upon graduating from Wayne State, Blickwede was employed by the Curtiss-Wright Corporation in Caldwell, New Jersey, where he worked until the end of World War II. During his residency in New Jersey, he attended evening graduate-level courses in metallurgy at Stevens Institute of Technology. In September of 1945, Blickwede was accepted as a graduate student in physical metallurgy at the Massachusetts Institute of Technology and received an appointment to the staff of the metallurgy department as a research assistant. At MIT he studied under the tutelage of Dr. Morris Cohen, one of the world's outstanding physical metallurgists. Upon graduation from MIT in September 1948 with the degree of doctor of science in physical metallurgy, he took a position as head of the high-temperature alloys group at the Naval Research Laboratory in Washington, D.C.

In early 1950, Blickwede accepted employment as a research engineer at Bethlehem Steel Corporation in Bethlehem, Pennsylvania. By 1963 he had advanced to the position of vice president of research, a job he held until his retirement in 1983. During 1969 he took a sabbatical to attend Harvard University's Advanced Management Program.

Among his many accomplishments at Bethlehem Steel, Blickwede was instrumental in developing a process for continuously galvanizing sheet steel and the invention and production of a new grade of steel suitable for the application of a fired ceramic porcelain coating. During the 1970s he was involved in the invention and patenting of a corrosion-resistant sheet steel particularly suitable for prefabricated buildings. The latter product, now known as Galvalume, has become the standard throughout the world for commercial and residential siding and roofing. In addition, Blickwede worked with architects and construction engineers to design and build Bethlehem Steel's Homer Research Laboratories during the 1960s, which upon its completion and for many years afterward was considered to be the premier metallurgical research facility in the world.

During his career, Blickwede was active in various professional organizations, most notably the Industrial Research Institute, of which he was president in 1978, and the American Society for Metals (ASM, now the American Society for Materials), of which he was president in 1983. In 1977 he was awarded the ASM William Hunt Eisenman Award.

Blickwede was also a renowned orator. During the course of his career, he presented two distinguished lectures: the Campbell Memorial Lecture at the 1968 meeting of the ASM in Detroit and the Yukawa Memorial Lecture for the Japan Iron & Steel Institute in Tokyo in 1983. He was elected a member of the National Academy of Engineering in 1976.

Apart from his professional activities, Blickwede enjoyed a wide variety of activities with his family, including trout and salmon fishing, golf, and watercolor painting. In his later years he became especially involved in the latter, and in 1999 he served as president of the Eastern Shore Art Association while living in Fairhope, Alabama. In the last three years before his passing, Blickwede won either first- or second-place prizes for watercolor painting in the statewide competitions of the Texas Association of Homes and Services for the Aging.

Probably Blickwede's most beloved activity during his retirement years was his leadership of a volunteer group for the U.S. Forest Service while residing in Green Valley, Arizona, during the 1990s. The "Hazardous Abandoned Mine Finders" was a group of eight retired men who devoted at least one day a week over many years to exploring a vast portion of the rugged and remote southern Arizona mountains in search of old abandoned mines, recording their locations and posting warning signs for hikers and mountain bikers in the region. The exercise, adventure, and camaraderie of those activities were certainly some of the main factors in his enjoyment of a long, healthy life.

Blickwede is survived by his beloved wife of 67 years, Meredith Lloyd, who continues to live in Houston, Texas; his son Jon Blickwede, also of Houston; daughter Karen (Kim) Knowlton of Pocatello, Idaho; and grandsons Jon Jr. (Jack), Jesus, and Rafael Blickwede.

GEORGE BUGLIARELLO

1927–2011

Elected in 1987

"For outstanding contributions in biomedical engineering, fluid mechanics, and socio-technology, and for leadership in technological education."

BY RICHARD THORSEN
SUBMITTED BY THE NAE HOME SECRETARY

GEORGE BUGLIARELLO, a visionary leader who understood the role of engineering in improving the world, died on February 18, 2011, at the age of 83.

George, or Giorgio, as he was called by his family, was born in Trieste, Italy, on May 20, 1927. He studied engineering at the University of Padua, graduating summa cum laude in 1951, and then earned a master's degree in civil engineering at the University of Minnesota in 1954 and a doctorate in civil engineering and hydrodynamics at the Massachusetts Institute of Technology in 1959. He joined the engineering faculty at Carnegie Mellon University (CMU) in 1959 as assistant professor of biotechnology and civil engineering and rose to the rank of professor. In 1964 he became the founding director of the bioengineering program at CMU, and in 1969 he became dean of engineering at the University of Illinois at Chicago Circle. George became the first president of Polytechnic Institute of New York (now Polytechnic Institute of New York University), formed by the merger of Polytechnic Institute of Brooklyn and the New York University's School of Engineering and Science in 1973. He served for 21 years until 1994.

George embraced change and was a leader who went about making change possible. His range of interests and expertise transcended many disciplines, including civil engineering, biomedical engineering, urban development, science policy, water resources, and environmental science. He recognized that engineering was not an isolated endeavor but an integral part of the natural world and society. This concept was embraced in the word *biosoma*, coined by George, from the contraction of *bio*logy, *so*ciety, and *ma*chines and eloquently expressed in the seal of the Polytechnic Institute, which George was instrumental in designing: *Homo et hominis opera partes naturae* (Man and the works of man belong to the natural world).

When Bugliarello became president of Polytechnic Institute of New York, the institution had limited resources, had a declining enrollment, and was located in a deteriorating neighborhood in downtown Brooklyn. George approached the challenges of his presidency in the best engineering tradition: analyze, plan, execute.

He outlined the pillars of his plan on a paper towel on New Year's Eve 1973 in Paddy's Clam House, on 34th Street near Penn Station in Manhattan, where George and four close advisers met to lay out the institute's future. What emerged were three priorities that formed a stable platform and would define much of George's presidency:

- First, the institute would increase enrollment through growth on satellite campuses. This was necessary to preserve faculty positions and jobs for staff, something always foremost in George's mind.
- Second, it would begin something it had historically been reluctant to do—undertake organized fund-raising.
- Finally, it would create a new campus for the flagship academic programs in Brooklyn.

Under George's leadership, undergraduate programs were introduced on Long Island in 1974. Within two years Polytechnic began its first organized fund-raising efforts.

Success on these two fronts stabilized the institute's finances and enabled it to focus on the third and most audacious of George's goals—a new campus for the Brooklyn component of Polytechnic. This project—15 years in duration from concept to completion—required working with the city's fathers and the corporate sector to renew the area surrounding Polytechnic by creating an urban corporate-university park to be known as the Metropolitan Technology Center or MetroTech.

MetroTech became the largest urban corporate-university park in the country, boasting 22,000 corporate employees at its peak. It was the catalyst that transformed downtown Brooklyn, giving rise to new businesses, hotels, and modern high-rise housing. George was honored by the *Engineering News-Record* as one of "Those Who Made Marks," and in 1994 he was awarded the New York City Mayor's Award for Excellence in Science and Technology.

His many other accomplishments as president of Polytechnic included creation of a state-funded Center for Advanced Technology in Telecommunications in 1982, which continues to receive funding from the state of New York as a resource for business creation and support. In 1994 he launched the Center for Technology and Financial Services at Polytechnic, with teaching and research and a strong focus on users of technology in the financial industry. The center gave rise to the first master's program in financial engineering in the country.

George was a prolific researcher and writer, authoring more than 300 papers and several books. His early pioneering work on the fluid mechanics of blood flow not only was his personal window into bioengineering but also ignited subsequent work by many researchers around the world. He was also a creator of important application tools, most notably *Hydro*, a computer language for water management.

After stepping down as president of Polytechnic, George devoted himself to service to the engineering community. He continued as editor of the journal he cofounded, *Technology in Society*, and taught advanced courses in urban sustainability and introductory courses preparing first-year students for the rigors, challenges, and excitement of engineering. His many service positions included foreign secretary of the National Academy of Engineering and interim editor of *The Bridge*, the NAE's journal. He held honorary lifetime membership in the National Association for Science, Technology and Society. From 1994 to 1997 he chaired the Board on Infrastructure and the Constructed Environment of the National Research Council. Later he served as chair of the NRC's Committee on Alternatives to Antipersonnel Landmines and as a member of the Committee on Army Science and Technology for Homeland Defense. He also served on numerous national boards and committees, including the Advisory Committee for Science and Engineering Education of the National Science Foundation, the National Academies Committee on Megacities, the National Committee on Science Education Standards and Assessment, and the Lawrence Livermore National Laboratory's Engineering Advisory Committee.

Bugliarello's international contributions included consultantships abroad for the United Nations Educational, Scientific and Cultural Organization and the Organization for Economic Cooperation and Development, as well as assignments as a specialist for the U.S. Department of State in Venezuela and Central Africa. He was the U.S. member of the Science for Stability Steering Committee and the Science for Peace Steering Committee of the Scientific Affairs Division of the North Atlantic Treaty Organization.

Although he rarely spoke of his honors, George was widely recognized, garnering eight honorary doctorates, the Walter L. Huber Civil Engineering Research Prize of the American Society of Civil Engineers in 1967, and the 2009 Marconi Society's Beacon of Light Award. He was a fellow of the American Society of Civil Engineers, the American Society for Engineering Education, the American Association for the Advancement of Science, the New York Academy of Sciences, and the Biomedical Engineering Society. He was a founding fellow of the American Institute for Medical and Biological Engineering and served as president of the scientific research society Sigma Xi.

The memory of George Bugliarello would be woefully incomplete without mentioning his quiet kindness to friends and colleagues who came upon tragedy and sadness in life. He always found time to be a consoling voice to those who were suffering the loss of a parent, spouse, or child or to those who themselves were in their final days.

George Bugliarello's leadership, collegiality, civility, keen mind, and kindness made those he touched better for knowing him. He will be missed.

In 1960, he married Virginia Upton Harding. She survives him as do his sons, Nicholas and David.

MOUSTAFA T. CHAHINE

1935–2011

Elected in 2009

"For leadership in determining the structure and composition of the Earth's atmosphere from space observations."

BY CLAIRE L. PARKINSON

MOUSTAFA T. CHAHINE, a senior research scientist at the Jet Propulsion Laboratory (JPL) of the National Aeronautics and Space Administration (NASA) at the California Institute of Technology (Caltech) and an international leader in atmospheric remote sensing from satellite observations, died on March 23, 2011, at the age of 76.

Affectionately known as Mous to hundreds of friends and colleagues, Moustafa was born in Beirut, Lebanon, on January 1, 1935. After growing up in Lebanon, he moved to the United States in December 1954 and proceeded to power through his academic studies at the University of Washington, Seattle. He received a bachelor of science degree in aeronautical engineering in 1956 and a master of science degree in aeronautical engineering in 1957. He then entered the University of California at Berkeley as a doctoral candidate and received his Ph.D. degree in mechanical engineering in 1960. His studies centered largely on fluid physics.

It was while in graduate school in 1957 that Mous saw a photograph of JPL Director William Pickering with Wernher von Braun and James Van Allen, holding aloft a model of the just-launched Explorer 1 satellite, the story of which stirred his interest sufficiently that he resolved that he too would work in the space program. Three years later, after graduation, Mous began his 51-year career at JPL, initially examining the shock waves anticipated as a space capsule reentered Earth's atmosphere. Soon, he was examining other aspects of the atmosphere and working on methods to derive atmospheric information from the radiation received by satellite-based instrumentation.

Among Mous's heralded scientific and engineering accomplishments were his development in the late 1960s of an exact mathematical method for the inverse solution of the radiative transfer equation and his applications of that method to deriving atmospheric temperature and water vapor profiles. This "Relaxation Method" was subsequently widely used for obtaining satellite-based profiles of atmospheric temperature and composition not just for Earth's atmosphere but also for the atmospheres of Venus, Mars, and Jupiter. Later, in the 1970s, Mous formulated a multispectral approach to remote sensing in the presence of clouds, incorporating both infrared and microwave data. In 1980, Mous and others used his equations to generate the first satellite-based global distribution of Earth's surface temperature, using data from the High Resolution Infrared Radiation Sounder and the Microwave Sounding Unit. Many additional uses followed.

By this time Mous had proposed what was to become the Atmospheric Infrared Sounder (AIRS), a remarkable satellite instrument that was to dominate much of the next 30 years of his scientific and engineering career. He received his initial funding for AIRS in 1978, and he continued to develop and advocate the concept over the succeeding years. As NASA formulated plans for its multidecadal Earth Observing System (EOS), Mous was intimately involved as a member of NASA's Earth System Sciences Committee. The proposed AIRS instrument received broad-based support because of its potential applications for both weather forecasting and climate change research. Consequently, it was selected in 1988 to be one of the primary Earth-observing instruments on the Aqua satellite (originally known as EOS PM). Mous was selected as the first AIRS science team leader and remained in that position until his death over 20 years later.

Under Mous's leadership, the AIRS instrument was built in the 1990s to exacting standards, with a temperature-controlled 2,378-channel infrared grating spectrometer and a 4-channel visible/near-infrared photometer. Algorithms were developed to derive from the radiative data a suite of atmospheric and Earth surface variables. AIRS was launched on the *Aqua* satellite on May 4, 2002, and it quickly became the world's premier atmospheric sounder, providing well-calibrated global data every 1 to 2 days, with a spatial resolution of 13.5 kilometers at nadir for the infrared channels and 2.3 kilometers at nadir for the visible/near-infrared channels.

The AIRS data have been widely used by both the research and the operational communities. As foreseen years earlier by Mous, incorporation of AIRS data into weather forecast models measurably increased forecast skill, and Mous delighted in the many positive comments made by forecast experts and governmental leaders. The administrator of the National Oceanic and Atmospheric Administration, Vice Admiral Conrad Lautenbacher, said the following about the impact of the AIRS data: "The AIRS instrument has provided the most significant increase in forecast improvement in this time range of any other single instrument." The AIRS data have also been of practical value to the aviation field, by monitoring volcanic emissions.

One of the major research advances made with AIRS data was Mous's derivation of atmospheric carbon dioxide (CO_2) amounts in the midtroposphere. He did this through a "Vanishing Partial Derivatives" method that he developed for determining trace gas concentrations. His initial results provided the first satellite-derived global map of atmospheric CO_2. Once several years of data were obtained and animated, Mous's CO_2 results gave a striking display of the global distribution of both the seasonal cycle and the long-term upward trend in atmospheric CO_2. As such, these results became popular fixtures in scientific presentations and were presented to policymakers and popular media outlets and in peer-reviewed scientific publications. AIRS data also were used to create the first global maps of upper-tropospheric water vapor, soon after the 2002 *Aqua* launch, and a continuing data set of upper-tropospheric water vapor derived from the AIRS data has been available ever since.

In addition to being a prominent NASA and Caltech researcher throughout his 51-year JPL career, Mous served in important managerial positions. He headed JPL's Planetary Atmospheres Section from 1975 to 1978 and then founded the Division of Earth and Space Sciences, which he headed from 1978 to 1984, leading its approximately 400 researchers. Afterward, he served as JPL's chief scientist from 1984 to 2001. Mous was also the first chair of the Science Steering Group of the World Meteorological Organization's Global Energy and Water Cycle Experiment (GEWEX), serving in that role from 1989 to 1999. During that time the steering group defined the goals and objectives of GEWEX and established connections with the international earth sciences community, helping bring together satellite-based data collection and climate modeling.

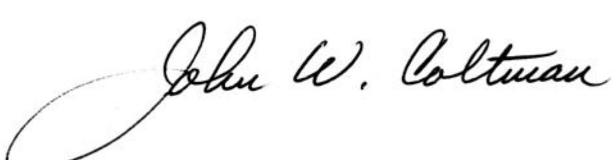
Throughout his career, Mous's excellence was rewarded with notable honors. He received NASA's Medal for Exceptional Scientific Achievement in 1969, NASA's Outstanding Leadership Medal in 1984, the William T. Pecora Award from NASA and the U.S. Department of the Interior in 1989, the Jule G. Charney Award from the American Meteorological Society in 1991, the Losey Atmospheric Sciences Award from the American Institute of Aeronautics and Astronautics in 1993, the William Nordberg Medal from the Committee on Space Research in 2002, NASA's Medal for Exceptional Scientific Achievement in 2007, and the George W. Goddard Award from the International Society for Optics and Photonics in 2010. The latter award was given specifically for Mous's "exceptional achievement in optical science and instrumentation for aerospace and atmospheric research." Mous was a fellow of the American Physical Society, the American Meteorological Society, the British Meteorological Society, the American Geophysical Union, and the American Association for the Advancement of Science. He was elected a member of the National Academy of Engineering in 2009 and was also a member of both the International Academy of Astronautics and the Society of Sigma Xi.

One of the highlights of Mous's career came in 2005, when he was among 15 invited international participants speaking in Vatican City at the Pontifical Academy of Sciences, Working Group on Water and the Environment. The purpose of the meeting was to address important issues surrounding hydrology, the environment, and sustainable development.

Moustafa Chahine was a uniquely tolerant, understanding, and generous person who had numerous lasting impacts on a personal level as well as through his many research accomplishments, the latter well documented in his dozens of peer-reviewed research publications. He radiated enthusiasm for science and engineering and delighted in mentoring and encouraging others and in teaching students and the public about the value of satellite observations. He was also generous in his advice and ideas about numerous other aspects of life. He was well rounded in his knowledge of the world, loved all types of music, and could read, write, and speak three languages with amazing fluency.

One might read about Mous's professional accomplishments and conclude that his work must have come first, but anyone concluding that would be badly mistaken. Those very close to him knew that for Mous there was no question that family came first. He was the compass and anchor for his wife, Marina, in their 53-year journey together, and as a father he led by quiet example, always placing his sons, Tony and Steve, as his top priority.

Mous was a vital part of NASA, JPL, and Caltech for over 50 years and of his family for even longer. His presence is sorely missed throughout the earth sciences community and by his family and many friends. His death, from a heart attack several hours after what had seemed to be successful hernia surgery, was a devastating loss for all those who knew him well. In the words of his sons, Mous's "astonishing balance between work and family, art and science, reason and passion is what makes his passing such an indescribable loss for us all." Moustafa T. Chahine is survived by his wife Marina, his sons Tony and Steve, his brother Najib, and his sisters Salma and Haifa.


John W. Coltman

JOHN W. COLTMAN

1915–2010

Elected in 1976

"For pioneering advancements in X-ray and low-light level imaging devices, undersea equipment, and electron tubes."

BY MAURY FEY
SUBMITTED BY THE HOME SECRETARY

JOHN W. COLTMAN, physicist and retired research executive of Westinghouse Electric Corporation, died February 10, 2010.

John W. Coltman was born in Cleveland on July 15, 1915. His father was an analytical chemist with the National Carbon Company (which became part of Union Carbide). He obtained his B.S. degree in physics from Case School of Applied Science (now Case Western Reserve University) in 1937 and an M.S. in physics and a Ph.D. in nuclear physics from the University of Illinois in 1941. That same year he was married to Charlotte Coltman of Urbana, Illinois, and they moved to Pittsburgh, Pennsylvania, where he joined Westinghouse Research Laboratories.

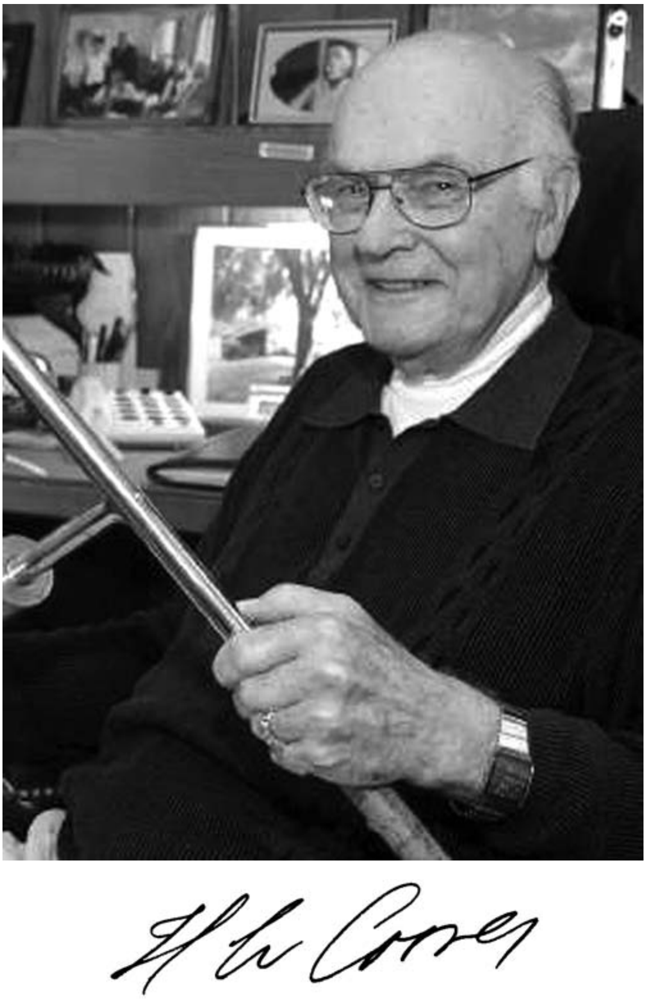
During World War II, Dr. Coltman did research in microwave tubes for use in radar and jamming enemy radar. Later, he took charge of a group of scientists whose aim was to solve the problem of the extremely dim images then obtainable in medical fluoroscopy. The resulting development of the X-ray image amplifier provided a brightening of 500 times and revolutionized modern clinical fluoroscopy. It made possible the techniques of cine-fluorography, television fluoroscopy, digital angiography, and video X-ray recording. It is used in many surgical procedures and today is still standard equipment in every hospital radiology department. Work on this device also resulted in the scintillation counter, of which Dr. Coltman was coinventor.

In 1949, Dr. Coltman was named manager of the electronics and nuclear physics department. He became responsible for research programs in acoustics, information theory, infrared, underwater sound, nuclear physics, optical pickup tubes, semiconductor devices, and television. In 1960 he was named associate director of the research laboratory, responsible for a group of several departments. In 1969, Dr. Coltman was appointed research director for the Public Systems Company and later director of R&D planning for Westinghouse's Research and Development Center, the position from which he retired in 1980. He held 22 patents and wrote 66 technical articles and chapters in three books.

Ever since his school days, Dr. Coltman played the flute. He was associate director of the Wilkinsburg Symphony Orchestra and played in the Pittsburgh Woodwind Quintet. His interest in flute led him to research on its acoustics, carried out in his home laboratory. He published some 40 articles on musical acoustics and was a recognized authority on the acoustics of the flute. Among his other pursuits were sailing, woodworking, and amateur radio, for which he was first licensed in 1932.

Many honors came to Dr. Coltman. He was elected a fellow of both the Institute of Electrical and Electronics Engineers and the American Physical Society. He served on many committees of the U.S. government and was a member of the National Research Council's Commission on Human Resources. In 1960, Dr. Coltman received the Longstreth Medal of the Franklin Institute for his development of the X-ray image amplifier and was also named Pittsburgh's Man of the Year in Science by the Junior Chamber of Commerce. In 1968 he was awarded the Westinghouse Order of Merit, not only for the X-ray amplifier and scintillation counter but also for his pioneering contributions to the infant science of radar in the 1940s and his later work on undersea equipment and electron tubes, including television. In 1970 he was awarded the Roentgen Medal by the Roentgen Museum in Germany, and in 1976 he was elected to the National Academy of Engineering. In 1982 he received the Gold Medal of the Radiological Society of North America in recognition of the development of the X-ray image amplifier.

Dr. Coltman is survived by his wife Charlotte of Strongsville, Ohio; their daughters, Sally Condit, also of Strongsville, and Nancy Horner of Severn, Maryland; four grandchildren; and four great-grandchildren.



HARRY W. COOVER, JR.

1917–2011

Elected in 1983

"For significant contributions in widely diverse fields of applied chemistry, management of industrial research, engineering and development, and national research activities."

BY VINCENT EDGAR PAUL
SUBMITTED BY THE NAE HOME SECRETARY

HARRY W. COOVER, JR., one of the most prolific 20th-century innovators in the chemical industry and former vice president for research at Eastman Kodak, Chemicals Division, died on March 26, 2011, at the age of 94 of heart failure.

Harry was born in Newark, Delaware, on March 6, 1917. At age 16 the car he was driving was struck by a train on a railroad crossing. He survived a coma that lasted 6 weeks. Nursed back to health by two devoted sisters, he emerged as a budding scholar. He was tutored by an aunt and ultimately passed the New York Regents Exam. Hobart College was his choice for undergraduate study. There he came under the tutelage of the late Dr. Ralph Bullard, professor of chemistry. Contemplating a career in medicine, he instead chose to focus on chemical science. He earned his B.S. at Hobart, winning the Southerland Prize. He later completed an M.S. and a Ph.D. in chemistry at Cornell University. His doctoral dissertation was on a commercial synthesis for vitamin B6.

Soon after, turning down a position at DuPont, Harry joined Eastman Kodak as a research associate and was soon transferred to the Tennessee Eastman Company in Kingsport, Tennessee—and thus evolved the research arm of the Kodak Chemical Division. He quickly rose through the ranks to become research director and later executive vice president for development.

Harry concentrated his efforts on polymers, contributing methods for the use of catalysts in their synthesis and graft polymerization, and also plastics, textiles, and insecticides. Later he worked on cyanoacrylate adhesives, now known as "superglues." Originally, work on these compounds was directed toward their possible use as plastics for impact-resistant jet canopies and as optically perfect gun sites for the military.

Famously, a lab associate inadvertently stuck together the lenses of an expensive refractometer, thus ruining the device. This was the "lightbulb" moment. Harry always said it was "one moment of serendipity and 10 years of hard work." Afterward, in a moment of television history, Harry and TV host Garry Moore hung from a device joined by one drop of superglue on the show "I've Got a Secret."

Ultimately, Harry was awarded more than 460 U.S. patents and became a champion for innovation and applied research. One of his passionate ideas was to engage the entire company in the research process. This he called "Programmed Innovation." Under his direction, an example of this process resulted in a method for the gasification of coal. Even after retirement, Harry's zeal landed him positions as a consultant for new product development at Locktite Corporation and the Reilly and Lilly chemical companies.

Numerous awards during his career included the Southern Chemist Award and the Gold Medal of the Industrial Research Institute, of which he was later elected president. In 2004 he was inducted into the Inventors Hall of Fame in Akron, Ohio. In 2010 he was awarded the National Medal of Technology and Innovation at the White House by President Obama.

Harry's last philanthropic act was to create a lovely multiuse memorial dome in memory of his wife of over 60 years, Muriel Zumbach Coover, on the grounds of the Allendale Mansion in Kingsport, Tennessee. He also endowed a grant for the development of an outdoor pavilion for the arts at the same site.

An iconic figure of industry and science, Harry W. Coover epitomized the polished gentleman. A world traveler, he represented America as the best of sophisticated life and accomplishment. His example is revered by his family and all who knew him. Dr. Coover is survived by his sons Harry Wesley Coover III and Stephen Rohm Coover; daughter Melinda Coover Paul; and four grandchildren—Brett Coover, Dana Coover, Adam Paul, and Kirsten Paul.

FRANK W. DAVIS

1914–2001

Elected in 1967

"For design, development, and testing of supersonic aircraft and missile systems."

BY ROBERT J. PATTON

FRANK WILBUR DAVIS, a former test pilot and executive with Convair and General Dynamics, died on July 15, 2001, at the age of 86.

Frank W. Davis was born on December 6, 1914, in Charleston, West Virginia. Raised in Charleston, he was an excellent student. He was also mechanically inclined and wanted to become an engineer. He applied for admission to and was accepted at the California Institute of Technology. He graduated with a B.S. degree in mechanical engineering in 1936.

After graduation he joined the U.S. Navy as an aviation cadet, so that he could learn to fly an airplane. Davis received his wings in 1937 and joined the U.S. Marine Corps. In 1940 he resigned from the Corps and became a test pilot for Vultee Aircraft. On March 15, 1941, he married Frances Pfeiffer in San Marino, California. In 1945 he was promoted to chief of aerodynamics and flight test at Vultee Aircraft.

Vultee Aircraft became Consolidated Vultee Aircraft, and Frank became assistant chief engineer in 1950 and assistant vice president of engineering in 1952. During this time he was instrumental in the development of the first U.S. turboprop fighter, the XP-81, and the first delta wing supersonic fighter, the XF-92A. Under his guidance the company developed the first vertical takeoff fighter, the XFY-1, in 1954. Frank also had an important role in America's first intercontinental missile—Atlas.

In 1954, Frank Davis was named chief engineer of the Fort Worth Division of what was then called Convair (the name had been changed from Consolidated Vultee Aircraft). He and Fran moved to Fort Worth, where Frank supervised development of the B-58 supersonic bomber, which first flew near the end of that year. The B-58 was a successful bomber, but it was ahead of its time for maintainability. Over 100 were built and flown by the U.S. Air Force.

The next major aircraft program starting in the 1960s was the Tactical Fighter Experimental, or TFX. Davis was promoted to have full responsibility for the complete Fort Worth Division (including the TFX proposal) in 1959. The competition dragged on for several years, but his division finally won the F-111, as it was then called in 1962. Development went well, and over 600 were built.

In 1970 the company was reorganized, and Davis became president of the Convair Aerospace Division, which included the Convair Division in San Diego, the Fort Worth Division, and the Astronautics Division in San Diego. During this period he and Fran moved back to San Diego.

Back in the 1960s Convair had purchased Canadair, Ltd., a Canadian airplane manufacturer located in Montreal. Frank Davis was made a member of the Board of Directors in 1963 and continued until his retirement from the company in 1975.

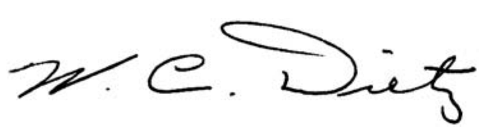
In 1960, Frank was honored by the University of West Virginia with a doctor of science degree. Shortly thereafter he was elected a fellow of the American Institute of Aeronautics and Astronautics. Then in 1967 he was elected to membership in the National Academy of Engineering. Davis received the California Institute of Technology Alumni Award in 1968. He was also elected an honorary fellow of the Society of Experimental Test Pilots.

Frank continued to be active professionally after his retirement. He continued as a consultant to Canadair and was a director of Convair, Langley Corporation, VAI Computer, Inc., and Kanawha Manufacturing Company.

While in Fort Worth, Davis was active in many local activities. He was named Engineer of the Year by the Fort Worth Society of Professional Engineers. He was one of the organizers of and on the board of the Fort Worth International Science Fair Committee in 1969. The Fort Worth Exchange Club named him Outstanding Citizen of the Year for 1970.

When Frank and Fran moved back to California, they settled in La Jolla in an apartment with a beautiful view of the Pacific Ocean. They located near the La Jolla Country Club because Frank loved to play golf. He played regularly and in 1994 managed to score below 80 (his age) and was very proud of the accomplishment. During the mid-1970s, Fran Davis suffered from throat cancer, which reduced her activities. She died about 1992. Frank continued to play golf regularly and socialized with old friends. In the late 1990s his health deteriorated, and he died in 2001.

Frank Davis was a wonderful engineer as well as a great person. He had a keen interest in everything mechanical. He was also a friendly, religious man who is much missed.



WILLIAM CHARLES DIETZ

1919–2006

Elected in 1982

"For major technical and engineering advancements incorporated in high-performance bomber and fighter aircraft of the U.S. Air Force."

BY ALAN C. BROWN

WILLIAM DIETZ, best known as chief engineer of the F-111 and F-16 aircraft programs at General Dynamics, in Fort Worth, Texas, died on July 31, 2006, at the age of 87.

He was born on April 17, 1919, in Chicago, and graduated from the Aeronautical University of Chicago in 1940 with a B.S. in aeronautical engineering.

Bill joined Consolidated Aircraft in San Diego on October 10, 1940, staying with that company, which became General Dynamics, for 53 years until his retirement on October 31, 1993, as vice president and senior technical staff member. He was very proud to have been the first employee to reach 50 years of company service in October 1990.

He progressed through the Engineering Loft and Lines Group at Consolidated Aircraft to the Structural Design Group as a structural designer, working on projects such as the Consolidated PBY Catalina, the twin-engined World War II flying boat (PBY, PB2Y, PB4Y, P4Y, B-24, B-32, and B-36). In 1943 he was promoted to group engineer on the P4Y project and transferred to the newly organized New Orleans Division. After termination of this project, he was promoted to project engineer of the PBY.

In 1945, Mr. Dietz transferred to the Fort Worth Division as fuselage group engineer and then was promoted to project engineer, responsible for all second-shift engineering operations in connection with production of the B-36. He then became assistant project engineer for the YB-60. After completion of the program, he was promoted to project engineer on the B-58 and continued with that project until August 1961, being promoted to senior project engineer and then chief of B-58 projects.

In August 1961 he was transferred to the F-111 project, where he was responsible for technical coordination of the proposal effort. After award of the contract in November 1962, he was appointed chief engineer of the F-111 project and managed and directed the F-111's engineering design and development. In May 1969 he was assigned as director of airframe and structures technology, responsible for airplane design, structures analysis, loads, and engineering test laboratories.

Mr. Dietz was made engineering director in October 1971 and in this position was responsible for the lightweight fighter proposal. After award of the contract in April 1972, he became director of YF-16 engineering. In July 1974 he was promoted to vice president of F-16 engineering and directed the engineering effort for full-scale development and production of the program.

In 1979, Mr. Dietz transferred to the General Dynamics Convair Division, in San Diego, as vice president and program director of the cruise missile programs. He returned to Fort Worth in 1982 and assumed responsibility for the newly organized Special Projects Department as vice president and program director.

In September 1988 he was assigned the task of assisting the vice president of the YF-22 program in coordinating the design and development effort. In March 1989 he became responsible for providing division-wide coordination of engineering tasks on key programs, including the A-12 program. In January 1991 he became division vice president and senior technical staff member. Then in March 1991 he was tasked with the engineering design of the AX program (a Navy program to develop a stealthy shipborne attack/fighter aircraft), retiring from the company two and a half years later.

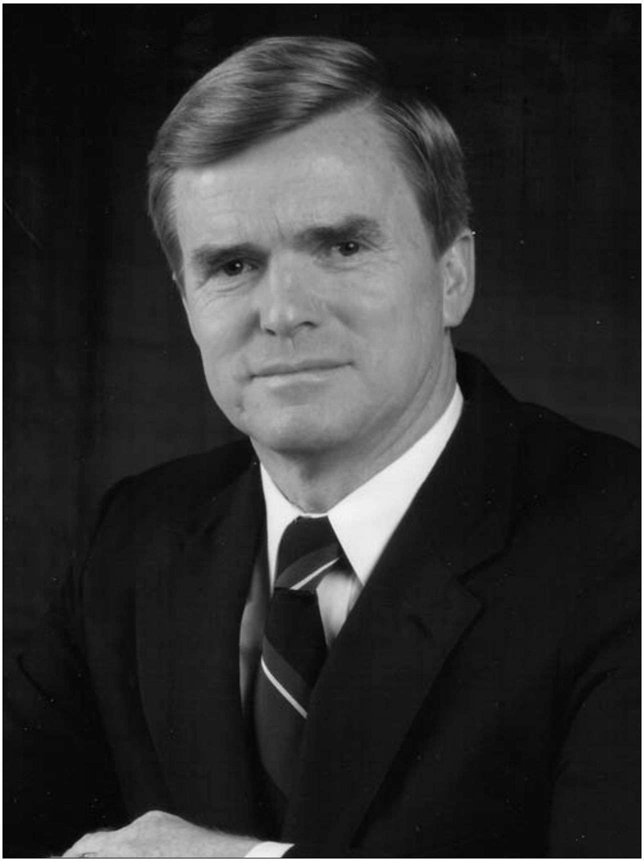
Mr. Dietz's personal list of career highlights includes the first supersonic bomber (B-58 Hustler), the first swing-wing military aircraft (F-111), and of course the F-16 fighter, which became one of the dominant international fighter aircraft of the past 30 years. As impressive as his accomplishments were, Mr. Dietz accepted little individual credit for innovations his work helped foster. "Nobody does anything single-handedly at a modern aerospace company," he said. "All of our accomplishments have been team efforts with a lot of contributions from different people."

Mr. Dietz was elected to the National Academy of Engineering in 1982. He was a fellow of the American Institute of Aeronautics and Astronautics. He was a past member of the Air Force Scientific Advisory Board, for which he received the Air Force's Exceptional Civilian Service Award, and he served on numerous Air Force and National Research Council committees and advisory panels. He was a member of the Advisory Group for Aerospace and Research Development's Flight Mechanics Panel, and in 1977 he received the American Institute of Aeronautics and Astronautics Reed Award.

Also in connection with his leadership of the F-16 fighter development team, Mr. Dietz received an award for outstanding engineering accomplishments from the Society of Professional Engineers, and he was a member of the team that received the Collier Trophy for F-16 development. More recently, in 1992 he won the Kelly Johnson Aerospace Vehicle Design and Development Award (named for the engineer who led the Lockheed Skunk Works), and in 2000 he was nominated as a National Aeronautic Association Elder Statesman of Aviation with the following citation: "Over 53 years William C. Dietz led or contributed to the design of thirteen outstanding military aircraft, spanning projects from the PBY seaplane to the F-22 air superiority fighter."

Bill was married to Leta Ruth Dietz for 47 years until her death in 1993. Survivors include his wife of 11 years, Loraine Dietz; a son, David Dietz; daughter Deborah Pipes and her husband Wayne; four grandchildren; nine great-grandchildren; stepdaughter Earline Wood and her husband Jerry; two step-grandsons; and six step-grandchildren.

Deborah Pipes described her father as "kind, considerate, caring and generous. He was totally unassuming, never wanting the spotlight on himself. He was a hard worker and a man of integrity." She also wrote that he enjoyed wonderful times with his family and friends, including bowling leagues, golf, holiday parties, and cookouts. In his later years he enjoyed trips with his wife Lori to Arkansas and New Mexico.



EDSEL D. DUNFORD

1935–2008

Elected in 1989

"For eminent leadership in the development and integration of satellites, electronic payloads, and advanced technology for space."

BY GEORGE J. GLEGHORN

EDSEL DELANO (ED) DUNFORD, former president and chief operating officer of TRW, Inc., a major aerospace and systems engineering company, died October 3, 2008, at his home in Rolling Hills, California, from kidney cancer. He was 73.

Ed Dunford was born May 7, 1935, in Langdon, North Dakota, about 20 miles south of the Canadian border. Growing up poor on a subsistence farm, he was one of the younger children in a large family. He was educated in the public schools of Osnabrock, North Dakota. Soon after graduation in the early 1950s he joined the armed services, serving for three years in the U.S. Army. Upon leaving the Army he attended the University of Washington, graduating with a B.S. in electrical engineering in 1960. In 1973 the University of California at Los Angeles (UCLA) awarded him a master of engineering degree, and he completed the Executive Program at Stanford University in 1982.

Ed began his professional career at the Aeronutronic Division of Ford Motor Company. He spent nearly four years there as a designer of communications equipment: receivers, demodulators, digital circuitry, and similar signal processing equipment. He was proud of his responsibility for development of a detection system that was installed in American embassies to detect and locate hidden eavesdropping devices.

In 1964, Ed joined Space Technology Laboratories, the part of TRW that produced satellites and space-related hardware, to participate in the exciting and innovative technological activities that were the order of the day. His experience led to his being assigned to the design and construction of spacecraft command receivers using phase-locked loop techniques to achieve the extreme sensitivity needed for interplanetary communications. He was responsible for the *Pioneer 10* command receiver. *Pioneer 10* was a National Aeronautics and Space Administration (NASA) spacecraft launched in 1972 on a mission to study the asteroid belt and fly by Jupiter. In 1983 it became the first man-made object to leave the solar system.

Another of Ed's projects in the late 1960s with which he was particularly intrigued was the design and construction of a system involving a small satellite that relayed signals from friendly covert receivers deployed in denied areas in the Far East to a nearby island. As the project manager, Ed spent several months installing the ground station and later personally installed the satellite on its launch rocket. Some projects in the early days involved a great deal of personal service!

During the next 11 years Dunford was deeply involved in the design and development of increasingly complex electronic equipment and systems. All involved interlinked communication systems and intricate data processing equipment for both classified and civilian projects. This was a period when mass and power requirements were stringent, leading to an increased emphasis on miniaturization and eventual development of very large scale integrated circuit technology. Typical of these systems was NASA's Tracking and Data Relay Satellite System, for which Ed was the payload manager. The system involved three geosynchronous relay satellites and a ground station, all interlinked so as to simultaneously track a number of scientific satellites and relay their data and command links to the ground.

Over this 20-year period Ed held various positions of technical and project management within TRW's Electronic Systems Group, becoming vice president and group general manager in 1984. Ed had a top security clearance, and many of his accomplishments are classified and may never be disclosed. Under his guidance the company won the contract for the payload of the military's Milstar communications satellite teamed with Hughes Aircraft.

Dunford became vice president and general manager of the Space and Technology Group in 1985 and of the Space and Defense Sector in 1987 and thus was head of all military and civilian space, intelligence, and systems engineering work for the corporation. His tenure there was marked by a period of remarkable success in contractual and financial performance.

In 1991 he was selected to be president and chief operating officer of the parent company, TRW, Inc., and turned his attention to expanding the old-line auto parts business with a major new product line. To this end over 100 employees were transferred from the space and defense group to enhance product design and create modern manufacturing and test facilities. These practices—applied to more than 100 plants of the company's automotive parts business—enhanced the quality and performance of these product lines also. Ed retired in late 1994, having presided over a period of unusual corporate growth, with the company's stock price more than doubling.

Ed served as chairman of the Aerospace Industries Association in 1991 and was on the board of directors of several corporations—TRW, National Steel Corporation, and Cordant Technologies among them.

In 1989 he was elected to the National Academy of Engineering "for eminent leadership in the development and integration of satellites, electronic payloads, and advanced technology for space." He served as chairman of the National Research Council's Committee on the National Aerospace Initiative in 2003. He was a fellow of the American Institute of Aeronautics and Astronautics and received outstanding alumnus awards from the University of Washington and UCLA. In 1990 the Southern California Minority Business Development Council awarded him its annual leadership award.

In his career Ed had longtime direct and indirect contact with the Cold War. It became a major interest of his, and in 2004 he coauthored and coproduced a two-hour documentary entitled "The Cold War and Beyond." This was shown on Public Broadcasting System stations and later modified to a form suitable for college and high school history instruction.

Ed Dunford had a management style that emphasized teamwork and an ability to solve challenging problems that were at the forefront of technology. He will be remembered for his directness and integrity, his warmth, and his sense of humor. These traits made it a pleasure to work with him both as a colleague and as a subordinate. He will be missed.

His son Wyman wrote:

> Ed loved to golf and belonged to several clubs, including Palos Verdes Country Club in California where he played for over 35 years with longtime friends, colleagues, and family. Over the years he enjoyed golfing in Europe, Africa, and Asia as well as the U.S. Another passion was hiking from his early years and he took pride in summiting many peaks, including Mt. Whitney, the highest peak in the continental United States. Ed also enjoyed running and, consistent with his competitive nature, always tried to improve his race times.
>
> In the 1970s Ed decided he wanted to fly airplanes, so he became a licensed pilot. For many years he enjoyed taking family and friends for rides.
>
> Ed was a voracious reader and huge history buff. He loved to travel and would always read about the locations he was about to visit. His memory was incredible and he could dazzle people with facts about any country or era in time.
>
> Ed was actively involved with his family and quietly created a level of expectation that has provided

inspiration for generations of success and caring. He led by example with humility, respect for others, and a passion to do well.

Ed was UCLA Engineering Alumnus of the Year in 1987. Ed's son, Wyman, and his granddaughter, Alyssa, were given special recognition shortly after Ed's death at UCLA's engineering alumnus of the year ceremony for three generations of graduates from the UCLA program. His grandson, Mark, is attending the University of Washington, where his grandfather earned a bachelor's degree.

Ed's family has so much love and respect for him that his sons Stan and Phil and grandson Bradley climbed the same mountain that Ed climbed years earlier and spread his ashes on the peak. It is fitting that Ed has become a permanent part of the grandeur of this great country he served and loved.

Survivors include his wife, Lorie Dunford; his sons, Wyman Dunford (and wife Marianne); Stanley Dunford (and wife Helen); Philip Dunford; and daughter Marlo Garrett (and husband Tim); stepchildren Matthew Henning and Abbey Greene; and his grandchildren, Carina Dunford, Laurel Dunford, Alyssa Dunford, Bradley Dunford, Amy Dunford, Mark Dunford, Michele Dunford, Katie Dunford, Jessica Garrett, and Jason Garrett.

WALTER A. ELMORE

1925–2010

Elected in 1998

"For advancing protective relaying technology and providing education in its application."

BY STAN HOROWITZ

WALT ELMORE was recognized as one of the world's leading experts in protective relaying, an engineering discipline that is vital to the safe and economic performance of electric power systems. His technical achievements are legendary. Walt was affiliated with the Westinghouse Electric Corporation, which was later absorbed into ABB Power T&D. He retired in 1996 and died on January 20, 2010, at the age of 84.

Born in Bartlett, Tennessee, on October 2, 1925, Walt was active in a wide variety of activities. He was a Life Boy Scout and a navigator in the Army Air Corps during World War II. Following the war, Walt went to the University of Tennessee and in 1949 earned a B.S. in electrical engineering. He began his technical career at Memphis Light, Gas and Water Division, in the substation design department. In 1951 he went to Westinghouse Electric Corporation, where he was an application and consulting engineer for the next 38 years.

Teaching was a large part of Walt's activities. He participated in hundreds of customer schools in Newark and later in Coral Springs. Walt's unique contribution was recognized by Westinghouse/ABB in the naming of a Coral Springs office building in his honor. A protective-relaying textbook, *Applied*

Protective Relaying, which was published by Westinghouse in 1979 and is a standard text for all utility engineers, contains a half-dozen chapters written by Walt.

Walt taught protective-relaying classes at Texas A&M, Georgia Tech, Washington State University, and numerous Institute of Electrical and Electronics Engineers/Power System Relaying Committee (IEEE/PSRC) conventions and seminars. His homespun, no-nonsense approach to the mathematics, application, and manufacturing details of electromechanical relays, followed by solid-state and eventually computer relaying, was essential to understanding the overall value of power system protection. His outstanding technical abilities were evidenced in the five patents he was awarded and the over 50 papers he wrote and presented at international, national, and regional conferences. Walt's discussion of papers presented at the various conferences added value and substance to this specialized literature.

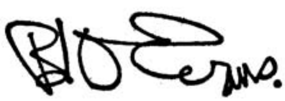
Walt's participation in the IEEE/PSRC Power Engineering Society (PES) is especially noteworthy. He was a life fellow of the IEEE, past chairman of the Technical Council (the organization that directs the technical activities of the PES and past chairman of the IEEE/PES Power System Relaying Committee. His impact on electric power systems was worldwide. As a leader of these committees, he influenced the research and practice of protection, operation, and control of electric power systems to a degree that cannot be overemphasized.

Along the way, Walt garnered honors that hardly begin to describe his impact on electric power. Citations from the IEEE honors such as IEEE's Gold Medal for Engineering Excellence, a PSRC Award for Distinguished Service, Texas A&M's award for the most prolific author, and ABB's dedication of a building in his honor present only small evidence of Walt's impact on the industry and society in general.

I had the pleasure and honor to be a close friend of Walt and his wife Jane for over 50 years. We met at all the PSRC meetings and other PES functions. I saw firsthand the impact Walt had on other engineers during discussions at working group and subcommittee meetings. He contributed technical, historical, philosophical, and sensible discussions with humor that endeared him to all of those present. Knowing Walt's background and expertise, all of his comments were accepted and included in all of the papers and other technical organization output.

The PSRC had a 50th anniversary during Walt's tenure as chairman, and his remarks at a dinner are still recorded as a milestone event. In addition to this special event, Walt participated in the technical and social activities of countless engineering functions. Not content with only technical areas of interest, Walt was a regular at the Monday morning "Golfing Subcommittee" meetings played regularly before the serious business of the PSRC began.

Walt is survived by Jane Huey, his wife of 59 years; his three daughters—Robin Spicer, Jamie West, and Laura Elmore; six grandchildren; and two sons-in-law. After Walt's retirement from Westinghouse/ABB, he continued to attend technical meetings and never introduced himself without mentioning Jane and the family of which he was so proud. He was a giant of the industry and will be sorely missed.



BOB OVERTON EVANS

1927–2004

Elected in 1970

"For personal and leadership contributions to the development of computer technology and the design of computer systems."

BY GENE M. AMDAHL

I first met Bob Evans in the summer of 1952 at the IBM laboratory in Poughkeepsie, New York. I had just arrived in Poughkeepsie in June as a new employee. Bob was associated with the same engineering group that I was entering, the group that had designed the IBM 701 computer. At that time most of the engineers were involved in supporting the field engineering activities, but Bob was working on the design and implementation of a graphical display system for the RAND Corporation. We became friends right away, and I was excited to see the engineering techniques he employed in the display system, which turned out to be very effective.

With many of the original planners of the IBM 701 assigned to the Sage System, I was assigned the task of planning the follow-on to the IBM 701—the IBM 704. I did the defining of the 704, including floating point and indexing. Bob Evans and the other 701 engineers did the logic designs involved in implementation of the changes. The market size estimation for the IBM 704 was 32, but the actual number sold was 140, so it was a remarkably profitable program! I was then asked to plan the IBM 709. At this time Bob Evans was assigned to the management of another project, so I lost track of him. I left IBM in late 1955, when the laboratory structure was changed and my project, Stretch (the IBM 7030), was altered, such that I no longer had control of the planning. Bob was subsequently involved as a project engineer in the Stretch I/O subsystem design. From there he became the assistant to J. A. Haddad, director of advanced machine development, IBM Corporate Headquarters.

In 1956, Bob became the technical assistant to E. R. Piore, director of the newly formed IBM Research Division, Corporate Headquarters. Additionally, he was given a special assignment at the National Security Agency (NSA) to place a special computer in operation. In 1957 he was systems manager of Navy Development, Data Processing Division, where he led the development of special electronic computers for NSA, including SLED II, IBM's first large-scale transistorized computer, and other classified projects. In 1959 he was systems manager of intermediate systems and developed the IBM 7070 in the Data Processing Division. And in the General Products Division he developed the IBM 1440/1401G/1410 machines.

In 1960, E. R. Piore hired me to join the IBM Research Division to head up the experimental machines department. This was to be for a minimum of four months to a maximum of seven months, at which time I was to be transferred to IBM's San Jose laboratory. I had just started at IBM when Bob Evans requested me to meet with him at a budget session at Jug End in New York state. There, I sat through requests for funding hardware and software programs for two generations of three different computer families, for the second generation in each computer family was not quite compatible with the first generation.

In August of 1961, Bob requested me to be in charge of the design of the function and hardware of the members of what became the family of System 360. Bob was to be in charge of the corporate program.

I moved to Poughkeepsie into an area where Bob Evans and his family lived. Our son played with their son, a bit mischievously at times. Bob was vice president of development of the Data Systems Division, Poughkeepsie, an organization of more than 3,500 responsible for worldwide development of System 360 and all other midrange and large system products. Fred Brooks as corporate processor manager had responsibility for assuring adherence to spread committee uniformity rules.

After four years (not four to seven months), I accepted a visiting professorship at Stanford, so IBM moved me to California as promised. IBM also made me a fellow in January 1965. At that time Bob was made president of the Federal Systems Division, in Gaithersburg, Maryland, concentrating on advanced technology and systems for aerospace, such as the National Aeronautics and Space Administration's Gemini and Apollo programs.

In 1969, Bob was made president of the Systems Development Division. He was responsible for management of IBM's principal computer product lines, including systems programming, and development and manufacturing of terminals and communications systems, point of sale, and banking subsystems.

In 1972, Bob Evans was elected a vice president of IBM. In 1974 he initiated the IBM-Comsat partnership, which became Satellite Business Systems. In 1977 he was made vice president of engineering, programming, and technology, to ensure the effectiveness of IBM's wordwide technical activities.

On July 1, 1984, Bob took early retirement from IBM after 32 years, 9 months, to pursue other interests. He became general partner at Hambrecht and Quist Venture Partners, becoming managing partner in 1988. In 1995 he became president of Vanguard International Semiconductor Corporation.

Bob had so many other activities and positions that it is impossible to list them all here, but I must mention that he received the Edwin H. Armstrong Achievement Award in 1984 from the IEEE Communications Society, and in 1985 President Ronald Reagan presented him with the National Medal of Technology and Innovation for his work on IBM's System 360.

I thought Bob had the most fantastic memory of any person I have known and felt that he related all previous experience to any new circumstance immediately! Bob was also a loyal and supportive friend and human being.

Bob is survived by his wife of 54 years, the former Maria Bowman; three sons, Robert, Douglas, and David; a daughter, Cathleen Licero, who works in marketing at IBM; and eight grandchildren.

JAMES R. FAIR

1920–2010

Elected in 1974

"For contributions to mass transfer technology and computer simulation of chemical processes."

BY DONALD R. PAUL

JAMES R. FAIR, a giant in chemical engineering who straddled the industrial-academic interface with great ease, died on October 11, 2010, just three days short of age 90.

Jim was born on October 14, 1920, in Charleston, Missouri, south of St. Louis and near where the Ohio River intersects the Mississippi River. He spent his early years in Tonganoxie, Kansas, and Little Rock, Arkansas. As a young boy Jim was very fond of watching baseball games and was fascinated by all aspects of trains and railroads; these were pastimes that stayed with him throughout his life. He was very active in scouting and became an Eagle Scout before his 16th birthday.

At age 18, Jim entered the Citadel, in South Carolina, in the tradition of his father. In 1940 he transferred to the Georgia Institute of Technology, where he received a B.S. in chemical engineering in 1942. After graduation he joined the Monsanto Chemical Company as a junior engineer in St. Louis. Later he had assignments in Karnack and Texas City, Texas. During World War II he was vitally involved with the government's high-explosives and synthetic rubber programs.

As it turned out, Jim was transferred to Texas City just prior to what has been called the worst industrial accident in U.S.

history, and he narrowly missed being one of its fatalities. On April 16, 1947, a French-registered ship, the *Grandcamp*, which was docked at the port of Texas City, adjacent to the Monsanto facility and loaded with approximately 2,300 tons of ammonium nitrate, caught fire. Seeing the smoke, Jim and some of his colleagues went to the docks to investigate. Very fortunately, though, Jim decided to return to his office to complete some calculations while the others remained on the dock to watch the fire. On his way to the office, the ammonium nitrate detonated and the explosion destroyed the Monsanto plant. Many of Jim's coworkers were among the nearly 600 who died. Jim was knocked unconscious and injured by the blast; he was quite fortunate to have survived the disaster.

Because of his outstanding work and promise as a young engineer, Jim was granted an academic leave of absence for one year by Monsanto and used it to obtain a master's degree in chemical engineering from the University of Michigan, which he completed in June 1949. He returned to Monsanto in Texas City and soon met a lovely young Texas girl by the name of Merle Innis. Merle and Jim were married January 14, 1950. Their first child, James Rutherford Fair, was born in Texas City on February 8, 1951.

Following the Michigan experience, Jim gave a lot of thought to obtaining a Ph.D. and considered reaction kinetics an important area to pursue. In 1952 he took an unpaid leave of absence from Monsanto to enter the graduate program in chemical engineering at the University of Texas at Austin, where he did research with Professor Howard F. Rase. After receiving his Ph.D. in 1954, Jim joined Shell Development Company in Emeryville, California, where he worked for about two years. A second child, Elizabeth Fair, was born in Oakland, California, on April 30, 1955.

In 1956, Jim returned to the Monsanto Chemical Company in its Corporate Research Laboratories in Dayton, Ohio, as a research section leader. In 1961 he was transferred to Monsanto's headquarters in St. Louis, where he took on ever-increasing responsibilities. For a decade he was director of corporate technology. While at Monsanto he maintained several academic connections, including serving as an affiliate professor of chemical engineering at Washington University from 1964 to 1979. Jim and Merle's third child, Richard Innis Fair, was born in St. Louis on April 26, 1963.

Meanwhile, in the mid-1970s the first endowed chair in the College of Engineering at the University of Texas at Austin was established by the family of one of its successful alumni. Soon after I became chair of the chemical engineering department in 1977, the dean of the college, Earnest F. Gloyna (NAE member), and I had several conversations about Jim Fair and his strong interest in engineering education. We decided to see if this chair could be used to attract Jim to return to Austin as part of our faculty. In 1979, Jim began a full-time academic career at the University of Texas at Austin by accepting the offer of the Ernest & Virginia Cockrell Chair in Engineering. In 1985 he was appointed to the new John J. McKetta Centennial Energy Chair in Engineering, established to honor his friend and colleague. Jim established the Separations Research Program, a very successful industrial-academic consortium, in 1983 at the university and remained its head until 1996. At its zenith this program had as many as 40 corporate sponsors. During his academic career, Jim directed the research for 21 master's theses and 22 doctoral dissertations. Over his entire professional career, Jim published more than 200 technical papers and book chapters. He served as technical consultant to many companies. For 25 years he taught a continuing education course under the sponsorship of the American Institute of Chemical Engineers, the course being the organization's most popular; it was offered over 125 times. Jim officially retired from his academic position at age 72 but continued to work every day while holding emeritus status.

The majority of the technical work Jim did during his 33 years in industry was of a proprietary nature, but he was also able to establish a remarkable publication record in the archival literature. His technical expertise and interest were always in the design of the components that make up chemical manufacturing plants—reactors, heat exchangers, separations devices, and so forth. His true love was the design and operation efficiency of distillation columns. He wrote many review articles and contributions to handbooks in these areas. After joining the University of Texas at Austin, Jim started an active research program on separations, mainly in the areas of distillation and extraction. These topics had been largely abandoned by most universities owing in part to the lack of government funding for topics of such practical concern to companies. However, Jim solved the funding problem by using his strong industry background and connections to obtain very generous support of both fundamental and applied separation research from a wide array of corporations. He added professional staff and included a number of his faculty colleagues and supported their contributions via the industrially funded Separations Research Program.

Jim Fair was involved in many professional activities, with service on many boards and committees. He was widely recognized for his contributions to engineering practice and education. He served as vice president of Fractionation Research, Inc., and was a registered professional engineer in Texas and Missouri. He received the Professional Achievement Award from *Chemical Engineering* magazine in 1968 "for contributions to chemical engineering design education and to the field of separations technology" and was elected to the National Academy of Engineering in 1974.

Jim was especially active in the American Institute of Chemical Engineers (AIChE), where he served a term as an elected director and held the grade of fellow since 1971. He received the following awards from the AIChE: the William H. Walker Award (1973), the Chemical Engineering Practice Award (1975), the Founders Award (1976), and the Gerhold Award in Separations Technology (1994). In November 1979 he delivered the annual institute lecture before AIChE and in November 1983 was recognized as one of 30 living eminent chemical engineers at the AIChE Diamond Jubilee Meeting. In November 2000 he was honored in a special symposium of AIChE for his many contributions to the institute's distance-learning program. He received the Malcolm Pruitt Award from the Council for Chemical Research (1991), the Gold Medallion

Award from the American Society for Engineering Education (1993), and the Separations Science and Technology Award of the American Chemical Society (1993). In October 1993 he was honored by a festschrift of the international journal *Industrial and Engineering Chemistry Research*, published by the American Chemical Society. He was inducted into the Engineering Hall of Fame at Georgia Tech in 1994.

Jim received honorary doctorates from Washington University (1977) and Clemson University (1987). He was named a distinguished engineering graduate by the University of Texas at Austin (1976) and also received the university's Joe J. King Professional Engineering Achievement Award (1987) "for exemplary leadership in the engineering profession."

Following his childhood interest in trains, Jim conducted research on railroad history and, to this end, published a number of articles as well as two full-length books on the subject. His very large collection on railroad history and operations has been given to the Railroad and Heritage Museum in Temple, Texas. He was an avid book collector, and his extensive collection of technical books was given to the University of Guanajuato in Mexico. Jim wrote his memoirs for his family and a few friends, which he subtitled "Recollections of a Good Life."

Jim led an active church life and served University Presbyterian Church in Austin, including session membership. He is survived by his wife of 61 years, Merle; their two sons (their daughter died earlier in 2010); and six grandchildren.

DANIEL J. FINK

1926–2012

Elected in 1974

"For contributions to aeronautics and space in government and in private industry."

BY ROBERT WERTHEIM

DANIEL J. FINK, whose professional lifetime was spent in service to our country, passed away on Friday, June 1, 2012, at the age of 85. Born in Union City, New Jersey, Dan graduated from the Massachusetts Institute of Technology (MIT) with B.S. and M.S. degrees in aeronautical engineering. He had been afflicted with polio at the age of 13, which in later years required the use of canes and walkers and ultimately a wheelchair but which he never allowed to restrict his ebullient nature, brilliant insights, and leadership skills.

Dan's services were in management and advisory capacities to the U.S. Department of Defense and many other agencies, both public and private. From 1963 to 1967 he served in the Pentagon in the Office of the Secretary of Defense, first as assistant director for defensive systems and subsequently as deputy director of defense, research and engineering (strategic and space systems). He returned to private industry in 1987, joining General Electric Company where he held the positions of vice president and general manager of the Space Division, vice president and group executive of the Aerospace Group, and senior vice president for corporate planning and Development. In 1982 he retired from GE to form a strategic management consulting firm, D. J. Fink Associates, Inc.

Dan served as a member of the Defense Intelligence Agency (DIA) Scientific Advisory Board, the Army Scientific Advisory Panel, and the Defense Science Board, where he chaired or cochaired many committees. From 1983 to 1988 he served as chairman of the National Aeronautics and Space Administration (NASA) Advisory Council. Dan served as president of the American Institute of Aeronautics and Astronautics, of which he was an honorary fellow. After election to the National Academy of Engineering, he served as chairman of the Space Applications Board, the Board on Telecommunications/Computer Applications, and the Committee on U.S.-Japan Linkages in Transport Aircraft. He was a member of the NASA/White House Committee on the future of the U.S. Space Program (the Augustine Committee) and of the Vice President's Space Policy Advisory Board, where he chaired a committee on the future of the U.S. space industrial base.

Along with NASA's Dr. John Clark, Dan was awarded the 1974 Collier Trophy, the nation's top aerospace award by the President of the United States for leadership of the NASA/industry team responsible for the Earth Resources Technology Satellite Program, LANDSAT.

Dan was awarded the Department of Defense's highest civilian decoration, the Distinguished Public Service Medal, and NASA's Medal for Outstanding Leadership. In October 2010, he was awarded the prestigious Eugene G. Fubini Award as "an individual who best exemplifies the extended contributions and leadership in advisory activities and personal service to the United States." In supporting this award, former Secretary of Defense Harold Brown characterized Mr. Fink as "someone whose technical skills, ability to manage difficult programs and deal with difficult people, and dedication to U.S. national security were invaluable in formulating and executing the weapons systems component of the deterrent strategy that served the nation during the most dangerous period of the Cold War." Former NASA Administrator Robert Frosch added, "He was always a supportive source of independent information and views, always valuable, not least for being sometimes pungently expressed."

His dedication went so far as to bark out orders for a Defense Science Board summer study while being loaded into an ambulance after being injured in a fall.

In addition to his long and dedicated service to government, industry, and academe, Dan took on many other responsibilities that supported the national defense and space programs and policies. He served on the board of directors of the Armed Forces Communications and Electronics Association, the Board of Governors of the National Space Club, and the National Advisory Council of the Opportunities Industrialization Centers of America. He served on the United Technologies Technical Advisory Committee from 1987 to 1997 and as director of Orbital Science for 25 years, from 1983 to 2008. During this period he was the first lead independent director, and for over 20 years he was the first chairman for the Market and Technology Committee of the board. Dan also served on the Board of the Titan Corporation from 1984 until 2005. He was a member of the MIT Corporate Visiting Committees for the Department of Aeronautics and Astronautics and for the Sloan School of Management. He was also chairman of Rensselaer Polytechnic Institute's Departmental Advisory Board (mechanical engineering, aeronautical engineering and mechanics).

While small in stature, Dan Fink was a giant in his lifetime of service to his country. He will be sorely missed by his many friends, colleagues, and family. He is survived by Tobie, his wife of 61 years; three children—his son Kenneth (and wife Paula) and his daughters Betsy (and her husband Jeffrey Lupetin) and Karen Lawrence Perlmutter; and six grandchildren—Stephen and Jeff, Zachary and Lila, and Rachel and Joselyn. In accordance with his wishes, his ashes will be launched into space orbit.

LEE S. GAUMER

1926–2010

Elected in 1992

"For contributions to cryogenic gas liquefaction and separation technology, especially for the production of liquefied natural gas."

SUBMITTED BY THE NAE HOME SECRETARY

LEE STROHL GAUMER, a chemical engineer who contributed creatively to the field of cryogenics for over 37 years, died July 24, 2010, at the age of 84.

Born in Palmerton, Pennsylvania in 1926, Lee was the son of the late Lee Strohl Gaumer, Sr., and the late Mary Louise (Kistler) Gaumer. He graduated from Pennsylvania State University in 1948 with a degree in chemical engineering. He served his country in the U.S. Army during World War II, working on the Manhattan Project. He also worked at White Sands Rocket Proving Grounds.

From 1948 until 1952, Lee worked as a chemical engineer at Argonne National Laboratory. In 1952 he joined Air Products and Chemicals, Inc., as a process engineer. Lee was a part of Air Products and Chemicals from its earliest days and contributed to the development of major industrial gas technologies instrumental in the company's growth. He retired from the company as technical director in 1992. His research was concerned with many low-temperature processes such as cryogenic air separation, hydrogen and helium extraction and purification, and natural gas liquefaction. The pioneering nature of his research career is evidenced by his 16 patents. His major career achievements were the liquefaction of hydrogen, the fuel of choice for the Apollo and Space Shuttle missions, and the liquefaction of natural gas, now applied worldwide.

In recognition of his work, Lee was the first winner of the Chairman's Award for Excellence in 1989, bestowed for his development of the technology for the liquefaction of natural gas and the design of heat exchangers used in the liquefaction process. Rising natural gas prices in the 1960s increased interest in liquefied natural gas (LNG) equipment. Lee applied his expertise to several technologies that overlapped and interacted. While working on aluminum heat exchangers for the Helium Conservation Program, he and Chuck Newton developed a multicomponent refrigeration system to separate helium from natural gas. To find the right gas mixture to apply the helium technology to the liquefaction of natural gas, Lee crunched data and undertook numerous and tedious mathematical calculations on the research and development department's new computer—a task he said would have been impractical without the computer. Lee continued to apply his sharp intellect and creative skills to other business and technical challenges, even finding (with George Harnett) a novel manufacturing technique for the huge LNG exchangers. The rest was LNG history. By the 1980s, Air Products was supplying equipment for the vast majority of the world's supply of LNG.

Lee was the recipient of the 1990 Coors American Ingenuity Award, which honors great American inventors. He was presented the Apollo Achievement Award in 1970 by the National Aeronautics and Space Administration for his contributions to the U.S. space program—creating technology for the high-volume production of liquid hydrogen rocket propellant. He was elected a member of the National Academy of Engineering in 1992.

Pennsylvania State University recognized Jim as an Outstanding Engineering Alumnus. He was involved with the university's Department of Chemical Engineering as a guest lecturer and provided resource materials. He also served on the Chemical Engineering Industrial and Professional Advisory Council.

Jim enjoyed golf, shooting pool, and reading. He is survived by his sons Thomas L. Gaumer (and wife Janet of Whitehall, Pennsylvania), Daniel W. Gaumer (and wife Kathy of Topton, Pennsylvania), and Randon S. Gaumer (and wife Kristin of Allentown, Pennsylvania), as well as six grandchildren—Victoria L., Jacob, Sloane, Elle M., Daniel, and Diana. His wife, Madalyn Claire (Daugherty) Gaumer, predeceased him.

WILLIAM C. "DUB" GOINS

1920–2009

Elected in 1990

"For recognition of his pioneering contributions to blowout prevention leading to safe economical drilling of high-pressure oil-gas wells."

BY FRANK J. SCHUH

WILLIAM C. "DUB" GOINS, JR., senior vice president of O'Brien-Goins-Simpson & Associates, Inc., and a respected innovator of oil and gas drilling and completion technology, particularly in blowout prevention, died May 22, 2009, at the age of 88.

Dub was born in Dallas, Texas, on December 22, 1920. He was the first son of William Cecil Goins, Sr., and Winnie Lee Richburg. He attended Texas A&M University, where he received a B.S. in chemical engineering in 1942. He served in the Chemical Corps from May 1942 to October 1945, with a final rank of captain.

He joined Gulf Oil Company in 1945 and began a career in drilling and completion engineering and research assignments. He was one of the industry's top drilling engineering pioneers. While there were many opportunities to improve drilling operations during Dub's early career, there was little interest in pursuing them at most oil companies.

During the mid-1950s, W. C. "Dub" Goins and his sidekick T. B. O'Brien, however, had the opportunity to work on a high-profile drilling problem, and they used it to become the world's champions in applying engineering technology to oil drilling operations. They single-handedly changed our nontechnical drilling business into an engineering lead enterprise. The change occurred so swiftly that "Goins and O'Brien" became the engineering idols of all young engineers who worked in drilling assignments. They earned the right to be labeled the best drilling engineers of all time.

At that time, Gulf Oil Company was the biggest offshore operator in the Gulf of Mexico. Gulf Oil drilled the most wells and had the most production. After the oil downturn that began in 1957, the operations people in the Gulf of Mexico were visited by a vice president of finance out of Gulf Oil's headquarters. He reportedly explained in significant detail that the company's offshore oil and gas exploration and production operations were not economical and that "you people" would have the "first chance to bring the costs down." They were challenged to cut drilling costs in half. Gulf Oil Company started a maximum effort to solve the problem.

At that time, drilling operations were saddled by a maze of customs and concerns that had been followed for years. The engineers normally spent so little time on the rigs that no one had a good idea of what actually went on there. The Gulf engineers moved desks onto their rig floors and manned them 24 hours a day. Goins and O'Brien were heavily involved. They recorded all of the things that were being done and how much time was involved.

The norm in the Gulf Coast at the time was for it to take 30 days to drill to a depth of 10,000 feet. Goins and O'Brien's record keeping soon led to an action program that was named the "Massive Elimination Program." They began streamlining operations. They left no sacred cows. They replaced the heavy and viscous mud with the industry's first seawater mud. They made major improvements in drilling hydraulics and drilling operations. They hit their ultimate performance with a well that reached 10,000 feet in just three days! That was a 90 percent improvement, which I believe to be the best performance ever. They drilled only one well in the record three days, but they changed the 30-day norm for the entire industry to reach 10,000 feet in just 10 days.

In 1982, Goins received the Lester C. Uren Award from the Society of Petroleum Engineers and was named a distinguished engineer of the society. He was elected to the National Academy of Engineering in 1990.

The most extraordinary accomplishments of Goins and O'Brien were to become real-life engineering idols for a whole generation of drilling engineers who became motivated to match or exceed their extraordinary performance.

ROBERT W. GUNDLACH

1926–2010

Elected in 1994

"For contributions to the development of xerographic copying and printing, including manifold inventions."

BY DAN A. HAYS
SUBMITTED BY THE NAE HOME SECRETARY

ROBERT W. GUNDLACH, a prodigious inventor of photocopying technology at Xerox Corporation, died on August 18, 2010, in Rochester, New York, at the age of 83.

Robert, or Bob as he was called by his many friends, was born in Ebenezer, New York, a small town near Buffalo, on September 7, 1926. His father, Emanuel, was a chemist who invented the hair-dressing Wildroot Cream-Oil. His grandfather was a minister in the German Reformed Church, but Emanuel and his family became members of a pacifist organization called the Fellowship of Reconciliation. Bob attended the University of Buffalo but was drafted after the end of his freshman year. After a year in conscientious objector camps, he returned to the University of Buffalo and switched his initial major from chemistry to physics. He obtained a B.S. degree in 1949 and continued graduate work in physics toward an M.S. degree.

In seeking a job, Bob was interested in companies that did not do war work. He found a job at Durez Plastics and Chemicals in the physical testing laboratory. In 1952 he learned from a University of Buffalo classmate that the Haloid Company, a small photographic firm in Rochester, New York, was hiring for work on a new dry electrophotographic process for copying documents. He applied for a job and was immediately hired after obtaining an exceptional score on a written physics test and a promise from the firm's president that he would not work on military projects.

Bob quickly had a large impact on the company by coming up with three patentable ideas within his first year. His early inventions in electrophotography had a profound influence in enabling the firm to generate a new revenue stream through the leasing of equipment to produce masters for offset printing machines. When Chester Carlson, inventor of electrophotography, saw one of Bob's early inventions, he was compelled to remark, "Bob, you are an inventor!" This positive reinforcing statement from Carlson had a profound motivating effect on Bob. In Bob's lifetime he received 163 patents.

Rapid growth in the new electrophotographic business of the Haloid Company led to its ultimate transformation into the Xerox Corporation. The success of electrophotography was propelled by the introduction of automatic copiers, as exemplified by the Xerox 914 brought to market in 1959. Bob contributed many technological advances required for higher speed electrophotographic copying and printing, for not only black-and-white but also color printers. Perhaps Bob's most novel patent disclosed a process for producing black and colored prints in a single-pass printer that was introduced to the market in 1991.

Beyond Bob's many technical contributions to the Xerox Corporation, he played a central role in a number of patent litigation lawsuits. The combination of his broad knowledge of electrophotographic technology and his excellent communication skills proved to be effective in obtaining favorable verdicts for Xerox.

Bob's passion was to solve technical problems through laboratory experiments. As such, he was not interested in pursuing a managerial career. Due to Bob's many technical achievements over the years, Xerox's management decided to institute a dual-ladder promotion system, whereby the significant achievements of individual contributors could be recognized in a manner similar to the recognition afforded those in management. Bob was among four to first be recognized as a "principal scientist" in 1963. In 1966 he was named Xerox's first research fellow. In 1978 he was appointed the first senior research fellow—the highest recognition bestowed on an individual contributor by the company.

Bob's many honors and awards included the Charles E. Ives Award for "Best Paper of the Year" in 1963, the Inventor of the Year Award granted by the Rochester Patent Law Association in 1974, the Kosar Memorial Award from the Society of Photographic Scientists and Engineers in 1976, the Johann Gutenberg Prize from the Society for Information Display in 1993, the Carlson Memorial Award from the Society of Photographic Scientists and Engineers in 1986, the Fellowship Award from the Society of Imaging Science and Technology in 1991, the Clifford C. Furnal Award from the University of Buffalo in 1992, the Xerox President's Award in both 1979 and 1995 for Lifetime Achievement, and the Lifetime Achievement Award from the Electrostatics Society of America in 1997. He was elected to the National Academy of Engineering in 1994 and inducted into the National Inventors Hall of Fame in 2005.

Bob was a positive role model to all who knew him. He was kind and charming to all, regardless of their station in life. He had close relationships spanning the full range of employees from those at entry-level jobs to the chief executive officers of Xerox. His interesting presentations were always a delight to audience members, as evidenced by the attentive glow on their faces.

Bob always exhibited much self-confidence regardless of his particular interest. He loved challenges, such as those provided by the many technical problems in electrophotography. His love of challenges extended to a variety of sports, including downhill skiing (often with family members), cross-country skiing, jogging, canoeing, tennis, swimming, walking on his hands, and windsurfing. He was always physically fit by virtue of aerobic exercises, strength training such as chin-ups, and a healthy diet. Bob always looked for ways to make a game of whatever he was doing. In driving to work during the spring, the challenge was to see how many different birds one could identify. My son said that Bob could even make fun out of going over speed bumps. The challenge was to apply the brakes at the right moment to minimize the car bounce.

Bob had a deep love of mankind and nature. In his mind, greater efforts in diplomacy were needed to circumvent wars between nations. He marveled at the variety of life in animals and birds. He was an enthusiastic bird watcher with a lifetime list of 138 species. He enjoyed spending time at a wooded Gundlach family retreat south of Buffalo called "Starlit," which provided much solace and family fellowship in a natural setting.

Bob had excellent leadership skills due to his breadth of knowledge and pleasant personality. Soon after he joined the Haloid Company, he was asked to lead a Boy Scout troop from the city of Rochester on a camping trip to the Adirondacks. Bob knew he could not take that much time off having just started work, but the president of Haloid recognized the importance of Bob's scouting leadership and granted him the time off. Another example of Bob's many talents and interest in helping others was his willingness to serve on the National Advisory Board for the Children's Television Workshop from 1979 to 1984.

Much of electrophotographic technology exploits various applications of electrostatics. Bob had a well-grounded understanding of electrostatics principles. Due to this expertise, he was one of the charter members of the Electrostatics Society of America, which formed in 1970. He was president of ESA from 1977 to 1981 and served on the Board of Advisors from 1981 to 1994. Bob had an uncanny ability to listen to an ESA presentation and then suggest several applications of the technology that might be patentable.

Consistent with his love of nature, Bob was passionate about conserving natural resources. He had the means to be a lavish consumer, but he chose to live a frugal life. He drove a diesel Volkswagen Rabbit (about 50 mpg!) in the 1970s and made every effort to carpool. He would temporarily repair the rusty exhaust system with cans and wire to extend its life. His passion for conservation was the motivation for inventing more efficient snow-making machines and heat pump systems during his postretirement years.

Bob is survived by his wife of 60 years, Audrey B. Gundlach; his brother, Arthur Gundlach; sons Gregory E. Gundlach of Vermont, Eric R. Gundlach of Maryland, and Kurt B. Gundlach of Massachusetts; and 10 grandchildren.

ARNOLD HALL

1915–2000

Elected in 1976

"For contributions in aeronautics, including design and construction of the first large-scale British transonic wind tunnel and other developments in aircraft navigation and structures."

SUBMITTED BY THE HOME SECRETARY

SIR ARNOLD HALL, aeronautical engineer, scientist, and industrialist, died January 9, 2000, at the age of 84.

Born in Liverpool to parents who had left school at the age of 12, Arnold Hall grew up during the Depression. His father was an upholsterer, and his mother a brilliant self-taught pianist. "My mother tried to teach me, but I'm afraid I was something of a disappointment to her. My interests were always in engineering and science," Hall recalled. "I was too busy making steam engines and other gadgets."

He attended Alsop High School at Walton, then an all-boys school, to which he won a scholarship. He excelled in mathematics, science, and engineering. He enrolled at Clare College, Cambridge, where, in addition to a first, he won the Moir Prize in Engineering, the Seely Prize in Aeronautics, and the Ricardo Prize in Thermodynamics. On a postgraduate fellowship he worked with Frank Whittle on compressor stress calculations for Whittle's jet engine. On exhibit at the Science Museum in London, it was the first in the world to run.

Hall joined the Royal Aircraft Establishment (RAE), Farnborough, in 1938. During the war he managed teams that produced both the advanced bombsight and the gyro gunsight, which from D-Day onward more than doubled the kill rate of Allied fighter aircraft. After the war he was appointed Zaharoff Professor of Aviation at the Imperial

College of Science and Technology. He initiated construction of the laboratory for aerodynamics and construction research. In 1951, upon the death of the Farnborough director, Hall was appointed director of the RAE with the understanding that after five years he would return to Imperial College.

Hall's Comet investigation became the model for major aviation inquiries. In May 1952 the first passenger-service Comet took off from Heathrow, establishing Britain as a leader in the aviation industry. The Comet 1 was a symbol of confidence and promised financial success for Britain's aviation industry. However, after two years in service, three Comets failed in flight, causing panic in the industry.

All Comets were grounded. The government sought Hall's advice and answers for the failures, for which there appeared no obvious explanation. RAE teams were asked to conduct an independent investigation of all possible causes. Hall thought that some of the crucial stress calculations could not be answered by mathematical theory alone. He organized and oversaw the building of the "whole pressurized aircraft" test rig at Farnborough. These labs created an environment in which the stresses of repeated flight cycles could be tested on the aircraft. The evidence revealed that failure of the aircraft's pressurized cabin was at fault. The conventional testing that had been used until this time proved to be inadequate in determining the "fatigue life" of aluminum alloys under repeated stress.

When his Farnborough agreement came to an end in 1955, Hall accepted a position with the Hawker Siddeley Group as technical director of Bristol Siddeley Engines. Four years later he was appointed managing director of the newly formed Bristol Siddeley Engines, Ltd. In 1967 he was named chairman and managing director of the Hawker Siddeley Group. By the mid-1970s the Hawker Siddeley Group employed about 85,000 people, and had expanded its portfolio to include electrical and civil engineering. Hall believed in private enterprise and was opposed to the government's nationalization proposals. He left the aircraft industry in 1977 when the government nationalized the industry.

In 1975 he was appointed Businessman of the Year for his "vision, courage and commercial discipline." He was a fellow of both the Royal Society (1953) and the Royal Aeronautical Society, of which he was president in 1958–1959. He was knighted at the age of 39 in 1954. He received the von Baumhauer Medal of the Netherlands Association of Aeronautical Engineers for his contributions to flight safety. He also was awarded the Gold Medal of the Royal Aeronautical Society in 1962 and was elected a member of the National Academy of Engineering in 1976.

Hall was concerned about the need for improved technical education, which led to his involvement in the creation of Warwick University, serving as a pro-chancellor from 1965 to 1970. He was chancellor of the Loughborough University of Technology from 1980 to 1989.

A note in his obituary in the *Guardian* reads:

> He appeared to have no recreations, no passions, but in fact there were two: his family and deep-sea sailing. Late in life, when he had given up sailing, Hall said it was his great good fortune to have been blessed by a family who "always put up with my eccentricities and was never too harsh when I made mistakes." For this quiet giant who was usually right, their support was crucial.

Hall is survived by his second wife, Iola; three daughters from his first marriage; a stepdaughter and stepson from his first wife's first marriage; and three stepsons and five stepdaughters from his second wife's first marriage.

ARTHUR G. HANSEN

1925–2010

Elected 1976

"For pioneering work in flow phenomena in turbomachine blade row and ducts and contributions to engineering education."

BY WARD O. WINER

ARTHUR GENE HANSEN, university administrator, professor, and applied mathematician, died July 5, 2010, in Fort Myers, Florida, of complications from surgery at the age of 85.

Arthur Hansen was born in Sturgeon Bay, Wisconsin, on February 28, 1925. Both his parents were also born in Door County, Wisconsin. His maternal grandparents came from Norway and his paternal grandparents from Alsace-Lorraine. He had an older brother by six years. His mother died when Art was about 8. He was raised by his father who had an eighth-grade education and was a clerk in a hardware store in Sturgeon Bay. When the Depression hit in 1929, the family moved to Green Bay, Wisconsin, where Art's father first worked in a paper mill and then owned a small grocery store, where as a young boy Art stocked shelves and delivered groceries. Art attributed his love of learning to his father who read to him every night. He attributed his lifelong interest in mathematics to a high school teacher, Ernestine Ruble, whose name he could still remember the month before he died. She challenged him with interesting mathematical problems. Growing up in Green Bay, Art loved fishing and the Green Bay Packers.

Art attended public schools, where he was on the track team and graduated as valedictorian of his high school class in 1943. At that time he realized that he faced being drafted into the Army for World War II unless he found an alternative way to serve. One day while walking around Green Bay not sure what he was going to do, he came upon a Marine Corps recruiting office. He looked at the uniform in the picture and thought it was "neat" so he went in. The recruiting officer quickly signed him up to get an engineering degree and become a commissioned officer in the Marines. Art was sent off to a V12 program at a place he had never heard of—Purdue University—to study electrical engineering. The V12 program was an accelerated college degree program introduced by the U.S. Navy in 1943 to meet the need for college-educated commissioned officers in World War II. Participants took 17 credit hours per semester plus nine hours of physical training per week for three semesters every 12 months and finished the degree in two and a half years. One hundred thirty-one colleges and universities in the U.S. participated in the program. Approximately 60,000 young men completed the program and became commissioned officers in the Navy and Marine Corps.

Art received his bachelor's degree in electrical engineering in 1946. By that time the war was over. He was assigned to the reserves and set free. Not knowing what to do, he decided to stay at Purdue, where he received a master's degree in mathematics in 1948. He claimed he then "wandered into the Purdue Placement Office," where he met a recruiter from the National Advisory Committee for Aeronautics who hired him to go to NACA's Lewis Research Laboratory in Cleveland where Art launched his research career.

There, Hansen worked on the fluid dynamics of flow over wings and compressor blades by applying the math skills he had learned at Purdue. His work mostly centered on using similarity methods to reduce the order of differential equations, making them easier to solve. Art also used curvilinear coordinate frames along with similarity methods to solve for unusual flow patterns in three-dimensional fluid dynamics. Most of his work was analytical, but he was also involved in experimental studies of compressor flow to validate his analytical solutions. Midway in his 10 years at NACA he decided to enroll in a Ph.D. program part time at Case Western Reserve University, where he studied under Gustav Kuerti and received his Ph.D. in applied mathematics in 1958. His thesis was on the use of similarity solution methods to solve the Navier-Stokes equations in curvilinear coordinates. Art's colleagues at NACA later described him as a typical closet researcher, sitting at his desk in the corner with a pad and pencil cranking out papers. He showed little interest in being a people person, which is ironic given the rest of Art's career. His colleagues were surprised when he finished his Ph.D. and decided to move to Cornell Aero Labs in Buffalo, New York, to manage a small new group in nucleonics.

Art stayed at Cornell Aero Labs for only about a year. In 1959 he moved to the University of Michigan to become a professor of mechanical engineering. There he was assigned to teach an undergraduate course and a graduate course in fluid dynamics, which was somewhat of a challenge since he was not a mechanical engineer and had never taken a fluid dynamics course at any level. Hansen was an excellent teacher—enthusiastic and open, and he knew the material well. He got to know his students individually and involved them in his classes. He was not happy with the textbook that was in use, so he decided to write one—*Fluid Mechanics* (Wiley and Son, 1967). It was a companion volume to Gordon Van Wylen's successful thermodynamics book in the Wiley Thermal Science Series. While at the University of Michigan he was chair of the mechanical engineering department from 1964 to 1966.

Most of Art's technical publications were from the period when he was with NACA. He had a few at Michigan that he coauthored with his doctoral students. In addition to the textbook mentioned above, he wrote *Similarity Analyses of Boundary Value Problems in Engineering* (Prentice-Hall, 1964), which is a very nice contribution. Art would occasionally joke about one publication he had as a result of a summer he spent at Whirlpool Research while on the faculty at the University of Michigan. Whirlpool was fostering relations with the mechanical engineering department and invited faculty members to come for the summer to work on any problem they wished. Art decided to analyze and design a washing machine pump that could ingest small objects such as safety pins and paper clips. He presented the work at an American Society of Mechanical Engineers conference. It was published not as an archival publication but as a conference reprint. Much to his chagrin, Art had more requests for reprints of that paper than he did for all his more advanced papers put together.

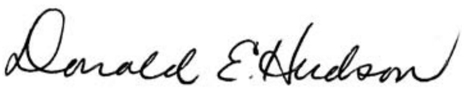
Hansen left the University of Michigan to become dean of engineering at Georgia Tech in 1966. This assignment launched his successful career as a university administrator. With his open and positive personality, he was the right person in university administration for the difficult times on college campuses during the late 1960s and the decade of the 1970s. He shared with many of the student leaders a concern for contemporary social problems. In 1969 he became president of Georgia Tech, a position he held for only two years. He then accepted the call to be the first alumnus and eighth president of Purdue University.

His 11 years (1971–1982) as president of Purdue were highly successful for both Art Hansen and the university. Under his leadership, Purdue grew in size, stature, and breadth of academic offerings. He led the way to greater external fund-raising and broadened the extracurricular activities available to the community. The Arthur G. Hansen Life Sciences Research Building on the Purdue University campus was an important tribute to his influence. In 1982, Art left Purdue to become chancellor of the Texas A&M System, a position he held for four years before retiring to become director of research for the Hudson Institute for two years. In September 2002, he returned to Purdue to donate $1.8 million for the construction of a performing arts theater named after his wife, Nancy Tucker Hansen, who died the following year. At Purdue again, Art was considered the students' president and helped them advance numerous social and academic causes on campus.

A continuous thread throughout Hansen's career was his abiding interest in people and their desire to advance themselves. He made numerous decisions as an academic administrator, and took personal actions, to help others. Early in his career he picketed a barber shop in suburban Cleveland because it would not integrate its customers. He spent six months on the faculty of the Tuskegee Institute in Alabama, during which time he took his family to witness the civil rights march from Selma to Montgomery, Alabama, as it crossed the Edmund Pettus Bridge in March 1965. Art helped establish the 3-2 programs (3 years liberal arts and 2 years engineering) between Georgia Tech and several historically black colleges. He supported establishment of the Black Cultural Center at Purdue and helped establish the National Society of Black Engineers. He chaired the National Research Council's Committee on Minorities in Engineering. Hansen also approved establishment of the Gay Rights Club at Purdue despite considerable opposition. While at Texas A&M he succeeded in increasing financial support for Prairie View A&M, a historically black college in the Texas A&M System, by threatening the governing board with a lawsuit if the board did not agree. Art Hansen was the right person at the right time to be a university leader.

Art served on several corporate boards—International Paper Company, Ball Corporation, Navistar International, and Cutler Hammer Corporation. He was a member of the board of directors of both the Corporation for Educational Technology and the Indiana Commission for Higher Education. In retirement he served as an educational consultant internationally. He also served as a councillor for the National Academy of Engineering (1978–1984).

Arthur Hansen's first wife, Margaret Kuehl Hansen, passed away in 1974, His second wife, Nancy Tucker Hansen, passed away in 2003. He is survived by his third wife, Marylin White Hansen, of Fort Meyers, Florida; five children—sons Geoffrey (wife Angela) of San Francisco, James of Houston, and Paul (wife Dee Ann) of Saratoga, California; daughters Ruth Rachel (husband Michael) of Carmel, California, and Chris Glancy (husband Michael) of Fort Myers, Florida; as well as five grandchildren.



DONALD E. HUDSON

1916–1999

Elected in 1973

"For the development of widely used instruments to record destructive earthquake ground shaking."

BY MIHAILO D. TRIFUNAC
SUBMITTED BY THE NAE HOME SECRETARY

DONALD ELLIS HUDSON, Don as he was known to his friends, died of heart failure on April 24, 1999, at the age of 83. By the time of his death he had built a distinguished career of teaching, research, and service, spanning a broad range of science and engineering and centered in earthquake engineering. His work extended from experimental mechanical engineering, geophysical engineering, vibration engineering, rocketry, and underwater ordnance design during World War II to the development of instrumentation and data processing in earthquake engineering.

Don was born on February 25, 1916, in Alma, Michigan. In 1924, to avoid hay fever, his family moved to Pasadena, California, where he attended Franklin Elementary School, Woodrow Wilson Junior High, and Pasadena City College and then switched to the California Institute of Technology (Caltech) in his junior year in 1936. He completed his B.S. degree in 1938, M.S. degree in 1939, and Ph.D. in 1942. He then began his distinguished 39-year-long career at Caltech. He was assistant professor of mechanical engineering (1943–1949), associate professor of mechanical engineering (1949–1955), professor of mechanical engineering (1955–1963), and professor of mechanical engineering and applied mechanics (1963–1981). He retired from Caltech with emeritus status in

1981. From 1981 to 1985, Don chaired the Department of Civil Engineering at the University of Southern California School of Engineering, where he held the Fred Champion Professorship in Civil Engineering. He retired from USC in 1985.

Hudson's first exposure to earthquake studies, which would later guide him in his pioneering work in earthquake engineering, dated back to his undergraduate and graduate studies at Caltech where he and some of his classmates, who eventually also became leaders in earthquake studies (Walter Munk, Ben Howell, Egor Popov), took classes and interacted with Guttenberg, Benioff, Richter, von Kármán, and Biot. While Don was a graduate student, von Kármán and Biot completed their book *Mathematical Methods in Engineering* (New York: McGraw-Hill, 1940), which included the basic theory of structural mechanics and dynamics. Thirty years later, in the mid-1960s, when I took Don's class in the dynamics of structures, the simplicity and elegance of the physical formulation of the von Kármán and Biot approach were still evident. Don's lectures were exceptionally well prepared, and his blackboard work was like a Dürer painting, photographically perfect to the minute detail.

Don's thesis adviser and mentor was Frederick C. Lindvall, who later chaired the Division of Engineering at Caltech (from 1945 to 1969). During the World War II projects at Caltech, Hudson worked for the jet-assisted takeoff group, which was headed by Lindvall. They developed methods for carrying rockets on an airplane and launching them. When the U.S. Navy needed to solve the stability problem of aircraft-launched torpedoes, Lindvall and his group set up the testing facilities, behind Morris Dam, above Azusa, and in China Lake, which eventually became the China Lake Naval Ordnance Test Station. The stability of the torpedoes was solved by adding a shroud ring over the tail of a torpedo—just in time to build several thousand torpedoes for the battle of Midway. During these projects, Don worked with many future leaders in engineering and applied sciences at Caltech (C. Anderson, C. H. Wilts, and R. B. Leighton).

In 1958–1959, Hudson spent six months in India, at the University of Roorkee, sponsored by the Technical Cooperation Mission of the U.S. State Department (subsequently the Agency for International Development). Roorkee, the oldest technical institute in Asia (formerly the Thomason College of Engineering), was founded by the British to train surveyors for the North India canal system. Today it is the Indian Institute of Technology, Roorkee. During a visit to Caltech in 1957, Professor A. N. Khosla, then vice chancellor and president of the University of Roorkee, was impressed with the dynamic measurement laboratory Hudson had set up at Caltech, and arranged with Caltech President Lee A. DuBridge for Don to take a leave of absence and go to Roorkee. Don's assignment was to organize a dynamics measurement laboratory there and to teach courses in dynamic measurements and structural mechanics. This stay in India marked the beginning of a long and fruitful cooperation between Roorkee and Caltech faculty and students and the beginning of earthquake engineering in India. Several times Don went back to India to evaluate their progress.

He was also a member of the steering committee and Caltech representative on the Kanpur committee, which coordinated establishment and organization of the American-sponsored I.I.T. campus at Kanpur. One of the people who came over to work with Don at Caltech was Jai Krishna. Later Krishna became vice chancellor of Roorkee and president of the International Association for Earthquake Engineering and founded the Indian Academy of Engineering in Delhi. Don Hudson was the first and for many years the only foreign member and until his death the only earthquake engineer from America to be elected a member of this highly selective academy. In 1978 during the world conference on earthquake engineering, Prime Minister Indira Gandhi held a tea party at her house and on behalf of her father thanked Don for his contributions and help with establishing the earthquake engineering program in India. Don always felt that this was a remarkable expression of appreciation and gratitude, and he proudly shared his memory of the event with friends.

Following the first steps at Caltech made by von Kármán and Biot in the early 1930s, the dynamic response of structures to earthquake shaking remained in the academic sphere of research for many years and did not gain widespread engineering acceptance until the early 1970s. There were two main reasons for this. First, computation of the response to earthquake ground motion, without digital computers, led to formidable numerical difficulties; second, there were only a few well-recorded accelerograms that could be used for that purpose. This started to change in the 1960s with the arrival of digital computers and the commercial availability of strong-motion accelerographs. By the late 1960s and early 1970s, however, the digitization of analog accelerograph records, organized by Hudson and his graduate students at Caltech, and the digital computation of ground motion and of the response spectra were developed completely. Then in 1971 with the occurrence of the earthquake in San Fernando, California, which was recorded by 241 accelerographs, the modern era of earthquake engineering was launched.

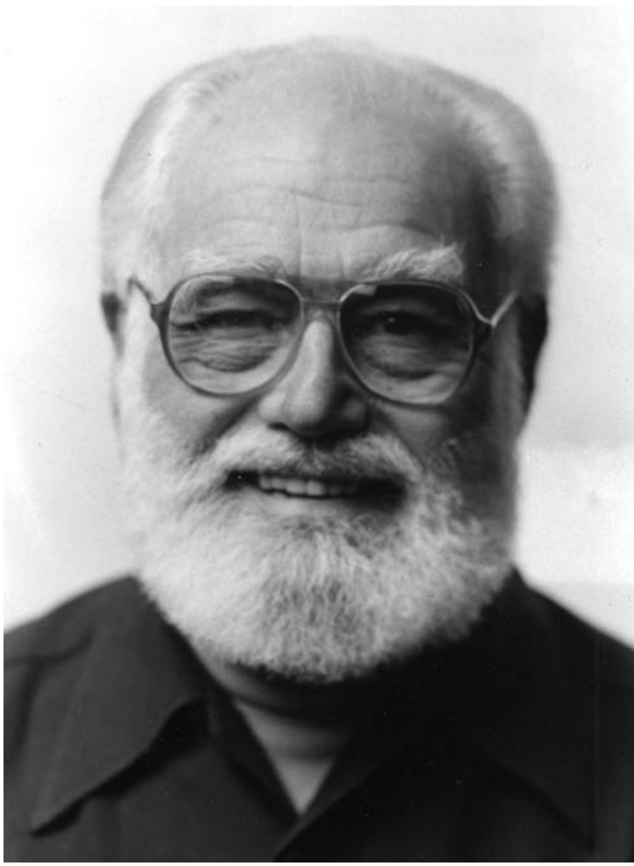
Don was among the first to recognize the significance of the availability of a comprehensive and accurate database for future developments of earthquake engineering. With T. Caughey, his former student and later a faculty colleague at Caltech, Don invested considerable effort to develop a special-purpose analog computer (Mark II) for computation of the response spectra from recorded strong-motion accelerograms, but the process was time consuming and the results were not accurate. In retrospect, it is clear and logical that in the mid-1960s Hudson decided to gather all important records of strong ground motion and to organize digitization, processing, and dissemination of digital strong-motion data, a *conditio sine qua non* for all subsequent developments in modern earthquake engineering. Von Kármán and Biot formulated the response spectrum method in earthquake engineering, but it was Don Hudson who made modern analyses possible by gathering and processing the data, thus providing a sound and realistic experimental basis for the theory.

Don was erudite; he read widely in history and literature; and he loved music, Oriental art, and philosophy. He had an impressive collection of classical music records and was always willing to share his rare books on Buddhism and Indian art. He loved chamber music and enjoyed travel and archeology in Europe, India, Japan, and South America. His travel was often combined with work for the United Nations, foreign universities, and international conferences.

A bachelor in the earlier part of his life, Don married Phyllis Henderson in 1972. They organized and supported many chamber music performances at Caltech and enjoyed traveling together.

Don's many achievements did not go without recognition. He was elected to the National Academy of Engineering in 1973 and to the Indian Academy of Engineering in 1987. He was president of the Seismological Society of America (1971–1972) and president of the International Association of Earthquake Engineering (1980–1984). In 1989 the American Society of Civil Engineers awarded him the Nathan M. Newmark Medal, and in 1992 the Earthquake Engineering Research Institute awarded him the Housner Medal.

Don was a patient, thoughtful, and generous gentleman. The respect and immense influence he commanded were the result of his reputation for fairness and his ability to lead through reason and unselfish motives, which were aimed for the benefit of others and for the common good. He had the ability to attract and to lead his students and coworkers with unassuming suggestions and by carefully listening to their views and ideas. His students continue to emulate and to propagate his methods and ideas on how to educate young people and new creative minds. Theodore von Kármán, one of Don's teachers, was cited for saying that "scientists study the world as it is, but engineers create the world that has never been." We will always remember Don as our teacher who helped create those engineers. He was a friend and communicator par excellence.



ARTHUR R. KANTROWITZ

1913–2008

Elected in 1977

"For leadership in the fields of gas dynamics, magnetohydro-dynamics, and bioengineering."

BY FRANCIS E. KENNEDY
SUBMITTED BY THE NAE HOME SECRETARY

ARTHUR R. KANTROWITZ, an innovative and forward-looking physicist and engineer whose accomplishments ranged from aviation and space to medicine and public policy, died on November 29, 2008, at the age of 95. He had been the founder and longtime director of the Avco-Everett Research Laboratory and was professor emeritus at the Thayer School of Engineering at Dartmouth College.

Arthur Kantrowitz was born in New York City (in the Bronx) on October 20, 1913, the eldest child of Bernard and Rose Kantrowitz. During his youth he developed a love of science in general and physics in particular. He graduated from DeWitt Clinton High School in the Bronx and went on to study physics at Columbia University, receiving his B.S. in 1934 and M.A. in 1936. He then went to work for the National Advisory Committee for Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration (NASA), at Langley Field in Virginia. One of the experiments he did while at NACA was the first known attempt of a thermonuclear fusion reaction. In 1938, Arthur and his supervisor, Eastman Jacobs, heated hydrogen with radio waves while constricting the gas with a magnetic field in order to achieve fusion. Although the experiment was not successful, and the project was canceled by the laboratory director before further attempts could be made, it was the first of many research activities in which Arthur was well ahead of others in his research fields. While at NACA, Arthur also designed the first meaningful supersonic wind tunnel in the United States (which achieved Mach number 2.5 in 1942), and his research on shockwave formation, propagation, and stability in supersonic flows made important contributions to turbine engine development and the war effort. During his time at NACA, he continued his graduate studies at Columbia on the subject of gas dynamics. His dissertation adviser was Edward Teller, and his doctoral research involved the measurement of vibrational relaxation times of carbon dioxide molecules using simple aeronautical instrumentation. His Ph.D. in physics was awarded by Columbia in 1947.

In 1946, before completing his Ph.D. dissertation, Arthur Kantrowitz was appointed to a faculty position in the Departments of Aeronautical Engineering and Engineering Physics at Cornell University. He established a very active laboratory at Cornell, where he and his students did groundbreaking research on supersonic nozzle flows, high-temperature (over 10,000 K) shock tubes, and molecular beams. The supersonic high-intensity "nozzle beam" method developed by Arthur and his students at Cornell was critical to the research of at least nine Nobel Prize winners, most notably Yuan Tseh Lee and Dudley Herschbach (1986) and John Fenn (2002). Arthur proved to be an inspiring teacher and research adviser at Cornell. A number of his outstanding students later played important roles in the aerospace industry and in higher education.

While at a cocktail party at Cornell in 1954, Arthur met Victor Emanuel, chairman of Avco Corporation, who told him about a difficult problem being encountered in the design of ballistic missiles. The missiles would have to be able to survive reentry into the atmosphere, where frictional drag could cause surface temperatures to reach 7,500 K or higher, but American missile engineers had not yet been able to duplicate those high-temperature conditions in the laboratory. Arthur informed him that he and his students had been able to achieve even higher temperatures in their laboratory using shock tubes, which had the added advantage of producing shock waves of the type that might be encountered by the missiles during reentry. Mr. Emanuel immediately set up a meeting with General Bernard Schriever, head of the U.S. Air Force ballistic missile program, who agreed to fund a six-month "crash program" to investigate the shock tube idea. Avco set up a new research lab, the Avco Everett Research Laboratory (AERL), at which the work would be carried out. Arthur took a leave of absence from Cornell to direct the laboratory and oversee the research program, and he recruited a number of his recent Cornell graduate students to carry out the work. The research was so successful that AERL accelerated the research program on reentry physics, and in 1956 Arthur resigned from his tenured faculty position at Cornell to remain as director of AERL and to become a vice president of Avco. Subsequent research under Arthur's guidance at AERL on shockwave kinetics, heat transfer rates for blunt body stagnation points, and nonequilibrium radiation contributed greatly to further development of ablative heat shields for missiles and later for manned spacecraft, and Avco became a leading producer of heat shields for space applications.

During the 1960s and 1970s, Arthur Kantrowitz recruited many outstanding engineers and scientists to AERL. He mentored and motivated them to significant achievements in a number of research areas. Dr. Kantrowitz always maintained that while most universities engaged in pure research, he was interested in "impure research"—that is, work that would lead to practical results, science that made an impact on the real world. Under his guidance, AERL researchers attempted to focus their activities on areas in which they could create a unique capability. He provided overall guidance for each research project, and important technical contributions in many cases, and he ensured that innovation and professional excellence were hallmarks of all research at AERL. Among the many areas in which significant advances were made at AERL under Arthur's guidance were magnetohydrodynamic (MHD) power generation, superconducting magnets, high-power laser development, laser propulsion, and artificial heart assist devices.

MHD research at AERL was aimed at developing a highly efficient electric power generator that used hot gases flowing at supersonic speeds to produce megawatts of electric power. The concept was proven at AERL in 1959; subsequent research and development efforts at AERL and Avco resulted in a combustion-powered MHD generator that laid the foundation for much of the later development of MHD generators in the United States and elsewhere. During the development of MHD power generation systems at AERL, research there under Arthur Kantrowitz's guidance also resulted in a stabilized superconducting magnet, the first demonstration of which occurred at AERL in 1964.

Under Arthur's leadership, AERL pioneered in the development of high average power lasers. Gas dynamic lasers, electric discharge lasers, and chemical lasers were developed at AERL, many of them to the megawatt class, in the 1960s and 1970s. Many of these advances emanated from the basic principles of gas dynamics that Arthur had developed in his Ph.D. research. The research expertise at AERL in chemical kinetics and plasma physics and the experimental capabilities in shock tube studies of high-velocity, reacting flow fields proved to be well suited for the nascent field of high-power lasers. After successful development of high-power lasers at AERL, Arthur turned his attention to using the newly developed lasers for rocket propulsion, in which a ground-based laser would be used to move a payload into low-Earth orbit. His far-reaching vision had high-powered lasers providing the key to affordable access to outer space. A proof-of-concept experiment and scaling analysis were accomplished at AERL in the 1970s.

When Arthur Kantrowitz was a young man, he and his brother Adrian, who became one of the world's foremost cardiac surgeons, had a dream that they could design an artificial heart. Arthur continued to pursue that dream while at AERL, where he assembled a multidisciplinary team to work toward the goal of an implantable cardiac replacement device. They initially collaborated with Adrian Kantrowitz on the development of an auxiliary left ventricle, which suffered from blood clotting problems after being implanted in humans for the first time in 1966. Arthur and his team decided to explore the relationship between fluid mechanics and the chemistry of blood clotting to solve the clotting problems. This led to the intra-aortic balloon pump, a streamlined counter-pulsation pump that required minimal surgery for use in humans. Though a balloon concept had been attempted earlier, development of a safe and reliable device relied on understanding the dynamics of using a light fluid, in this case carbon dioxide, to move blood, a heavy fluid, around the body. The intra-aortic balloon pump developed at AERL in 1967 resulted from the unique contributions in engineering, fluid mechanics, chemistry, and medicine from members of the team Arthur had assembled and led. The AERL balloon pump was brought to clinical use by a close collaboration with Massachusetts General Hospital and is still in clinical use today, more than four decades after its introduction. The device has been used in more than 3 million patients around the world, including Arthur Kantrowitz himself after he suffered a heart attack in November 2008.

In 1978, Arthur reached Avco's mandatory retirement age, and he left to take a position as professor of engineering at the Thayer School of Engineering at Dartmouth College. He continued to give lectures on gas dynamics, MHD, and lasers, but his primary focus moved to the role of the scientific and engineering communities in the public perception of technology. He proposed a new norm for the scientific community: "Any scientist who addresses the public or lay officials on scientific facts bearing on public policy should stand ready to publicly answer questions not only from the public, but from expert adversaries in the scientific community." To implement this norm, he proposed and tried to develop scientific adversary procedures, known as the "Science Court." In those procedures, anyone making an allegedly scientific assertion that was important for public policy could be challenged to publicly answer scientific questions from an expert representative of those who opposed the assertion. As a member of President Gerald Ford's Advisory Group on Anticipated Advances in Science and Technology and chairman of his Presidential Task Force on the Science Court (1978), Arthur had the opportunity to develop his idea to help provide a factual basis for policymaking. While at Dartmouth he continued to advance the Science Court procedure as a means to find the best-available scientific facts, and the limitations of scientific knowledge, to bear on important controversial issues.

Arthur Kantrowitz was the recipient of many awards and honors during his lifetime. In addition to the National Academy of Engineering, he was a member of the National Academy of Sciences and was a fellow of the American Academy of Arts and Sciences, the American Physical Society, the American Institute of Aeronautics and Astronautics, the American Association for the Advancement of Science, and the American Astronautical Society. He was both a Fulbright and a Guggenheim fellow, and in 1967 he was presented the Theodore Roosevelt Distinguished Service Medal by President Lyndon Johnson. He was an honorary trustee of the University of Rochester; an honorary life member of the Board of Governors of the Technion (Israel Institute of Technology); and an honorary professor of the Huazhong Institute of Technology in Wuhan, China. He was a member of the advisory board of television's popular *Nova* program and a director of the Hertz Foundation. He served the U.S. government on advisory boards for President Ford's White House, the U.S. Department of Commerce, NASA, the U.S. General Accounting Office, and the National Science Foundation. He was granted 21 U.S. patents and published extensively.

A man of many interests and talents, Arthur developed a love for classical music, literature, and sailing. He was as well versed in Beethoven and Shakespeare as he was in gas dynamics. He relished sailing off the coast of Maine on his beloved 33-foot sloop, *ARK.*

Arthur is survived by his second wife, Lee Stuart (of Hanover, New Hampshire, and Amelia Island, Forida); three daughters—Barbara Kantrowitz (of New York City), Lore Kantrowitz (of Lexington, Massachusetts), and Andrea Kantrowitz (of Pelham, New York); and six grandchildren.

Arthur Kantrowitz was a compassionate and gracious person and was generous to his colleagues and employees. His innovative spirit, visionary instinct, outstanding achievements, and courage in breaking new ground will long be remembered.


Robert W Keyes

ROBERT W. KEYES

1921–2010

Elected in 1976

"For systematic development of a definitive theory of the fundamental limits of digital computer devices."

BY MARSHALL I. NATHAN

ROBERT W. KEYES, a condensed matter physicist and major contributor in the areas of the physics of computation and semiconductor physics, died on April 5, 2010, after an accidental fall.

Bob was born on December 2, 1921, in Chicago. He grew up there, attending Parker and Calumet high schools and graduating from the latter in 1939. He attended the University of Chicago and received his bachelor's degree in physics in 1942. His education was then interrupted during the remainder of World War II by a stint in the U.S. Navy, where he served as an electronics technician. After the war in 1946 he started work at Argonne National Laboratory. In 1950 he returned to the University of Chicago for graduate study. He got his Ph.D. in physics in 1953, under the direction of Andy Lawson. For his research he measured the electrical conductivity of liquid germanium and studied the electrical properties of black phosphorus under hydrostatic pressure.

After receiving his Ph.D., Bob joined the newly formed Westinghouse Research Laboratory in suburban Pittsburgh. There he built a high-pressure laboratory of the Bridgman type, working to 12 kilobars. He and other researchers used this facility to study the electrical properties of silicon and germanium group and III-V (from the Periodic Table) semiconductors, for example, gallium arsenide. Some of these studies constituted the Ph.D. theses of two graduate students at the University of Pittsburgh. Bob expanded these studies to include uniaxial stress experiments. His work and that of others elucidated the energy band structure of germanium and silicon. He showed that, because of the multivalley nature of the conduction band structure in silicon and germanium, the free energy can be lowered by strain that reduces the electron energy due to transfer among the valleys. This causes a reduction in some of the elastic constants in heavily doped n-type silicon and germanium. He experimentally verified the existence and magnitude of the predicted effect several years later.

While at Westinghouse, Bob worked in several other areas of semiconductors, including thermal conductivity, thermoelectric power, and the effects of strain. He and his colleagues observed a very large magnetoresistence in n-type (electrons carry the current as opposed to holes) indium antimonide, which amounted to a metal-insulator transition. He spent the fall quarter of 1957 at the University of Chicago as a visiting scientist on leave from the Westinghouse Research Laboratory. Bob spent his time there studying interpretations of measurements of atomic diffusion in solids at high pressure. His work showed that simple models by and large explain the pressure effects.

In 1960, Bob resigned from Westinghouse to join the new and rapidly expanding IBM Research Laboratory in Yorktown Heights, Westchester County, New York. He spent the remainder of his career there, first as a research manager, then as a research staff member, and finally as a research staff member emeritus. Bob actively engaged in research right up to the time of his death. His last paper was published posthumously.

His first assignment at IBM was to manage a small group involved at various times in work on novel devices, including transistor engineering, the physical basis of the Gunn effect, solar cells, process instrumentation and gas panel displays, and ion-implanted superconducting devices. The group included

Bill Dumke, Al Michel, Frank Stern, Edward J. Walker, me, and others. Under Bob's leadership, some members of the group started work aimed at finding a semiconductor diode laser. Bob sought and got partial support for this work from the U.S. Army Signal Corps in 1962. In the proposal that he wrote to get this support, he made the bold promise to construct the laser before the end of the year. In retrospect it is difficult to realize how audacious that promise was in view of the fact that the semiconductor laser has been around for almost 50 years. His group and those at other laboratories fulfilled that promise and successfully made semiconductor lasers toward the end of 1962.

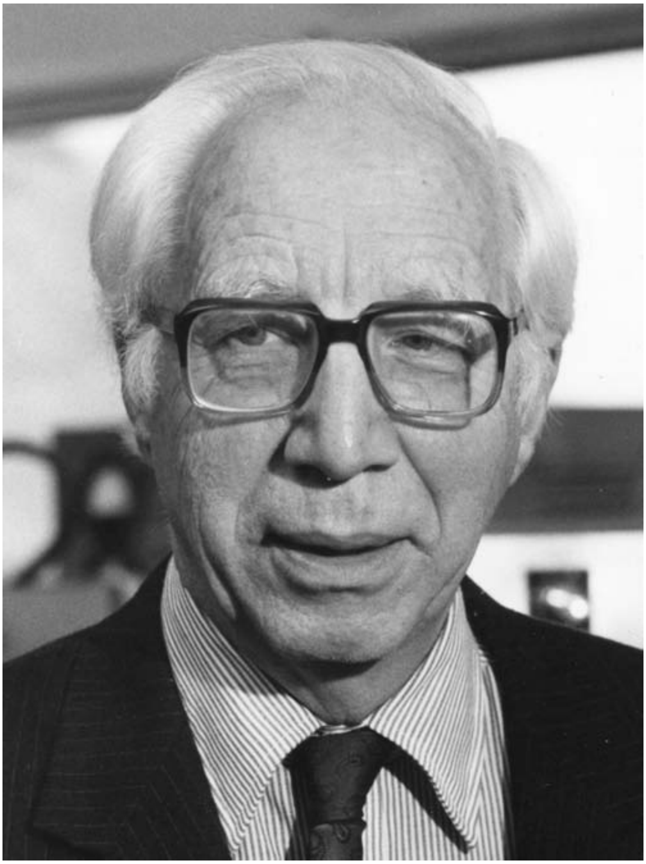
It was shortly after this time that Bob met his wife to be, Sophie, while hiking in the nearby hills. They were married in 1966. Their children, Andrew and Claire, were born in 1969 and 1971, respectively.

Bob's work at IBM, especially his interactions with his group, led him to become more interested in semiconductor devices and the applications of semiconductor physics to computers. Semiconductor devices were being made smaller and smaller, with increasing numbers of them on a chip. The questions were: Where is this leading? How small a device can work? Why is so much energy being used to execute logic? What can we do about the heat that more and more devices are creating in a small space? He discussed these issues in the Institute of Electrical and Electronics Engineers (IEEE) *Spectrum* in 1969 in a paper that attracted widespread attention and brought him several invitations to speak at conferences and institutions throughout the United States. He had become one of the leading practitioners of the subdiscipline known as "Limits." Other questions that he became interested in were: What voltage to use? Does fundamental physics require energy dissipation to switch? From consideration of these questions he concluded that silicon transistors were the best of the contending logic devices.

Eventually, Bob summarized his views of limits in the *Proceedings of the IEEE* in 1975. This paper was recognized in 1976 with the IEEE's W. R. G. Baker Prize for an outstanding paper in an IEEE publication that year. Widespread interest in limits continued to garner invitations for Bob to write or speak on the subject in other venues for many years.

Bob Keyes was a very productive scientist. During his lifetime he published over 200 papers, for almost all of which he was the sole author. He wrote one book, *The Physics of VLSI Systems* (Addison-Wesley, 1987), and he made contributions to several others.

Bob was well thought of for generously reaching out and helping his fellow scientists, including several just starting out, whenever he could. His colleagues and many friends will remember him for his quick wit and wry sense of humor. He was an avid hiker and a bird watcher. He is survived by his wife Sophie and their children Andrew and Claire Ames.



WILLEM J. KOLFF

1911–2009

Elected in 1989

"For innovative and unique artificial organ research and for leadership in bringing advanced engineering concepts to artificial organ design, construction, and implantation."

BY LAURA GUNDRY
SUBMITTED BY THE NAE HOME SECRETARY

WILLEM J. KOLFF, widely considered the father of the field of artificial organs, and University of Utah distinguished professor emeritus of bioengineering, surgery, and medicine, passed away on February 11, 2009, at the age of 97, in Newtown Square, Pennsylvania. Dr. Kolff invented the kidney dialysis machine and was instrumental in the development of the intra-aortic balloon pump, membrance oxygenator, artificial heart, and artificial eye.

Dr. Kolff based his highly productive research career on collaborative research because he believed it to be the most effective way of achieving his goal of developing and exploiting the possibilities of artificial human organs as a means to "restore people to an enjoyable existence."

Due to his groundbreaking work on the artificial kidney, millions of patients worldwide have benefited from life-sustaining hemodialysis. His artificial heart is still in use, in subsequent designs, as a bridge to transplantation in patients with heart failure. Dr. Kolff's broad vision inspired his colleagues to explore a wide variety of organs—an effort that contributed to pioneering research on such other artificial devices as the lung, placenta, ear, arms, and legs.

Dr. Kolff was born on February 14, 1911, in Leiden in the Netherlands. He received his medical degree at the University of Leiden Medical School in Holland in 1938. He received his Ph.D. at the University of Groningen in Holland in 1946. As a young physician in the Netherlands before World War II, he developed an interest in the artificial kidney when he witnessed the death of a young man due to kidney failure. In 1939 he began developing the first crude artificial kidney by finding parts and materials from a local factory in Nazi-occupied Holland. By 1942 he developed a prototype machine, and three years later the first patient was saved by an artificial kidney.

After the war, Dr. Kolff and his family immigrated to the United States in 1950, and he joined the Cleveland Clinic in Ohio as a researcher. At Cleveland he turned to the study of cardiovascular problems. His first work on an artificial heart began in 1957. He built one of the first heart-lung machines, a device that made open-heart surgery possible for the first time. He also improved his dialysis machine. The first membrane oxygenators were used successfully in patients in 1955.

In 1967, Dr. Kolff went to the University of Utah, where he headed the Institute for Biomedical Engineering and the Division of Artificial Organs. He continued his work on the artificial heart, and in 1982, under his supervision, the first "permanent" artificial heart was implanted into Seattle dentist Barney Clark at the University of Utah Hospital. Clark survived four months. When he died, the artificial heart was still functioning. The feat put the University of Utah at the forefront of artificial organ research and made Dr. Kolff and his team international medical celebrities.

Dr. Kolff's presence at the University of Utah acted as a magnet to attract scientists from all over the world who were interested in artificial organ research, and under his leadership the university has since developed one of the world's leading artificial organ research centers. Although he officially retired in 1986, Dr. Kolff continued to work as a research professor and director of the Kolff Laboratory at the University of Utah until 1997.

During his lifetime, Dr. Kolff published numerous books and more than 600 papers and articles, was inducted into the Inventors Hall of Fame in 1985, and received hundreds of awards. In 1990, *Life* magazine named him one of the 100 most important Americans of the 20th century. He was elected to the National Academy of Engineering in 1989. He also received the 2002 Albert Lasker Award for Clinical Medical Research, one of the highest honors in American medicine, as well as more than 12 honorary doctorates from universities all over the world.

Dr. Kolff once told a reporter that his mind rarely took a rest from the mechanics of medical device designs and how they could save or improve lives. "I nearly always do something. I can't bear to just lie in the sun. It would drive me crazy," he said. Dr. Donald Olsen, a former colleague and director of the Utah Artificial Heart Institute, said Dr. Kolff's work influenced most of those working today in artificial organs research. He said many worked either in Dr. Kolff's lab or with him on site. Dr. Olsen also said that Dr. Kolff had the ability to "recognize new technologies and find an immediate application to his own research. He also recognized talent, so that over the years he developed a tremendously important team of researchers."

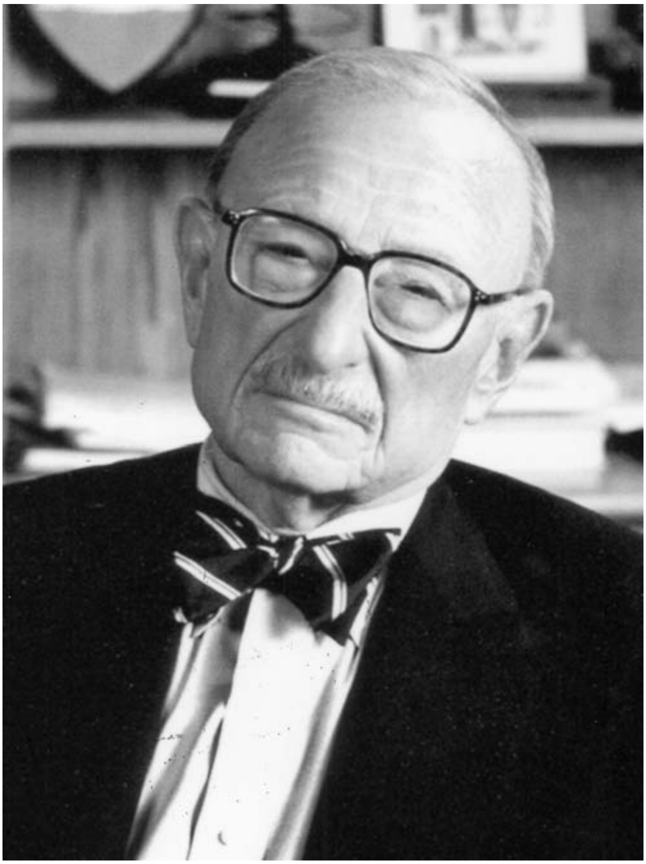
His son Jack wrote:

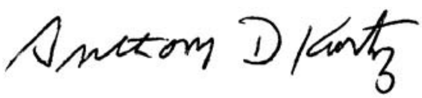
> As a father, he was an active family man. He spent summer vacations with his family traveling through the United States pulling a home-made trailer holding a boat, camping gear, and compartments to hold personal gear for each of his five children and their various friends. Any other free time was spent on the family's 125-acre tree farm, one hour outside of Cleveland, where many a Cleveland Clinic resident or fellow joined the family for painting, planting or chopping wood in exchange for hamburgers and hotdogs.
>
> Dad always tried to reserve time for his family and openly criticized medical meetings or conferences that were scheduled on weekends. As an antidote, he would frequently include one or two children on selected medical travels where they would enjoy the local area

while he attended the meeting. Saturday evenings he would engage in family board games or card games and Sunday spring mornings were reserved for early bird walks.

He encouraged all of his children to pursue their own careers, yet three of them followed him into medicine and one into medical architecture.

Dr. Kolff is survived by four sons, Jack, Kees, Albert, and Therus; one daughter, Adrie Burnett; 12 grandchildren; and 6 great-grandchildren.





ANTHONY D. KURTZ

1929–2010

Elected in 2008

"For the conception, development, and commercialization of the silicon semiconductor pressure transducer."

BY ALAN EPSTEIN

ANTHONY DAVID KURTZ, founder and chief executive officer of Kulite Semiconductor Products, and a prolific inventor, innovator, and entrepreneur, died on February 9, 2010. He was 80 years old.

Kurtz started Kulite Semiconductor Products, Inc., in 1959 to manufacture silicon strain gauges. He was among the first to demonstrate the piezo-resistive silicon pressure transducer (1961) and to bring the silicon transducer to market (1964). Kurtz and Kulite have continued as the technology leader in this business such that over the past 50 years "Kulite" has become synonymous with miniature high frequency response transducers. Kurtz grew Kulite to about 700 people and $100 million per year in sales. His product innovations include the first silicon accelerometer, the first silicon-on-oxide transducer, the first acceleration-compensated transducer, and the first high-temperature (>500°C) silicon transducer. His last work was on silicon carbide, porous silicon, and diamond-based transducers. His record of inventions is apparent in his more than 200 patents and 60 papers. His patent combining a micromechanical sensor with electronic computation was among the most frequently cited of the 1980s. His pioneering contributions were recognized by *Industrial Research* magazine with an IR 100 award in 1968 and by awards from the

Instrument Society of America in 1978 and 2005. Tony was elected to the National Academy of Engineering in 2008.

Anthony David Kurtz was born on May 3, 1929, in Brooklyn, New York. His father was a metallurgist, a pioneer in powder metallurgy, and a founder of Callite Tungsten. His mother was a member of the 1924 U.S. Olympic swim team. Together, his parents later started Kulite Tungsten. Tony attended high school in Teaneck, New Jersey. He enrolled at the Massachusetts Institute of Technology (MIT), playing club rugby and swimming, and received a B.S. and an M.S. in physics in 1951 and 1952, respectively. He worked at MIT's Lincoln Laboratory while pursing an Sc.D. in physical metallurgy. He graduated in 1955. His thesis topic was the mechanical properties of a newly promising element—silicon. Upon graduation from MIT, Kurtz became manager of diffused device research at Cleavite Transistor Products. In 1957 he set up an applied semiconductor research laboratory for Honeywell and served as its director until 1960.

Kurtz wanted to own his own company and looked for a niche in which he would not need to compete with large established players in the semiconductor business (which meant transistor and diode manufacturers in those days). He found his niche in silicon semiconductor strain gauges. In 1959 he set up Kulite Semiconductor Products in an unused loft of his parents' company in Ridgefield, New Jersey. Kulite negotiated a license from Western Electric for its patent on the piezo-resistive properties of silicon. Kulite teamed with Bytrex (an established strain gauge manufacturer) to form Kulite-Bytrex to bring the first semiconductor strain gauge to market. Semiconductor strain gauges offered 100 times the sensitivity of conventional metal foil and wire gauges. Their initial customers were established pressure transducer manufacturers. The Kulite-Bytrex marketing partnership came to an end when Schaevitz, an established transducer manufacturer, acquired Bytrex, leaving Kulite free to develop and promote its own gauges and transducers.

Kulite soon brought the silicon diaphragm pressure transducer to market. Silicon is an excellent material for pressure transducer diaphragms because of its high stiffness-to-mass ratio, which enables very high frequency response with low acceleration response. These Kulite transducers were among the first micromachined products to enter the market, a field now known as MEMS (microelectromechanical systems). Small enough to fit through the eye of a needle (albeit a large one), the first Kulite miniature semiconductor diaphragm transducer was a technical marvel of its time. It quickly became the backbone of aerospace dynamic testing in the 1960s. It was extensively used in aircraft and spacecraft development—an application that continues to be important to this day.

The early Kulite transducers had excellent sensitivity and acceleration resistance but relatively poor thermal stability, so they were mainly used in dynamic applications. Over the next few decades, Tony's innovative spirit, combined with his deep understanding of solid state physics, spurred numerous design and manufacturing innovations. Today's Kulite transducers are among the most stable available and operate over an enormous temperature range. This stability was gained without sacrificing other desirable qualities, such as small size and high-frequency response. This greatly expanded the market for silicon transducers, which now encompasses medical, oil exploration, and automotive applications. As is often the case with pioneers, Kulite spawned several spinoffs and competitors.

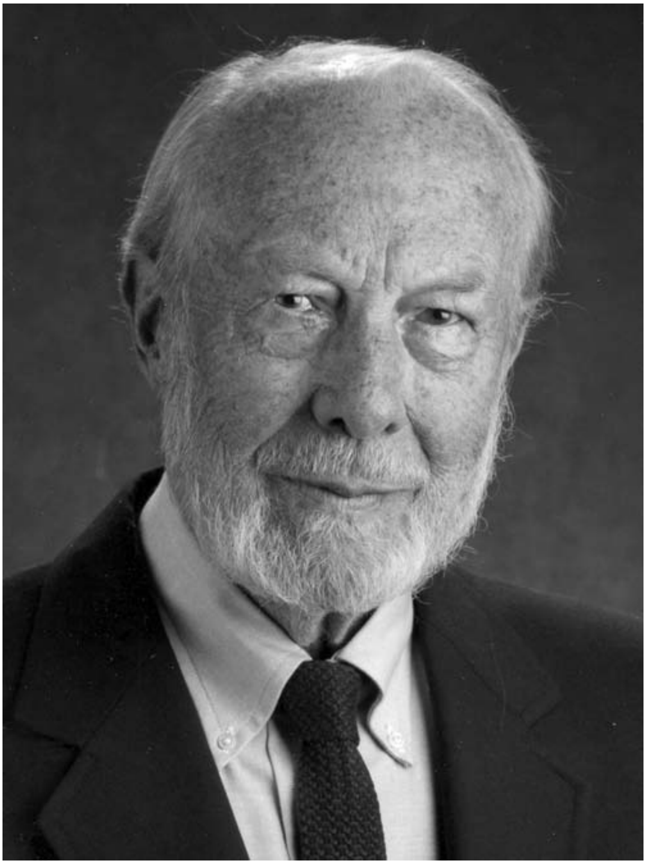
Learning from his father's tungsten business in which the profit was in collecting the dust from the saw kerfs when cutting vacuum tube filaments, Tony Kurtz eschewed commodity businesses with low margins—such as those that developed for disposable medical transducers and production automobiles. For 50 years he kept Kulite on the cutting edge of technology, which allowed him to indulge his love of invention and innovation as well as get premium prices for premium products. His focus on the pressure transducer market and its technology served Kulite well as competitors were acquired by diversified corporations and often lost the innovation and drive that are characteristic of many enterprise founders.

Over the decades, Tony maintained close relations with MIT, Columbia University, the New Jersey Institute of Technology, and Oxford University in many ways. He was a generous benefactor, a research collaborator, and a direct sponsor of graduate students and their research. At Columbia he was an adjunct professor and served on the dean's council of the engineering school for many years.

Athletics was an important part of Tony's life. As an undergraduate at MIT, he was a founding member of the Rugby Club. This club team included an amazing assortment of young men who went on to become leading engineers, architects, executives, generals, professors, Central Intelligence Agency leaders—and two national Academy of Engineering members. Tony learned his love of swimming from his mother and swam daily for most of his life.

Tony remained as chief executive officer and chief scientist of Kulite until his death. As a closely held, privately owned company, Kulite reflected the values of its leader and is best described as having a family atmosphere. A significant number of its employees have been there for essentially their entire working lives, and more than 50 percent of the employees have one or more family members in the company. Walking through the company was like a trip to the United Nations, with an amazing cross section of the world's peoples and their languages represented.

Tony Kurtz always placed great value on education. In addition to being a generous benefactor to universities, he strongly encouraged members of the Kulite family to further their education and funded college for a very large number of employees and their families. This commitment reflected two sides of this interesting man: a compassion for people and a shrewd business sense. As Tony liked to say, "I always felt the real capital is in the brains of the people."



CHRISTIAN J. LAMBERTSEN

1917–2011

Elected in 1977

"For contributions to environmental science and to diving physiology and technology."

BY TOM HAWKINS
SUBMITTED BY THE HOME SECRETARY

CHRISTIAN J. LAMBERTSEN, a distinguished scientist, medical doctor, inventor, environmentalist, pioneer in undersea and aerospace medicine, and professor at the University of Pennsylvania School of Medicine for his entire adult life, died on February 11, 2011, at the age of 93. He excused himself from daily activities at the university only in the past several years, when he was forced to slow down because of physical incapacitation. He was held in especially high regard by the U.S. Navy SEALs, who considered him a friend, mentor, and "Father of U.S. Combat Swimming," a title he very much appreciated.

Dr. Lambertsen received a B.S. degree from Rutgers University in 1938 and his M.D. degree from the University of Pennsylvania in 1943. His extraordinary lifetime of accomplishments began during involvement with the Office of Strategic Services (OSS) during World War II when, as a 23-year-old medical student, he presented his invention of a self-contained underwater swimming apparatus. Once developed, it was called the Lambertsen Lung and eventually the Lambertsen Amphibious Respiratory Unit (or simply LARU). The LARU would enable a well-trained swimmer to work bubble-free underwater and thus operate around objective areas without detection from above. The OSS immediately understood the LARU's potential and quickly embraced the concept.

Upon completion of his medical training, Dr. Lambertsen was commissioned in the U.S. Army Medical Corps and attached for service with OSS, specifically to take advantage of his expertise in underwater operations. He became instrumental in establishing the OSS Maritime Unit as the unit's medical officer and primary trainer of its operational swimmers, including development of tactical functions of the LARU and a swimmer submersible. After the surrender of Japan and before being reassigned to hospital duty in Atlanta, Georgia, Dr. Lambertsen did everything he could to protect and save the Maritime Unit's diving equipment, since OSS was disbanded almost immediately in September 1945.

Dr. Lambertsen joined the University of Pennsylvania medical faculty in 1946 and became a professor of pharmacology in 1952. While a faculty member, he continued to combine diving research and underwater equipment developments and began a one-man campaign to introduce OSS diving capabilities to the Navy's Underwater Demolition Teams (UDTs), the U.S. Coast Guard, and the U.S. Army Corps of Engineers. In 1947 he wrote a lengthy letter to the chief of naval operations summarizing underwater swimmer capabilities.

The UDTs fully adopted OSS capabilities, which were called simply "Submersible Operations" and were immediately classified to protect the tactics and techniques being used. This was a seminal period for the UDTs, since the LARU and OSS tactics vastly improved their maritime special operations potential. Capabilities introduced by Dr. Lambertsen also included use of the British submersible canoe *Sleeping Beauty*, which would lead to decades of UDT and SEAL team combatant submersible refinement, organization of the U.S. Navy SEAL delivery vehicle teams, and modification of U.S. Navy nuclear submarines for dedicated support of SEALs. Indeed, his expertise in all areas of underwater operations placed him at the forefront of this rapidly developing field.

In 1952, Dr. Lambertsen and a colleague wrote a paper for the National Academy of Sciences describing his "Self-Contained Underwater Breathing Apparatus," which resulted in the acronym SCUBA.

From 1952 to 1960, Dr. Lambertsen served as a distinguished member of the Office of Naval Research's Cooperative Underwater Swimmer Project and on the National Research Council Committee on Amphibious Operations Panel on Underwater Swimmers. He also served as member of the Assistant Secretary of Defense Advisory Panel on Medical Science, as a member of the U.S. Air Force Scientific Advisory Board, as a consultant to the U.S. Army Chemical Corps, and as chairman of the National Research Council Panel on Shipboard and Submarine Medicine. His work with the federal government continued through the 1990s, with service on the U.S. Navy's Oceanographic Advisory Committee and as a member of the U.S. Special Operations Command's Medical Advisory Board for the Advanced SEAL Delivery System.

Dr. Lambertsen's medical research expanded to the earliest days of the National Aeronautics and Space Administration's (NASA) manned space program, where he actively participated in advancing man's capability for space exploration. In 1960 he served as a member of the Space Sciences Board of the National Academy of Sciences and as chairman of the Committee on Man-in-Space, providing oversight to eight subordinate panels covering a variety of disciplines.

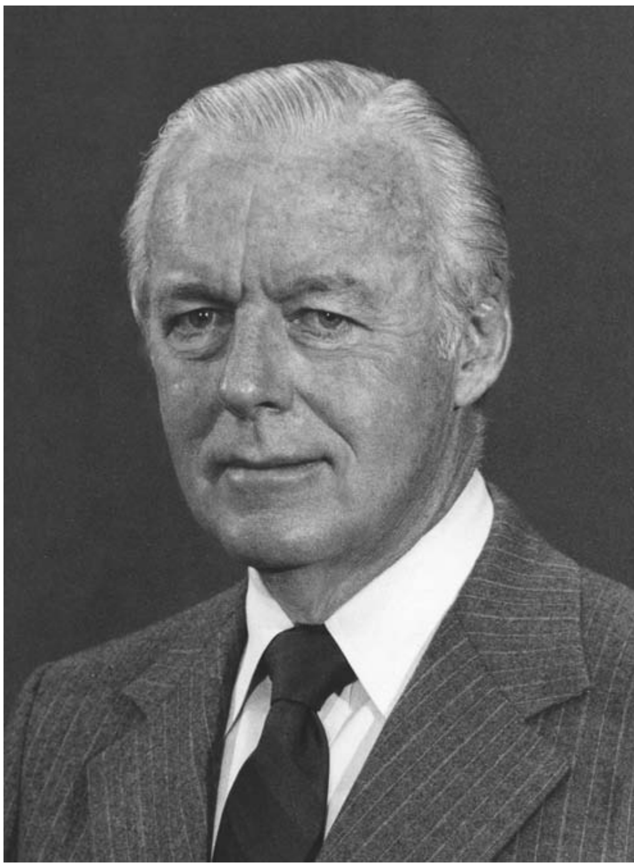
From 1960 to 1967 he was chairman of the Life Systems Advisory Board for the Mercury and Gemini projects. Throughout the 1970s and 1980s he remained actively engaged in scientific research surrounding man's ability to handle the environmental stresses of space. He was a member of the President's Space Panel from 1967 to 1970 and from 1983 to 1986 served as chairman of the Environmental Science Review Committee as a member of NASA's Space Medicine Panel on the Lunar Base Planning Group. Dr. Lambertsen's work with NASA continued into the 1990s with participation in a Radiation and Environmental Health Working Group, Life Sciences Division Environmental Biomedical Sciences

Working Group, and Hubble Telescope Repair Project. From 1998 to 2000 he served as chairman of NASA's Advisory Committee on the International Space Station Decompression Risk Definition and Contingency Plan.

Dr. Lambertsen's impact on science and the military earned him numerous honors, including the Alumni Award of Merit from the University of Pennsylvania and in 1989 the Distinguished Graduate Award from the Perelman School of Medicine—the highest honor bestowed on alumni. He was also presented the Legion of Merit Award and the Distinguished Public Service Medal in 1972, the highest award bestowed on a civilian by the U.S. Department of Defense; the U.S. Coast Guard's Distinguished Public Service Award in 1976; the U.S. Army Special Forces Green Beret Award in 1996; the national UDT-SEAL Association Lifetime Achievement Award in 1999; and the U.S. Special Operations Command Medal in 2001. He was elected to the National Academy of Engineering in 1977. He also received the New York Academy of Sciences Award for Research in Environmental Sciences, the Pioneer Award of the Navy Historical Society, and in 2010 the John Scott Award from the Philadelphia Board of Directors of City Trusts, which previously honored Marie Curie, Thomas Edison, and Jonas Salk. In May 2011 the U.S. Special Operations Command honored him with establishment of the "Dr. Christian J. Lambertsen Award for Operational Innovation," which will be presented annually.

Dr. Lambertsen's most significant and crowning achievements undoubtedly came in 1967 and 1968, when he served as founding president of the Undersea Medical Society (now Undersea and Hyperbaric Medical Society) and established the University of Pennsylvania's Institute for Environmental Medicine and its companion Environmental Biomedical Stress Data Center, where researchers continue to explore the pathophysiology of oxygen toxicity, diving-related diseases, and mechanisms of hypoxic response. His service to our country as a combat veteran, an educator, a medical doctor, an inventor, and a distinguished citizen represents a lifetime of achievement. His impacts on diving physiology, undersea and hyperbaric research and medical treatments, hydrospace sciences, biomedical sciences, and environmental sciences were without equal.

Dr. Lambertsen is survived by his sons Christian Jr., David, Richard, and Bradley and by six grandchildren. His wife of more than 40 years, Naomi Hill Lambertsen, died in 1985. His son, Christian, remembers his father as being dedicated to his family, immediate and extended, and that he was an adventuresome sailor. As an environmentalist, he was active in land preservation along the shores of his farm, called Lostock, near St. Michaels, Maryland.



DAVID S. LEWIS, JR.

1917–2003

Elected in 1971

"For contributions to aerospace management in conception, development, and production of aircraft and spacecraft."

BY ROBERT J. PATTON

DAVID S. LEWIS, JR., a major force in the nation's aerospace industry and former chief executive officer of General Dynamics, died on December 15, 2003, at the age of 86.

David Sloan Lewis, Jr., was born on July 6, 1917, in North Augusta, South Carolina. His father, Dick Lewis, was an executive with Standard Oil of New Jersey and was transferred to Columbia, South Carolina, in 1933. Dave graduated from Columbia High School in 1934. After studying engineering at the University of South Carolina for three years, he transferred to the Georgia Institute of Technology, where he received a B.S. in aeronautical engineering in 1939.

After graduation he joined the Glenn L. Martin Company in Baltimore and during World War II worked on many new aircraft designs in the aerodynamics department. There Dave met his wife, Dorothy, who also worked at the Martin Company, and they were married on December 20, 1941.

In 1946, Lewis joined the McDonnell Aircraft Corporation in St. Louis as chief of aerodynamics. There he worked on the FH-2 Phantom, the U.S. Navy's first jet aircraft, the F2H, and the F-101 for the U.S. Air Force. McDonnell formed an Advanced Design Department with Lewis as head. They developed the Navy's F-4 Phantom II. McDonnell delivered more that 5,000 F-4s to the U.S. Navy and U.S. Air Force and to the armed forces of several allied nations. In 1956, Lewis was promoted to vice president of McDonnell Aircraft. He was instrumental in the company winning the Mercury spacecraft for the National Aeronautics and Space Administration. In 1962, Dave was named chief operating officer for all of the company's activities.

As a part of the aerospace industry's consolidation in the early 1960s, McDonnell merged with Douglas Aircraft Corporation. Lewis was named chairman of the Douglas Division and was charged with turning the company around regarding deliveries and its financial problems. With the infusion of McDonnell's money and Lewis's leadership and attention to detail, Douglas become profitable again and Lewis returned to St. Louis. He continued to work on DC-10 sales and was instrumental in winning the federal government's contract to develop the F-15 Eagle.

Lewis became chairman and chief executive officer of General Dynamics in 1970 and had the corporate headquarters moved to St. Louis. By 1974 his leadership had made the company profitable. The biggest opportunity for the aerospace part was the competition for a new lightweight fighter. Dave Lewis took a very personal part to ensure a winning proposal: He flew to Fort Worth (where the F-16 proposal was being prepared) every Saturday to personally review the design, structural details, proposed development plans, and pricing. Their proposal was the winner, and General Dynamics went on to build several thousand F-16s.

During the Persian Gulf War, General Dynamics products were very much in evidence. Lewis was proud of the General Dynamics systems that were used by the U.S. military: Tomahawk Cruise missiles, F-16s, Phalanx ship defense gun systems, and the M1 Abrams main battle tank.

The submarine business at the Electric Boat Division then took much of Lewis's time. The division obtained a contract for many SSN 688 attack submarines. Then Lewis worked hard to get the Trident ballistic missile submarine design and construction (including the building of a large new land-level assembly facility). He retired from General Dynamics in 1985.

As a result of his work in the aerospace field, Lewis received many honors, among them the Robert Collier Trophy for the F-16 in 1975, the Fleet Admiral Chester W. Nimitz Award in 1981, the Daniel Guggenheim Medal in 1982, and the Wright Brothers Memorial Trophy in 1984. He also received an honorary doctor of sciences degree from Clarkson College of Technology in 1971 and an honorary doctor of law degree from St. Louis University in 1977.

Lewis served as a director of Ralston Purina in St. Louis, Bank of America in San Francisco, Cessna Aircraft in Wichita, and the Mead Corporation in Dayton, Ohio. He was also a trustee of Washington University in St. Louis and the Georgia Tech Foundation.

In addition to being a member of the National Academy of Engineering (1971), Lewis was a fellow of the American Institute of Aeronautics and Astronautics and a member of the Board of Nominations for the Aviation Hall of Fame, the National Aeronautics Association, the Navy League, and the Air Force Association. He was on the board of the Aerospace Industry Association and the American Ordnance Association. Starting in mid-1986 he served on the National Academy of Engineering's Committee on Aerospace Defense.

Dave Lewis was an active and lifelong member of the Episcopal Church. As a child he was an altar boy at Grace Episcopal in Charleston, South Carolina. While he was in St. Louis, he continued to be active and served on the vestry and as a senior warden at the Church of St. James the Apostle. After retirement he returned to South Carolina and was again active at Grace Episcopal.

In 1982, anticipating retirement, Lewis began developing a plantation near Albany, Georgia, which grew to 8,500 acres of farmland and swampland. There he and Dorothy built a home and produced peanuts, pecans, corn, and quail. In 1996 they sold the plantation and moved to Charleston.

His daughter, Susan Winslow, wrote:

> In his retirement era he continued his love for golf, maintaining his affiliation with Augusta National,

and also serving a term as President of the Highlands Country Club in Highlands, North Carolina, where he and Dorothy spent many summers. In 2000 he was inducted into the South Carolina Business Hall of Fame by then-Governor Jim Hodges.

David Lewis had the aura of a well-bred Southern gentleman. Despite all his wealth and skill with high technology, he preferred to drive a Ford Falcon or Dodge Dart.

At the time of his death in 2003, Mr. Lewis was survived by his wife of 62 years, the former Dorothy Sharpe; his daughter, Susan Winslow (of Mt. Pleasant, South Carolina); and his three sons—David III (of Chevy Chase, Maryland), Robert (of Marietta, Georgia), and Andrew (of Gainesville, Georgia).

Harvey F. Ludwig

HARVEY F. LUDWIG

1916–2010

Elected in 1969

"For advances in environmental engineering research and development in water and waste-processing methods."

BY DANIEL GUNARATNAM
SUBMITTED BY THE HOME SECRETARY

HARVEY F. LUDWIG had a "presence" as a personality and an engineer. He was born in 1916 in Canada and grew up in Los Angeles (1920–1936).

Many outstanding engineers and scientists have shaped the environmental engineering field since its inception. Harvey F. Ludwig was a legend. His 70-year career of continuing contributions and leadership helped shape the modern practice of environmental engineering. Dr. Ludwig obtained his B.S. degree in 1938 in civil and sanitary engineering from the University of California, Berkeley, and his M.S. in 1941. During World War II he was a commissioned officer of the U.S. Public Health Service (USPHS).

In 1946 he started a consulting practice and in 1949 became an associate professor at the University of California, Berkeley. In 1951 he became assistant chief engineer of the USPHS (under Dr. Mark Hollis). In this position he presided over the development of institutions (i.e., laws, federal agencies, programs) that were the foundations for what emerged in final form in the 1970s (and have continued to evolve). At the same time, Dr. Ludwig oversaw research funding at various universities across the country that fueled research and graduate programs which led to a "flowering" of the field that has continued.

In 1956, Dr. Ludwig resigned from the USPHS and started Engineering-Science, Inc. (ES). His modus operandi was to hire mostly M.S. and Ph.D. students recruited from his network of academic colleagues who would adapt their research knowledge into practice. At that time, hiring engineers with graduate degrees was more unusual than common. ES expanded rapidly with offices in key cities in the United States, including a research laboratory and office in Oakland (1956), later in Washington, D.C. (c. 1966), headed by his longtime USPHS associate Gordon MacCallum, and then in Austin, Texas, started by Dr. Davis Ford (1968). The firm grew rapidly with important projects throughout the country, and it started to develop an international clientele. Dr. Ludwig was by this time (1969) a legend in environmental engineering. In the same time, the field was experiencing a golden age—research was advancing knowledge, graduate programs were spreading, the practice was flourishing, and the public had adopted a widespread environmental ethos that was being translated by politicians into laws and policy. At that time, ES was, arguably, at the crest of this movement. It was one of the most visible firms in the field and at the forefront of innovation. This was due not only to Dr. Ludwig individually but also to the way he had structured the firm with both depth and breadth of expertise and leadership. In addition, Dr. Ludwig had extensive involvement with professors from throughout the country.

ES was actually, though, part of a larger corporate structure. One entity was a construction company that had financial difficulty. The "way out" was a buyout offer in 1968 by Zurn Industries of Erie, Pennsylvania. The new corporate structure did not work out, and Dr. Ludwig left the firm in 1972 to set up his own consulting practice in Washington, D.C. ES was later purchased by its employees and remained prominent in the field through 2004, when its identity was assimilated fully by Parsons, an international construction company.

In 1973, Dr. Ludwig's private practice led him to Bangkok where he started a new firm, Seatec International, which has influenced environmental engineering throughout Southeast

Asia (Indonesia, Malaysia, Thailand, Laos, Cambodia, and the Philippines), China, South Asia (India, Bangladesh, Nepal, Sri Lanka), South Korea, and Taiwan. While there he championed the case for adapting environmental standards and designs to match the socioeconomic context of developing countries—as opposed to imposing the design approaches of industrialized countries. He worked with multilateral banks (the World Bank and the Asian Development Bank), and bilateral institutions, such as the U.S. Agency for International Development and others. He proceeded to revise their procedures to fit appropriate environmental standards that were more workable in developing countries. His contribution to the Asian Development Bank to prepare guidelines for environmental impact assessments for all sectors of projects was simply outstanding. In his final years he championed the integration of environmental issues into all economic development to ensure that environmental issues were mainstreamed into economic plans.

Dr. Ludwig was a mentor to countless practicing engineers in both the United States and Asia. He was known for his high standards in writing, in professional practice, and in getting a job done. To quote Professor Donald Anderson, in 1965, when he headed the Oakland office of ES, "When you work for Harvey Ludwig. . . ," much was expected. He was instrumental in founding what is now the American Academy of Environmental Engineers (a certifying organization) in 1956 and sponsoring the founding of the Association of Environmental Engineering and Science Professors (AEESP) in 1963. In 1966 his firm ES initiated the sponsoring of a "best thesis" cash award within AEESP. Dr. Ludwig's rationale was that the significant cash ($1,000 at that time) added prestige to the award. The award has continued under the auspices of other firms, with inclusion of both master's and doctoral theses.

As of 2008, Dr. Ludwig had some 358 publications, ranging from research on coagulation (1941) to strategies for saving the forests in Southeast Asia (2005). In addition, he wrote eight textbooks on environmental engineering. Four of his papers won awards: the American Water Works Association John M. Goodell Award, with W. F. Langelier, in 1942; the Water Environment Federation's Harrison Prescott Eddy Medal in 1954; and the American Society of Civil Engineers (ASCE) Rudolph Hering Medal in 1955. Personal achievement awards included an honorary doctoral degree from Clemson University in 1965; election to the National Academy of Engineering in 1969, shortly after its founding; the AEESP's Founder's Award; the American Academy of Environmental Engineers (AAEE) Honorary Member Award in 1999; the University of California College of Engineering Alumnus of the Year Award in 1999; the AEESP/AAEE Special Joint Award in 2005 for services as a principal founder of both organizations at Clarkson University; and various other awards in Bangkok and Southeast Asia.

As implied, the passing of Harvey Ludwig leaves a void in the profession and in his family, which included his wife, Vanida, and four daughters, a son, five grandchildren, and two great-grandchildren. Harvey was a wonderful husband and a good father to his children. He continued to disseminate his frequent e-mails (to over 60 friends, family members, and colleagues) to within a few weeks of his passing on April 24, 2010. He had opinions on every issue, including global warming, economic crises, education, the European Union, graft and what to do about it, appropriate technologies, environmental standards for developing countries, and more. He tried to advance the issue of appropriate technologies for developing countries at every opportunity, including writing textbooks on the topic. Harvey as a personality and as an engineer was not only a legend but also an institution whose influence continues.

MAX V. MATHEWS

1926–2011

Elected in 1979

"For contributions to computer generation and analysis of meaningful sounds."

BY C. GORDON BELL

MAX VERNON MATHEWS, often called the father of computer music, died on April 21, 2011, at the age of 84. At the time of his death he was serving as professor (research) emeritus at Stanford University's Center for Computer Research in Music and Acoustics.

Max was born in Columbus, Nebraska, on November 13, 1926. He attended high school in Peru, Nebraska, where his father taught physics and his mother taught biology at the state teachers college there. Peru High School was the training school for the college. This was during World War II (1943–1944). One day when Max was a senior in high school, he simply went off to Omaha (strictly on his own volition) and enlisted in the U.S. Navy—a fortunate move because he was able to have some influence on the service to which he was assigned, and after taking the Eddy Aptitude Test, he was selected for radar school. Radar, however, was so secret, that Max was designated a "radio technician." After basic training he was sent to Treasure Island, San Francisco, where he met Marjorie (Marj), who became his wife.

After returning from the war, Max applied to the California Institute of Technology (Caltech) and to the Massachusetts Institute of Technology (MIT). On graduating with a bachelor's degree in electrical engineering from Caltech in 1950, he went to MIT to earn a doctorate in 1954.

In an oral history interview, Max describes his career at Bell Labs:

> I went to the Acoustic Research Group at Bell Telephone Laboratories in 1955. And in those days, speech transmission facilities were both expensive and very limited. . . . And so the Acoustic Research Department worked very hard to try to make speech coders that were efficient enough so that we could put more channels . . . onto an existing communication link.
>
> So I developed the equipment to put speech into a computer via magnetic tape, and to take speech out of a computer. And this proved to be a real revolution in speech research, and in the development of good digital codes. And so that instead of working for years before finding out something was no good, we could write a program in a couple of weeks. . . . This led to speech coders that are very good and very efficient, which are in use today. And so the computer became the great research tool for speech coding.[1]

Max's serendipitous transition to music occurred through John R. Pierce, who headed Bell Telephone Laboratories:

> Although I'm not a musician—I'm an engineer—I love music, and I learned to play the violin, and I still love to play the violin, whether or not I can play it very well. And I still play the violin. And I was very lucky in that in those days the boss's boss, John Pierce, also loved music. And we went to some concerts together. . . . And in the intermission, John turned to me and said, "Max, now you've gotten telephone speech into and out of a computer. Could you write a program to make a computer synthesize music?" And I said, "John, I would love to do that!" And so John said, "Well, take a little time off from your regular job, and write a musical program." And so I was delighted to do that. And that was the source of Music I, which was really the precursor of programs II through V that I think are the seeds from which most of the digital music in the world today sprouted."

Music V, written in FORTRAN for portability, led to later programs, including Csound, Cmix, and MAX, a visual programming language for music and multimedia. It was written in the 1980s and named in honor of Mathews.

Max recalled the famous song "A Bicycle Built for Two," which was accompanied by synthesized singing that John Kelly provided. He said, "That's the only composition that I have orchestrated really."

> The piece came to Stanley Kubrick's attention for the movie "2001." An assistant heard "Bicycle Built for Two,"[2] and Kubrick was enchanted with this idea, then put it in as when the computer went crazy, its final utterances as they took him apart, as you remember. . . . The music you hear in the movie is not the original digital synthesis. Kubrick had Hollywood make a copy of my version of "Bicycle."

Max chronicled the first 50 years of progress in computer-generated music:

> In those days it took 100 seconds to make a second of sound. And if you divide that by 10,000, that means that you can produce about—you can control about 100 instruments in one laptop computer. So you could make sound, not for a single instrument in the laptop computer, but for a whole symphony orchestra of instruments.

And he outlined the future challenge:

> Nowadays, that's not the limiting factor. There's more power in the computers than anyone knows how to make use of. And the limiting factor is what sounds and what timbres, and our understanding of what the human listener thinks is beautiful in music. And this, to me, points the road to a very interesting future, and this is not the development of more technology. This is the understanding of the human mind and the human ear, and the kinds of sounds and timbres and rhythms and sequences that light up the pleasure center in the human mind. And there's no question what is lit up.

> We've known that for centuries. But now we must know more about what new things can we put into the ear and make sounds out of that that will be music that is both exciting and, I think, necessary, because human beings really want music.

Mathews went on to create major programs for orchestral performances, the GROOVE system (Generated Real-time Output Operations on Voltage-controlled Equipment), and a system for conducting using two batons where a "conductor" is able to control three variables with each arm. In the online version of the Computer History Museum Revolution Exhibit, Max gives a fine demonstration of the batons for controlling an orchestral piece in much the same fashion as a conductor.[3]

From 1974 to 1980, Mathews was scientific adviser to the Institut de Recherche et Coordination Acoustique/Musique (IRCAM) in Paris, a center founded by composer/conductor Pierre Boulez and devoted to research into the science of music, sound, and avant-garde electro-acoustical music. John Pierce also served on the technical advisory board. I was privileged to be in their presence and served several years as an adviser, particularly with regard to the design of several IRCAM synthesizers.

Mathews served as director of the Acoustical and Behavioral Research Center at Bell Laboratories from 1962 to 1985. He continued his research as a professor of music at the Center for Computer Research in Music and Acoustics (CCRMA) at Stanford University. At CCRMA, various collaborators included John Pierce and CCRMA founder John M. Chowning, who acknowledged: "Mathews gave us a whole new way to imagine and create music. He has had an enormous effect on how music has evolved in the past 50 years."

Mathews was a member of the National Academy of Sciences (1975) and the National Academy of Engineering (1979). He was also a fellow of the American Academy of Arts and Sciences, the Acoustical Society of America, the Institute of Electrical and Electronics Engineers, and the Audio Engineering Society. He held a Silver Medal in Musical Acoustics from the Acoustical

Society of America and the Chevalier dans L'Ordre des Arts et Lettres, from the Republique Francaise.

Max Mathews lived in San Francisco. He is survived by his wife, Marjorie; three sons, Vernon (of San Francisco), Guy (of Palo Alto), and Boyd (of Berkeley Heights, New Jersey); and six grandchildren.

Marjorie, his wife, remembers:

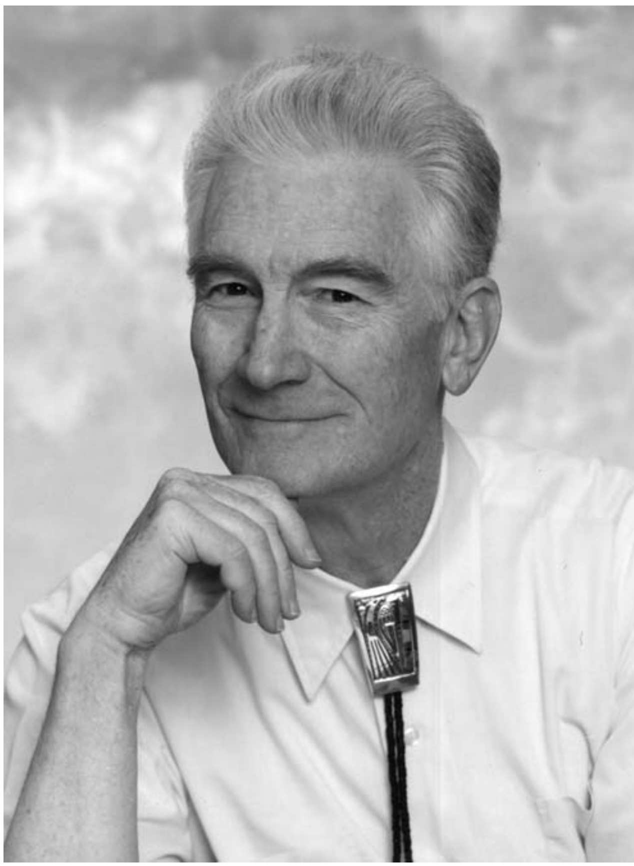
> Both our families had enjoyed camping and Max and I continued that tradition, making a number of trips around the U.S. and in Europe with our children. We were also fond of boating, working up through a series of small boats to our 30-foot ketch *Nimble* on which we made many trips on the East Coast anywhere from Norfolk to Nova Scotia. We rented sailboats in the Aegean and in the Caribbean. Max did the navigation when we sailed with John Chowning on his boat from San Francisco to Hawaii. We managed several trips with our friend Derek Scovil, sailing in Puget Sound and the Gulf Islands of Western Canada.
>
> Max hadn't done any skiing in Nebraska, but when we married he took it up to humor me, and we had many fine ski vacations with our children in New England, Eastern Canada, Austria, Switzerland, and the Sierras of California.

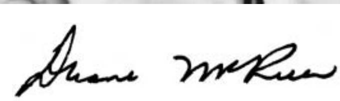
Notes

1 Computer History Museum, *Max Mathews Oral History* (Mountain View, California).

2 M. Mathews, 1961, Daisy Bell: Computer generated "A Bicycle Built for Two," Accompanied by Synthetic Speech. Available at: http://www.youtube.com/watch?v=41U78QP8nBk.

3 M. Mathews, 2011, *Max Mathews Using Two Batons Providing Six Degrees of Control to Conduct an Orchestra*. Available at: www.computerhistory.org/revolution/computer-graphics-music-and-art/15/221/2304.





DUANE T. MCRUER

1925–2007

Elected in 1988

"For pioneering application of guidance and control theory and to experimental man-machine interactions."

BY ARTHUR E. BRYSON AND JASON SPEYER

DUANE T. MCRUER, a guiding force in the development of modern aircraft flight control technology and founder and former president of Systems Technology, Inc. (STI), died on January 24, 2007, at his home in Manhattan Beach, California.

"Mac," as he was affectionately called, was born in Bakersfield, and received his B.S. degree in mechanical engineering in 1945 from the California Institute of Technology (Caltech). He then joined the U.S. Navy and quickly rose to Lieutenant (j.g.) in charge of the CIC and Fighter Direction School on San Clemente Island, where he also worked on antisubmarine techniques. Upon discharge from the Navy he returned to Caltech and received an M.S. degree in electrical engineering in 1948. From 1948 to 1954 he worked for Northrop Aircraft, Inc., where he became the technical chief of flight control. There, he pioneered new techniques for controlling high-speed aircraft, where in particular he made aircraft stability augmented hydraulic and fly-by-wire controls practical. Simultaneously, he took night courses at the University of California, Los Angeles (UCLA) in aeronautics, controls, mathematics, psychology, and neural physiology. He was the first to apply theories, well understood in academia, to aircraft flight control and stability augmentation systems. He developed the automatic "sideslip stability augmenter," for which he holds four patents. These stability augmenters reduced the uncomfortable swaying motions that were present in early commercial aircraft, such as the "Dutch roll" present in the early Boeing 707, and were first applied to the F-89D. These innovations were the forerunners of current flight control systems.

From 1954 to 1957 he was president and chief engineer of Control Specialists, Inc. There he advanced the state of the art in systems as well as applied research in vehicle dynamics and aerodynamics. A particular accomplishment was the RYAN X-13, an experimental vertical takeoff and landing aircraft flown in the 1950s. The main objective of the project was to demonstrate the ability of a pure jet to vertically take off, hover, and transition to horizontal forward flight and then vertically land. An unusually advanced stability augmentation system was developed to address the lateral phugoid mode.

In 1957, with his wife Betty and Irving Ashkenas, Mac started Systems Technology, Inc. (STI) where he was president and technical director until he retired in 1993 and was chairman of the board until his death in 2007. STI grew from a small engineering consulting company into a prime contractor to the U.S. government and a consultant to industry recognized internationally. Some of Mac's accomplishments during his tenure at STI are advanced flight control design and analysis techniques; man-machine systems and human operator dynamics; McRuer's crossover law; vehicle handling qualities; pilot-induced oscillations (PIO); comprehension, analysis, and prevention; ground vehicle dynamics and driver control; manual control display system design; neuromuscular system dynamics; and impaired operator behavior.

Mac was a principal contributor to the theory of human operator control of vehicles and the mathematical modeling of man-machine systems. He pioneered the fundamental principle known as McRuer's Law, according to which for compensatory tracking, the pilot will act on the controlled element in such a way that the magnitude of the open-loop transfer function, the pilot transfer function times the plant transfer function, will be approximately an integrator around the region of the crossover frequency, whose experimental gain is the crossover frequency. Mac performed pioneering work on the phenomena of PIO in which a pilot's efforts to control an aircraft can make the overall man-machine system unstable. Many aircraft have encountered PIO in their development and operations. As a final example of the innovative atmosphere of STI, a flying model of a pterodactyl was created in cooperation with Paul MacCready, president of AeroVironment, and paleontologists, in which great pains were taken to anatomically reproduce the original flying qualities of this flying reptile, that is, the head produced directional stability. A movie was generated for the Smithsonian Institution in which the pterodactyl was dramatically brought back to life.

These ideas were disseminated by Mac to a generation of engineers in a series of 10 books; the most popular were *Analysis of Nonlinear Control Systems* (Wiley, 1961), *Aircraft Dynamics and Control* (Princeton University Press, 1973), and *Mathematical Models of Human Pilot Behavior* (North Atlantic Treaty Organization, Advisory Group for Aerospace Research and Development, 1974). He was an adviser to the government serving on committees of the U.S. Department of Defense, Department of the Air Force, and National Aeronautics and Space Administration (NASA) Advisory Council and on the Space Shuttle Flight Readiness Review Board. He also served on many National Research Council committees, including chairing the following: Aeronautics and Space Engineering Board (1990–1994); Space Station Engineering Design Issues (1988–1989); Aeronautical Technologies (1990–1992); and Effects of Aircraft-Pilot Coupling on Flight Safety (1995–1997).

JoAnn Clayton Townsend, director of the Aeronautics and Space Policy Board (1990–1997), remembers that in addition to his technical genius and accomplishments, Duane McRuer was an informed and effective aerospace policy expert. He became an advocate of government investment in basic research, that is, long-term research of a type not likely to be undertaken by industry. He was an active participant and leader in many studies that defined and recommended government spending priorities.

Mac began his service on the National Research Council's Aeronautics and Space Engineering Board (ASEB) in 1997 with participation in a decadal study recommending priorities in advanced space technology, and from 1990 to 1995 he led studies that advised NASA, Congress, and federal agencies regarding directions for national investments in technology. He was persuasive in briefing the content of ASEB studies to members of Congress, NASA, the Federal Aviation Administration, and the U.S. Department of Defense.

Mac was especially interested in guidance, navigation and control systems, and the interfaces between humans and aeronautics and space vehicles. He chaired the ASEB 1995–1997 seminal study on the effects of aircraft-pilot coupling and flight safety as well as the earlier Panel on Information Sciences and Human Factors. He also led ASEB's Workshop on Space Station Engineering Design Issues and follow-on space station studies. These included peer-reviewed letters to the NASA administrator regarding the use of a space station as an engineering research facility and various program evaluations. During these years, he volunteered a great deal of his time and energy to providing the best technical information available to Congress and relevant government agencies for policymakers to apply to their decision-making processes.

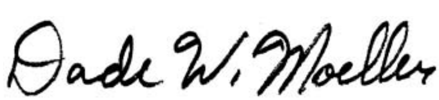
He was a fellow of the Institute of Electrical and Electronics Engineers and the Society of Automotive Engineers. He was an honorary fellow of the American Institute of Aeronautics and Astronautics. He was proud to be named one of Caltech's Distinguished Alumni in 1983.

Mac received many awards, including the Louis E. Levy Gold Medal of the Franklin Institute in 1960. The AIAA presented him with the Mechanics and Control of Flight Award in 1970 and the Aerospace Guidance Navigation and Control Award in 2004. He was a recipient of the NASA Distinguished Public Service Medal in 1991.

A man of wide interests, Mac climbed Half Dome at Yosemite National Park when he was only 12. He joined the Sierra Club in 1963 and became an enthusiastic mountaineer as well as an outstanding leader of the Sierra Peaks Section of the Angeles chapter and served as its chair in 1976. He had an obsession with "lists." He finished climbing all three lists of the Angeles Chapter including Sierra Peaks, Desert Peaks, and Hundred Peaks sections. In addition to receiving all the awards available from the Angeles Chapter, in 1997 he was given the Sierra Club's Oliver Kehrlein Award. This was the Sierra Club's top honor for outings leadership. Mac's love of the mountains and finishing lists involved climbing more than 1,500 mountains in California, Nevada, and Arizona as well as all the high points in every state in the United States except Alaska. His great contribution to the Sierra Club was the development of hundreds of other leaders. His skills as an organizer in the outings program are legendary.

In addition to aeronautics, he knew a lot about European/ U.S. history and geology. He enjoyed sharing his knowledge with his fellow climbers around evening campfires and on the trail.

He was a mentor both at work and on the trail, having an encouraging word for everybody and showing an interest in what they were doing. Mac was a great engineer/entrepreneur and a kind, generous friend.



DADE W. MOELLER

1927–2011

Elected in 1978

"For leadership in education and research and services to governmental agencies in the control of radiation in the environment."

BY MATTHEW P. MOELLER
SUBMITTED BY THE NAE HOME SECRETARY

DADE W. MOELLER, a pioneer in environmental engineering and radiation health physics, died on September 26, 2011, in New Bern, North Carolina, at the age of 84.

Dade was born in Grant, Florida, a small town on the intercoastal waterway, on February 27, 1927. Soon thereafter his family moved to the town of Malabar, population 200. As a young boy, Dade participated in the family's primary activity of raising Leghorn hens on their 20-acre poultry and animal farm and selling eggs to local restaurants. The Moeller family was well known for their hard work and ethical business dealings, as well as for their charitable interactions with neighbors, despite their own humble circumstances.

A curious and dedicated student, Dade was the only person in his high school who passed the exam for the V-12 Navy College Training Program. After seeing a doctor for the first time in his life at the age of 17, he entered the U.S. Navy in 1944 during World War II. He took courses at the University of South Carolina and, because he liked math and had enjoyed building chicken houses with his dad, decided to become an engineer. He was told that the best engineering school in the south was the Georgia Institute of Technology and that, if he requested a transfer to Howard College in Birmingham, Alabama, he would thereafter be transferred to Georgia

Tech. So Dade spent a year at Howard College, a seminary school, and then transferred to Georgia Tech as planned. He graduated magna cum laude from the Georgia Institute of Technology with a B.Sc. in civil engineering and an M.Sc. in sanitary (environmental) engineering in 1948.

It was while at Georgia Tech that he met his lifelong inspiration and intellectual equal, Betty Jean Radford, whom he married on October 7, 1949, in Atlanta. She had majored in biology and was the director of laboratory classes at Agnes Scott College in Decatur, Georgia. During their first date (Dade's first ever), after admitting he was struggling with his parasitology coursework, Betty Jean gave him an hour-long tutorial on the subject over dinner. "She was beyond any doubt the smartest human I ever knew," Dade told a reporter in the months prior to his death.

In 1948, Dade then began his 18-year career as a commissioned officer in the U.S. Public Health Service. His early duty stations included the Oak Ridge, Tennessee, and Los Alamos, New Mexico, installations of the U.S. Atomic Energy Commission and the headquarters office of the Radiological Health Program in Washington, D.C. His principal responsibilities were related to the health impacts of nuclear reactor cooling water systems and the safe management of radioactive wastes. While stationed in New Mexico, Dade became a registered professional engineer, and, in 1957, under U.S. Public Health Service sponsorship, he earned his Ph.D. in nuclear engineering at North Carolina State University. In 1958 he became a certified health physicist and in 1959 a certified environmental engineer. His later assignments with the U.S. Public Health Service included serving as director of the Radiological Health Training Program at the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio (1957–1961) and, at the age of 34, director of the Northeastern Radiological Health Laboratory in Winchester, Massachusetts (1961–1966), where workers studied radioactive fallout from weapons testing and conducted thyroid monitoring of children for radioactive iodine uptake.

After retiring from the U.S. Public Health Service in 1966, Dade was appointed to the faculty of the Harvard University School of Public Health as an associate professor, soon thereafter becoming a full professor. During his tenure at Harvard from 1966 to 1993, Dade served with the highest distinction in several positions, including associate director of the Kresge Center for Environmental Health (1966–1983), professor of engineering in environmental health (1968–1993), chairman of the Department of Environmental Health Sciences (1968–1983), and associate dean for continuing education (1984–1993). His activities at Harvard included research on natural background radiation, nuclear air cleaning systems, environmental radiation surveillance, and planning for nuclear emergencies. His primary teaching responsibilities were related to radiation protection and general environmental health. Referring to his appointment to Harvard as "a calling," Dade loved teaching and was equally admired by his students, who awarded him Harvard's "Golden Apple" award for teaching excellence in 1974. One of his students recalls being in Dade's office in 1979 when he received a telephone call from then President-elect Reagan's transition team, trying to entice Dade with one of a number of high-level posts in the federal government. "Gee, thanks," replied Dade, "I'm very honored, but I really prefer being a college professor at Harvard."

Dade was appointed to several national technical committees, including the National Academy of Sciences/ National Research Council Committee on the Biological Effects of Ionizing Radiation (1977–1980) and its Subcommittee on Environmental Effects (1970–1972). He also served on and chaired committees for the U.S. Nuclear Regulatory Commission, U.S. Environmental Protection Agency, National Council of Radiological Protection and Measurements, International Commission on Radiological Protection, and American Academy of Environmental Engineers. He was very active in the Health Physics Society, becoming the New England chapter's president in 1966 and the society's national president in 1971. Dade was chair of the American Board of

Health Physics for four years (1967–1970) and a consultant to the World Health Organization for 15 years. From 1988 to 1993 he was the founding chairman of the U.S. Nuclear Regulatory Commission's congressionally mandated Advisory Committee on Nuclear Waste.

After his retirement from Harvard, Dade knew that he wanted to continue to consult. Together with son Matt, a certified health physicist who had graduated from the Harvard School of Public Health, colleague Steve Merwin, and his wife Betty Jean, Dade helped found the environmental consulting firm that bears his name. Headquartered near the Hanford nuclear site in Richland, Washington, Dade Moeller & Associates (today known simply as "Dade Moeller") provides professional and technical services to federal, state, and commercial clients in support of environmental, nuclear, radiological, and worker safety operations. Since its start in 1994, the company has grown from 4 to nearly 300 employees and has more certified health physicists than any other company in the United States.

Dade was elected to membership in the National Academy of Engineering in 1978, the same year as Neil Armstrong. He loved telling the story of how he shared an elevator with the astronaut on their way to the induction ceremony in Washington, D.C. Noting that Mr. Armstrong was well known for rarely giving autographs, Dade was touched to later receive an autographed picture of the legendary astronaut.

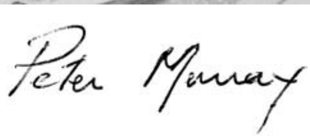
Throughout his life, Dade earned numerous other honors and awards, including the Health Physics Society Distinguished Achievement Award (1982), the U.S. Nuclear Regulatory Commission Meritorious Achievement Award (1988), being named Distinguished Emeritus Member of the National Council on Radiological Protection and Measurements (1997), induction into the Georgia Institute of Technology Engineering Hall of Fame (1999), the Health Physics Society Robley D. Evans Commemorative Medal (2003), the American Academy of Health Physics William McAdams Outstanding Service Award (2005), and the Harvard University School of Public Health Professor Emeritus Award of Merit (2006).

He was a fellow of the Health Physics Society (1968), the American Public Health Association (1988), and the American Nuclear Society (1988). Dade served for over 30 years on the National Council on Radiation Protection and Measurements and became a distinguished emeritus member of the council.

Always thinking and contributing, Dade was a prolific writer who authored or coauthored 250 journal articles, 75 letters to the editor, and two patents for radon reduction units. His textbook, *Environmental Health* (Harvard University Press, 1992), for which Dade published a fourth edition in June 2011, is the Harvard University School of Public Health's preferred text for its course on the topic.

Despite his lifetime of achievements and accolades, Dade was a genuinely humble "country gentleman." He was a monumental leader in every sense of the word, a skilled mentor to so many of us, and an inspiration to the thousands of students, employees, and colleagues who knew him. He was one of those rarefied gentle giants in our profession with a work ethic and moral compass for all of us to emulate.

Dade leaves 5 children and 16 grandchildren and a legacy of intellect, kindness, and humor. He was preceded in death by his beloved wife Betty Jean, a most extraordinary woman in her own right. We will miss him sorely, yet we celebrate his accomplishments and are so thankful for the riches he bestowed on us.



PETER MURRAY

1920–2009

Elected in 1976

"For contributions to the understanding and engineering application of materials in high-flux radiation and high-temperature corrosion environments."

BY HOWARD J. BRUSCHI, B. DON RUSSELL, JR., AND JOHN J. TAYLOR

PETER MURRAY has been recognized internationally for his contributions to the development of nuclear energy for the production of electricity and for the recycling of nuclear fuel with the potential to increase dramatically nuclear fuel resources for the centuries ahead. His career was devoted to high-temperature materials and nuclear fuel research and the design and engineering of uranium dioxide fuel used in today's worldwide fleet of nuclear electricity-generating plants as well as in advanced reactors being developed for nuclear fuel recycling. Dr. Murray died on July 26, 2009, at the age of 89.

Born in Rotherham, Yorkshire, England, on March 13, 1920, Peter Murray was an outstanding product of the British education establishment, gaining a B.Sc. with honors in chemistry and a Ph.D. in metallurgy and ceramics from Sheffield University in 1950. From 1949 to 1967, he was employed by the U.K. Atomic Energy Research Establishment (AERE), in Harwell, starting as a metallurgist, and was appointed head of the metallurgy division in 1960 and assistant director in 1964. Peter worked extensively on the effects of radiation and reactor coolants on materials, including metal, oxide, and carbide fuels. He became heavily involved with both thermal and fast reactor development programs, including the reactors in Dounreay, Scotland. He participated in many trips and discussions on nuclear energy and nuclear fuel, including trips to facilities in the United States. He was one of the first foreign nationals to tour American facilities and participated with American scientists on nuclear fuel and nuclear power. He was part of the U.K. team that visited Soviet nuclear facilities in the early 1960s (he subsequently participated in a U.S. visit to Soviet facilities about a decade later). He also hosted overseas visitors to the U.K. facilities; one such visit involved then U.S. Navy Captain Hyman Rickover, who was very impressed with the work being done on ceramic uranium dioxide as a nuclear fuel. (Rickover subsequently investigated these ceramic fuels further for naval propulsion reactors.)

During this time Dr. Murray engaged vigorously in the activities of his professional associations. He was president of the British Ceramic Society in 1965. He received the Holland Memorial Prize in Research from Sheffield University in 1949 and the Newton Chambers Prize of the Royal Institute of Chemistry in 1954. He was the Mellor Memorial Lecturer of the Institute of Ceramics in 1963. He was also a member of the powder and metallurgy and nuclear energy committees of the Institute of Metals and a fellow of the Royal Institute of Chemistry and the Institute of Ceramics.

By the mid-1960s the United States was building more nuclear power plants for electricity production than any other country. The U.S. industry was short on skilled manpower, so intense recruitment was pursued overseas. Peter was one of the prime rewards from that recruitment. His recruitment caused an uproar in the United Kingdom, where the media protested the "American brain drain" even more loudly when he left the AERE in 1967 and joined the Westinghouse Advanced Reactor Division (ARD) in Pittsburgh, Pennsylvania. There he played a leading technical and management role in ceramic fuel development for the pressurized water-cooled reactors that were the prime commercial offerings by Westinghouse as well as for advanced sodium-cooled reactors in the fuel recycling mode.

ARD's highest-priority research and development effort was the sodium-cooled fast breeder reactor, the most promising system that could recycle used nuclear fuel to produce plutonium to fuel additional reactors. The term "breeder" denoted the capability of the system to produce more fuel than it used to produce power. Westinghouse was awarded a contract by the U.S. Department of Energy (DOE) to design, build, and operate a major sodium-cooled test reactor, the Fast Flux Test Facility (FFTF) in Hanford, Washington, to demonstrate the reactor performance and fuel capability of a breeder system. The FFTF was completed and operated successfully, placing Westinghouse in the technical lead in fast breeder technology in the United States. The reliability and high-burnup capability of the fuel were also successfully demonstrated. Dr. Murray was a key technical contributor to this effort. He was instrumental in the development of the reference fuel pin design for the FFTF, which was utilized in the subsequent breeder demonstration plant. He also contributed to development of the fuel's heavily cold-worked stainless steel cladding to control radiation-induced swelling. He played a key role in the development of major test facilities and programs investigating corrosion transport phenomena in liquid metal systems.

As confidence rose that the FFTF program would be successful, DOE issued a competitive request for proposals to build a demonstration breeder plant. With the substantial help of Dr. Murray, Westinghouse won that contract. The 350-MWe plant, called the Clinch River Breeder Reactor, was designed and licensed, and construction preparation started in Clinch River, Tennessee.

A related Westinghouse business objective to which Peter contributed substantially was the commercial fabrication of mixed plutonium (IV) oxide–uranium dioxide fuels, based on the FFTF fuel design, which would fuel future breeder reactors as well as water-cooled reactors. A demonstration fabrication facility was built at the ARD, and plans were laid to build a commercial fabrication plant in the southeastern United States. As Westinghouse's market expanded in Europe, in 1975 Peter was assigned for a year as director of research for Westinghouse Electric Europe in Brussels. He enlarged the research and development effort there, benefiting further from available skilled European researchers, and then returned to the ARD in Pittsburgh as chief scientist.

In the late 1970s DOE curtailed its sodium-cooled reactor program because of a greatly reduced need for expanded nuclear fuel reserves and concerns about the proliferation resistance of recycled fuel systems. The Clinch River Project was canceled. Operation of the FFTF continued until 1992 and, though very successful, its mission was not expanded to cover other attributes of sodium-cooled fast reactors. Westinghouse's plan for commercial mixed-oxide fuel fabrication also was discontinued. Westinghouse realized the need for a greater technical presence with the federal government on nuclear power matters, so Peter was asked to fulfill this role and was appointed director of the nuclear programs of the Government Affairs Office of Westinghouse in Washington, D.C., in 1981. He was the principal Westinghouse architect of the strategy to revitalize nuclear energy through an innovative reactor design and to secure support from DOE, U.S. utilities, and the Electric Power Research Institute (EPRI).

Peter was instrumental in shaping the strategy for a revolutionary reactor technology that Westinghouse was developing in 1985. This technology was to be a new design that would depend only on natural forces to safeguard a nuclear power plant from an accident, even though an accident was quite unlikely. This would mean that the plant's design would not employ safety-grade pumps, motors, valves, and diesel generators. Instead, the new design would depend on gravity, evaporation, condensation, and natural circulation to safeguard the plant. This design was dubbed the Advanced Passive 600 (AP600), capable of delivering in excess of 600 megawatts of electrical power, safeguarded by passive safety systems that used natural forces. If successful, this new plant design would result in substantial simplification of systems and components and a concomitant reduction in building sizes—thus resulting in superior safety and economics.

To develop such a design was a large undertaking. In 1988 the DOE, U.S. utilities, and EPRI were engaged in discussions with suppliers, such as Westinghouse and General Electric, to develop nuclear plant designs that were safer and more economical than the already-safe plants in operation at that time. Peter worked tirelessly and effectively with the DOE and EPRI to formulate two major programs—the Advanced Light Water Reactor Design Certification Program and the First of a Kind Engineering Program. The objective of the first program—design certification—was to develop the safety details of a nuclear design and obtain approval from the U.S. Nuclear Regulatory Commission. The DOE established a cost-share program wherein Westinghouse's AP600 was one of four designs selected in 1990. Peter's role in this success, along with several other major accomplishments, earned him the Order of Merit, the highest award of the Westinghouse Electric Corporation. As work on the design certification program progressed from 1990 to 1994, it become evident that the AP600 had the potential to be a key element in a nuclear energy renaissance, not only in the United States but around the world as well.

Nevertheless, there remained much work to be done on the nonsafety aspects of the plant—an expensive undertaking for any given organization. Peter devised a second program—First of a Kind Engineering—in collaboration with DOE and EPRI. This time the competition was more intense. Only the four designs involved with design certification would be considered, and the amount of funding to be distributed would be based on voting from the American nuclear utilities involved. Peter's strategy, counseling, and persuasiveness resulted in a compelling affirmation of the AP600 passive design. Only two of the four competing designs were selected by the utilities, and of the two winners the AP600 garnered 74 percent of the votes for funding. Peter was also instrumental in the development of the related AP1000 reactor design, which offered the same passive safety approach of the AP600 but with a higher power output.

Russell Smith of Willkie Farr & Gallagher, LLP, remembers that working with Peter Murray to obtain government support for research, development, and licensing of the Westinghouse

AP600 reactor remains one of the highlights of his experience as a lobbyist and government relations counselor. Peter brought to this undertaking a commitment to both nuclear power and the AP600 design, a depth of knowledge that no one (supporter or opponent) could equal, and a unique ability to communicate that knowledge to anyone from a senior senator to the "greenest" congressional staff member. Of course, Peter's charm and his wonderful accent were the icing on the cake. Once he began talking, we were usually well on our way to winning a vote!

He added: "So few of our clients become friends. I looked forward to every encounter with Peter, and I can't think of anyone with whom I have enjoyed 'walking the halls' of Congress more than Peter. It is satisfying to know that he had a long, eventful, and valuable career and life, and to think fondly of picking up the phone and hearing him talking about activity at the Energy Department facility in 'Mary-land' and exclaiming 'Hello, what's this?' when learning of a new development. He was one of a kind." Peter continued in that role as well as remaining as a consultant on nuclear programs to Westinghouse after his retirement until his death.

Dr. Murray authored 80 scientific and technical papers published in professional journals and had several patents. In addition to his election to the National Academy of Engineering in 1976 and much recognition in the United Kingdom, he was elected to membership in the Institute of Ceramics, the American Nuclear Society, and the American Ceramic Society. He also acted in advisory capacities to the DOE, including as a U.S. delegate to the U.S./Japan Ceramic Fuel Exchange Meeting, as a member of U.S. reactor teams to Europe in 1969 and the USSR in 1970, and as a member of Argonne National Laboratory review committees for metallurgy.

He was broadly recognized professionally in the United States for his technical achievements: the Outstanding Achievement Award from the American Nuclear Society, Materials Science and Technology Division in 1983 "for pioneering work on the development of oxide fuels for thermal and fast reactors"; the Order of Merit Award from

Westinghouse Electric Corporation in 1983 "for his outstanding accomplishments in the field of nuclear science and technology"; fellow of the American Nuclear Society in 1986 "in recognition of his pioneering achievements in developing metals and ceramics for application to nuclear power generation and for fostering an international development of safe, reliable reactor system performance through managerial and technical leadership"; and the Walker Lee Cisler Medal of the American Nuclear Society in 2004 in recognition of his leadership in the development of fast breeder reactor technology.

In the English tradition, Dr. Murray was a Renaissance man, not just an outstanding scientist devoted only to nuclear science and engineering. In his spare time he enjoyed reading the poetry of William Shakespeare and Robert Burns. He was known for his ability to recite long passages from *King Lear* and *Hamlet* on the spot. He had a positive and optimistic attitude that showed up especially at moments of general discouragement when tests and experiments produced unexpected results. He was an undaunted promoter of nuclear energy because of his conviction that it was an essential contributor to the world's energy future. He always introduced safety into discussions about performance and economics. He always respected people and treated them well.

H. Vaughn Gilbert remembers that upon discovering that Gilbert was an amateur Churchill scholar, Peter told him this story. In the early 1950s, when Churchill was in his second stint as prime minister, he visited a confidential site that was being used to develop civilian nuclear power. Peter was assigned as one of the technical hosts who was to answer any questions the prime minister might have.

Churchill, looking through thick glass at a uranium pellet of some sort that was on display for the VIP visitor, asked Peter what would happen if one touched it. Peter responded that it would probably kill you but not for 30 or 40 years. Churchill then quipped: "Given that I am now well into my 70s, call me if it falls off and needs to be repositioned on the display case."

Peter married Josie Glaisher in 1947 and was a devoted husband until her death in 2007. He remained active in retirement—as a consultant, as a husband, and as a caregiver to Josie when she became ill—and as a father, grandfather, and great-grandfather. He volunteered at a nursing home, helping residents often 10 to 20 years his junior. He actually broke his hip while volunteering and, with his indomitable spirit and family love, recovered and went back to living at home. He remained mentally and physically active until pneumonia took him away. He was a loving father and family man and is survived by his three children—Jane Weston (of East Amherst, New York), Paul Murray (of Key West, Florida), and Alexander Murray (of Gaithersburg, Maryland); four grandchildren—Robert Weston, Jamie Weston, Peter Murray, and Krista Murray; a great-granddaughter, Julia Jane Weston; and a great-grandson, Peter Alan Gerard Weston. The family has many fond memories of Peter, including the many visits of American scientists to his home in England, playing with the children and the pets, and chatting with anybody on anything and everything. He is missed both professionally and personally.

WESLEY L. NYBORG

1917–2011

Elected in 1996

"For the applications of acoustic physical theory to the safety of medical ultrasound."

BY HAROLD M. FROST III
SUBMITTED BY THE NAE HOME SECRETARY

WESLEY L. NYBORG, professor emeritus in the Department of Physics at the University of Vermont (UVM), in Burlington, died on September 24, 2011, at the age of 94. Born May 15, 1917, in Ruthven, Iowa, he was the last of six children born to Isaac Nyborg and Leva Larson. In his childhood he lived on a farm before rural electrification was widely available and was taught in a one-room schoolhouse. Early social life included family sing-alongs at the piano. With humble beginnings, he had a rare chance to attend Luther College in Decorah, Iowa, which was founded by Norwegian immigrants. There he earned a B.A. in physics and mathematics in 1941. In 1945 he married Beth, his wife of 44 years until her death in 1989.

As a graduate student during and shortly after World War II, Wes earned an M.S. in 1944 and a Ph.D. in 1947 in physics from the Pennsylvania State University. His physics dissertation was titled "High Frequency Whistles: Edge Tones and Resonance," with adviser Harold K. Schilling, consummate teacher and researcher and a future dean of the Graduate College at Penn State. He helped Wes form his own style of teaching and research, including striking a balance between the aims of science and religion. Wes's early research there had an application of ultrasonic signaling for the U.S. Army Signal Corps. Soon, though, he turned to liquids. What resulted was a lifelong career of research on the physical acoustics of ultrasound in condensed matter, mostly liquids and liquid-like media such as emulsions and soft solids, with special interests in ultrasound bioeffects and analytical assessments of the risk versus safety of medical ultrasound.

From 1947 to 1950, Wes was an instructor and assistant professor of physics at Penn State. Then he was assistant and associate professor of physics at Brown University (1950–1960), brought there by R. Bruce Lindsey, then chair of the Department of Physics. After a stint as a visiting scientist at Oxford University in 1960 to work with A. Rogers and D. E. Hughes, Wes arrived that year as a professor of physics at UVM. On sabbatical in 1969 he returned to the United Kingdom as a visiting scientist in the Department of Microbiology, University College, Cardiff, Wales, to collaborate with W. T. Coakley, D. E. Hughes, and A. R. Williams. In 1984, Wes was UVM University Scholar in the physical sciences. The next year he received the American Institute of Ultrasound in Medicine's Joseph H. Homes Pioneer Award, named after a developer of early B-mode ultrasound imaging and contact scanning. In 1986, Wes retired from UVM as professor emeritus.

To Wes, people were very important, not only functionally as students or colleagues in science, technology, engineering, and mathematics (STEM) education and research but also as individuals with needs and aspirations. The lists provided here only sample those he worked with. Postdocs, scientists, and faculty members visiting UVM included E. E. Fill (Austria), Robert K. Gould (Middlebury College, deceased), S. Hawkins (U.K.), E. A. Neppiras (U.K., deceased), T. K. Saksena, A. R. Williams (U.K.), and Marvin C. Ziskin (Temple University School of Medicine). Fellow UVM faculty members Wes interacted with included N. R. Alpert, J. A. Crowell (deceased), Alex Gershoy (deceased), Wm. Halpern, J. E. Krizan, B. K. Kusserow, F. J. Wiercinski, W. L. Wilson, and Junru Wu.

His students were many. Those coauthoring papers with Wes in his favorite *Journal of the Acoustical Society of America* included Douglas L. Miller (now at the University of Michigan), Richard E. Packard (now at the University of

California, Berkeley), James A. Rooney (University of Maine, Orono; then Jet Propulsion Laboratory; now deceased), William E. Rowe (IBM), R. M. Schnitzler, and R. Bruce Steele (deceased). Other thesis students at UVM who shared Wes's interest in research on the action of ultrasound on liquids or liquid-like media were Brian B. Brennan, Colin C. Connolly (of England), and Donald Storm. In retirement Wes continued to do scientific research, with J. S. Abramowicz, A. J. Bramer, A. A. Brayman, E. L. Carstensen, S. Z. Child, W. C. Dewey, Floyd Dunn, M. J. Edwards, M. W. Miller, S. Norton, O. Rudenko, A. P. Sarvazyan, G. R. ter Haar, G. Whitworth, and Junru Wu, among others.

After retirement, Wes's star in the engineering world rose even higher, with a Silver Medal in 1990 from the Acoustical Society of America (ASA) in the "Interdisciplinary" category for contributing to "Physical Acoustics and Bioresponse to Vibration." That year he also received the W. J. Fry Memorial Lecturer Award from the American Institute of Ultrasound in Medicine (AIUM). In 1996, besides receiving the Distinguished Service Award from Luther College, his alma mater, he was elected to the National Academy of Engineering (NAE) for contributions to physical acoustics and ultrasound bioeffects. The following year he became a member of the Vermont Academy of Science and Engineering, and in 2001 he received the Lauriston S. Taylor Lecture Award from the National Council on Radiation Protection and Measurements (NCRP), with a lecture titled "Assuring the Safety of Medical Diagnostic Ultrasound."

Wes was a fellow of the ASA, AIUM, and American Association for the Advancement of Science and a life member of the Institute of Electrical and Electronics Engineers. A special symposium of talks by colleagues and former students was held at UVM in October 2009 to celebrate Wes's 50 years on its faculty and to honor his path-breaking research.

How can one sum up the major accomplishments of Wesley L. Nyborg in the context of so many scientific and engineering collaborators with each of whom he valued a relationship? This can be done in three major categories: education, research, and leadership.

In *education*, Wes learned from role models H. K. Schilling and R. Bruce Lindsay that science has an underlying unity and serves society and its needs. That unity was bimodal, important, and interdisciplinary in which laboratory research and education in the classroom complemented each other. Not just students but even members of Congress require scientific knowledge for intelligent decision making. Wes passed this sense on to his own undergraduate and graduate students. As a UVM example, in 1968 Wes taught the course Biological Physics (Physics 122) from his own notes as used and then tested by students so that extensive revision occurred before his book based on these notes came out, *Intermediate Biophysical Mechanics* (Cummings Publishing Co., 1975). Lab experiments were integral to the required coursework, plus precise definitions of terms and rigorous logic in solving assigned problem sets. This method worked well with Wes's thesis students, too, whom he expected to achieve great clarity and precision in their writing.

In the *research* category, Wes was not afraid to explore the jungle of mathematics of nonlinear partial differential equations for motion in continuous fluid media. Vital was the Navier-Stokes equation, a version of Newton's second law of motion for continuous media and one of the grand mathematical challenges of the 20th century. Solutions to this master equation required the use of supporting equations for conservation of mass, momenta, and energy; Hooke's law; and laws for mass and heat diffusion and for thermodynamics. Wes applied perturbation expansions of field variables (i.e., for acoustic pressure, $p = p_0 + p_1 + p_2 +$ higher order) that generated many terms. So, Wes was a careful bookkeeper who developed accurate solutions to zero, first, second, and even higher orders, in a time before symbolic math programs ran on a personal computer. (Perhaps he was looking over his shoulder at his former colleagues at Brown—nonlinear acousticians Robert T. Beyer and Peter J. Westervelt!)

Thus, Wes was sure-footed in understanding troublesome concepts of radiation pressure, radiation force, and radiation torque arising in equations in his papers in peer-reviewed scientific and engineering journals that withstood the scrutiny of peers over the span of decades. To this writer's knowledge, Wes never published an inconsistent definition or an unsound theory in the process of interpreting the results of ultrasound experiments via models such as for cause-and-effect laws. His high standard of scholarship was matched by confidence as an applied mathematician, as evidenced by publishing early in his career at UVM (1965) a book chapter titled "Acoustic Streaming" in the renown series Physical Acoustics (Academic Press, 1964), edited then by Warren P. Mason of Bell Labs of whose own experimental methods Wes made skillful use.

These latter methods included applying so-called resonant Mason horns of solid metal machined into various profiles for achieving high acoustic pressure levels in media such as gassy liquids, single plant cells, and soft solids. Invented by Mason, these horns mechanically amplified ultrasonic motion at 20 to 100 kHz well enough to permit use of conventional transducers bonded to them as driven by off-the-shelf RF power supplies. Wes's research group integrated a novel capacitance bridge developed by E. E. Fill into the Mason horn system to enhance sensitivity of measured transducer currents to localized motion in sonicated media. These motions included resonant oscillations of ultrasonically cavitating microbubbles, plus the acoustic microstreaming they caused. The vibrating tip could also indent a single plant cell or a soft solid. Experiments with other localized ultrasound sources used vibrating wires and bubbles trapped at ends of capillary tubes or in pores of polymer films to yield high hydrodynamic shear rates in contiguous viscous media. Methods at megahertz frequencies included calibrated plane-wave, hollow-waveguide, and resonant-cavity sources to cause ultrasonic motion.

Wes was also a pioneer in the use of high-speed cinematography in biological physics studies, as during his year at Oxford, to view directly the complex localized motions arising from the effects of high-power ultrasonics on complex media, especially when cavitation was present. Wave interference methods with both laser and incoherent light sources, plus displacement transducer techniques, enabled measurement of motion directly. Sonoluminescence was recruited to further peer into the mysteries of ultrasonic cavitation.

However, Wes's level of *leadership* as a researcher and an educator eclipses the standards of his achievements in the educational and research categories per se. One begins to see this through the many book chapters he wrote, especially in retirement as professor emeritus at UVM. In these he made accessible to a large readership (1) the physical principles of ultrasound; (2) how it acts on biological media in laboratory settings and medical diagnosis, therapy, and surgery; and (3) what the implications of that action are for the public's benefit and safety versus harm and risk. In this regard, Wes's true identity as a soft-spoken but firmly moral exemplar to the medical ultrasound bioeffects research community begins to emerge, in the best traditions of "engineers and scientists behaving well" under difficult circumstances. As argued below, his name can thus be added to that short list of such exemplars maintained at NAE's Online Ethics Center/Center for Engineering, Ethics, and Society (OEC/CEES).

Wes behaved very well to chair over a two-decade period the three definitive reports that his Scientific Committee 66 prepared for the NCRP as chartered by the U.S. Congress in 1964: (1) No. 74 (1983), *Biological Effects of Ultrasound: Mechanisms and Clinical Implications*; (2) No. 113 (1992), *Exposure Criteria for Medical Diagnostic Ultrasound: I. Criteria Based on Thermal Mechanisms*; and (3) No. 140 (2002), *Exposure Criteria for Medical Diagnostic Ultrasound: II. Criteria Based on All Known Mechanisms* (including nonthermal and cavitation).

The scale of Wes's achievements can be inferred from the list of members who served on this committee: P. L. Carson, E. L. Carstensen, F. Dunn, D. L. Miller, M.W. Miller, H. E. Thompson, and M. C. Ziskin. Advisers and consultants included R. E. Apfel (deceased), C. C. Church, L. A. Crum, and M. Edwards. An array of specialties, perspectives, and interests gathered year after year at a conference table in midtown Bethesda, Maryland, at which conflicts were resolved and consensus was reached on technically daunting topics. To hold such an effort together for over two decades required good working relationships and mutual respect for opposing viewpoints.

Moral as well as intellectual leadership was crucial to achieving this, as provided by Wes's well-known laser-like focus when solving a problem, his tenacity while surmounting difficulties, and his inner drive to transform rigorous thinking into the right action to serve societal needs. Wes's gentle leadership style engendered loyalty from fellow committee members, advisers, and consultants. Among Wes's 11 associates just listed, 6 stayed with him as chair over this period. From this can be inferred the operation of effective infrastructure and protocols to keep these group efforts for radiation protection and measurement going for so long. This required a leader to hold everything together and on goal. That leader was Wes.

Digging even deeper, it can be seen that Wes has left a legacy not only of these three NCRP reports and all his publications and presentations preceding and supporting them, plus a fire-tested way of developing consensus under difficult conditions, but also an institutional infrastructure at the NCRP for accommodating what now-unknown future research discoveries will reveal in medical ultrasound bioeffects. For research results on the action of ultrasound on biological media is a potential two-edged sword cutting out new image contrast and other interaction mechanisms beneficial for practical and efficient use of ultrasound in medicine but also mechanisms yet to be discovered for ultrasonically producing permanent or delayed damage in biological tissue. Such discoveries will for the large part be made by the upcoming generation of scientists, engineers, and physicians, many of whom have not yet even entered the science, technology, engineering, and mathematics (STEM) educational standard pipeline.

It is mostly for the sake of these neophytes to come that Wes served so tirelessly as chair of NCRP Scientific Committee 66, a service to which he brought all his decades in academia and that consumed most of his intellectual energies over the entire periods of his retirement and NAE membership. This is because forthcoming research-driven discoveries of new knowledge will lead to new conundrums of whether it is safe to use ultrasound in medicine in given situations where there is a rational basis for concern. The horizon for these forthcoming concerns can be envisaged, for example, in the increasing use of contrast agents and higher ultrasound power and intensity levels in biomedical imaging.

Sadly, another NAE member working along the same lines as Wes—Harry E. Bovay, Jr.—died at age 96 in May 2011. A civil engineer who started his own company of consulting engineers in 1946, he came to support the best-possible uses of the engineering profession to benefit the general public through philanthropic activities over the last 20 years of his life. This philanthropy supported NAE's new Center for Engineering Ethics and Society (CEES), founded by former NAE President Bill Wulf. This giving brought the center to life, and and also provided support to keep the NAE's Online Ethics Center (OEC) in operation today.

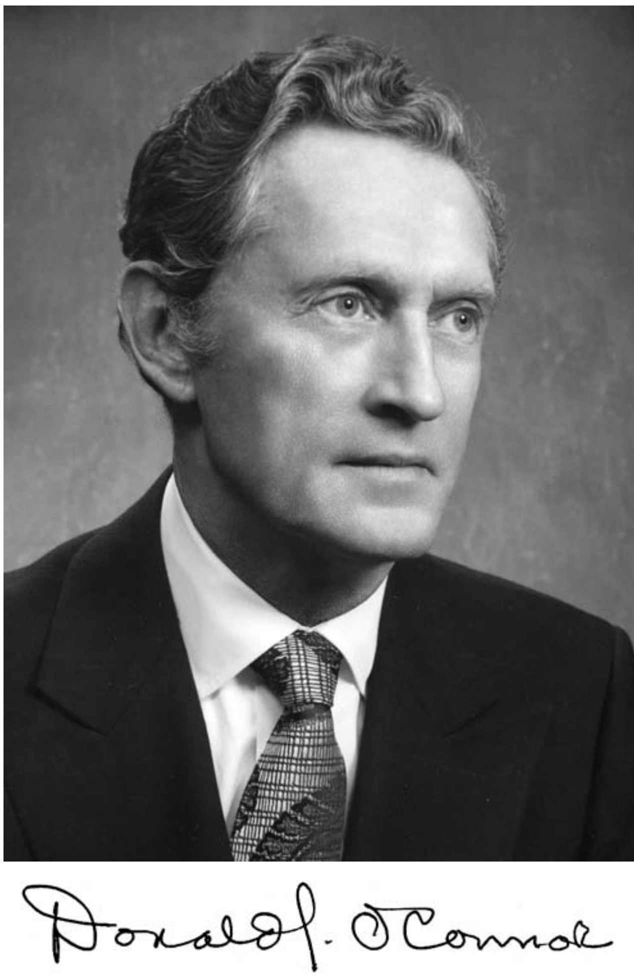
Thus, with this moral vision and mission embedded within the core of the NAE, it is easy to see the parallel between Wes Nyborg and Harry Bovay. As a businessman, Harry did for the NAE what Wes as an academician did for the NCRP—building bridges for the neophyte engineer or scientist. This is illustrated by the poem "The Bridge Builder," written by Will Allen Dromgoole about a century ago, a poem that Harry and his Dad valued. The last eight lines are quoted:

> The builder lifted his old gray head:
> "Good friend, in the path I have come," he said,
> "There followeth after me today,
> A youth, whose feet must pass this way.
> This chasm, that has been naught to me,
> To that fair-haired youth may a pitfall be.
> He, too, must cross in the twilight dim;
> Good friend, I am building this bridge for him."

Professionally speaking, then, in the area of the action and effects of one type of societally useful radiation on materials and people—ultrasound—Wes built a bridge between the wisdom of an older generation and the energy of a newer generation so that the latter, when its own day comes, can span its own gaps between ignorance and knowledge, conflict and consensus. In this sense, Wes will be sorely missed by all who knew him.

This conclusion also refers to the family he loved, of not only his cherished wife Beth and their daughter Elsa Mondou, and son-in-law Philip M. Mondou of Raleigh, North Carolina, but also their four children—Christine, Julie, Michael, and Martin. That is, it was very evident at the funeral service for Wes on October 1, 2011, at his longstanding place of worship—Community Lutheran Church in South Burlington, Vermont—that his family loved him immensely and was very aware of the high ethical standards of conduct that he put into practice in all his actions, whether public or private. Indeed, in his personal life Wes was a devoted husband, father, and grandfather who provided unconditional love and patient kindness. Underlying this was a gentle spirit of one who enjoyed gardening, singing, and playing the piano. For example, as a member of the church choir for years, he welcomed neighbors to his house for evenings of song and friendship.

A little-known aspect of Wes's giving that extended beyond his immediate family and social circle was his compassion for those engineers or scientists who suffered from short- or long-term disability. He lifted their spirits by helping them socially, intellectually, and even materially as they struggled to recover function and enter or return to mainstream life, at work or in their studies. Consistency in how Wes treated those he came to meet and know, whether they could give him something back or not, marked the single-minded strength of character of one at peace with himself. Though Wes was too modest to so recommend himself, he was indeed a role model for other engineers and scientists to emulate. In this sense of an exemplary vision of a higher moral order for practicing the engineering profession today, the legacy Wes Nyborg passed on to us will have its greatest impact.



DONALD J. O'CONNOR

1922–1997

Elected in 1978

"For leadership in the field of mathematical modeling to gauge the effects of pollution and abatement measures."

BY KEVIN J. FARLEY
SUBMITTED BY THE HOME SECRETARY

DONALD J. O'CONNOR, a distinguished professor at Manhattan College and a pioneer in the field of water quality modeling, died on April 18, 1997, at the age of 74.

Don was born in Brooklyn, New York, on November 7, 1922, the son of a scenic artist who painted sets for films, operas, and Broadway plays. His younger years with his mother, father, and younger brother Robert were happy times filled with laughter and early exposure to literature, philosophy, religion, and the arts. His early family influences initially led Don toward the liberal arts, with thoughts of following his father into a career as a scenic artist. The tough economic times of the 1930s, however, led Don to ultimately pursue a more practical career in engineering.

In 1940, Don accepted a partial scholarship to study civil engineering at Manhattan College. Although he had very little idea of what engineering involved, he was intrigued with its logic and its puzzle-solving nature. It was during his studies at Manhattan College that Don started to appreciate what he calls the beauty and the power of mathematics. In his junior year he was drawn to the civil engineering department's sanitary engineering option, where he studied under Professor Clarence J. Velz. It was Professor Velz who introduced Don to the Streeter-Phelps dissolved oxygen equation, which served as a focal point of Don's seminal work on water quality modeling over the next two decades.

After receiving his bachelor's degree in civil engineering from Manhattan College in 1944, Don served in the U.S. Army Medical Corps in Europe during the final years of World War II. He returned home in 1946 ready to continue his studies and pursue his career. He completed his master's degree in civil engineering at the Polytechnic Institute of Brooklyn in 1947 and accepted a job as a structural engineer with the design firm Parsons, Brinckerhoff, Hall and MacDonald. Away from the office, Don's fancy was soon captured by Anita Lordi, a dress buyer for a New York–based department store. They married in 1948 and soon after had three children—Dennis, Arlene, and Jeanette.

While juggling the responsibilities of a full-time job and a new family, Don began his doctoral work in sanitary engineering at New York University. Shortly after, he left his full-time job as a structural design engineer to assume a full-time teaching position at Manhattan College. He continued his doctoral studies at night. Don's research initially focused on the hydraulics of side-channel weirs for combined storm water systems. However, he found water quality issues much more challenging, and he was particularly intrigued by what happened to oxygen levels in streams impacted by wastewater discharges. This led Don to reexamine the Streeter-Phelps equation, which he had first studied at Manhattan College 10 years earlier.

Don received his doctorate in engineering science from New York University in 1956 for his dissertation titled "The Mechanism of Reaeration in Natural Streams." This work established the basis for quantitative definition of the reaeration coefficient in streams. It is still being used today and is the basis of the O'Connor-Dobbins equation, named after Don and his doctoral adviser, William Dobbins.

Don's work on reaeration was followed by further work on dissolved oxygen depletion in streams. He extended the range of applicability of the Streeter-Phelps dissolved oxygen equation with the addition of the photosynthetic source, nitrification, and benthic sinks. His most lasting accomplishment, though, was his solution to the estuary problem, which involved application of the Streeter-Phelps dissolved oxygen framework to what appeared to be a hopelessly complex physical setting that included tidal motion, stratification, and irregular geometry. His solution was to model the slack water distributions and represent longitudinal mixing using a dispersion coefficient. According to his colleagues, "This was vintage O'Connor: an insightful manipulation of the data (slack time concentrations translated to mean tide positions) combined with an intuitive leap to a mathematical model (tidal- and density-driven mixing modeled as a dispersion coefficient)." His 1960 paper in the sanitary engineering journal on the subject is considered by many to mark the beginning of modern water quality modeling.

Realizing the need for expert services in sanitary engineering and water quality modeling, Don and fellow faculty colleague Wes Eckenfelder founded Hydroscience, Inc., in 1962. This was one of the first consulting firms in the country to specialize in combined wastewater treatment planning and analysis of water quality impacts. One of the firm's early projects was a comprehensive water quality study of the New York–New Jersey Harbor complex. The work, which was based largely on Don's application of the Streeter-Phelps framework to the estuary problem, has served as a basis for subsequent water quality studies of the harbor.

The implementation of secondary wastewater treatment in the late 1960s and early 1970s brought tremendous improvements in dissolved oxygen levels in streams and estuaries, as well as a new set of water quality concerns. During this time, Don and his colleagues at Manhattan College turned their attention to problems of nutrient enrichment. Don worked extensively with Bob Thomann and Dominic Di Toro in developing eutrophication models to assess the impact of nutrients on algal growth. Those models were applied in studies of the Great Lakes and a number of estuaries. Expanding his seminal work on estuaries in the 1960s, Don focused largely on eutrophication problems in the Sacramento–San Joaquin Delta, the Chesapeake Bay, and the New York Bight.

In the late 1970s and early 1980s, Don expanded his work on estuaries to address new concerns of toxic contamination by pesticides and other industrial chemicals. During this time I had the honor of working with Don in developing the first model for the pesticide Kepone in the James River estuary of the Chesapeake Bay. The model synthesized multiple factors, including hydrodynamics, sediment transport, and chemical behavior, into a comprehensive analysis. This approach continues to serve as a basis for current modeling studies of toxic contamination in rivers, lakes, and estuaries. In the late 1980s, Don carved out a new research topic, namely, seasonal and long-term variations of dissolved solids in lakes and reservoirs. His final work in the 1990s led him back to his earlier work on gas exchange in natural waters.

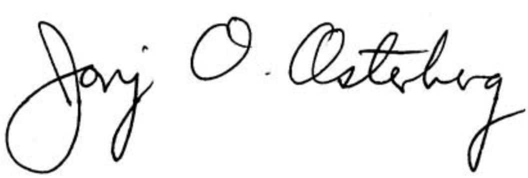
Don's work in mathematical modeling of water quality will always stand next to that of the great researchers and practitioners in the environmental field. The insights gained through carefully constructed analytical models of water quality processes, developed long before the advent of modern computers, and the steadfast insistence on comparison of model results to observed data are hallmarks of his work.

Don's accomplishments are documented by his many publications and awards. He received four Rudolf Hering medals (1959, 1966, 1984, 1989) and the J. James R. Croes Medal (1991) from the American Society of Civil Engineers (ASCE) Environmental Engineering Division (EED). These awards clearly reflect the four decades of significant contributions that Don made to the environmental engineering field. Based on his work in water quality modeling, Don was elected to the National Academy of Engineering in 1978. The following decade he was named the Association of Environmental Engineering Professors Distinguished Lecturer in 1986, the Gordon M. Fair Distinguished Educator by the Water Pollution Control Federation in 1989, and the ASCE-EED Simon W. Freese Distinguished Lecturer in 1990.

In addition to his research and consulting activities, Don gave generously of his time to serve on countless boards and advisory panels. From 1972 to 1977, he served on the advisory committee to chart the role of the National Oceanic and Atmospheric Administration. During the 1980s and early 1990s, he served on the Environmental Engineering Committee of the U.S. Environmental Protection Agency's Scientific Advisory Board and the Water Science and Technology Board of the National Research Council.

Perhaps it is Don's legacy as a teacher of so many members of our profession that will stand as his greatest achievement. Over his five decades at Manhattan College, he combined a remarkably clear teaching style with an infectious excitement and enthusiasm for environmental engineering. His chalk renderings on the blackboard reminded us of the scenic artist that he could have been, and his tales of consulting experiences from around the world kept us glued to our seats. But it was his enthusiasm for using mathematics to solve real-world problems that was most contagious. Don opened our minds to the many dynamic processes affecting streams, lakes, and estuaries through the beauty of mathematical modeling for which we are all forever grateful.

Don is survived by his children—Dennis O'Connor, Arlene O'Connor Bell, and Jeanette O'Connor—and by two grandchildren, Christopher and Kristin, as well as by many of his former colleagues and students whom he deeply inspired during his wonderful career.



JORJ O. OSTERBERG

1915–2008

Elected in 1975

"For contributions to soils and foundation engineering through research, teaching, practice and professional leadership."

BY RAYMOND J. KRIZEK

JORJ O. OSTERBERG passed away on June 1, 2008, in Denver, Colorado, at the age of 93. The son of Swedish immigrants, Jorj was raised in the Bronx borough of New York City. In 1931, at the age of 16, he entered Columbia University, where he befriended Professor Donald Burmister. While at Columbia his interest was piqued by the new field of soil mechanics, and he attended the first undergraduate and graduate courses given on the subject. After completing his B.S. in 1935 and his C.E. in 1936, Jorj's interest in soil mechanics led him to graduate school at Harvard University to study with a young professor by the name of Arthur Casagrande. After earning his M.S. at Harvard in 1937, Jorj enrolled in the Ph.D. program at Cornell University, from which he graduated in 1940.

From Cornell, Jorj went to work at the U.S. Army Corps of Engineers Waterways Experiment Station (WES) in Vicksburg, Mississippi. It was there that he met and married Ruth Embree, a Virginian, who was working in Vicksburg as a nurse. While at WES, Jorj invented and patented the WES soil pressure cell and worked with many of the researchers who were instrumental in the development of soil mechanics during World War II. During the 1942–1943 academic year, he taught at the University of Illinois, and in 1943 he joined the civil engineering faculty at Northwestern University.

Jorj's first project at Northwestern was to build the soil mechanics laboratory. Although much of the equipment designed by Jorj was inspired by that built at Purdue University and Harvard by Professors Rutledge and Casagrande, its style and operational characteristics incorporated some improvements and provided the basis for the early equipment produced and sold commercially. During his more than four decades on the faculty at Northwestern, hundreds of successful consulting engineers and university professors took his classes and benefited from his wealth of professional experience and vast collection of case histories—and the impact of his philosophy has been felt throughout the world. Jorj retired from Northwestern in 1985 and shortly thereafter moved to Colorado.

In addition to his significant service to several professional and civic organizations over the years, Jorj practiced widely as a consultant for governments, large industrial companies, and consulting firms in almost all 50 states and more than two dozen countries. Of the many recognitions of his contributions to our profession, his election to the National Academy of Engineering in 1975 is perhaps the most prestigious.

Without doubt, Jorj O. Osterberg justifiably earned his place among the most noteworthy pioneers in the field of geotechnical engineering. Throughout his career he continually manifested an enviable combination of sound theoretical background, excellent engineering judgment, good appreciation of economic considerations, and an astute understanding of human relationships. The years provided innumerable examples of Jorj's keen ability to recognize and diagnose a problem and to suggest a technically implementable and economically feasible solution. In most instances his philosophy inherently equated an overly conservative and expensive design with poor engineering.

Another strong aspect of Jorj's personality was his intense devotion to professionalism and its associated code of ethics. He always manifested very strong feelings about acting in a manner that was both morally and ethically proper—even in very small matters—and his own conscience, rather than popular opinions, always guided his actions.

In the field of foundation engineering, Jorj's accomplishments spanned the gamut from soil exploration and sampling in the early phases of a project to serving as an arbitrator or expert witness in the resolution of all too frequent disputes in the latter phases. His inventiveness and penchant for innovation were demonstrated in many ways, ranging from ingenious patents to creative solutions to foundation problems. His WES pressure cell design was among the first in the field; his piston sampler is still the standard in the profession after more than half a century; and his drilled shaft load cell literally changed the practice in deep foundations worldwide. As a practitioner, Jorj Osterberg was not only a good foundation engineer, but he was also an engineer's engineer.

Notwithstanding all of Jorj's technical accomplishments, his human qualities were among his most defining traits—the advice he gave when asked (and sometimes even when not asked), the stability he provided in times of trial, and the concern he manifested when personal problems loomed on the horizon. Those of us who were privileged to know him will certainly attest to the fact that our lives are richer, both professionally and personally, because our paths crossed with that of Jorj Osterberg.

Preceding Jorj in death was his loving wife, Ruth, who passed away in 2004. Surviving him are his four children—Lawrence, Arvid, Ralph, and Lois—and seven grandchildren. Jorj's cremains are buried with those of his wife on the Embree family plot in Buena Vista, Virginia.

UN-CHUL PAEK

1934–2011

Elected in 1998

"For the practical production of optical fibers."

BY AUDREY PAEK
SUBMITTED BY THE NAE HOME SECRETARY

UN-CHUL PAEK, a pioneer in fast optical fiber drawing technologies and a chaired professor and professor emeritus at the Gwangju Institute of Science and Technology (GIST), passed away on May 3, 2011, in Gwangju, South Korea.

He was born in Jinju City, Gyeongnam Province, in South Korea on December 2, 1934. A self-starter who loved learning about the world, he valued education as a path to a better life after enduring personal loss and hardship following the Korean War. In 1957 he received a B.S. in engineering from the Korea Merchant Marine Academy. Given his aptitude for math and his skills for complex problem solving, he was encouraged by a naval officer to apply for graduate studies in the United States. After returning to Korea to get married, he undertook graduate studies at the University of California at Berkeley, where he received an M.S. in mechanical engineering in 1965 and a Ph.D. in applied physics in 1969.

After Berkeley he returned to Korea to start a family. His only child, Audrey, was born in 1970. He then decided to move his family to the United States and joined AT&T Bell Laboratories in Princeton, New Jersey, where he worked from 1969 until 1991. Among his many accomplishments, he became a distinguished member of the technical staff and was named a Bell Labs fellow. Un-Chul Paek was a pioneer in fast optical fiber drawing technologies, which enabled installation of today's global fiber-optic networks. His primary research interests included fiber design for high-speed wavelength division multiplexing systems, specialty fiber fabrication and fiber devices, and large-capacity fiber production processes. His work included the development of a furnace for drawing fibers; techniques for high-speed drawing, cooling, and coating of these fibers; analysis and perfection of fusion splicing; and, ultimately, theory and design of clad lightguide fibers.

Un-Chul Paek later served as an adjunct professor at Rutgers University, from 1987 to 1993 before returning to Korea in 1991 to become executive vice president of the Korea Academy of Industrial Technology. Rather than pursue a position in the Korean government, he returned to academia to pursue his passion as a lifelong scholar, teacher, and mentor to the next generation of graduate research students. In 1994 he became dean of faculty and a professor with the information communications department at the Gwangju Institute of Science and Technology (GIST). He was then named director of the Research Center for Ultrafast Fiber-Optic Networks in 1995. From 2000 to 2006, he served as a chaired professor and professor emeritus at GIST.

Un-Chul Paek received many honors throughout his career for his technical achievements and publications. He was inducted as a member of the National Academy of Engineering in 1998 for the practical production of optical fibers. In recognition of his lifelong contribution to the development of science and technology, he received the National Order of Civil Merit—the Presidential Medal of Honor—from former South Korean President Dae-Jung Kim. He was also a fellow of the Optical Society of America, the American Ceramic Society, and the Institute of Electrical and Electronics Engineers, as well as a member of Sigma Xi and an associate member of the Third World Academy of Science.

His thirst for knowledge, his personal diligence and devotion to research, and his mentorship of students and colleagues were hallmarks of his career. He believed in creating a life of meaning through service. Most people will remember him as a brilliant scientist, collaborator, and educator, who pushed not only the boundaries of one's intellect but also the boundaries of what was possible in science and technology to positively impact society. To his family and friends, he will always be known as the consummate gentleman, devoted husband, and loving father who had great integrity, wit, and an appreciation for storytelling with amazing recollection of historical facts and an understanding of diverse cultures and languages. He will continue to live in the hearts and memories of those he personally touched in meaningful ways.

Un-Chul is survived by his beloved wife of 49 years, Lee; his daughter, Audrey, and son-in-law Frank; his two younger brothers, Woon-Soo (Paul) and Woon-Seo and their families; his nephew Sang Hoon and his wife Kyung Sook; and his great-nephew Yoonha (James).

JOSEPH A. PASK

1913–2003

Elected in 1975

"For contributions to the technical literature and to the development of modern science and technology of non-metallic materials."

BY DOUGLAS W. FUERSTENAU

JOSEPH ADAM PASK, emeritus professor of ceramic engineering at the University of California, Berkeley, died peacefully in his sleep on June 14, 2003, at the Brentwood residence of a home health care nurse. He had been moved there from his home in Berkeley a week earlier after his wife of 65 years, Margaret, suffered a heart attack.

Pask was born February 14, 1913, in Chicago to Adam and Catherine Poskoczem. After changing his name to Pask at the suggestion of a high school teacher, he entered the University of Illinois, where he received a B.S. degree in ceramic engineering in 1934. He obtained a master's degree in 1935 from the University of Washington and completed a Ph.D. in ceramic engineering at the University of Illinois in 1941. From 1941 to 1943 he served as an assistant professor in ceramic engineering at the University of Washington, where he broadened his research experience through a concurrent appointment as associate engineer in the Northwest Experiment Station of the U.S. Bureau of Mines. There he furthered his interest in clays and their properties as a ceramic raw material. Subsequently, he obtained valuable industrial experience and a reputation for research achievement as a research ceramist and research section engineer in the Lamp Division of Westinghouse Electric Corporation, in Bloomfield, New Jersey, which led to a lifelong interest in glass-metal seals. In 1948 he accepted an appointment as associate professor of ceramic engineering at the University of California at Berkeley, with the daunting assignment of initiating a graduate program in the field of ceramic engineering, a task he carried out with distinction.

By 1954, Pask had developed an impressive teaching and research program and had been promoted to professor. He was then authorized to recruit two junior faculty members. Within a few years the program, under his leadership, had grown to have an enrollment of more than 20 graduate students and postdoctoral researchers, and an upper-division major in ceramic engineering was instituted. The ceramics programs, which continued under Pask's benevolent and effective leadership until the time of his retirement in 1980, were remarkably successful. More than 40 graduate students and postgraduate researchers from the program rose to tenured positions at major universities throughout the world. Pask directed the research of 39 master's and 31 Ph.D. students. With only 3 faculty members, ceramic science and engineering at Berkeley attained a level of professional regard comparable to that of elite graduate programs that were staffed by more than 20 faculty.

During his years at Berkeley, Joe Pask was considered one of the leading professionals in the United States, and worldwide, in ceramic science and engineering, with a definite orientation toward ceramic processing. Over the years he was a strong proponent of the need for ceramic processing research in order to produce more reliable ceramic products. He helped organize and served on numerous National Research Council committees and panels on ceramic processing, particularly emphasizing the need for research directed at producing more reliable ceramic bodies. Early on, with several of his graduate students, he made significant contributions to clay mineralogy and the behavior of clay suspensions with regard to ceramics. He had a long-term interest in phenomena involved in producing glass-metal bonds, which started from his years in research at Westinghouse. He is well known for his many studies on mullite ceramics (a dense alumina-silica compound used in engines, turbines, and energy conversion systems) and was one of the world's leading experts on this material. With many of his graduate students, he investigated interfacial phenomena involved in ceramic processing systems. Over his career he made more than 200 contributions to archival journals and conference proceedings and authored or edited 8 books in the field, including the important Ceramic Microstructures Conference series proceedings, which served as a benchmark of progress in ceramics and identified new frontiers for research. The Ceramic Microstructure Conferences were held in Berkeley at the University of California. The various proceedings were published by a number of different publishers.

Pask served his department (first known as the Department of Mineral Technology, followed by a name change to the Department of Materials Science and Engineering in 1969) one year as vice chairman, followed by three years as chairman from 1958 to 1961. It is noteworthy that he filled that often vexing role with unruffled good humor while simultaneously maintaining his momentum in research and serving as associate dean of engineering in charge of the graduate office, a responsibility he discharged from 1969 until his nominal retirement in 1980. After that date he continued to arrive at his office every normal workday, in term and out, to pursue research and provide advice solicited by students and a stream of visiting professionals. He was well into his 80s before his defective knees forced him to abandon his routine of walking his downhill mile in the morning, to be picked up by his wife in the evening.

In addition to election to the National Academy of Engineering, Joe Pask was an honorary member of the Ceramic Society of Japan, a charter member of the International Academy of Ceramics, and a fellow of the American Association for the Advancement of Science. The awards that he probably treasured most were the Berkeley Citation awarded at his retirement and the Distinguished Life Membership and the Jeppson Award of the American Ceramic Society. The Distinguished Life Membership is the highest honor of the American Ceramic Society and recognizes lifelong achievement and contributions to the society. The Jeppson Award recognizes distinguished scientific, technical, or engineering achievements in ceramics. In addition to the American Ceramic Society, he was exceptionally active in other professional societies and on National Research Council committees and panels related to ceramic materials. He was not only a member of the ceramic society of several different foreign countries but also a member of the American Mineralogical Society, the Clay Minerals Society, and the American Institute of Mining, Metallurgical, and Petroleum Engineers, among others.

The first stop for Japanese junior and senior scientists en route to an American Ceramic Society meeting was, for many years, Berkeley, where Joe and his wife Margaret welcomed them into their home. There the fog always seemed to lift in time to provide a spectacular view of the bay, San Francisco, and the Golden Gate Bridge. In this way, the Pasks played a significant role in fostering early collaboration between Japanese and American ceramic researchers. Joe and Margaret were devoted members and seemingly tireless servants of the Berkeley campus and the society.

Margaret Pask died in February 2005. She and Joe are survived by their son Tom, daughter Kathryn Pask Hruby, three grandchildren, and four great-grandchildren.

DONALD O. PEDERSON

1925–2004

Elected in 1974

"For leadership in integrated circuits research and innovation in related computer-aided design."

BY PAUL R. GRAY, DAVID A. HODGES, AND
A. RICHARD NEWTON

Don Oscar Pederson was born on September 30, 1925, in Hallock, Minnesota. He entered Iowa State College in the fall of 1943 but was soon drafted. He served in Germany as a private in the U.S. Army from 1943 to 1946. After the war, he completed his undergraduate education at North Dakota Agricultural College (now North Dakota State University), where he earned a B.S. in electrical engineering in 1948. He earned master's and doctoral degrees in electrical engineering from Stanford University in 1949 and 1951, respectively. After receiving his Ph.D., Pederson stayed on for a period as a researcher in Stanford's electronics research lab. From 1953 to 1955, he worked at Bell Telephone Laboratories, in Murray Hill, New Jersey, and also taught night classes at Newark College of Engineering (now the New Jersey Institute of Technology).

Soon Don concluded that he enjoyed teaching even more than his work at Bell Laboratories. In 1955 he contacted acquaintances in California and subsequently was offered and accepted a position as an assistant professor at the University of California at Berkeley. He was an exciting and popular teacher, well remembered by generations of students. With colleague Ernest Kuh, he coauthored *Principles of Circuit Synthesis* (McGraw-Hill, 1959), a leading undergraduate text of its time. Later he authored another textbook, *Electronic Circuits*

(McGraw-Hill, 1965). His tenure at Berkeley included stints as director of the campus's Electronics Research Laboratory and as vice chair and chair of the Department of Electrical Engineering and Computer Sciences. He retired in 1991.

The year 1959 marked the invention of the integrated circuit, changing the world of electronics. Don foresaw that dramatic reductions in the size and cost of electronics would become possible. He became the preeminent pioneer in university research and teaching on integrated circuits, now generally known as "microchips." Don decided that to undertake research in integrated circuits and to teach students to design them, the university needed its own semiconductor fabrication facility. When he voiced this idea, he met a host of objections—building such a facility was too complicated; his group was made up of engineers, not chemists; the university had no money for expensive fabrication equipment; and the project simply could not be done. Ignoring the objections, Pederson, with Professors Tom Everhart, Paul Morton, and Bob Pepper and a group of graduate students, started designing the facility. "Never wait for approval. Don't tell anyone you are doing something. Just do it," Pederson said later. "That's my motto."

Resourcefulness trumped the many difficulties. By 1962 the new facility was operational, producing publishable research and educating a new breed of engineers. Notable leaders from industry visited and praised the facility, the first microfabrication facility at a university. Graduates of the program soon became leaders in the semiconductor industry. Microfabrication capabilities at Berkeley have advanced and grown steadily ever since. As of 2006, several hundred students and faculty members from a wide range of academic fields had made use of this extremely flexible research facility.

In the mid-1960s, Don became interested in the application of computer aids to the analysis of integrated circuits. He and his students used a Bendix G15 minicomputer (the very one now displayed in the Smithsonian Institution's Museum of American History) with only a typewriter and paper tape input and output, to try to gain a deeper understanding of the behavior of certain circuit designs. Don became convinced that the computer would play a necessary role in the design and analysis of integrated electronics.

A decade of research, involving many undergraduate and graduate students, eventually produced the integrated circuit computer simulation program called SPICE (Simulation Program with Integrated Circuit Emphasis). The program allows engineers to analyze and design complex electronic circuitry with speed and accuracy. Virtually every electronic chip, developed anywhere in the world today, uses SPICE or one of its derivatives at critical stages during its design. Don and his students made many other contributions to electronic design automation along the way as well, in areas from device modeling, mixed-mode simulation, rule-based circuit diagnosis, to macromodels.

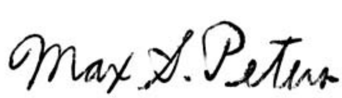
SPICE was one of the first significant open-source computer programs. The policy established by Don was that SPICE was available free of charge to any chip designer. The only request he made was that if a bug was found, or a new feature added, a copy should be sent back to Berkeley so that it could be made available to all other users. This policy accelerated the improvement of SPICE and its enhancement with many new features.

Soon after Don retired, former students and colleagues made substantial gifts to endow a professorship in his name and to pay for major renovations on the fifth floor of Cory Hall in a student area now identified as the "Donald O. Pederson Center for Electronic Systems Design."

Don Pederson died on December 25, 2004, at the age of 79, of complications from Parkinson's disease. He is survived by his wife of 27 years, Karen; four children from his first marriage, to Claire Nunan—son John and daughters Katharine Rookard, Margaret Stanfield, and Emily Sanders; and four grandsons.

Don was elected to membership in the National Academy of Engineering in 1974 and to membership in the National Academy of Sciences in 1982. He garnered numerous other honors and awards, including a Guggenheim fellowship in 1968, an American Association for the Advancement of

Science fellowship in 1988, the Berkeley Citation in 1991, the Phil Kaufman Award from the Electronic Design Automation Consortium in 1995, and the Medal of Honor from the Institute of Electrical and Electronics Engineers in 1998. He also received an honorary doctorate from Katholieke Universiteit Leuven in Belgium.



MAX S. PETERS

1920–2011

Elected in 1969

"For contributions to the study of kinetics and mechanisms of chemical reactions."

BY CAROL ROWE
SUBMITTED BY THE NAE HOME SECRETARY

MAX S. PETERS, who will be remembered for his strong leadership and remarkable achievements over 16 years as dean of engineering at the University of Colorado, Boulder, as well as for his fun-loving personality, athleticism, and service to the engineering profession, died on June 20, 2011, at the age of 90.

Born in Delaware, Ohio, on August 23, 1920, Max grew up in State College, Pennsylvania, the son of a noted professor of education at Pennsylvania State University—Charles C. Peters—and his wife Dixie. It is said that Max loved to run footraces as a child for the sheer joy of competing and doing well, a trait he exhibited throughout his life. After graduating from State College High School, where he ran track and made an early name for himself by scoring five touchdowns at the football field dedication game, Max went on to study chemical engineering at Penn State. He was active in a variety of organizations, including serving as captain of the ski team, before graduating with his bachelor's degree in chemical engineering in 1942.

After graduation he worked for two years as the supervisor of a nitric acid production unit for the Hercules Powder Company and then joined the Army in the middle of World War II. This reportedly occurred over the protests of his college dean, who claimed Max was needed more by the chemical engineering profession. But Max wanted to be where the action was, and he chose rigorous infantry training as an Army ski trooper in the 10th Mountain Division, A Company, 85th Regiment. He participated in the Italian Apennine Mountains and Po Valley campaigns, winning numerous medals for his service, including two Bronze stars, the Silver Star, and the Purple Heart.

Following World War II, Max returned to Penn State as a graduate student and earned his master's degree in chemical engineering in 1947. He also married his childhood sweetheart, Laurnell Louise Stephens, that year and went to work as a technical plant superintendent for the G. I. Treyz Chemical Company in New York. In 1949 he returned once again to Penn State, where he completed his Ph.D. in chemical engineering in 1951.

Thus began a career in which he would have a far-reaching impact as a teacher, an administrator, and a leading air pollution researcher. He joined the faculty of the University of Illinois in 1951, and within a few years started research on air pollution controls, including studies on reducing nitrogen oxide from automobile exhausts catalytically and the effects of lead on these catalysts. Eventually, his work and that of others led to the use of catalytic converters in automobiles and the elimination of lead from gasoline.

Max rose to become head of the Division of Chemical Engineering at the University of Illinois. He spent just 10 years at Illinois before leaving to become the eighth dean of the College of Engineering and Applied Science at the University of Colorado, Boulder. From 1962 to 1978, Max led the engineering school through the construction of a new, modern-day engineering center and oversaw significant increases in research funding and improvements to graduate education. "It was a golden time for research funding," he recalled upon his retirement in 1987.

Richard Seebass, who was dean of engineering at the University of Colorado, Boulder, when Max retired, is quoted as saying that "Max never ran a race he couldn't win." Indeed, he succeeded in winning a $7.2 million grant from the state of

Colorado and a $1.3 million grant from the National Science Foundation to build the new engineering center in 1965—and that was only the beginning. His team, which included longtime friend Klaus Timmerhaus—whom he recruited from Illinois to be associate dean, also won a $3 million National Science Foundation Excellence Grant for faculty development and a large grant from the Sloan Kettering Foundation to develop joint graduate research with the University of Illinois.

At the same time he was building the school's capacity for research and graduate education, Max was able to continue the school's emphasis on undergraduate learning for its 2,000 students. He did not relinquish his teaching and research activities while dean, choosing instead to teach courses ranging from the freshman introduction to the senior design course in chemical engineering. He also wrote many technical papers and several textbooks on chemical engineering, including the widely known *Plant Design and Economics for Chemical Engineers* (McGraw-Hill, 1958), which is now in its fifth edition and has sold over 100,000 copies. After Max wrote the original book, Klaus and Ronald West joined him as coauthors on the later editions.

Max also was active in professional service, so much so that the College of Engineering and Applied Science created the Max S. Peters Faculty Service Award and presented it to him as the first recipient the year he stepped down as dean. Previously, Max had served as president of the American Institute of Chemical Engineers (AIChE), chairman of the President's Committee on the National Medal of Science, and chairman of the Colorado Environmental Commission, which presented a detailed report in 1972 on actions recommended for the future of the state. He also served on the National Research Council's Advisory Board on Military Personnel Supplies from 1977 to 1980 and later on the NAE Nominating Committee.

Max also was active in the American Society for Engineering Education (ASEE) and received its Lamme Gold Medal Award for Distinguished Service in Engineering Education in 1973. He also received ASEE's George Westinghouse

Award for Outstanding Teaching in 1959 while at the University of Illinois. Max served on the Board of Directors and the Accreditation Committee for the Engineers' Council for Professional Development, and he chaired the National Research Council Committee on Alternatives for the Reduction of Chlorofluorocarbon Emissions in 1979. He also was active in the 10th Mountain Division Association, serving as secretary and president of the Rocky Mountain Chapter and on various boards and committees in the Boulder community.

In 1969, Max became the first resident of the Rocky Mountain region to be honored by election to the National Academy of Engineering. The same year he received the Award of Merit from the American Association of Cost Engineers. He was named Engineer of the Year by the Professional Engineers of Colorado in 1971, and he received the AIChE Founders Award in 1974 and the Warren K. Lewis Award for Outstanding Teaching in 1979. The University of Colorado honored Max with its Distinguished Engineering Alumnus Award (as a special recipient), the Robert L. Stearns Award, and the University Medal. Penn State University recognized his achievements with its Distinguished Alumnus and Distinguished Engineering Alumnus awards.

Max was a registered professional engineer in Pennsylvania and Colorado and a fellow of AIChE. In 1983, AIChE selected Max as one of 30 Eminent Chemical Engineers in the United States, and in 1994 he received the Colorado Engineering Council's Gold Medal Award in recognition of his distinguished engineering career. He also received centennial awards from the ASEE for outstanding service in engineering education and from the College of Engineering and Applied Science of the University of Colorado, Boulder, for being one of the "Top 100" individuals in the college's history.

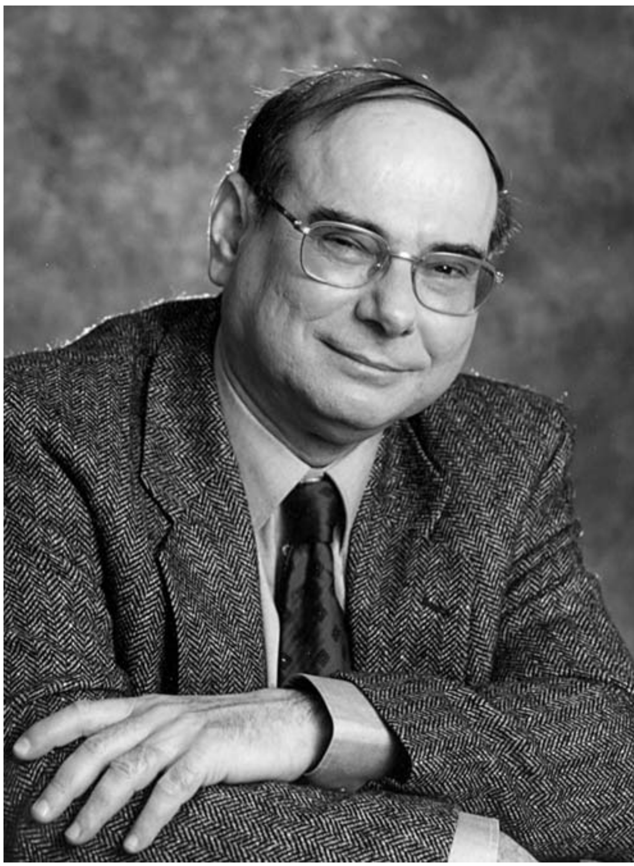
Throughout his life Max enjoyed competing in athletics, including running, skiing, ice skating, and later race walking. In addition to being a member of Penn State's ski team during his college years, he served as an assistant coach of the team as a graduate student, and as president of the Penn Valley Ski Club, and he helped organize the Pennsylvania Ski

Federation, serving as its first president in 1946. He won first place in cross-country skiing at the 1947 Pennsylvania State Ski Championships and was named "Outstanding Skier" of the event. After leaving Penn State in 1948, Max had his own ski school in Phoenecia, New York, and he continued to compete in skiing events after moving to Colorado in 1962. He did well in skiing competitions with the Rocky Mountain Masters Ski Series, winning first place in his class in the downhill, and second place in the slalom, giant slalom, and the combined, in 1986–1987. He was also a figure skater, focusing on ice dancing, and he ran regularly in the Bolder Boulder 10K Road Race.

For Max, competition and fun went hand in hand. As dean he shared his competitive nature with his students, racing them annually during so-called engineering days. Creating races that only he could win, Max manipulated the rules before and during the races. His antics ranged from announcing that the winner would have to wear an unusual hat and then producing the wildest hat possible to devising rules that the winner had to finish last, next to last, or third from last, then running backwards, turning somersaults, and running around trees with the baffled students following him. "I was the only one who knew the rules," he said playfully. "But the students didn't get mad. They just tried to outwit me."

He served as dean of engineering until 1978, when he returned to full-time teaching and research. Subsequently, he served as chairman of the Department of Chemical Engineering from 1981 to 1985 and retired from active duties in 1987, when he became professor emeritus of chemical engineering and dean emeritus of the college.

Max is survived by his wife of 63 years, Laurnell Stephens Peters, to whom he first proposed at the age of 6 while visiting his grandparents who lived up the road from Laurnell's family, and their two children, Margaret and Stephen, and four grandchildren, Emily, Katie, Hannah, and Grace.



AMIR PNUELI

1941–2009

Elected in 1999

"For the invention of temporal logic and other tools for designing and verifying software and systems."

BY DAVID HAREL AND MOSHE VARDI

AMIR PNUELI, a pioneer in the fields of specification, verification, and analysis of computer systems, and a Turing Award winner, died after suffering a brain hemorrhage on November 2, 2009. His sudden death shocked the international computing community.

A brilliant man who was shy, modest, and graceful, Pnueli, or simply Amir as he was called by anyone who knew him, was born in Nahalal, in what is now Israel, on April 22, 1941. He spent the bulk of his career at Tel Aviv University and at the Weizmann Institute of Science in Israel and in recent years also at New York University.

Amir did his doctoral work at Weizmann in applied mathematics under the late Chaim L. Pekeris, writing a thesis in 1967 on the calculation of ocean tides. Immediately thereafter he made a transition to computer science, working as a postdoctoral fellow at Stanford University and at IBM's research center in Yorktown Heights, New York, for two years. He returned to Israel in 1968 as a faculty member in the Department of Applied Mathematics at the Weizmann Institute and in 1973 moved to Tel Aviv University, where he founded the Department of Computer Science and was its first chair. In 1980, Pnueli returned to the Weizmann Institute as a professor, together with three younger computer scientists—

Adi Shamir, Shimon Ullman, and David Harel. Together, they invigorated the computer science group there, which has grown steadily since.

Amir's modest demeanor belied groundbreaking technical achievements. His 1977 paper, "The Temporal Logic of Programs," marked a crucial turning point in the verification of concurrent and reactive systems. Incidentally, the paper was published in the proceedings of the Institute of Electrical and Electronics Engineers Symposium on Foundations of Computer Science but never in a journal; it apparently did not have to appear in an archival journal to become so influential. Temporal logic was developed by philosophers in the late 1950s to reason about the use of time in natural language. By introducing it to the field of formal methods, Pnueli gave researchers a set of tools that enabled them to specify and reason about the ongoing behavior of programs. His 1977 paper opened up a new world for computer scientists, and its impact is crucially felt in both the theory and the practice of the continuously growing field of program verification and analysis. At the time of its writing, program verification was widely considered a hopeless challenge, but Pnueli's paper quietly established a framework for advanced techniques and gave new life to the domain. For this contribution, Pnueli received the Association for Computing Machinery's A. M. Turing Award in 1996, considered the "Nobel Prize" of computing. The citation reads: "For his seminal work introducing temporal logic into computing science and for outstanding contributions to program and system verification."

Throughout the rest of his career, Pnueli continued to extend and strengthen his ideas and to contribute to the development of other verification methods. In a joint paper with David Harel in 1986, they coined the term "reactive system" to describe systems that maintain an ongoing interaction with their environment and argued for its significance; the term has since become deeply ingrained in the literature. Working with a variety of collaborators—including current and former students—Pnueli made numerous additional contributions to a number of related topics, from algorithmic verification to automated synthesis of reactive modules. Noteworthy was his extremely fruitful longtime collaboration with Zohar Manna from Stanford University, with whom he coauthored books on temporal logic and its use in the specification and verification of concurrent and reactive systems.

He had boundless curiosity and was deeply interested in developing techniques that could be used in industrial applications, not only research settings. Over the years he cofounded a number of companies, designing and supervising systems that included message switching, operating systems, software development tools, and compilers.

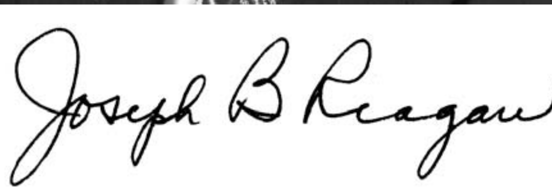
Pnueli's graciousness and humility endeared him to colleagues and students alike. He listened attentively to all who sought him out, and he had a knack for finding the best in what they said. "People loved working with him because he made them feel smart," said Lenore Zuck, a former doctoral student who is currently at the University of Illinois in Chicago. At work, Pnueli was laid-back and informal, alternating between research and conversation and indulging in long digressions about politics, food, music, and literature. "It never felt tiring to work with him," said Zuck. Beneath his casual comportment lay deep insight and intuition, and collaborations often happened inadvertently. One could start a new piece of work in a discussion with Amir while standing in line for lunch at the cafeteria or during a coffee break at a conference in some remote part of the world.

Amir's accomplishments were also honored in 2000 by the Israel Prize, the state's highest honor, and in 2007 by the ACM Software System Award, given to him jointly with a team of colleagues for their work on Statemate, a software engineering tool that evolved from the Statecharts language and that supports visual graphical specifications that represent the intended functions and behavior of a system. He also received honorary doctorates from the University of Uppsala, the Université Joseph Fourier in Grenoble, and the Carl von Ossietzky Universität in Oldenburg.

At Pnueli's funeral the first-listed author of this tribute challenged himself to identify Amir's vices but found it very difficult. He ended up finding two. The first: in all his letters of recommendation, about anyone at all, Amir wrote only good things. But in his defense, he really believed that everyone was very good, and this was simply part of the way he considered others, out of his unusual measure of modesty. The second problem: he was often late—late in delivering a paper on time, late with a letter of recommendation, late with a report, late with the response to some request, and so forth. But here too, in his defense, the issue was always taken care of eventually and was always done in depth and in detail and combined with the great grace of his personality and his deep wisdom.

Amir Pnueli died at the scientifically young age of 68, when he was in the process of doing some of his best work. We will never know what else he would have achieved, nor what other ideas and directions he would have brought to computer science, if he had lived another 15 or 20 years, as he so very well deserved. For us—his direct scientific beneficiaries—we followed him not just for his intelligence, his wisdom, and his universally acknowledged greatness as a scientist but also for his personality, for his ability to share with everyone his wisdom and ideas—everyone small and large—with his hallmark unlimited generosity.

Amir is survived by his wife, Ariela; his three children, Shira, Ishai, and Noga; and his grandchildren, Noam, Romy, Gaya, and Ella.



JOSEPH B. REAGAN

1934–2011

Elected in 1998

"For contribution to space science and instrumentation and their application to national space programs."

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SUBMITTED BY THE NAE HOME SECRETARY

JOSEPH B. REAGAN died unexpectedly on August 14, 2011, leaving behind a loving family, friends, and associates who are still coping with the loss of a brilliant mind and an even greater man. Joe was born in November 26, 1934, in Somerville, Massachusetts.

Dr. Reagan received his B.S. and M.S. degrees in physics from Boston College in 1956 and 1959, respectively. He received his Ph.D. degree in space science from Stanford University in 1975. He also attended Pennsylvania State University's Executive Management Program in 1981, the Lockheed Management Institute in 1977, the Lockheed Advanced Institute in 1983, the Lockheed Executive Institute in 1985, and the Lockheed Senior Management Institute in 1986.

His last position was as an independent consultant to senior management in industry and the U S. government as principal of JBR Associates. From 1991 until his retirement in 1996, he was a vice president of the Lockheed Martin Corporation and a vice president and general manager in the Missiles and Space Company. He was responsible for the technical and management direction of the Research and Development Division of the Palo Alto Laboratories in California, where some 750 scientists and engineers engaged in advanced technology development in the fields of physical science, space science, materials, optics and electro-optics, software engineering, intelligent systems, cryogenics, and guidance and control. He was responsible for annual research and development contract revenues of $100 million from government agencies, in addition to a comparable amount in support of major Lockheed Martin corporate programs.

Dr. Reagan joined Lockheed in January 1959 as a scientist. He led the Space Instrumentation Group for 10 years and was responsible for the development and on-orbit deployment of over 20 scientific satellite payloads for the National Aeronautics and Space Administration (NASA) and the U.S. Department of Defense (DOD), including 7 major scientific payloads carried piggyback aboard the world's first photoreconnaissance satellites known as *Discoverer/Corona*. Dr. Reagan conducted personal research in the areas of radiation belt particles, solar particle events, and the effects of particle precipitation on the neutral atmosphere and the ionosphere. He was the principal or coprincipal author of over 110 published papers and the principal author of four chapters in technical books. He was an invited speaker at national and international scientific conferences on 10 occasions. He was an expert consultant to several U.S. Air Force, U.S. Navy, and NASA committees in the area of radiation belt physics and radiation effects on space and terrestrial operational systems. As the principal investigator of four scientific space missions and coinvestigator on 13 other missions, Dr. Reagan was responsible for the development and successful deployment of complex space instrumentation.

Dr. Reagan was manager of the Lockheed Space Payloads Program from 1973 until he became manager of the Space Sciences Laboratory in 1975. He became director of Electronic Sciences in 1984 and director of the Physical and Electronic Sciences Laboratory in 1985. In June 1986 he became the deputy general manager of the Research and Development Division and in 1988 vice president and assistant general manager. In January 1991, Dr. Reagan became vice president and general manager of the Research and Development Division of the Missiles and Space Company and a vice president of Lockheed Corporation.

Upon his retirement in January 1996, Dr. Reagan became the technology panel leader of the Naval Studies Board (NSB), an element of the Commission on Physical Sciences, Mathematics, and Applications of the National Research Council. In this role he led 18 scientists and engineers from academia and industry in a major 18-month study entitled “Technology for Future Naval Forces: The United States Navy and Marine Corps, 2000–2035, Becoming a 21st Century Force.” For this study commissioned by the Navy’s chief of naval operations, the technology panel attempted to forecast trends in the most important technologies that would impact Navy and Marine Corps operations over the next 35 years. In 1998, Dr. Reagan participated in another major study, “Recapitalizing the Navy: A Strategy for Managing the Infrastructure,” which advised the Navy on how to recapitalize and modernize for the future while maintaining fleet readiness. In 1999 he was one of the leaders of a study entitled “Network-Centric Naval Forces: A Transition Strategy for Enhancing Operational Capabilities.” This study focused on the transition of the Navy from a platform-centric force to one based on network-centric operations. In 1999 he was a committee member of an NSB study called “Review of the Office of Naval Research (ONR) Technical Vision for Uninhabited Combat Air Vehicles.” In 2001 he was chairman of an NSB committee study of ONR’s Aircraft Technology Program and followed up in 2004 as chairman of a committee study entitled “Identification of Promising Naval Aviation Science and Technology.” In 2003 he was a member of a classified NSB study on the Navy’s Needs in Space for Providing Future Capabilities.

In 1998, Dr. Reagan was appointed NSB’s vice chair. In 1999 he was selected to be vice chairman, an office he held until his mandatory retirement from the board in 2004. Dr. Reagan was elected to the National Academy of Engineering in 1998. He was a fellow of the American Institute of Aeronautics and Astronautics since 1990 and was the “Outstanding Engineer in Astronautics” of the San Francisco chapter in 1988. He was also a member of the American Geophysical Union and the National Physics Honor Society—Sigma Pi Sigma—where he served on the Development Committee from 2004 to 2006. He received the NASA Group Achievement Award for his work on the Pioneer Venus program. In 1992 he was awarded the Silver Knight of Management by the Lockheed Management Association. In 1993 he received the Outstanding Alumni Award in Science from his alma mater, Boston College. He was a member of both the Stanford University and the University of California at Berkeley engineering schools' advisory councils from 1992 to 1996.

Dr. Reagan also participated as an ad hoc member of the U.S. Air Force Scientific Advisory Board. From May 2002 to November 2003, he was a member of the National Research Council's review of NASA's aerospace technology enterprise, which produced a report titled *An Assessment of NASA's Pioneering Revolutionary Technology Program.* From November 2007 until October 2008, he was a member of the National Research Council's Space Studies Board workshop, which produced a report titled *Severe Space Weather Events—Understanding Societal and Economic Impacts.* From July 2005 to June 2007, Dr. Reagan was chairman of the Aerospace Engineering Section of the National Academy of Engineering.

Dr. Reagan served from 1987 to 1992 and from 1993 to 2004 as director of Southwall Technologies, Inc., a public company located in Palo Alto, California. Southwall is a high-technology company that specializes in producing wide-web, transparent thin films that are used to control ultraviolet, visible, and infrared solar radiation in such applications as industrial and residential windows, antiglare screens for liquid crystal displays, and laminated glass for cars. Dr. Reagan was a member of the Finance Committee and chairman of the Human Resources Committee and served for a time as chairman of the Board of Directors.

He was also director of the Technology Museum of Innovation (the TECH) in San Jose from 1992 to 2004, where he served as chairman of the Exhibits Committee and as a member of the executive, education, finance, and corporate development committees.

From July 2004 until December 2008, Dr. Reagan was a director of SM&A, a public company in Newport Beach, California, that supports the development of proposals for major business opportunities, such as major DOD programs, where he was a member of the Finance Committee and chairman of the Human Resources Committee. He also served as director of Planning Systems, Inc., in McLean, Virginia, from 1989 to 1991. He was also a member of the Senior Advisory Council of the Industry Initiative for Science and Math Education in Cupertino, California, starting in 1986.

Joe and Dottie literally traveled the world, including visits to Europe, Russia, China, Australia, South America, and the Middle East. They especially enjoyed family vacations to destinations such as Fiji, Hawaii, Mexico, Canada, and, of course, Joe's beloved Napa Valley. He loved fine wine and shared many exceptional vintages with family and friends. Joe indulged his passion for fine woodworking in his retirement, creating many special one-of-a-kind pieces of furniture for his family.

Dr. Reagan is survived by his high school sweetheart and loving wife of 54 years, Dorothy; his seven children and their spouses—Patrick, Michael (Kate), Kevin (Maria), Kathleen (Orlando), Brian, John (Tahmineh), and Maureen; four grandchildren—Christina, Kaitlin, Tea, and Riley; his sister, Rita Duffy; and many nieces, nephews, and cousins. He was preceded in death by his sister Helen and granddaughter Lauren.

LYMON C. REESE

1917–2009

Elected in 1975

"For contributions in geotechnical engineering and education."

BY JOHN E. BREEN

LYMON C. REESE, Nasser I. Al-Rashid Chair Emeritus in Civil Engineering at the University of Texas at Austin, and one of the nation's most influential experts on laterally loaded piles and drilled-shaft foundations, died on September 14, 2009, at the age of 92. He was elected a member of the National Academy of Engineering in 1975 for "contributions in geotechnical engineering and education."

The journalist Tom Brokaw proposed the term "The Greatest Generation" to describe the generation that grew up during the Great Depression, went on to fight in World War II, and came home to rebuild America into a superpower. Lymon Reese was such a person, par excellence.

Lymon was born on April 27, 1917, in Stanley, Pike County, Arkansas. His father was a "log scaler" for a timber company. After primary education in Murfreesboro, Lymon completed high school in Abilene, Texas. While in high school he worked as a caddy at the Abilene Country Club, where he earned money to help his family and entered into a lifelong love with the game of golf.

Lymon entered Abilene Christian College, but with the financial pressures of the Depression, he had to withdraw to go back to work to help support his family. At Abilene High School he had had an opportunity to learn survey calculations. So he joined survey crews along the Rio Grande Valley and at a munitions plant in Alabama. Shortly after the Japanese attack on Pearl Harbor, Lymon joined the U.S. Navy Seabees as a chief carpenter's mate (surveyor). At 25 he was one of the youngest chief petty officers in the 66th Naval Construction Battalion. He served in the Aleutian Islands and on Okinawa constructing airfields.

Following World War II, Lymon began civil engineering studies at Rice University, where he lettered on the golf team. He transferred to the University of Texas (UT) and using the G.I. Bill received a B.S. in civil engineering in 1949 and an M.S. in civil engineering in 1950. While at UT he met and married fellow student Eva Lee Jett. Lymon was a spiritual person and met his future wife at church in 1948. After receiving his M.S., he became an assistant professor of civil engineering at Mississippi State University. After a year there, combining G.I. Bill and competitive fellowships, Lymon went to the University of California at Berkeley. He completed his Ph.D. program at Berkeley in 1954, receiving the doctoral degree in 1955. In the fall of 1955 he joined the Texas faculty. Returning to Texas with Eva Lee and their three children, Lymon began 33 years of active service on the UT faculty as teacher, researcher, and administrator. From 1965 to 1972 he was chair of the civil engineering department, and from 1972 to 1979 he was associate dean for research. He held the Nasser I. Al-Rashid Chair from 1981 to 1984. A year after his retirement from UT in 1984, Lymon founded Ensoft, Inc., in Austin, a developer of engineering software. He carried out his worldwide consulting activities through a subsidiary, Lymon C. Reese and Associates.

Although Lymon began his college education at age 29, his widespread survey experience and Seabee "can do" spirit served him well as a firm foundation on which to build an active civil engineering teaching, research, and consulting career. He was a dedicated problem solver, always interested in challenging practical applications for his knowledge. In his early years at UT, he spent summers working with Shell Development Company and quickly became immersed in a host of geotechnical problems connected with offshore structures. Working closely with his faculty colleague Hudson Matlock, they developed numerous applications of soil-structure interaction with both analytical and experimental breakthroughs. Lymon's pioneering papers on piles laterally loaded with wind and waves were recognized as breakthrough classics by the Offshore Technology Conference. For decades major oil companies and offshore constructors sent their new personnel to a specialty short course on offshore structures developed by Lymon and Hudson at UT.

Around 1965, Dr. Reese's interests began to shift toward development of rational design and construction criteria for axially loaded drilled piers, spawning the very important drilled-shaft construction industry. His comprehensive studies showed the reliability of load transfer by skin friction, reducing reliance on end bearing and belled footings. He clearly tied in the effects of various construction methods on drilled-shaft capacity in a landmark 1999 Federal Highway Administration manual. The entire drilled-shaft industry recognized Lymon as a legend.

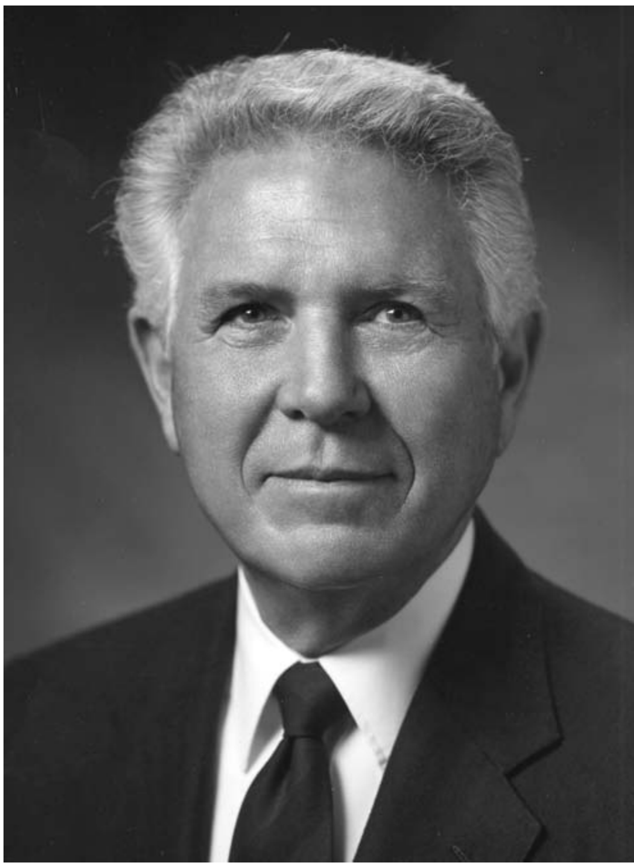
While Lymon Reese was always interested in challenging applications of soil-structure interaction and conducted many notable full-scale pile and drilled-shaft load experiments, he always relied on advanced mathematical and computational techniques. In his studies he used many finite difference and finite element solutions. He created user-friendly software for engineers interested in soil-structure interaction computations. The company he founded continues today to be successful, with numerous users spread across the globe.

In recognition of his accomplishments, Lymon received the American Society of Civil Engineers (ASCE) Middlebrooks Award in 1958, was the ASCE Karl Terzaghi Lecturer in 1976, received the ASCE Terzaghi Award in 1983, and was named an ASCE honorary member in 1985. The Offshore Technology Conference recognized him with a Distinguished Achievement Award for Individuals in 1985, and the same year he was named a distinguished graduate of the UT College of Engineering.

Throughout a career in which he supervised over 70 graduate students, authored or coauthored more than 160 journal papers, 280 technical reports, and 4 textbooks and received 3 patents, Lymon provided continuing counsel to his university, his profession, and his former students and coworkers.

Lymon Reese was deeply dedicated to his family and served faithfully as a deacon and a Sunday school teacher at his church. Near the height of his career, his beloved wife had a debilitating and almost fatal condition. Lymon set a great example for all who knew him with the love and determination with which he helped his family nurse her back to a greatly improved quality of life. He deeply loved his family, his children and grandchildren, his golf games, and his country. He was a patriot in the true meaning of the term who looked on his Navy service as a duty and a great opportunity. Just as Lymon Reese greatly influenced his students and his industry colleagues, he left an example of wisdom, dedication, and love for his family. He was preceded in death by his beloved wife Eva Lee in September 2003 and is survived by daughter Sally Reese Melant and her husband Michael Melant, by son John Reese and his wife Judy Reese, by daughter Nancy Reese, and by 11 grandchildren and numerous great-grandchildren.

Lymon Reese will not be forgotten by anyone who had the opportunity to know him. He leaves a large group of former students and colleagues who proudly extend his geotechnical applications.



LOUIS W. RIGGS

1922–2002

Elected in 1987

"For innovative leadership and design of bridges and rapid transit structures in the United States and foreign countries."

BY JAMES LAMMIE

LOUIS W. RIGGS, retired chairman of Tudor Engineering Company, died on June 12, 2002, in Lafayette, California. With his passing, the engineering and construction industry lost a leader, a manager, a teacher, and a real gentleman.

Louis was born in Pearsall, Texas, on June 29, 1922. He was raised in Riverside, California. He joined the U.S. Air Force in World War II and was assigned to the 494th Squadron as a navigator, a position in which he used his early engineering and mathematics training. While on a bombing mission over Bulgaria, his plane was shot down and he was held in a prisoner of war camp there. He did not speak highly of his captors. After the USSR entered the war, Louis was released. He was decorated, returned to the United States, and assigned to March Field in Riverside where he met his future wife, Patricia. After marriage, they moved to San Francisco where he started his professional life.

Louis attended the University of California, Berkeley, graduating with a B.S. in civil engineering in 1948. He was a member of Tau Beta Pi and was elected to the civil engineering society, Chi Epsilon. He served the university in many capacities. He received the Trustee Citation Award from the university's Berkeley Foundation in 1981 and the Distinguished Engineering Alumni Award from the university's Engineering

Alumni Society in 1984 (now called the Berkeley Engineering Innovation Award). He was a frequent speaker in civil engineering courses and a loyal "Bears Backer" for many seasons.

After graduation, Louis went to work as a junior engineer for the state of California with the Division of San Francisco Bay Toll Crossings, further stimulating his interest in bridges. Then in 1951 he joined Tudor Engineering Company, at that time a small firm with an excellent reputation in structural design, particularly of bridges. Within 10 years he became a vice president and a member of the Board of Directors. In 1963 and for the next 20 years he served as president and chief executive officer of Tudor. He became chairman in 1983 and served in that position until his retirement in 1986.

During his career Louis managed many challenging projects. One of his favorites was the Tagus River Bridge piers in Lisbon, the deepest in the world at that time and made more difficult by the steeply sloping rock foundation. Louis was also one of a select group of visionary leaders who foresaw the need for a regional rapid transit system in the San Francisco area. This led to his proudest accomplishment, the BART System—the San Francisco Bay Area Rapid Transit System—America's first modern transit system. In this joint venture—PBTB (Parsons Brinckerhoff-Tudor-Bechtel)—Louis was on the Joint Venture Board of Control, with overall design and construction responsibilities. Tudor had direct responsibility for the design of the entire system, aerial structure, with its difficult soil and foundation conditions and strong seismic design requirements. That aerial structure has since survived two major earthquakes in San Francisco. The PBTB Joint Venture moved on to guide the design of the Caracas Metro, with heavy emphasis on technology transfer to the local Venezuelan staff.

The final PBTB joint venture project was MARTA—the Metropolitan Atlanta Rapid Transit Authority—for which planning began in 1967 and, after many political and environmental issues, moved into construction in 1975. Louis was again on the joint venture board, with overall design and construction responsibilities, until 1976. At that time, new contract terms dictated that Bechtel withdraw from the project and the joint venture was reconfigured as PB/T (Parsons Brinckerhoff/Tudor). Louis played a key role in all projects, particularly structural engineering, until his retirement. Along the way he continued to grow Tudor and moved the company into hydropower, building designs, such as the Oakland bulk mail facility for the U.S. Postal Service, and many bridges, such as the Dry Creek/Warm Springs Bridge in California. These projects do not represent all of Louis Riggs's contributions to the design industry but do serve to illustrate the scope and scale of his many accomplishments.

Louis also contributed to the engineering industry and his profession through lectures, with his many papers that featured innovations and improved practices, on his current projects and through his active participation in many professional societies and organizations. He was a long-term member of the American Public Transit Association and the American Public Works Association. He was elected a fellow of the American Consulting Engineers Council and served as vice president from 1979 to 1981. For the Consulting Engineers Association of California, he was director from 1964 to 1974 and served as president in 1973. He was also a fellow of the American Society of Civil Engineers (ASCE). He was very active in the Society of American Military Engineers as a director and vice president of the San Francisco post and was elected president of the national society in 1981. Finally, he was a member of the Building Research Advisory Board of the National Research Council from 1975 to 1981 and then chairman and director of the follow-on Buildings Future Council.

Louis was also recognized for his accomplishments with the Greensfelder Construction Prize in 1967 by the ASCE for his paper on the Tagus River Bridge and with an Honor Award from the Building Industry Conference Board in 1974. He received the Golden Beaver Award for Engineering in 1979. (The Beavers are the organization of the western U.S. heavy construction contractors.) The recognition that Louis was proudest of was his election to the National Academy of Engineering in 1987.

Louis is survived by his loving wife of over 55 years, Patricia; his daughter, Katherine Stimson, and her husband, John; and his son, James Riggs. He is also survived by his brother Leroy Riggs and wife Marilyn. In addition to his legacy as an outstanding and innovative structural engineer, Louis was known as a kind, loving, intelligent human being who never stopped teaching others and supporting his family.

JAMES E. ROBERTS

1930–2006

Elected in 1996

"For the development and implementation of innovative bridge retrofit concepts and criteria under seismic conditions."

BY RICHARD DOKKEN
SUBMITTED BY THE NAE HOME SECRETARY

JAMES E. ROBERTS, a longtime leader in the bridge design profession, died on July 6, 2006, at the age of 75. He was born on November 24, 1930, in Missouri and moved with his family to California when he was 6.

Jim Roberts held a number of significant engineering titles throughout his 50-plus-year career, including state bridge engineer for California and chief deputy director for the California Department of Transportation. He was a leader during the state's highway and bridge construction boom in the 1950s and 1960s. He is the only Caltrans employee to have been inducted into the National Academy of Engineering. Jim earned his bachelor of science degree in engineering from the University of California, Berkeley, and his master of science from the University of Southern California (USC). He was a registered professional engineer. He served on active duty in the U.S. Army Corps of Engineers during the Korean conflict and in all served 33 years in the U.S. Army Reserve. He retired as a colonel. His obituary called him "An Engineer's Engineer," a term respectfully coined by a coworker. Roberts did not identify himself as an engineer's engineer, however.

He always maintained a professional attitude, work ethic, and appearance in the office, which carried over, in part, from his military experience. His career at Caltrans started in 1951 as a junior engineer before he had completed his B.S. degree from UC Berkeley. He later earned his master's degree while working full time as a resident engineer at Caltrans. For several years he logged a full day at a job site in the Central Valley and then made the six-hour round trip to USC for evening classes. Even then he was always the first one to the office in the morning.

After accumulating a decade of field experience, Roberts was assigned to Caltrans' Design Section 2 in 1962. His mentors in the bridge design section were engineers who would go on to be public works directors and chief executive officers of engineering firms. The early 1960s were a time of tremendous change in bridge engineering. Computational tools had recently become available. Roberts learned quickly, worked fast, and asked questions constantly. He soon not only mastered the conventional bridge design techniques of the time but also absorbed the importance of the new computer-aided wave of bridge design. His bridge projects grew in importance as his experience grew.

In the 1960s, most steel bridges were simple. Curved steel bridges used short spans with straight girders flared to accommodate the curves. The slide rule was used for most design calculations. The first large bridge design that Roberts was responsible for as a senior engineer was the Tuolumne River Bridge in California's Tuolumne County. That bridge was substantially different from other steel bridges of the time. It was a six-span, 1,400-foot-long bridge on a 1,200-foot radius with a 350-foot main span and an 8 percent super-elevation. Time was of the essence, as the bridge would be constructed over a river that was soon to turn into Lake Don Pedro. Roberts's efforts on this project exemplified the leadership and engineering skills that he demonstrated throughout his career.

The design standards of the time did not fully address many of the structural issues presented by this particular bridge. Research was under way nationally on curved steel girders with spans as long as 150 feet, but these lengths were substantially shorter than the planned spans on this bridge. Preliminary longhand calculations of the structure implied results that were substantially different from those of a traditional short-span bridge, and the available design tables were completely inadequate to handle the three-dimensional effects of this highly curved bridge. The only computer software available to address bridge analysis was a then-experimental piece of software called STRUDL. The Tuolumne River Bridge became the first application of this type of software to a bridge in the western United States. Similar software applications to complex bridge designs have only recently become commonplace. Roberts's work was performed 40 years ago.

Roberts's leadership was further tested during the construction of the bridge. Midway through erection of the steel girders, a material failure occurred during construction of a steel bridge near Sacramento. That bridge utilized the same materials that were already in Roberts's partially constructed Tuolumne River Bridge. With flooding of the valley imminent, the design team feverishly worked out extensive field modifications to the fracture-critical girders while lawyers for the state and the steel fabricator argued over liability.

Roberts's team argued internally over an appropriate repair strategy. Ultimately, they relied on seasoned judgment, intuition, and new computer tools to produce field repairs for the substandard steel-plate flanges on the bridge. It would be more than a year before enough was known about fracture mechanics to determine just how close the team might have been to losing the bridge. In 2007, a year after Roberts passed away, the structure was officially renamed the James E. Roberts Memorial Bridge.

Roberts went on to many leadership roles. He soon took over a Caltrans bridge design section and then served several years as the chief engineer for the Sacramento Regional Transit's light rail system. He then went back to Caltrans and became director of the Engineering Service Center, where he was responsible for the work of 2,300 engineers, architects, and support staff responsible for designing, building, and maintaining all of California's bridges. He was at the reins as the state bridge engineer when the 1987 Whittier earthquake, the 1989 Loma Prieta earthquake, and the 1994 Northridge earthquake hit. He supervised a renaissance in seismic retrofit design that occurred at Caltrans in the late 1980s and early 1990s. Because California has historically been on the cutting edge of bridge design, his leadership made not only California's roads and bridges safer but also much of the nation's.

Roberts eventually served as chief deputy director (while simultaneously running the bridge department) of Caltrans before retiring in 2001. He continued to work part time, advising bridge designers until his death in 2006.

An engineer is someone who can confidently stamp a set of plans. Jim Roberts was responsible for the design and construction of countless bridges in California. More importantly, he was a leader, an accomplished speaker, a man with great foresight, and a mentor and he was politically savvy. That amounts to much more than a typical "engineer's engineer."

Jim Roberts is survived by his wife, Patricia Lee Brighton Roberts, of Carmichael, as well as two children and two grandchildren.

NICHOLAS ROTT

1917–2006

Elected in 1993

"For teaching and research leading to fundamental advances in aerodynamics, acoustics, and fluid mechanics."

BY BRIAN J. CANTWELL AND GEORGE S. SPRINGER

NICHOLAS ROTT, professor emeritus of fluid dynamics at the Swiss Federal Institute of Technology in Zurich, whose teaching and research led to fundamental advances in aerodynamics, acoustics, and fluid mechanics, died on August 10, 2006, at the age of 88.

He was elected to membership in the National Academy of Engineering in 1993.

Nicholas Rott was born on October 6, 1917, in Budapest, Hungary. He pursued his studies in aeronautical engineering, which became the foundation of his life's work, at the Zurich Institute of Technology. It was also in Switzerland that he met his wife, Rosanna. By 1951, Nicholas and his family, which included two children, immigrated to the United States. Nicholas taught at Cornell University, the first of three teaching positions. In 1959 he began teaching at the University of California at Los Angeles, and in 1967 he returned to Switzerland to become head of the Department of Aeronautical Engineering at the Federal Institute of Technology in Zurich. He retired in 1983 as professor of fluid dynamics from the Federal Institute of Technology. Nicholas and Rosanna moved to Palo Alto, California, in 1984 to be close to their children, Dainuri Rott and Katherine P. Roselli. After retirement he became a consulting professor in the Department of Aeronautics and

Astronautics at Stanford University, where he continued his research. At Stanford he collaborated with Brian Cantwell in theoretical modeling of vortex pairs and vortex rings and helped advise students in fluid mechanics and experimental methods.

As his National Academy of Engineering biography reads: "Rott and his colleagues in Zurich developed a theoretical foundation for thermoacoustics, which has applications in refrigeration and ventilation, especially in space capsules, where thermo-oscillation is used to replace the natural convection that occurs in gravity environments."

Nicholas was also interested in nonlinear dynamics. Starting with mathematical theory, he used a double pendulum to illustrate this theory and, in the process, created a unique system that demonstrates regular and chaotic motion. His pendulum, developed as an exhibit in conjunction with Ned Kahn on the staff of the Exploratorium in San Francisco, is on display at the Exploratorium. For many years it has been the first exhibit that greets visitors when they enter the museum.

With respect to Prandtl's formulation of boundary layer equations in 1904, Nicholas made "fundamental contributions to the solution of many boundary layer problems, such as laminar boundary layer calculations on yawed wings, compressible, time-dependent and acoustic boundary layers as well as boundary layers in rotating flows."

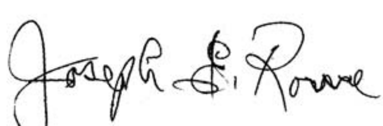
Nicholas wrote a landmark paper, published in 1956, in the first volume of the *Journal of Fluid Mechanics*. In this paper Nicholas proposed to parameterize vortex sheet spirals by their circulation and showed that this led to a particularly useful description of their motion. An analogous theory was given by Birkhoff in 1962 for the case of infinite vortex sheets. The resulting Birkhoff-Rott equation has influenced research to the present and can be used to provide a unified view of various approximations for the calculation of vortex sheet motion.

Nicholas collaborated with Harvey Lam of Princeton University on the theory of time-dependent boundary layers. Their results, in the form of the Lam-Rott solutions, have recently become a crucial ingredient in the analysis of boundary layer receptivity.

His daughter wrote:

> Nicholas played the cello and had a lifelong love for classical music. One of his grandsons became co-principal cellist at the State Opera Orchestra of Hanover, Germany.
>
> He translated the poetry of Rainer Maria Rilke as he felt the official translations did not do his favorite poet justice. He loved history and gave his children a world context for unfolding news.
>
> In his later years Nicholas took to riding a motorized tricycle around town, appreciating the mobility it gave him when he could no longer drive. Dainuri created a foundation in his father's name to promote hybrid tricycles for elders called Good Life Trikes, which has now developed into Good Life Mobility.

Nicholas Rott is survived by his daughter, Kathy Roselli of Ashland, Oregon; a son, Dainuri Rott of Palo Alto; five grandchildren; and seven great-grandchildren. He is fondly remembered by his family as "The Popster."



JOSEPH E. ROWE

1927–2002

Elected in 1977

"For contributions to the theory and design of high-power microwave electron tubes and solid-state microwave devices."

BY GEORGE HADDAD AND JONATHAN ROWE

JOSEPH E. ROWE, a leading pioneer in the development of microwave electron tube and solid state device technologies, and former vice president and chief scientist at Harris Corporation, Gould Corporation, and Pittsburgh Plate Glass, as well as former provost and dean of engineering at Case Western Reserve University and chair of electrical and computer engineering at the University of Michigan, died on October 23, 2002, at the age of 75.

Joe was born in Detroit on June 4, 1927, the son of an auto worker who emigrated from Cornwall, England, in 1920. Immediately upon graduation from high school, Joe enlisted in the U.S. Marine Corps and served in active combat in the Pacific theater. When his tour of duty ended in December 1946, Joe came home to study electrical engineering at the University of Michigan on the G.I. Bill. He always credited the Marine Corps with not only paying for his education but, more importantly, for teaching him the tough-minded discipline and unflagging work ethic that served him so well in his professional career. For the rest of his life, in all the best ways, Joe Rowe never stopped being a Marine.

Joe received his B.S.E. in electrical engineering and mathematics in 1951. In the summer of 1950 he married his college sweetheart, Anne Prine Rowe. Anne later distinguished herself as a University of Michigan metallurgical engineer (B.S.E., 1950; Ph.D., 1970), and she and Joe became the first couple to each receive distinguished engineering alumni awards from their alma mater. Joe and Anne were married 52 years. Their son, Jonathan, was born in 1954 and their daughter, Carol, in 1956.

Joe received his M.S.E.E. and Ph.D. in electrical engineering also from University of Michigan in 1952 and 1955 respectively, and promptly joined the university's engineering faculty—thus began the "academic phase" of his career. While at Michigan, Joe literally "wrote the book" on microwave electron tube devices and won the university's prestigious Distinguished Faculty Achievement Award in 1970 for his outstanding research and teaching and for mentoring scores of fine engineers. He served as director of the Electron Physics Laboratory from 1958 to 1968, where he managed and developed research programs in microwave electron tube devices, gaseous plasmas, and semiconductors. He was appointed chair of electrical and computer engineering in 1968 and served in that position until he left the university in 1974.

Joe was not only a first-rate scientist who made very significant technical contributions, he was also a great visionary and an astute businessman. He was a major pioneer in the area of microwave devices and, in particular, vacuum tube devices, such as traveling wave tubes and magnetrons, which are still in wide use today in many applications, including high-power communication and radar systems as well as microwave ovens. He wrote a book in 1965, *Nonlinear Electron Wave Interaction Phenomena* (New York: Academic Press), that to this day is a standard in the field.

Joe was an excellent researcher who published many seminal papers and supervised many Ph.D. students who went on to occupy leadership positions in academia and industry. After spending approximately 20 years on the faculty of the University of Michigan, serving as director of the Electron Physics Laboratory and chair of the department, he accepted the position of dean of engineering at Case Western Reserve University. He then went on to industry, where he held several important positions as vice president at Harris, Gould, Pittsburgh Plate Glass, and the Dayton Research Institute.

Under Joe's leadership, the Electron Physics Laboratory was one of the premier laboratories on campus and was the forerunner of the present Solid Sate Electronics Laboratory. During his years at Michigan, he also served as a consultant to several major industries and government laboratories.

Joe was truly an accomplished individual who made an impact during his long and distinguished career. In recognition of his accomplishments, he was elected a fellow of the Institute of Electrical and Electronics Engineers (IEEE), which is the highest honor for an electrical engineer. He was also elected a member of the National Academy of Engineering, which is the highest honor for any engineer. He served on many national committees, such as the Army Science Board and the Advisory Group on Electron Devices for the U.S. Department of Defense. He also chaired many conferences and symposia and provided excellent professional service to IEEE, the National Academy of Engineering, and other organizations.

In 1974, Joe became dean of engineering at Case Western, and soon thereafter was appointed provost. He very much enjoyed his time there, but in 1980 the Harris Corporation made him an offer he could not refuse—Harris bought Joe's "Shared Applications" business, which he had started while at Michigan to help in the design of electron tube devices, and, more importantly, gave Joe the opportunity to test his talents in the competitive world of private industry. This began the private-sector phase of Joe Rowe's career.

From 1980 to 1993, Joe worked as vice president and chief scientist, first at Harris in Melbourne, Florida, next at Gould Corporation in Chicago, and finally at Pittsburgh Plate Glass in Pittsburgh. For these three Fortune 500 companies, Joe was the perfect hire because he was able to apply his vast detailed academic expertise to their practical commercial engineering problems. For Joe, at a personal level, all three private industry jobs were immensely satisfying because they allowed him to engage fully both sides of his personality—the creative academic side and the hard-headed practical Marine side.

By way of one modest example, the next time you are in your car, and you think about how well your windshield keeps the heat out, compared to, say, your 1964 Dodge or even your 1985 Chevy, thank Joe Rowe because in the later stages of his career, Joe did a lot of truly outstanding work for Pittsburgh Plate Glass on glass and light refraction issues.

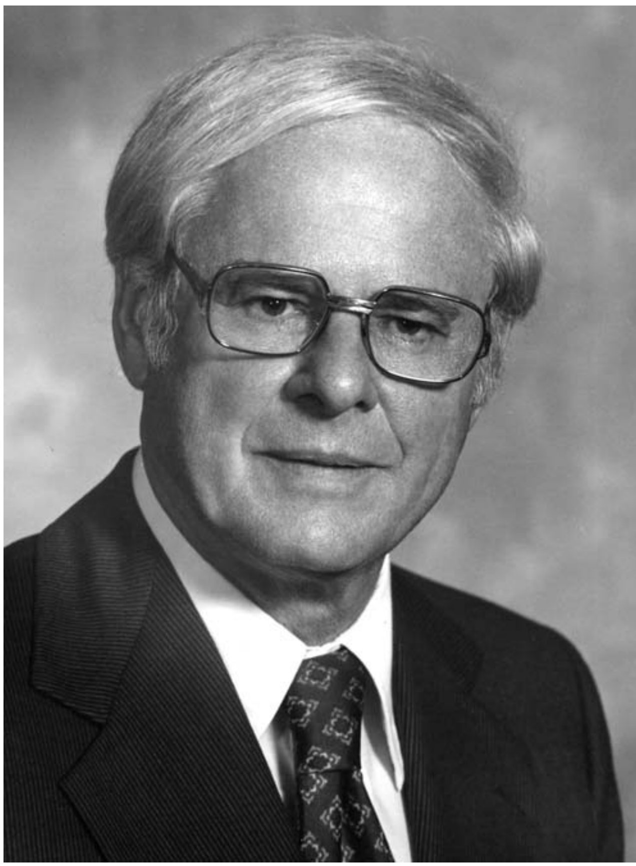
In 1993, Joe retired from the company, but retirement for him did not mean hitting golf balls in Florida. Instead, he accepted the position of director of the University of Dayton's Research Institute—what most people would regard as a full-time job, but for Joe, at age 66, it was a reduced schedule that afforded him the chance to get back to his first love: mentoring young engineers, as he had done a generation earlier at the University of Michigan.

Although Joe Rowe officially departed the University of Michigan in 1974, he never really left. He served in leadership roles on several fund-raising campaigns in the 1980s and 1990s. Later, in 2002, he and Anne endowed a faculty chair in electrical engineering and computer science (EECS) at the University of Michigan's Engineering College. Joe was also the first recipient of the EECS department's Distinguished Alumni Award. Perhaps most revealingly, official university records disclosed that, of the 324 home football games that Michigan played between 1946 and 2000, Joe attended approximately 300—despite living in Cleveland, Florida, Chicago, Pittsburgh, and Dayton during almost half of those years. Right to the end, Joe Rowe was a Michigan man, through and through. He was a very loyal alumnus and helped the department and the college on many occasions, particularly as a member of the national advisory committees for both and in development activities for the college. He was the first chair of the EECS Advisory Committee when it was established in 1986.

With all of Joe's accomplishments and superb professional career, he was always the most proud of his family and their accomplishments and often spoke about them. In particular, he was excited and pleased when Anne decided to enroll in the graduate program in chemistry and receive her Ph.D.

To Joe's great credit, he did not abandon his son Jonathan—the proverbial wastrel child—even when Jonathan decided to become a lawyer instead of an engineer (imagine Joe's dismay). Joe took great pride in Jonathan starting his own law firm, much as Joe had started "Shared Applications" a generation earlier. But Joe was most delighted when his daughter, Carol, was appointed director of engineering communications for the University of Colorado, Boulder. At least one acorn didn't fall so far from the tree.

It would be a great understatement to say that Joe Rowe is sorely missed, in all the many places where he plied his talents, by his family and friends, and of course most of all by his loving wife, Anne, and their children. Additional survivors included his father, Joseph, who succeeded him in death in 2005; his brother, Donald; and four grandchildren—Rachel, Alethea, Kyla, and Aaron. As the years go by, we who are left behind also realize, more and more, how much Joe taught us by his great example of unwavering personal integrity and plain old-fashioned hard work.



ROBERT W. RUMMEL

1915–2009

Elected in 1973

"For contributions to the integration of design and airline operational considerations in the development of economic transport aircraft."

BY JOSEPH SUTTER

ROBERT W. RUMMEL, space expert and aerospace engineer, died October 17, 2009. He was 94 years old. He had the "vision to understand what is required to face the future."

Bob was born in Dakota, Illinois, on August 4, 1915, to William Howard and Dora Elizabeth (Ely) Rummel. As a youth he became fascinated with aviation. He graduated from Mount Carroll High School and attended the Curtiss-Wright Technical Institute for Aeronautics in Glendale, California. He graduated in 1935 with a degree in aeronautical engineering and went to work for Hughes Aircraft Company as a stress analyst.

He worked for Lockheed Aircraft Corporation, Aero Engineering Corporation, National Aircraft Corporation, and Rearwin Aircraft, before starting as a senior engineer in 1943 with Trans World Airlines (TWA). He worked at TWA for 35 years and in 1969 was named vice president of technical development. While working at TWA, Bob was also a consultant on aviation affairs to Howard R. Hughes.

I first heard of Bob Rummel when I left the U.S. Navy in 1946. I was an aerodynamics engineer. Before the war, TWA bought the Boeing Stratoliner (the B307). These airplanes were called to war duty and were in the Air Transport Command. After the war they were given back to TWA. TWA made some major modifications to them, and Boeing and TWA recertified them to Civil Aeronautics Administration requirements. (The CAA was the forerunner to today's Federal Aviation Administration.) The Boeing engineer was Jack Steimer, who kept us up to date on the testing. Bob Rummel was the leader of TWA's efforts.

TWA then became very involved with several reciprocating engine airplanes. TWA was the lead airline in the development of the Lockheed Constellation airplane. Howard Hughes was a major owner of TWA at that time. Bob Rummel was head of the TWA effort to define the airplane and was the principal go-between for Hughes and Lockheed.

TWA then got into turbine-powered airplanes—first the 707 and 727 at Boeing. TWA also helped develop such airplanes as the Convair 880 and 990. Bob was head of engineering at that time and made a major contribution in defining the characteristics required for safe commercial operation. I got to know him better when TWA purchased and operated the Boeing 747 airplane. Again as head of engineering, Bob's input was helpful in defining the airplane. I retired from Boeing in June of 1986.

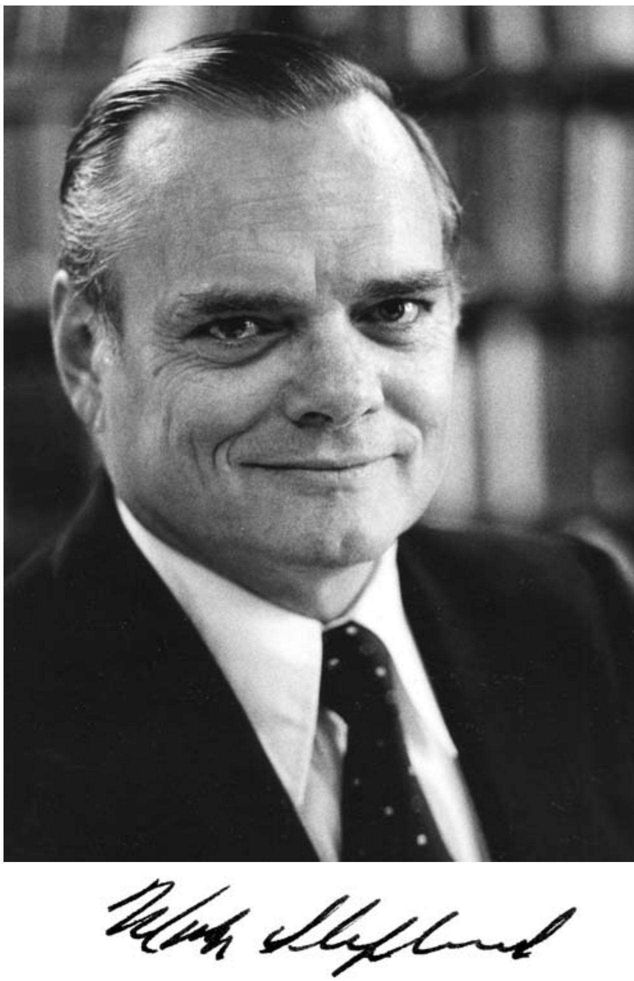
After retiring from TWA, Bob founded his own consulting firm—Robert W. Rummel Associates—before retiring to devote his time to writing.

Bob was appointed to the Presidential Commission on the Space Shuttle Challenger Accident, serving on the operations subpanel. I headed the design panel for the commission. The commission made 14 recommendations, which President Reagan told the National Aeronautics and Space Administration to comply with. I believe Bob and I were very helpful in developing these recommendations. For instance, an astronaut would review the readiness of the vehicle for launch. When shuttle operations were restarted, astronaut Bob Crippen was assigned launch approval duty. A chief of safety was established who reported directly to the NASA administrator. He and the astronaut assigned to the launch had to approve the launch. Bob Rummel served his country well.

Being the go-between for TWA and Howard Hughes was a task Bob performed for many years. Life as an engineer requires knowledge, the ability to deal with many people who have many interests, and the vision to understand what is required to face the future. Bob had the necessary attributes that made him a great engineer. I would urge everyone to read the book *Howard Hughes and TWA* written by Robert Rummel (Washington, D.C.: Smithsonian Institution Press, 1991).

Bob was awarded the NASA Distinguished Public Service Medal in 1979. He was a fellow of both the Society of Automotive Engineers and the American Institute of Aeronautics and Astronautics, and he was elected a member of the National Academy of Engineering in 1973. He served on a number of NASA committees and as chairman of the Aeronautics and Space Engineering Board of the National Research Council.

Bob is survived by his children, Linda Kay Yarbrough, Sharon Lee Barnes, Marjorie Susan DuBois, Diana Beth Gillespie, and Robert Wiland Rummel, Jr.; 10 grandchildren; and 13 great-grandchildren. His wife, Marjorie B. Cox Rummel, predeceased him in 2003.



MARK SHEPHERD, JR.

1923–2009

Elected in 1970

"For technological contributions and leadership in the growth of the semiconductor electronics industry."

BY THOMAS J. ENGIBOUS

MARK SHEPHERD, JR., whose leadership of Texas Instruments, Inc., spanned three decades, died on February 4, 2009, at his ranch in Quitman, Texas, at the age of 86.

A pioneer in the fledgling semiconductor industry, Mark's engineering and manufacturing know-how helped transition new technologies from the laboratory to mass production, sometimes years ahead of the competition. In the process he helped establish TI as one of the premier electronics companies. At various times beginning in the 1960s through his retirement in 1988, he led TI as chairman, president, chief executive officer, and chief operating officer.

Born in Dallas, Texas, on January 18, 1923, Mark was the only son of Mark and Louisa Shepherd. Wanting to give their son a head start, Mark's parents enrolled him in school at the age of 4. When most children entered elementary school, Mark was ready for the fourth grade. He showed an interest for technical things early in life, building his first crystal radio when he was about 7.

Mark's education continued at an accelerated pace. He graduated from high school at the age of 14. He then attended Southern Methodist University (SMU) on a scholarship, graduating with honors at the age of 19 in 1942 with a bachelor of science degree in electrical engineering.

After graduation, Mark joined the General Electric Company in Fort Wayne, Indiana. While in Fort Wayne, he met his future wife, Mary Alice Murchland, an event Mark described as the most important in his life. They married in December 1945 and went on to have three children: Debra Shepherd Robinson, Mary Kay Shepherd, and Marc B. Shepherd.

In 1943, Mark volunteered for the U.S. Navy. For three years he served as a lieutenant aboard the USS *Tucson* in the Pacific, where he specialized in radar and electronics maintenance. After completing his military service in the summer of 1946, Mark studied at the University of Illinois, where he received his master of science degree in electrical engineering in 1947.

Following graduation, Mark joined the Farnsworth Television and Radio Corporation in Fort Wayne, where he worked on engineering and development projects. In the spring of 1948, during a trip to Texas, he visited Geophysical Service, Inc. (GSI), the predecessor company of Texas Instruments. That visit put him on a career path that would shape the rest of his life. He joined GSI in May 1948.

Early on, Mark exhibited traits that were to exemplify his career, such as a willingness to work hard and drive himself and others to achieve extraordinary goals. His work and success on a magnetic anomaly detector project brought him to the attention of senior managers at TI.

In 1951, TI made the strategic decision to enter the semiconductor business and approached Western Electric for a license to manufacture transistors. After acquiring the license, a small team of TI engineers, which included Mark, attended a Bell Telephone Laboratories symposium in April 1952 to learn about transistor technology. Mark was charged with pioneering the development of transistor mass production. Under his direction, his team built a crystal puller in short order, besting the industry by two or three years. By the latter part of 1953, Mark's operation was mass producing grown-junction transistors, and Mark was promoted to chief engineer for semiconductor design. It was TI's first development effort in semiconductors.

Mark's dedication and ability to produce results brought increasing responsibilities. In 1954 he became assistant vice president and general manager of the semiconductor components division, and a year later he was promoted to vice president.

At that same time TI was producing germanium transistors, the company was trying to grow silicon crystals. In April 1954, TI succeeded in fabricating a grown-junction silicon transistor and by May announced that the silicon transistor was in production. Mark's next assignment was to produce silicon transistors on a commercial basis. He was a driving force in converting the technology from laboratory development into full-scale production in 1954, four years ahead of the competition. Under Mark's leadership, TI became the world's leading producer of semiconductors.

In 1958, Jack Kilby invented the integrated circuit at TI. The company demonstrated the device to the U.S. Department of Defense in late 1958 and sought converts to this new technology. The successful use of integrated circuits in the initial Minuteman missile program was a key element to their market acceptance. TI continued to produce and sell chips for later generations of the Minuteman program and eventually was able to sell similar devices in the commercial marketplace, once again bringing a new technology into the mainstream.

The 1960s saw the start of Mark's global executive responsibilities. In 1961 he became executive vice president and chief operating officer of TI, with responsibility for worldwide operations. He was elected to TI's Board of Directors in 1963, was named company president in 1967, became chief executive officer in 1969, and added the role of chairman of the board in 1976. Mark retired from active employment in 1985, though he remained chairman until 1988. He continued to serve as a general director until 1993.

Throughout the 1960s, Mark was a driving force in the establishment of TI's Asian operations, including those in Japan, Taiwan, and Singapore. Over the years, TI's worldwide operations grew throughout Europe, Latin America, and the

Asia-Pacific region, establishing it as one of the first global electronics companies.

Throughout the 1970s, Mark oversaw the growing diversification of TI and an increasing emphasis on vertical integration. An early example of this strategy was the company's successful entry into the consumer market with pocket calculators.

During the 1980s, Mark championed a more assertive stance toward the protection of TI's intellectual property against infringement by Asian semiconductor manufacturers. A series of lawsuits and trade actions before the International Trade Commission ultimately resulted in settlements that brought TI a steady stream of revenue and established a precedent not only for TI but throughout the industry for recognizing the true value of intellectual property that resulted from research and development.

In the 1970s, Mark emerged as a corporate statesman, sought after as an expert on topics such as free trade, U.S. competitiveness, and the role of multinational corporations. He was a consistent advocate of the American free enterprise system, a recurring theme in addresses and papers he delivered over the years.

Mark was actively involved with numerous professional organizations, often taking a leadership role. From 1976 to 1979, he served as chairman of the Advisory Council on U.S.-Japan Economic Relations (later known as the U.S.-Japan Business Council). He was a trustee of the Conference Board from 1975 to 1985, serving as chairman of trustees from 1980 to 1982. In 1983, Mark was named one of 30 members of the President's Commission on Industrial Competitiveness, an advisory group named by President Reagan to identify ways to increase the long-term competitiveness of U.S. industries in world markets, particularly in high technology.

Mark was also a strong advocate of high-tech higher education in the Dallas and North Texas region and a promoter of increased research and development at area universities. In 1984, then-Governor Mark White appointed Mark a member of the newly established Texas Science and Technology Council, charged with improving the state's position as a national leader in scientific and technical research and development.

Mark's contributions to the industry were acknowledged throughout his career. In 1962, *LIFE* magazine selected him, at the age of 39, as one of the 100 most important young people in the United States. *LIFE* recognized his role in leading the development of transistor mass production and in helping make TI the world's leading producer of semiconductors.

Mark was elected a member of the National Academy of Engineering in 1970 "for technological contributions and leadership in the growth of the semiconductor electronics industry." Alumni organizations at both SMU and the University of Illinois recognized Mark for his distinction. He was awarded an honorary doctorate of engineering from SMU in 1966 and another from Rensselaer Polytechnic Institute in 1979. He also received the Horatio Alger Award in 1984.

Mark perhaps summarized his legacy best when he recalled: "Not many people in their lives have the opportunity—and the privilege—of helping to build not only a company, but also an industry that has had as profound an impact on society as the semiconductor industry. I am grateful for that privilege."

He is survived by his widow, Mary Alice Shepherd, and three children.

RONALD SMELT

1913–2005

Elected in 1971

"For development of ingenious mathematical solutions to practical problems of aircraft and space vehicle design and testing."

BY ALAN BROWN

RONALD SMELT, or Roy as he was generally known, retired corporate vice president and chief scientist of the Lockheed Corporation, died on February 17, 2005, at the age of 91.

Roy was one of four children of Henry and Florence Smelt, born in the coal mining village of Houghton Le Spring in County Durham, England, on December 4, 1913. He was educated at King's College, Cambridge University, and earned B.A. and M.A. degrees in mathematics in 1935 and 1939, the latter while working at the Royal Aircraft Establishment in Farnborough, England. He completed his education in 1961, earning a doctorate in aeronautical engineering from Stanford University for his dissertation on determination of the drag characteristics of orbiting vehicles.

His career at the Royal Aircraft Establishment from 1935 to 1948 spanned the initial development of the jet engine and World War II and its aftermath. He worked with Sir Frank Whittle on the first flight of Sir Frank's jet engine while he was chief of high-speed flight from 1940 to 1945. Roy determined the characteristics of the German V-1 missile and how to combat it and was a member of the team that came to the United States to procure aircraft for Britain prior to the U.S. entry into World War II. From 1945 to 1948 he was head of the guided-weapons department, prior to his emigration to the United States in what is colloquially known as the postwar "brain drain."

Roy's first employer in the United States was the U.S. Navy Ordnance Laboratory, where he became deputy chief for aeroballistics research before leaving to become chief of the gas dynamics facility at the Arnold Research Organization (ARO), Tullahoma, Tennessee, where he worked from 1950 to 1957. In 1958 he joined the recently formed Lockheed Missiles and Space Company (LMSC) and stayed with Lockheed until his retirement in 1978.

His interest in wind tunnels at ARO sparked the development of high-temperature facilities at the LMSC research laboratories in Palo Alto, California, where he became director of research and was instrumental in turning that facility into one of the best of its kind in the aerospace industry. He moved on to become manager of the Discoverer space satellite system from 1959 to 1960, chief scientist from 1960 to 1962, and vice president and general manager of the space program division from 1962 to 1963.

From 1963 to 1978, Roy was chief scientist and a corporate vice president of the then-parent Lockheed Aircraft Corporation in Burbank, California. He was responsible for all corporate independent research and development, he established the Lockheed Research Council, and he arranged ties with other notable research facilities in the country, such as General Motors, Bell Laboratories, DuPont, and some U.S. Department of Defense establishments.

Roy was elected to the National Academy of Engineering in 1971 "for development of ingenious mathematical solutions to practical problems of aircraft and space vehicle design and testing." He participated in a number of activities for the National Aeronautics and Space Administration (NASA) and the American Institute of Aeronautics and Astronautics (AIAA). He was a member of the NASA Committee on Space Vehicle Aerodynamics from 1955 to 1966 and chairman of the Research Advisory Committee on Space Vehicles from 1966 to 1973. He was chairman of the Research and Technology Advisory Council from 1973 to 1977. Concurrently, from 1970 to 1974 he chaired the Technical Advisory Board to the U.S. Department of Transportation. He was also an honorary fellow of the AIAA, honorary director-at-large from 1966 to 1968, and a vice president in 1968, and he served two terms as president from 1969 to 1970. In 1978 he was the Guggenheim lecturer for the International Congress of Aerospace Sciences.

Dr. Smelt served on advisory committees for Stanford University from 1988 to 1989 and was on the advisory committee for the NASA–Stanford Center for Turbulence Research. He was also a member of the American Physical Society, a fellow of the American Astronautical Society, a fellow of the Cambridge Philosophical Society, and a fellow of the Royal Aeronautical Society. From the latter he received the Simms Gold Medal in 1962 for his paper on the Lockheed Agena satellite. He also gave an invited paper, "Looking Ahead in Aeronautics and Astronautics—A U.S. View," as part of the Royal Aeronautical Society Second Century Papers, in 1969.

Ronald Smelt married Marie Annita Collings on November 2, 1940. They had one son, David. Sadly, they both predeceased Ronald—Marie in May 1964 and David in October 2004. In January 1965, Dr. Smelt married Jean Lorraine Stuart, who, together with her daughter Anne and Roy's daughter-in-law Cheryl Smelt, survive him.


Joe M Smith

JOE MAUK SMITH

1916–2009

Elected in 1975

"For leadership in chemical reaction kinetics and thermodynamics and teaching of these subjects."

BY ALAN JACKMAN AND BEN MCCOY
SUBMITTED BY THE NAE HOME SECRETARY

JOE M. SMITH, professor of chemical engineering emeritus at the University of California, Davis, died at his home in Davis on June 7, 2009, at the age of 93. He was among a handful of educators who truly blazed new trails for chemical engineering in the 20th century. His groundbreaking textbooks on thermodynamics and kinetics have had profound influences.

Joe was born in Sterling, Colorado, on February 14, 1916. His family moved to Long Beach, California, when he was very young, and he was educated in the Long Beach public schools. At Long Beach Polytechnic High School, influenced by two outstanding teachers, he excelled at math and chemistry. Neither of his parents had a college education but his mother, in particular, was eager for Joe to attend college. When he was admitted to the California Institute of Technology (Caltech), his parents moved to Pasadena so that he could live at home and afford to attend college.

The decision to major in chemical engineering was the result of a process of elimination. Joe was not interested in mechanical drawing, civil engineering, or physics, but he loved chemistry and mathematics. So in his junior year he declared a major in applied chemistry, the name that Caltech used for its undergraduate chemical engineering program in those days, although it already offered graduate degrees in chemical engineering. Joe remembered the Caltech program as having been difficult. All chemical engineering classes were taught by either B. H. Sage or W. N. Lacey. They were the entire Caltech chemical engineering faculty at the time. Joe said that Lacey had a particularly strong influence on his career. It was Lacey who first introduced him to thermodynamics. He was also influenced by Lacey's Socratic teaching style, a style that Joe used for much of his career. He graduated in 1937 with a bachelor of science degree in applied chemistry.

Joe then took a job with the Texas Company (later Texaco and now Chevron) in its design department on the 21st floor of the Chrysler Building in New York. There, among other projects, he worked on the design of a "stabilizer" to remove low molecular weight hydrocarbons from a gasoline fraction. He was eager to return to California and moved to the Natural Gasoline Department of Standard Oil of California (later Chevron) in Santa Fe Springs. While there he worked on distillation and absorption to remove other hydrocarbon gases from methane. He spent about two years there before moving to Chevron's El Segundo refinery, where he worked on thermal cracking.

At this time, with almost four years of industrial experience, Joe found himself wanting more challenges and he decided to return to school. It was February 1941, and the United States was contemplating entering World War II. Some of his colleagues questioned his sanity for leaving a safe, deferred job to return to school and possible military service. Nevertheless, he headed off for doctoral studies at the Massachusetts Institute of Technology, the only school to which he applied. Fortunately, MIT wrote a note to his draft board and he received a deferment.

There were fewer graduate students during the war years and MIT followed a shortened academic calendar, so things moved very fast. Joe supported himself his first semester, after which he received a fellowship and a teaching assistantship. At the time, students sometimes had little choice on thesis projects. In Joe's case he was asked by W. K. Lewis to work on a project funded by the Chemical Warfare Service to study adsorption in gas masks, which became his thesis work.

Joe completed his dissertation in 1943 and accepted a position as an assistant professor at the University of Maryland. It was there that he met and married Essie McCutcheon. During his first year of teaching, a position opened at Purdue University. Joe was attracted to Purdue by the opportunity to develop a teaching program in chemical engineering thermodynamics. He had taken advanced thermodynamics courses at Caltech from Sage and at MIT from J. A. Beattie (of the Beattie-Bridgeman equation of state) and was excited by the opportunity. So he moved to Purdue University in 1945. In developing a new course in thermodynamics for undergraduate chemical engineers, he discovered that there was no appropriate textbook for undergraduate chemical engineers and started writing *Introduction to Chemical Engineering Thermodynamics* (New York: McGraw-Hill, 1949).

Joe spent 12 years at Purdue University, and he fondly recalled this period as the most satisfying years of his teaching career. It was during those years that he developed his teaching style and an interest in reaction kinetics and reactor design that would remain the focus of his research for the rest of his career. He wrote another text, *Chemical Engineering Kinetics* (New York: McGraw-Hill, 1956).

By 1957, Joe had become well known and was sought for various positions. He decided that it might be interesting to try his hand at administration, and so he accepted a position as dean of technology at the University of New Hampshire. He quickly realized that the role of a dean did not suit him well. After a year in that post, he decided to move on. He accepted a position as chair of chemical engineering at Northwestern University, moving there in 1958. This was a period of rapid change and Joe hired several new faculty members who would profoundly change chemical engineering at Northwestern.

In August 1961, eager to return to California, Joe accepted an offer from the University of California, Davis, to help found a college of engineering. Because such a college did not yet exist, Joe started his UC Davis career as a member of the Food Science and Technology Faculty in the College of Agriculture. In 1962 the regents authorized the College of Engineering, and

Joe's appointment shifted to the new College of Engineering almost transparently. He became the founding chair of the Department of Chemical Engineering and remained at UC Davis until he reached UC's mandatory retirement age in 1986. He maintained an active research program long after his retirement.

Joe was one of the most influential chemical engineering educators in the history of the profession. He started his academic career near the end of World War II, a time of great change in chemical engineering. Shortly after arriving at Purdue, he started writing *Introduction to Chemical Engineering Thermodynamics.* Drafts of the text were used at Purdue until 1949, when the first edition was published. Hendrick Van Ness joined him as coauthor of the second edition, published in 1959. More than 60 years later and in its seventh edition, with third coauthor M. M. Abbott, this volume is still in use and is by far the best-selling textbook in the history of chemical engineering. While still at Purdue, Joe wrote a second textbook, *Chemical Engineering Kinetics,* which also became the seminal text in the field, significantly changing the way chemical reaction engineering is taught.

Over the years Joe won numerous awards and honors, including most of the major American Institute of Chemical Engineers awards: the R. H. Wilhelm Award in Chemical Reaction Engineering, the Warren K. Lewis Award for Chemical Engineering Education, and the William H. Walker Award for Excellence. Joe was proudest of the American Society of Engineering Education's Union Carbide Lectureship Award (1970) and his admission to the National Academy of Engineering (1975).

Joe loved teaching, and students appreciated his individualized approach to education. His teaching style was greatly influenced by one of his professors at Caltech, and many of his students are now professors and emulate his style. Joe's influential textbooks are testaments to his commitment to teaching.

Joe was very humble about his accomplishments and contributions. When asked to explain how he had become so successful, he attributed it to his many very bright and hard-working graduate and postdoctoral students who "did the real work" and to his wife, Essie McCutcheon Smith, whose flexibility allowed him the freedom to pursue his teaching and research. With respect to *Introduction to Chemical Engineering Thermodynamics*, as noted above, Joe thought that he was simply in the right place at the right time. Could it be that some people are able to define the right place and the right time?

Joe and his wife endowed the Joe and Essie Smith Chair in Chemical Engineering in 1996 at UC Davis. The chair is dedicated to the support of outstanding young faculty members.

Joe is survived by his two daughters, Rebecca Conrad and Marsha Torbert; six grandchildren; one great-grandchild; and an untold number of academic children and grandchildren.

GLENN W. STAGG

1923–2009

Elected in 1997

"For the development of computer simulation techniques and their application to the economic planning and operation of power systems."

BY ARUN PHADKE

GLENN W. STAGG, a pioneer in developing computer applications in power system engineering, was born on August 28, 1923, in Brooklyn, New York. He passed away on August 27, 2009, at the age of 86. To quote his daughter, "Dad passed away the morning of August 27 (the day before his 86th birthday). He had gone down the street to the Deli for his morning walk and coffee, came home and was gone."

Glenn attended the Massachusetts Institute of Technology (MIT) under the G.I. Bill following combat service in the U.S. Army during World War II. He graduated from MIT in 1946 with a bachelor's degree in electrical engineering and went to work for the American Electric Power Service (AEP) the same year. Later he received an M.B.A. from New York University. In the years that followed, his name became synonymous with the application of digital computers to power system simulation and control.

The most important power system application, requiring considerable time and effort on the part of power system engineers, was the "load flow." This most basic of all engineering calculations was performed using analog models of the power system known as "network analyzers." Because of the physical size of these models, the power systems that could be studied with them had to be of modest size, and as interconnected power networks grew in size, the answers provided by the analog models were not satisfactory. Glenn Stagg was at the forefront of the development of computer-based load flow programs that did not suffer from the many shortcomings of the analog techniques. In 1957 the first successful large-scale load flow computer program was completed. The network analyzers were retired soon after the development of this program.

Other application program developments quickly followed the success of load flow. Under Glenn Stagg's leadership as the head of the computer applications department at the AEP in New York City, a whole suite of power system applications programs were developed that remain the foundation of all computer applications in power system engineering.

The culmination of these developments was the book *Computer Methods in Power System Analysis* by Glenn Stagg and Ahmed El-Abiad (New York: McGraw-Hill, 1968). My first contact with Glenn was around 1964–1965, when I took a course at Purdue University that was being taught by Glenn and Dr. El-Abiad. Their book was not yet published; it was being used as the course textbook but in draft form. The course was soon moved to the University of Wisconsin in Madison. Although Stagg and El-Abiad are no longer with us, some version and derivatives of the course they started have been offered in Madison continuously for more than 40 years.

Along with Professor Reitan of the University of Wisconsin, I had the good fortune to be asked to review the draft of the Stagg–El-Abiad book. After its publication, the book was recognized as groundbreaking in that it brought together in one place the techniques of power system analysis, computer algorithm developments, and numerical methods for solving algebraic and differential equations. The book reigned as the principal reference on the subject for over 30 years and is still the only authoritative source on many specialized topics in the subject.

Glenn Stagg spotted talent in young colleagues and coworkers and populated the computer applications department with young coworkers who became industry leaders in their own right. As the demand for Glenn's talent began to go beyond the environs of the AEP, Glenn formed the power engineering consulting company (Stagg Systems, Inc.) in 1970 and remained its president and chief executive officer until 1992. After his retirement from Stagg Systems in 1992, he became a consultant to the World Bank and later served as an energy specialist and an independent consultant to various power engineering companies throughout the world.

Apart from the Stagg–El-Abiad book, Glenn authored or coauthored over 30 technical papers on various aspects of computer applications in electric power engineering that are among the classics of the genre. Glenn was elected a fellow of the Institute of Electrical and Electronics Engineers in 1992 and was elected to the National Academy of Engineering in 1997. He received an Honorable Mention Award for Outstanding Young Electrical Engineer by the honorary society Eta Kappa Nu in 1957.

Glenn enjoyed art and history and he collected antiques. He truly enjoyed working on power system engineering problems, and he enjoyed the opportunities it gave him to do the things he enjoyed, such as traveling and meeting new and interesting people. He served during World War II and became a collector of military memorabilia also. When he was younger, he played football, and it remained his favorite sport throughout life. He was a devoted fan of the Brooklyn Dodgers and of the New York Jets. He enjoyed working on his home and did carpentry work and landscaping in his spare time. Glenn had a younger brother Ronald who was a doctor of biology and a professor at Hartwick College in Oneonta, New York. Ronald passed away several years ago of cancer. Ronald had five children, who are scattered throughout the United States. Glenn is survived by his wife, Oksana; his first wife, Eleanor; and their three daughters, Joan, Janet, and Virginia; two grandsons, John and Scott; and three granddaughters—Jennie, Janet, and Katherine.


Chauncey Starr

CHAUNCEY STARR

1912–2007

Elected in 1965

"Pioneer in development of atomic power."

BY CHRIS WHIPPLE

CHAUNCEY STARR, a physicist and nuclear energy expert, died on April 17, 2007, three days after his 95th birthday and a day after a celebration in his honor at the Electric Power Research Institute, where he was president emeritus. At the time of his death, he still went to his office at EPRI five days a week.

Chauncey Starr was born on April 14, 1912, in Newark, New Jersey. He attended the Rensselaer Polytechnic Institute, receiving an electrical engineering degree in 1932 and a Ph.D. in physics in 1935. He became a research fellow in physics at Harvard University, working with Nobelist P. W. Bridgman in the field of high pressures; then he worked as a research associate in cryogenics at the Massachusetts Institute of Technology. His work involved characterization of the magnetic properties of metals at very low temperatures and included a 1941 publication on the design of hydrogen liquefiers.

During World War II, Chauncey worked with E. O. Lawrence on the Manhattan project at the Berkeley Radiation Laboratory. He was sent by Lawrence to Oak Ridge, where he was the first operations manager of Building 9731, the first building to operate at the Y-12 plant and the first to have operating calutrons—large electromagnetic devices used to enrich uranium.

Following the end of the war, Chauncey stayed at Oak Ridge and worked at Clinton Laboratories (now Oak Ridge National Laboratory), where he became interested in the application of nuclear energy for electricity generation. This is where he was first involved with water-cooled reactors. He joined North American Aviation and became president of the Atomics International Division, which worked on the development of nuclear power for the Atomic Energy Commission. During this time, Chauncey was responsible for development of the sodium-moderated reactor, organically moderated reactor, and systems for nuclear auxiliary power (SNAP), small reactors to provide power for spaceflights. The SNAP-10A was the first U.S. nuclear reactor to be launched into space.

In 1966, Chauncey Starr became dean of engineering and applied science at the University of California at Los Angeles. While at UCLA, Chauncey wrote "Social Benefits Versus Technological Risk," published in *Science* in 1969. In this highly cited paper, Starr anticipated the development of risk analysis for technological systems and explored the question of "How safe is safe enough?" by evaluating risks and benefits from widely accepted technologies. Through his review of patterns of risk taking, Starr observed that much larger risks are accepted when they are taken voluntarily, in contrast to those that are involuntary. As Starr put it, "We are loath to let others do unto us what we happily do to ourselves."

Chauncey believed that the role of energy, particularly in the form of electricity, was a catalyst to societal development, and in September 1972 he wrote an article titled "Energy, Power and Society," which appeared in *Scientific American.*

In 1973, Starr became the founding president of EPRI, a nonprofit research institute funded by the electric utility industry. Prior to the creation of EPRI, most electric power utilities, with a few exceptions, did little research and development (R&D) but instead relied on equipment vendors for R&D. For several reasons, including the 1965 blackout in the northeastern United States and rapid growth rates in the demand for electricity, some members of Congress saw the low investments in R&D as a problem that could be fixed by creating a new government organization. The electric utility industry asked for a chance to form such an organization, and EPRI was the result. Under Chauncey's original design, EPRI had four operating divisions: nuclear power; advanced coal and all other generation technologies, including renewable; electrical systems, covering transmission and distribution; and environment and economics. In 1978, Chauncey became vice chairman of EPRI and in 1987 was named as the institute's only president emeritus. Following the 1979 accident at the Three Mile Island nuclear power plant, Chauncey was asked by the nuclear power industry to design the initial organizational plan and scope of the Institute of Nuclear Power Operations.

In 2001 (60 years after his publication regarding the liquefaction of hydrogen), Chauncey made a presentation at an American Nuclear Society meeting in which he proposed a continental superconducting supergrid, in which electricity would be delivered, along with liquid hydrogen. He continued to work on this concept with colleagues and coauthored a 2006 *Scientific American* article on the subject.

Among his many public and professional activities, Chauncey served on at least 18 boards and advisory committees, including service for the U.S. Department of Defense, U.S. Department of Energy, Office of Technology Assessment, Atomic Energy Commission, National Aeronautics and Space Administration, ENC, People's Republic of China, National Council on Radiation Protection and Measurements, President's Scientific Advisory Committee, Office of Science and Technology Policy, National Academy of Engineering, National Academy of Sciences, and four universities. He served as vice president of the National Academy of Engineering; as a fellow, founder, director, and president of the American Nuclear Society; as a consulting professor at the Stanford School of Engineering; and as a member of the Rockefeller University Council. In 2004, Starr donated $2 million to Resources for the Future to fund a chair in risk analysis that bears his name.

Over his long and productive career, Chauncey received many awards and honors. These included an honorary doctorate of engineering from Rensselaer Polytechnic Institute

(1964); election as a foreign member of the Royal Swedish Academy of Engineering Sciences (1973); the Atomic Energy Commission Award for Meritorious Contributions to the national atomic energy program (1974); the Pender Award for Outstanding Research Director of 1975, from the University of Pennsylvania; nomination to the rank of officer in the French Legion of Honor in recognition of efforts to promote and further understanding between France and the United States in the field of scientific and industrial achievements (1978); the Walter H. Zinn Award from the American Nuclear Society for outstanding contributions to the advancement of nuclear power (1979); the Founder's Award of the Seventh Energy Technology Conference in recognition of scientific planning and management talents leading to successful establishment of innovative concepts of industry-wide energy technology R&D, from EPRI (1980); an honorary doctorate of engineering from the Swiss Federal Institute of Technology (1980); the Henry D. Smyth Award from the Atomic Industrial Forum, Inc., for contributions to nuclear energy (1983); the Distinguished Contribution Award of the Society for Risk Analysis for contributions to risk analysis (1984); an honorary doctorate of science from Tulane University (1986); the "Tommy" Thompson Award from the American Nuclear Society, for contributions to nuclear reactor safety (1988); the Rockwell Medal by the International Technology Institute, for excellence in technology and contributions to the betterment of mankind (1988); the United States Energy Award from the United States Energy Association for long-term contributions to energy and to international understanding (1990); the National Medal of Technology from President George H. W. Bush for contributions to engineering and the electric industry (1990); the George E. Pake Prize by the American Physical Society for visionary leadership and physics contributing to the establishment of a worldwide nuclear power industry for peaceful purposes (2000); the George C. Laurence Pioneering Award by the American Nuclear Society for outstanding pioneering contributions to nuclear reactor safety (2006); and the Arthur M. Bueche Award from the National Academy of Engineering for leadership in the development of nuclear power, contributions to the creation of the field of risk analysis, and leadership in electric power R&D as the founding president of EPRI (2006).

Chauncey was a vigorous and dedicated outdoorsman. He swam regularly in the pool at his home. He hiked and backpacked throughout the Sierra Nevada Mountains, including a moonlight ascent of Mt. Whitney and crossing of the Palisades Glacier. He skied avidly in both California and the Alps, dissuaded only at last by a second broken leg. Following the move from UCLA to EPRI, Chauncey and Doris switched from season tickets to UCLA's men's basketball games to the Stanford women's team, and both agreed that they enjoyed the women's games more.

When he passed away, Chauncey was survived by his wife of 69 years, Doris Starr (of Atherton, California); two children, Ariel Wooley (of Los Altos) and Ross Starr (of San Diego); and five grandchildren.

ROBERT C. STEMPEL

1933–2011

Elected in 1990

"For outstanding contributions to automotive emission control, fuel economy, and safety engineering, and leading the integration of such developments."

BY BETSY ANCKER-JOHNSON AND BRUCE MACDONALD

ROBERT C. STEMPEL, a brilliant engineer, a compassionate leader, and an innovative team builder who led General Motors Corporation through the tumultuous years of the 1970s, 1980s, and early 1990s, died May 7, 2011, at the age of 77. He was the first engineer to lead General Motors when he succeeded Roger Smith as chairman and chief executive officer in 1990.

Bob, as he was generally called, was born in Trenton, New Jersey, on July 15, 1933. His interest in automobiles went back to his high school days, when he began work as a mechanic in an automotive repair garage. While continuing to repair cars and trucks to help pay for his engineering training, he earned a B.S. in mechanical engineering from Wooster Polytechnic Institute in Massachusetts. Fifteen years later, while working full time, he received an M.B.A. from Michigan State University. Upon graduating with his mechanical engineering degree, Bob was employed by the General Electric Corporation in its Wire & Cable Division. In January 1956 he began active service with the U.S. Army as a lieutenant in the Corps of Engineers at Fort Belvoir, Virginia. He was part of the team that developed a mobile liquid oxygen generating unit to fuel liquid rockets.

Bob decided to become involved in the design and manufacture of vehicles—hence his decision in 1958 to join the Oldsmobile Division in Lansing, Michigan, in an entry-level engineering job. He was given increasing responsibilities as senior designer, transmission design engineer, motor engineer, and assistant chief engineer. These jobs resulted in "automotive firsts" that we all expect now in our new cars and trucks, such as improvements in fuel storage systems that resulted in safer and more crashworthy designs and the first actions to reduce emissions from automobiles, such as the positive crankcase valve system that reduced unburned hydrocarbons by 30 percent. He was a member of the team that introduced the first modern front-wheel-drive car, the 1966 Oldsmobile Toronado, which established the practicality and durability of this vehicle drive system. He designed the front and rear suspensions and developed a unique application of an automatic transmission through a chain-link drive. His foresight in recognizing the value of "simultaneous" engineering by bringing tooling, manufacturing, assembly, and engineering together on this project was prophetic. This work contributed significantly to the impetus for fuel-efficient front-wheel-drive vehicles.

Bob's engineering leadership flourished when he was named a special assistant to GM President Ed Cole in 1973. He led the team that developed, manufactured, and introduced into production the catalytic converter system (CCS) installed on all GM cars in 1975 and used by virtually all car manufacturers today. The CCS provided major reductions in exhaust emissions and significant gains in fuel economy.

Bob was always interested in improving automotive safety. He guided the design and location of fuel tanks in rear-wheel-drive cars. His insistence on superior safety performance on this project left no doubt as to his commitment to safety. He engaged in the development and installation of rear-seat safety belts and fostered antilock brakes as standard equipment on GM cars and trucks in the late 1980s.

He was assigned to the engineering department of the Chevrolet Division, first as chief engineer for engines and components and in 1975 as director of engineering. During this time he participated in the development of the fuel-efficient, transverse, front-wheel-drive powertrain configuration introduced in 1980 and used by most manufacturers of front-wheel-drive cars today. He also encouraged the development of electronic computer-controlled fuel and ignition systems that minimize engine emissions while maximizing fuel efficiency.

Bob was a visionary engineer who enjoyed leading-edge technologies. He helped develop the world-record-setting solar power car "Sunraycer," which won the race across Australia (1,950 miles) in 1987. This General Motors experimental project led to the development of the very efficient electric car known as the Impact.

Bob rose swiftly as a manager at GM: general manager and vice president in charge of the Pontiac Motor Division; managing director of Adam Opel and head of GM's European operations; general manager and vice president in charge of Chevrolet; and GM executive vice president. He continued to be heavily involved in advanced battery technology that eventually led to the Chevrolet Volt electric car, currently the fuel economy leader as noted by the U.S. Environmental Protection Agency.

He retired from GM in 1992 and was named chairman of Energy Conversion Devices (ECD) in 1995. At ECD he led the development of renewable energy technologies such as lightweight flexible solar panels, nickel metal hydride batteries, hydrogen storage systems, and fuel cells. In 1999, Bob led the partnership with Intel Corporation to produce the joint venture Ovonyx, Inc. The company then developed a nonsilicon-based memory for electronic devices used by Intel, Samsung Electronics, and BAE Systems. A year later ECD formed three more joint ventures with Texaco Energy Systems, GE Plastics, and Belgium-based N. V. Bekaert S.A. He retired from ECD in December 2007 but continued to work as a consultant on new technologies and product development around the world.

Bob was well liked and respected within the auto industry and in the press corps for his deep knowledge of engineering and his genial, low-key manner. He had the great ability to reach out to people and make them feel important. He was at home in business councils and with the leadership of GM's Board of Directors, comfortable hosting dignitaries such as President Bush on new solar technology, at ease with fellow engineers on the test track, and comfortable with his dealers, and he always looked for new solutions with the academic community through such programs as the Sunrayce global competition.

Throughout his career, Bob continued to support many engineering associations and at the time of his death was a fellow of the American Society of Mechanical Engineers, a fellow of the Society of Automotive Engineers, and a fellow and past president of the Engineering Society of Detroit. Also, he was chairman of the Great Lakes Council of Industries, whose mission is to provide industry with the water it needs while improving water quality in the Great Lakes basin. Also, at his death he was a member of the Electric Drive Transportation Association's Board of Directors. He worked closely with the American Society for Quality Control, helping provide a national, long-range focus on quality, including emphasis on applied research and education. As a longtime student of Dr. W. Edwards Deming, Bob was committed to quality in every aspect of business activities and the concept of teamwork in the workplace.

Bob was also active in community educational and charitable organizations. He held such positions as trustee of the Detroit Country Day School, advisory council member of Junior Achievement of Detroit and Southeastern Michigan, director of the Michigan State University Business Alumni Association, advisory board member of the university's International Business Development, and trustee of the university Research Association. Bob was also director of the Economic Club of Detroit and received the Leadership Award from the Engineering Society of Detroit. In 2001 he was awarded the Soichiro Honda Medal for technical and business leadership in the automotive industry and for his role in the development of the catalytic converter and nickel metal hydride battery. In 2002 he received the Golden Omega Award for leadership in the automotive industry.

Despite the demands of his engineering leadership in such areas as the catalytic converter, Bob always had time for a journalist, a car enthusiast, or a GM owner who happened to meet him. He was known to be one of the rare auto executives who maintained a "double-booked" schedule but never shunned a visitor. Bob was known as the "driver," but he never sought the limelight. He always deferred to the team, to his fellow engineers, to manufacturing engineers, or to sales executives to be the center of attention.

When GM introduced the X car in the 1980s in Phoenix, Bob was tapped to be the lead GM vice president to introduce the vehicle as the general manager of Pontiac. The media plan was to have journalists drive cross-country in the new vehicles. Much to the surprise of the GM public relations team, Bob invited himself to go on the ride, something no vice president had done in the past. The journalists were impressed, and Bob's personal touch paid off because Pontiac received top reviews on the new Phoenix.

When Pontiac introduced the revolutionary Fiero, a two-seat sportscar, GM decided to showcase the actual assembly process by having a simulated assembly line at the Detroit Auto Show. The "stars" of the Pontiac exhibit were actual hourly employees, and the schedule called for a number of GM officers to shake hands together and then reach out to the hourly team. Not Bob. He bypassed the officer group and went directly to the hourly team first; the assembly build was the highest-quality launch in recent memory.

Bob was always in tune with the needs of GM's people and was one of the most loved and respected members of GM's management. Bruce MacDonald, Bob's vice president of communications, noted that Bob's brilliance was tempered with a kind, gentle leadership style that was always engaging. When Desert Storm started, MacDonald, who was the ranking reserve U.S. Army General at GM, was summoned to Bob's office and told: "You and your soldiers take care of the war. We will take care of your jobs and your families." He is greatly missed by all who knew him.

Bob is survived by his wife Pat (nee Patricia Bachman), daughter Barbara, and sons Timothy and Peter.

CLARENCE A. SYVERTSON

1926–2010

Elected in 1981

"For outstanding contributions in aerospace engineering, sound guidance of research and technology programs, and innovative institutional guidance."

BY WILLIAM F. BALLHAUS, JR., AND GLENN BUGOS

CLARENCE A. SYVERTSON, or "Sy" to his friends, was an extraordinary engineer and leader. He was a pioneer in hypersonic aerodynamics, both theoretically and experimentally, and led one of America's great research institutions.

Syvertson was a native of Minneapolis, born January 12, 1926. He earned his bachelor's degree in aeronautical engineering (with distinction) from the University of Minnesota in 1946, served as a private for a year in the U.S. Army Air Corps, and then earned a master's degree in 1948. Sy kept in touch with his friends at the university and throughout his career mentored its graduates. The University of Minnesota awarded him an Outstanding Achievement Medal in 1982 and an honorary doctorate in 2004.

Syvertson arrived at the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics (NACA) in 1948 as an aeronautical research scientist in Harvey Allen's high-speed research division. At Ames he joined a famous group of aerodynamicists who extended aeronautics beyond the supersonic and into the hypersonic regime. As a NACA aerodynamicist, Sy matched his theoretical insights on hypersonic airflow with brilliant experimental work. In 1951, after three years at Ames, he became assistant chief of the 10-

by 14-inch wind tunnel branch. This was the first hypersonic tunnel at Ames, capable of speeds varying from Mach 2.7 to 6.3. His early research on asymmetric nozzle contours of variable Mach number proved critical to the design of new hypersonic wind tunnels for NACA. He developed a new aerodynamic theory of second-order shock expansion that was used to predict the stability of slender vehicles flying at hypersonic speeds, including missiles and rockets like the Polaris and Aerobee. The American Institute of Aeronautics and Astronautics (AIAA) Lawrence Sperry Award in 1957 recognized the value of Sy's early work on hypersonic flows.

As a successor to that tunnel, Sy and Alfred Eggers designed the 3.5-foot hypersonic wind tunnel, capable of tests between Mach 5 and 14. The tunnel was a blow-down one, with air heated through a pebble bed heater to prevent liquefaction. Sy became chief of that branch in 1959, as the tunnel became the center of heat transfer studies for reentry vehicles, including the Apollo capsule. The aerothermodynamics database for detailed Space Shuttle design was later compiled in this tunnel, and more than a quarter of all wind tunnel testing done for the Space Shuttle was done there. With his colleagues in this tunnel, Sy did early sketches of some vehicles that the National Aeronautics and Space Administration (NASA) still hopes to build, such as hypersonic skip gliders, direct-to-orbit spacecraft, and hypersonic transports. Sy and Eggers did work underlying the design of the XB-70 *Valkyrie*, an experimental bomber capable of Mach 3, as well as the M2 lifting bodies, the research precursors to the Space Shuttle orbiter. His work on the M2 was recognized with a 1964 NASA Inventions and Contributions Award. With Eggers he also wrote an influential chapter on hypersonic flow for the *Handbook of Engineering Mechanics* (New York: McGraw-Hill, 1962).

In 1963 he established and led the Mission Analysis Division, an elite think tank located at Ames but organizationally part of the NASA Headquarters Office of Advanced Research and Technology. Sy's group defined future aircraft and space missions for NASA as well as the long-term research needed to achieve those goals. There he continued refining concepts for hypersonic flight and did early studies of a human mission to Mars, focusing on atmosphere entry and landing. Sy was a natural engineer. He loved to build model railroads and, even at home to relax, he built a model town with a railroad running through it.

Syvertson joined the ranks of Ames senior leadership in 1966, soon after Harvey Allen became director. As director of astronautics, Sy led much of the center's research in the physical sciences relevant to space travel. His purview included development of spacecraft, hypersonic aircraft, and thermal protection systems for reentry vehicles, as well as sophisticated facilities in which to test them. He also had managerial responsibility for basic research into spacecraft structures, thermal and gas dynamics, space science, and planetary atmospheres, including the success of the Apollo Lunar Surface Magnetometer and other spaceborne instruments.

In 1969, newly arrived Ames Director Hans Mark tapped Sy to serve as his deputy director. Soon after, though, from 1970 to 1971, Sy took a detail to Washington, D.C., to serve as executive director of the Civil Aviation Research and Development Policy Study, in the Office of the Secretary of Transportation. This study examined the economic, social, and environmental contexts of civil aviation—including aircraft noise, congestion, air traffic control, and airport capacity—and set the agenda for aviation research in NASA and around the nation. The report was hailed as a milestone in national policy for civil aviation research, and Sy was awarded NASA's Exceptional Service Medal in 1971.

Back at Ames, Sy took care of institutional management, while Hans jetted back and forth to Washington to open new research venues for the center. It was a time of rapid change for the center, as Ames pushed into new areas of expertise in computing and the life sciences and built alliances with new types of partners. As a leader, Syvertson was renowned for his ability to build consensus—to take opposing points of view and find common ground to allow compromise. "Sy embodied the best of Ames," remembers his friend Jack Boyd. "He was a brilliant scientist, an innovative leader, who assembled a dedicated and motivated staff and left them free to forge ahead."

When Mark departed Ames on July 7, 1977, Syvertson became acting center director. In April 1978, NASA Administrator Robert Frosch flew to Ames to remove "Acting" from his title and Syvertson became the center's director. Today, the main auditorium at NASA Ames has been named in Sy's honor, in part because he appreciated the community-building value of scientific talks, and on that day the room erupted in a standing ovation when Frosch announced Sy's promotion. Sy brought new energy to the center's programs, and the center continued to blossom as a world-class research organization. He directed the choice of engineering opportunities of national significance. He expanded collaborative programs with the U.S. Army, U.S. Navy, Defense Advanced Research Projects Agency, and Federal Aviation Administration. In aeronautics, Ames people expanded their research into air traffic control; vertical-lift aircraft, such as XV-15 tilt-rotor aircraft and the RSRA X-wing; and other advanced rotorcraft. Ames provided comprehensive test support for the aerodynamics and thermal protection systems of the Space Shuttle.

In the space sciences, Ames prepared the Galileo probe for its journey to Jupiter, flew the Kuiper Airborne Observatory, and developed the telescope for the infrared astronomical satellite, a joint project of the Netherlands, Great Britain, and the United States. In 1981, NASA Headquarters consolidated the Dryden Flight Research Center into Ames, to help it operate more efficiently, and Syvertson managed both laboratories. The Numerical Aerodynamic Simulation Facility was designed while Sy was director, and it later grew into a supercomputing center of national significance. The 40- by 80-foot wind tunnel was updated and an 80- by 120-foot test section was added, making it the largest wind tunnel in the world. Ames expanded its research program in human factors and built the Manned Vehicle Systems Research Facility. The search for extraterrestrial intelligence became a key component of NASA's work in exobiology. It was a golden age of intensive research, brilliant new ideas, and the energetic consolidation and expansion of the center's unique specialties.

Sy enjoyed a distinguished 35-year career at Ames, retiring in January 1984. In retirement he focused on educating the next generation of space explorers. He served as consulting professor at Stanford University and served on the boards of the National Space Club, the West Valley–Mission Colleges District, the California History Center at De Anza College, and United Way of Santa Clara County. Sy earned many awards for his service to NASA and to space exploration. He was elected a fellow of both the AIAA and the American Astronautical Society. He earned NASA's highest award—the Distinguished Service Medal—in 1984 and is a member of the NASA Ames Hall of Fame. His contributions to both aeronautical science and building Ames still resonate long after his departure. Those of us who were fortunate to work for him remember Sy as a great technical leader and an even better human being.

Sy died on September 13, 2010. His first wife, Helen, died in 1981, and he is survived by his wife JoAnn and his daughters Marguerite and Lynn Ann.

AL F. TASCH, JR.

1941–2004

Elected in 1989

"For outstanding contributions to semiconductor memory technology."

BY LOUIS C. PARRILLO

AL F. TASCH, JR., Cockrell Family Regents Chair Professor at the University of Texas at Austin and truly a giant in the semiconductor industry, passed away at Seton Medical Center in Austin on November 30, 2004. To many of us who knew him well, Al was a devoted husband, a loving father, a faithful friend, a staunchly devout man, and a great scientist and leader.

Al was born May 12, 1941, the son of Dr. Al F. and Dorothy Tasch. He received his B.S. degree in physics in 1963 from the University of Texas at Austin and his M.S. and Ph.D. degrees in physics in 1965 and 1969, respectively, from the University of Illinois, Urbana-Champaign. His thesis research in impurities in silicon was the pioneering work that led to the widely known deep-level transient spectroscopy for characterizing impurities in semiconductors, which is still used today worldwide. In 1969 he joined Texas Instruments, performing research that resulted in the first demonstration of a metal-insulator-semiconductor structure in mercury cadmium telluride, and he helped lay the foundation for infrared detector development and products throughout the 1970s and 1980s. He and his group did pioneering work in charge coupled device memories, dynamic memory, silicon on insulator, and scaled metal-oxide-semiconductor (MOS) transistors. Today's industry-standard MOS transistor structure, used in countless integrated circuit products worldwide, is based on seminal patents with sidewall oxides and self-aligned, silicided gates, sources, and drains patented by Al and his colleagues. They pioneered the charge coupled dynamic random access memory (RAM) cell, the Hi-C dynamic RAM cell, the grounded gate dynamic RAM cell, and leakage current analyses of dynamic memory structures. His patents on the Hi-C MOS dynamic RAM cell and the grounded gate MOS dynamic RAM cell have been used by most dynamic RAM manufacturers in the multibillion-dollar semiconductor industry. In 1978, Al was honored as a Texas Instruments fellow for his contributions to charge coupled devices and MOS dynamic memory technology. He was appointed associate director of the Very Large Scale Integration (VLSI) Laboratory in the Central Research Laboratories at Texas Instruments in 1980.

Al joined Motorola in July 1982, leading the start-up of the company's most advanced MOS integrated circuit manufacturing facility in Austin. In January 1984 he was promoted to director of the Advanced Products Research and Development Laboratory (APRDL), the laboratory with responsibility for the technological development of Motorola's new MOS memory, microprocessor, and logic products. A major endeavor in this responsibility was the move of APRDL from Phoenix to Austin and the start-up of a new R&D facility in 1984–1985. During this period, Al recruited me to Motorola to assist in this enormously challenging and complex program. I was drawn to join him in his vision of changing the organization, the technology, and the company. Al worked tirelessly to build the new R&D organization in Austin while keeping the Phoenix operation going. He had the highest expectations, continually striving to improve the ways in which we worked. Throughout this daunting project he exhibited the highest integrity and demanded the most of himself. During the simultaneous operation of the labs in Arizona and Texas, he was on a plane for 39 of 52 weeks in 1984, personally supporting both teams. He was appointed vice president of the technical staff of Motorola in February 1985.

Always drawn to education, Al joined the faculty of the electrical and computer engineering department at the University of Texas at Austin in July 1986, holding the Cockrell Family Regents Chair in Engineering. During 1987 he was in charge of the technical effort to successfully bring SEMATECH to Austin. Al played a major role in building the silicon-based education and research program at UT Austin to a level of national and international recognition. He established the silicon device fabrication laboratory in late 1987 with his students and his academic funds. This facility is used by most of the faculty and students in silicon-based materials, fabrication, and device research. Al initiated a research program with his students in MOS device modeling and analysis that is recognized worldwide.

Since starting at UT Austin, Al worked with the new faculty members as a mentor and collaborator to assist them in developing their graduate education and research programs. One of his colleagues at UT whom he closely mentored for many years reminisced that as an assistant professor he shared an office suite with Al. When he showed up for work the first day at UT at 8 a.m., Al was already hard at work in his office next door. Slightly embarrassed, his younger colleague would come in to work progressively earlier each day, but Al would always beat him to the office and welcome him with a wicked grin, a stack of papers to read, and countless ideas to try out jointly in the lab that day with graduate students. Over the next decade, the two of them progressed from mentor-mentee to the closest of friends and colleagues.

Al made many contributions to the Institute of Electrical and Electronics Engineers (IEEE) and to the Electron Devices Society (EDS). To name a few, he was a leader in the International Electron Devices Meeting, the largest and most prestigious meeting in the electronic devices industry, which he chaired in 1982. Additionally, he chaired the Symposium on VLSI Technology (1984) and the Semiconductor Interface Specialists Conference (1979)— heavily attended forums for the most advanced electronic devices research. He was associate editor of the IEEE's *Transactions on Electron Devices* between 1978 and 1991 and a member of the EDS Advisory Committee from 1982 to 1988. His contributions to industry and academia were well recognized with numerous awards. These included election to the National Academy of Engineering (1989); the IEEE Andrew S. Grove Award for outstanding contributions to solid state devices and technology (2001); the J. J. Ebers Award, the highest EDS award (1988); IEEE fellow (1983); Texas Instruments fellow (1978); the Semiconductor Research Corporation Technical Excellence Award (1992); the Billy and Claude Hocott Distinguished Centennial Engineering Research Award (1995); the University Leadership Award from the Semiconductor Industry Association (1997); the Electrochemical Society's Electronics Division Award (1997); the University of Illinois Alumni Award for Distinguished Service (1997); and election as one of the founding members of the Academy of Medicine, Engineering and Science of Texas in 2003. He held 38 U.S. patents.

Al was a respected mentor to many students, he had a strong sense of community responsibility, and he always had a clear vision for the future. He was a brilliant yet practical man, and, up until the end, his focus was on the well-being of his family. Al loved the outdoors and enjoyed being a part of the community of the Texas hill country. He was a member of the Stonewall Chamber of Commerce, the Stonewall Heritage Society, and the Fredericksburg Antique Tractor and Engine Club. He was also an active parishioner at both St. Mary's Cathedral in Austin and St. Francis Xavier Catholic Church in Stonewall. Throughout his many pioneering efforts, he was fortunate to have the unconditional love and support of his wife and soul mate, Judie. At their farm in Stonewall, they were able to integrate seamlessly into a very different world from that of Al's highly sophisticated and demanding professional life. Many of their rural neighbors honored Al at his funeral and had no idea that he was a man regarded internationally with such enormous professional respect. He was viewed as a neighbor who always gave of his own time and efforts to help make things better for his friends and his community.

Al is survived by his wife Judith; his son Edward and wife Anne; his son David and wife Sara and their children, Carsten and Kelsey; and his sister, Mary Jo Snider.

Professor Al F. Tasch, Jr., is sorely missed.

LEO J. "JACK" THOMAS

1936–2011

Elected in 1984

"For imaginative and productive leadership in the management of science and engineering leading to the development of innovative products for the consumer and commercial-industrial marketplaces."

BY EDWIN P. PRZYBYLOWICZ

LEO J. "JACK" THOMAS's election to the National Academy of Engineering at the age of 47 recognized not only his past accomplishments but portended his future as well. He succeeded Dr. Wesley T. Hanson (inventor of the Kodacolor film system) as director of research at the Eastman Kodak Company in 1977. His rise within the company, which he joined in 1961 as a new Ph.D. in chemical engineering from the University of Illinois, was meteoric. Jack tackled problems facing the research and development organization at a breakneck pace. The worldwide research organization that he managed numbered over 5,000 research scientists, engineers, and support personnel located in seven laboratories throughout the world. In 1984 he had established an eighth research laboratory in Japan.

Jack's abilities as a manager and a leader of people were evident from his earliest days at Kodak. In his interactions with people he conveyed an interest in and understanding of their work. He had a wonderful combination of curiosity, a photographic memory, and a strategic bent in his thinking. He was a voracious reader with an interest in not only science and technology but also people and their lives. His capacity for absorbing and utilizing information was unsurpassed.

A reflection from Jack's early days at Kodak came from a colleague who in 1962 was asked to act as a photographic mentor for Thomas, who had had no previous training in photography. He recalled this in 1987 on the 75th anniversary of Kodak Research:

> Jack was the brightest young colleague that I had ever met in my long career at Kodak. He had a knack of asking the right questions and of getting directly to the heart of a problem.
>
> When I had the opportunity to fill out a performance appraisal on Jack Thomas after he had been at Kodak for six months, I remember writing: "I predict that I will be working for him within 10 years, and that he will be head of the research labs within 20 years [he became Director of Research 16 years from when he started] if he is not president of the company first." He was a remarkable person to have as a friend, with whom to discuss serious and not-so-serious matters. He knew how to work and how to play and how to deal effectively with people.

As director of research, Jack challenged himself to know all 5,000+ members of the Kodak Research Laboratories in Rochester by their first name. He was a "walk the talk" manager, preferring to visit labs and talk with people in his organization rather than work in his office. During his tenure as director of research, he created an informal and open atmosphere in the research organizations across the Kodak world that facilitated communication and collaboration. Annually he would present a "state of research" presentation to members of the research community during which he would extemporaneously and comprehensively acknowledge the individual contributors to each project he highlighted.

"Make this elephant dance" was the company mantra under Walter A. Fallon, Kodak chairman and chief executive officer, who asked Jack Thomas, age 40, to lead the research organization. He inherited a world-renown, centralized research organization that like Kodak itself had grown large, bureaucratic, conservative, complacent, and somewhat too relaxed.

Jack led the transformation of the research laboratories from a technology-driven enterprise to a market-driven one. The organization became responsive to competitive pressures in existing markets and began to develop products for new ones where needs could be met by utilizing the science and technology base of the Kodak Research Laboratories. Jack himself discussed this challenge as he reflected on 75 years of Kodak research in 1987:

> We had come out of an era where the company had more or less grown outward from a set of core technologies. We grew to have a set of very large functions which were managed as functions. Taking an idea to the marketplace, therefore, required the very active cooperation of the people who were in all these functions. It wasn't possible for anyone, short of the chief executive officer, to get anything done by himself.

Under Jack's leadership many contributions were made to the success of major photographic programs, such as the Kodak Instant Camera and Print program and the VR family of color negative films (ASA 100, 200, 400, 1,000—the 1,000-speed film employing revolutionary tabular silver halide grains). The first Kodak commercial digital imaging system (the SP 2000 Motion Analysis System for recording up to 2,000 images per second), the development of the Kodak disc cameras and film system, and the Ektaflex PCT products for simplified enlargement of color prints were a result of the momentum Jack developed in the research laboratories' programs.

He led Kodak into new product areas, such as unique optical and organic light emitting diode technologies, equipment and dry film chemistry for carrying out clinical chemistry tests (Ektachem products), and copy/duplicator products based on electrophotography. During his tenure as director, the research laboratories produced an impressive series of new high-technology products and expanded the company's portfolio of intellectual property.

Jack led the search for new market areas that could be served by Kodak science and technology, and he was convinced that the strong base of chemistry and chemical engineering could be utilized to provide products in major markets such as the health care sector. In 1985 he left the research laboratories to form a new business group within Kodak, the Life Sciences Division, and became its first director. This division embodied a new direction for Kodak into the pharmaceutical industry. This coupled Kodak technology with that of the company's acquisitions, such as Sterling Pharmaceuticals and a joint venture with the pharmaceutical giant Sanofi. Jack became chairman of the Sterling Drug Company in 1988 and executive vice president of Kodak's Health Group in 1989.

Then, with the fortunes of Kodak's photographic business being heavily impacted by a shifting technology base from chemistry to electronics, Jack was called back in 1991 to head the photographic business. He was appointed president of the Imaging Group at Kodak and was elected a member of the Eastman Kodak Board in May 1992. By this time the technology shift in the imaging sector had gone beyond the "tipping point" toward digital imaging. Electronic imaging was displacing chemical imaging technology at a precipitous rate. Kodak shifted major resources to electronic imaging products but still had to manage its exit from conventional photographic products. Jack retired from Eastman Kodak in 1996 at the age of 60.

Throughout his career at Kodak, Jack was a strong supporter of innovation and the environment for the advancement of science and technology. During the late 1970s and early 1980s, he sought to improve working relationships among industry, academia, and government as a member of the Board of Directors of the New York State Science and Technology Foundation, which directed programs to stimulate the transfer of technology between universities and industry. In 1979 he was a founding member of the Council for Chemical Research, an organization that continues today as a strong voice for collaboration among academia, industry, and government. He also served on advisory committees at his alma maters—the University of Illinois and the University of Minnesota. In 1988 he was named Distinguished Alumnus of the Department of Engineering of the University of Illinois and in 2005 received the Outstanding Achievement Award from the Department of Chemical Engineering and Materials Science of the University of Minnesota. Also, Jack was the keynote speaker at the 120th commencement ceremonies (1988) of Worcester Polytechnic Institute, where he was awarded an honorary doctor of engineering degree.

As part of his broader professional activities, Jack was involved in leadership roles in the Industrial Research Institute as a member of the Board of Directors (1982–1985). He was elected to the National Academy of Engineering in 1984 in the Bioengineering Section and chaired the Bioengineering Peer Committee in 1988. He also served on the NAE Council from 1990 to 1995 and in 2002 chaired the Russ Prize Committee.

In 1991, Jack was elected to the American Academy of Arts and Sciences. He was also a member of the American Institute of Chemical Engineers and a founding fellow of the American Institute for Medical and Biological Engineering. In 1995 he was named "Man of the Year" by the Photographic Manufacturers and Distributors Association and also received the Presidential Proclamation Award from the Society of Motion Picture and Television Engineers. In 1996 he was elected an honorary member of the Society of Imaging Science and Technology, and in 1999 he received the prestigious Progress Medal and an honorary fellowship in the Royal Photographic Society of Britain.

On December 27, 1958, Leo "Jack" Thomas and Joanne Juliani were married in St. Louis County, Minnesota. They moved to Rochester, New York, in 1961. There they raised four children—Chris, Greg, Cindy, and Jeff. While Jack's responsibilities during his career at Kodak were daunting, he managed to find time to enjoying many other dimensions of life. He was a lifelong fisherman, stemming from his Grand Rapids, Minnesota, boyhood home. He regularly found time to go off on fishing weekends to the back country in Canada with family, colleagues from Kodak, or friends from his neighborhood. He delighted in recollections of these trips.

Jack's responsibilities for worldwide operations throughout his career afforded an opportunity to travel the world, which he relished with great interest and enthusiasm. During his working years at Kodak, he found time to travel widely with his wife Joanne and their family. He enjoyed the cultural experiences that such travel afforded. He was a bon vivant in addition to being a loving husband, father, grandfather, and outstanding member and representative of the National Academy of Engineering. His wife remembers that in retirement Jack spent time enjoying his grandchildren's sports, music, dance cheerleading, and drama activities.

Leo Jack Thomas passed away on April 11, 2011. He is survived by his wife Joanne; their four children and spouses—son Chris (and Kathy) Thomas (of Northport, New York), son Greg (and Elise) Thomas (of York, Pennsylvania), daughter Cindy (and Dave) MacLean (of Wayland, Massachusetts), and son Jeff (and Kim) Thomas (of Jobstown, New Jersey); and 12 grandchildren—Kelly, Michael, Eric, Jack, Emma, Annmarie, Megan, Joseph, Sean, Derrick, Julia, and Brad.

R. BRUCE THOMPSON

1941–2011

Elected in 2003

"For outstanding contributions to nondestructive evaluation, materials processing, and life-cycle management, and for the development of novel ultrasonic technology."

BY DONALD O. THOMPSON

R. BRUCE THOMPSON—Anson Marston Distinguished Professor in the materials science and engineering department and the aerospace engineering department and director of the Center for Nondestructive Evaluation at Iowa State University and editor of the *Journal of Nondestructive Evaluation*—died on March 7, 2011. He was 69 years old.

Bruce was born to George and Marion Hatch on July 18, 1941, in College Station, Texas. His father was professor of mechanical engineering at Texas A&M University, and his mother was a homemaker. He graduated from A&M Consolidated High School, where he was an excellent student and an active participant in the school's extracurricular programs. After high school, Bruce attended Rice University in Houston, from which he graduated summa cum laude with a degree in physics, and from Stanford University, where he earned an M.S. in physics and a Ph.D. in applied physics.

Bruce's professional career began after graduation in 1970 when he accepted a position with the technical staff at the North American Rockwell Science Center (later the Rockwell International Science Center) in Thousand Oaks, California. He became group leader of ultrasonic applications and initiated new research in ultrasonics with emphasis on the development of ultrasonic electromagnetic acoustic transducer technology, a subject in which he rapidly became a technical leader and in which he developed many patents. He was a strong supporter of nondestructive evaluation (NDE) technology throughout the corporation, particularly its aerospace divisions, where the B-1 strategic bomber program required new quantitative NDE approaches to meet and satisfy the new and challenging damage-tolerant design requirements derived from fracture mechanics principles.

NDE capabilities were required to both "size" a flaw and detect it with quantitatively known reliability. These newly placed demands on NDE spurred theoretical and experimental efforts at the North American Rockwell Science Center. Bruce played a key role in the development of this advanced quantitative NDE technology, in which he specialized in elastic wave interactions with defects. In 1980 he joined the faculty at Iowa State University as part of a core group enlisted to advance the engineering science of NDE and to form the center for NDE at that institution. During his years at Iowa State University, he became an internationally recognized leader in NDE, continuing his research specialties in theories of elastic wave scattering for defects ("measurement models"); theories and practices for NDE characterization of material properties, including microstructural features using elastic waves; and the development of theories and practices for determination of the probability of detection of "fatal" defects in structures by ultrasonic means. He served as graduate thesis adviser for 12 M.S. degree students and 22 Ph.D. degree students and as supervisor for 7 postdoctoral fellows. Bruce also played a key role in the development and teaching of undergraduate NDE courses and the first-of-its-kind NDE minor at Iowa State University. He leaves a rich technical legacy of over 200 publications and critical reviews in refereed edited journals and book chapters, as well as 24 patents.

Besides his research and teaching duties, Bruce was active in administering NDE activities at Iowa State University, serving as director of the center for NDE from 1997 until his death on March 7, 2011, and as co-organizer and host of the internationally attended annual "Review of Progress in Quantitative NDE" and meeting of the directors of the World

Federation of NDE Centers. Earlier, he served as program director of the materials and applied NDE programs and as associate director of science and technology for the Ames Laboratory (U.S. Department of Energy) on the Iowa State University campus. In 1988 he was appointed editor of Springer's *Journal of Nondestructive Evaluation*, a position he held until his passing.

Bruce was active in service to national organizations, especially those in energy and defense. He recently served on the Review Panel on High-Level Liquid Waste Nondestructive Evaluation, the U.S. Air Force Scientific Advisory Board, the Emerging Technology and Research Advisory Committee of the U.S. Department of Commerce, the Single Shell Tank Integrity Expert Panel, the Materials and Manufacturing Directorate, the Defense Science Board, and many others. He also provided expert consultation services for a wide variety of American industries.

Bruce received many awards and honors from various organizations for his outstanding work. In 1992 he became a fellow of the Institute of Electrical and Electronics Engineers. In 1997, Iowa State University honored Bruce by bestowing on him its highest faculty rank—Anson Marston Distinguished Professor—and again in 2001 with the D. R. Boylan Eminent Faculty Award for Research. In 2003, Bruce was elected to the National Academy of Engineering. The American Society for Nondestructive Testing honored him with the Lester Honor Lecture in 2004, the Tutorial Citation Award in 2006, and the Research Council Award for Sustained Excellence in 2007. The British Institute for Nondestructive Testing awarded him the President Honor Lecture and the Roy Sharpe Prize in 2006, and the Iowa Academy of Science presented him with the Distinguished Fellow Award in 2006. Iowa State University honored him again in 2008 by naming him (and his wife Ann separately) as one of 150 visionaries who helped build Iowa State University into today's university of science and technology. In 2009, Bruce earned the NDE Lifetime Achievement Award SPIE Smart Structures/NDE for his many contributions.

Bruce was endowed with many gifts. He led a life characterized by commitment and passion to his family, work, outdoor activity, maps, and always new experiences. Intellectually, he was a giant. Despite his intellectual prowess, he was always humble. He was a genuine person with a heart of gold. His boundless wisdom was matched only by his warmth and willingness to share. Some of his greatest gifts were his interpersonal skills—his ability to communicate with clarity and his sense of fairness for all. Colleagues have said that he was unequaled in his ability to explain complicated and difficult to understand technical issues. Perhaps his greatest gift was his sense of fairness and its demand for justice for all. He always saw the best in any person's actions and always put the best construction on all that the person did. In doing so, he had a firm faith that "things will work out." Bruce leaves behind a rich legacy of family and friends, students and colleagues, technical work, and a philosophy for life built on a wise use of bountiful gifts.

He is survived by his wife, Ann, of Ames, Iowa; son Robert Kirk and wife Leigh of Midland, Michigan; daughter Amy and husband Randy Standridge of San Antonio, Texas; five grandsons—Robert Kyle Thompson, Kolben Hatch Thompson, Alexander Kerr Thompson, Erik Mathew Standridge, and Andrew James Standridge; and a sister, Nancy Bliss, of Los Alamos. Bruce, as he was known to students, friends, and colleagues alike, also leaves an extended global family of hundreds of friends, a rich legacy of high accomplishments, a wealth of affection and admiration, and a heavy sense of loss among his many colleagues.

KLAUS D. TIMMERHAUS

1924–2011

Elected in 1975

"For contributions in research in cryogenic engineering and national leadership in support and development of chemistry and energetics research."

BY CAROL ROWE
SUBMITTED BY THE NAE HOME SECRETARY

KLAUS D. TIMMERHAUS, professor of chemical engineering at the University of Colorado, Boulder, for 42 years, associate dean for more than 20 years, and coauthor of the widely used textbook *Plant Design and Economics for Chemical Engineers* (New York: McGraw-Hill), died on February 11, 2011. He was 86.

Known as "Tim" to friends and colleagues and "Dr. T" to his students, Klaus was born into a German-speaking home in Minneapolis, Minnesota, on September 10, 1924. He learned English starting in the first grade, and ultimately graduated as valedictorian of Palatine High School in Illinois, where he won three letters in track, served as a student editor, and was elected student body president. Long-distance running became his lifelong passion, and the leadership qualities that emerged in his early years, his strong work ethic, and the meticulousness he showed as an editor came to define his career.

After serving in the U.S. Navy during World War II as a radar specialist in Corpus Christi, Texas, he continued his education at the University of Illinois, where he earned three degrees and graduated with a Ph.D. in chemical engineering in 1951. He worked as a project design engineer for two years at Standard Oil of California Research Corporation, before joining the University of Colorado faculty. He was appointed associate dean of engineering in 1963 by Max Peters, another esteemed chemical engineer who had been named dean of engineering at CU-Boulder the previous year.

"I knew Klaus as a grad student at the University of Illinois, where I was on the faculty," the dean recalled. "I knew he was a capable guy and so I asked him to be my associate dean." The two men worked closely together for more than three decades as college administrators, chemical engineering faculty, and coauthors of *Plant Design*, which is now in its fifth edition and has sold over 100,000 copies. They also shared athletic interests—running, skiing, and later race walking—and were regularly seen running across campus during lunch hours and in the Bolder Boulder Annual 10K Road Race, among other venues. Klaus earned many age-group titles, having been a world-class miler in his college days, and he also gave 50 years of service to the CU-Boulder track team during his free time.

"I can honestly say that Klaus is the most conscientious and dedicated person I have ever known. He truly is a great chemical engineer in every aspect of our field, in addition to being a true friend and a wonderful person," Dean Peters said in a 1985 article in *Chemical Engineering Education*.

The 1960s were an active period in the dean's office at CU-Boulder, with the planning and construction of a new engineering center complex and initiatives to improve education and research programs. Klaus prepared a proposal and secured a National Science Foundation matching grant worth $1.325 million (in 1966 dollars) for the center's construction, the largest construction grant ever made to the university. He also directed the Engineering Research Center, a three-campus organization of the University of Colorado, in addition to serving as associate dean. "All of the research proposals went through his office and he would read every page of every proposal and correct the language before he would sign it. That's the kind of attention to detail he had," said Ronald West, a faculty colleague who retired the same year as Klaus, in 1995.

A prominent national figure in cryogenics, Klaus served as chair of chemical engineering, acting chair of aerospace engineering, and even college safety officer, at various points in his career. He was extremely productive, which naturally led to even more projects and greater expectations being placed on him. Known for both the quantity and the quality of his work, he was founding editor of the publication *Advances in Cryogenic Engineering* (New York: Plenum Press), which he edited from 1954 to 1980. He also coedited more than 30 volumes in the International Cryogenics Monograph Series and coauthored the monograph *Cryogenic Process Engineering* (New York: Plenum Press), which is one of the most valuable texts in the field. The 1981 Cryogenic Engineering Conference was dedicated to Klaus in recognition of his 25 years of service.

Klaus was also recognized with the Samuel C. Collins Award for Outstanding Contributions to Cryogenic Technology in 1967, the Alpha Chi Sigma Award of the American Institute of Chemical Engineers for Chemical Engineering Research in 1968, and the W. T. Pentzer Award of the International Institute of Refrigeration in 1989. He was a fellow of the American Association for the Advancement of Science, the American Institute of Chemical Engineers, and the Cryogenic Society of America. He authored or coauthored 150 technical papers and was awarded one patent on cryogenic technology. In 2008 he was named one of the Top 100 Chemical Engineers of the Modern Era by the American Institute of Chemical Engineers.

He was an elected member of both the National Academy of Engineering and the Austrian Academy of Sciences. He served on two committees of the National Research Council—the Committee on Critical Technologies: The Role of Chemistry and Chemical Engineering in Maintaining and Strengthening American Technology (1991–1992) and the Committee on Chemical Engineering Frontiers: Research Needs and Opportunities (1984–1988). He was president of the American Institute of Chemical Engineers, Sigma Xi, and the International Institute of Refrigeration.

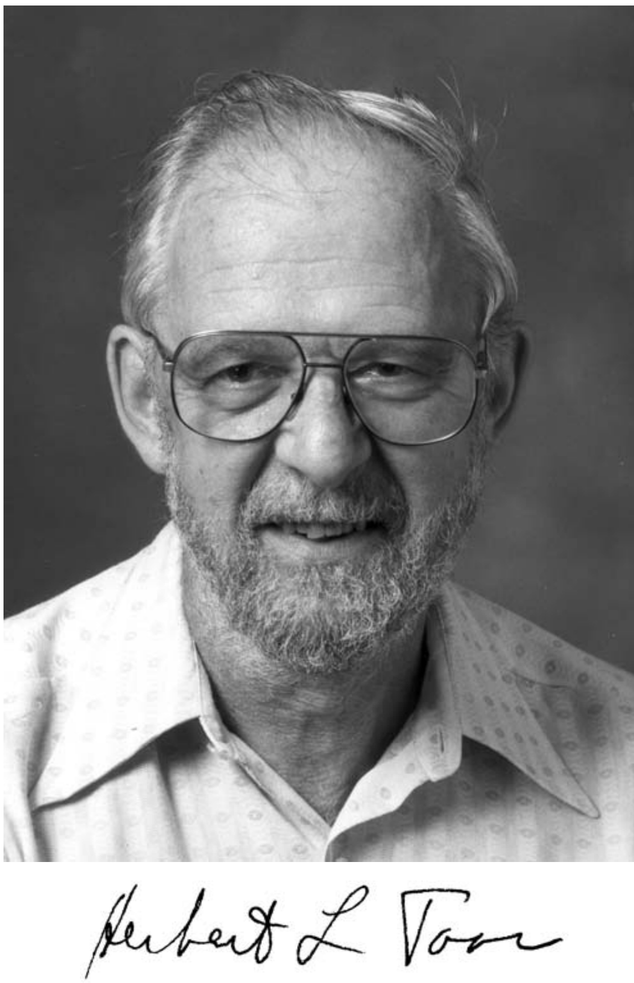
Klaus also was an outstanding teacher who took extra time and care to ensure that all of his students learned and understood the material. "He was quite an individual. He kicked me in the butt, made me work hard, and therefore I succeeded," said James Fisher, a former student who established a scholarship in his honor in 2002. Perhaps it was the infamous red pen used to mark up their homework assignments that led engineering students to present Klaus with the "Meanest Professor" award one year, but he held it as a badge of honor. According to his daughter, Carol Getty, "He was a hard-nose, but after his death, CU sent me the evaluations his students submitted about his teaching. They universally graded him as an A+."

"He had standards, but he gave us the freedom, guidance, and opportunity to develop," recalled Scott Fogler, a University of Michigan faculty member who did his Ph.D. thesis under Klaus. "I could not have developed more as a Ph.D. student than I did at Colorado." Klaus was awarded the American Society for Engineering Education's George Westinghouse Award for Outstanding Contributions to Teaching in 1968. He also received the Tau Beta Pi Outstanding Professor Award in 1980 and the Charles A. Hutchinson Teaching Award of the College of Engineering and Applied Science in 1989. He was selected to be in the University of Colorado's inaugural class of President's Teaching Scholars in 1989, and he was the first recipient of the Hazel Barnes Prize, the university's most prestigious teaching honor, in 1992. The University of Colorado also recognized him with the Distinguished Engineering Alumni Award in 1978, the Stearns Award for Outstanding Service in 1981, the Max S. Peters Service Award in 1987, and the President's University Service Award in 1988.

As part of his legacy at CU-Boulder, Klaus left a bequest establishing the Timmerhaus Teaching Ambassador Award. The award, which will be administered under the auspices of the President's Teaching Scholars Program, will honor strong teaching and showcase the high caliber of faculty on the university's four campuses through statewide outreach by the awardee. The endowment is his family's second major gift to the university, the first being a scholarship fund that Klaus and his wife Jean established for engineering students in 1992.

"Klaus Timmerhaus exemplified the idea of a scholar—a person who is passionate about his students, his field of study, and his university," said CU President Bruce Benson. "His generous contributions will benefit all three of these, and are a fitting legacy for a man who has been such an important part of the life of our university."

Klaus is survived by his second wife, Jan; daughter Carol; sister Gudren; and grandchildren Kristina and Matthew. He was preceded in death by his wife of 50 years, Jean, as well as his mother, father, and sister Ingy.


Herbert L Toor

HERBERT L. TOOR

1927–2011

Elected in 1990

"For research contributions in mass transfer and chemical reaction and for advancing the study of innovative design processes in engineering education."

BY IGNACIO E. GROSSMANN AND ARTHUR W. WESTERBERG

HERBERT LAWRENCE TOOR, affectionately known as "Herb" and recognized as one of the top academic leaders in chemical engineering, died of Alzheimer's disease in Middlebury, Vermont, on July 15, 2011. He was born on June 22, 1927, in Philadelphia to Matthew and Jean Mogul Toor. He grew up in Philadelphia and enlisted in the U.S. Navy when he was 17. He was discharged as a seaman first class shortly after the end of World War II. He then obtained a B.S. degree in chemical engineering from Drexel University in 1948 and an M.S. and a Ph.D. at Northwestern University, finishing in 1952. In 1950, while at Northwestern, he married fellow graduate student of chemistry Elizabeth M. Weir ("Beth") of Edmonton, Alberta, Canada.

Herb Toor became an assistant professor of chemical engineering at the Carnegie Institute of Technology (now Carnegie Mellon University) in Pittsburgh in 1953. He was promoted to associate professor in 1957 and to full professor in 1961. In 1962 he and his family spent a sabbatical year in Madras, India, sponsored by the United Nations Educational, Scientific and Cultural Organization, to help establish a graduate program at what is now the prestigious IIT Chennai. He became head of the Department of Chemical Engineering at Carnegie Tech in 1967 and was appointed dean of the

Carnegie Institute of Technology in 1970, a position he held until 1979. In 1980 he became the first Mobay Professor of Chemical Engineering (today the Bayer Professorship). In 1991 he and his wife Beth spent another sabbatical at the University of Sydney in Australia.

Herb Toor was a leader in the area of transport phenomena, in which he modeled complex processes involving mass transfer and chemical reactions. In particular, he addressed problems of mass transfer at interfaces, multicomponent mass transfer, chemical reactions in turbulent flow, and heat transfer in particulate systems. He and his students wrote over 60 publications for various chemical engineering journals.

In recognition of his research work, the American Institute of Chemical Engineers (AIChE) awarded Herb the Alan B. Colburn Award in 1964. He was the first faculty member at Carnegie Mellon to receive this prestigious award, which is presented to a member of AIChE less than 36 years of age for significant contributions through chemical engineering publications. In 1990, Herb Toor was elected to the National Academy of Engineering "for research contributions in mass transfer and chemical reaction and for advancing the study of innovative design processes in engineering education." On the occasion of the centenary of the AIChE in 2008, he was named one of the "One Hundred Engineers of the Modern Era" for his outstanding contributions in chemical engineering.

As a teacher Herb Toor was legendary in the classroom. In one famous anecdote he used his cigarette rather than chalk to write on the board. Quotes from some of his former students are as follows:

> I remember Herb could say to a few graduate students in the hall . . . "Let me show you something" and an impromptu 20 to 40 minute mini-lecture would follow. These were always riveting, and I remember some of them to this day. He was a true leader and communicator." —Dale Schruben, Ph.D., chemical engineering, 1973

> Having been a chemical engineering student during Dr. Toor's tenure as Head of the Chem E Department, I

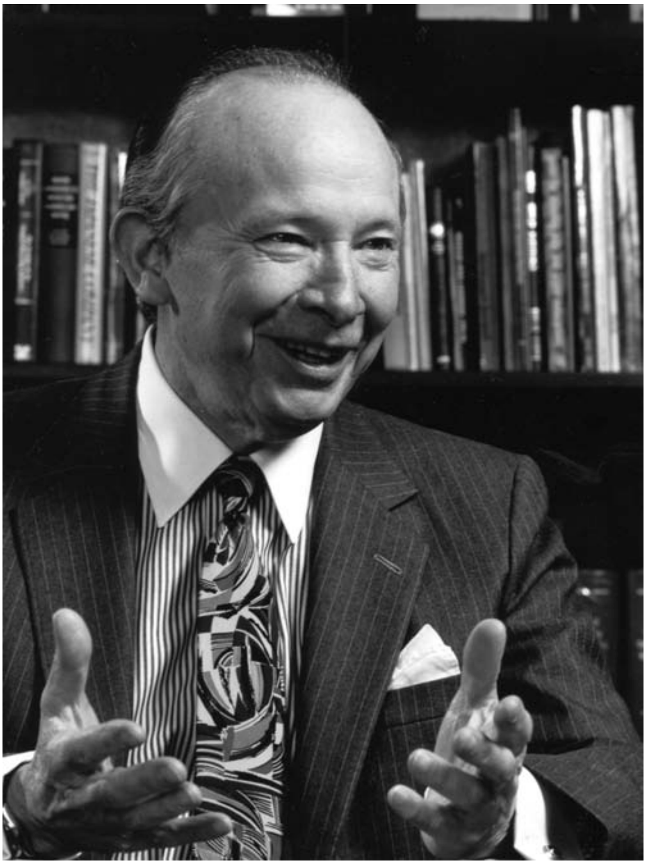
have many fond memories of him. I especially remember his response when asked how long it took him to work through the four problems on a three hour final in Transport Processes. Dr. Toor admitted that it took him around six hours to work through the problems. When then asked why he would give such a difficult exam, he said that occasionally he would have a student who could actually have finished the exam. He wanted to be able to identify brilliance at that level. To a certain extent, that is what the old Carnegie Tech was about. Identifying brilliance. —F. Denis d'Ambrosi, chemical engineering, 1969

At Carnegie Tech, Herb Toor was one of the most influential deans of engineering. He had a huge impact through two major outstanding contributions. The first was establishment of the Department of Engineering and Public Policy in 1976, a truly unique multidisciplinary educational research program in the United States. This program combined elements of engineering analysis and design with issues related to public policy, today offering double-major degrees to all engineering students. Inspired by the work on the "sciences of the artificial" by the late Nobel Prize winner Herbert Simon, Herb's second major contribution was the establishment of the Design Research Center, also in 1976. This was also a unique research program aimed at developing systematic and computational multidisciplinary approaches to engineering design, which at the time was still very much regarded as an art. Herb hired Steve Director from Florida, Steve Fenves from Illinois, Gary Powers from the Massachusetts Institute of Technology, and Art Westerberg from Florida, all recognized giants in their fields, who initiated groundbreaking research in this field, setting a new research direction in engineering that continues to this day. This pioneering effort also led to the establishment by the National Science Foundation of the Engineering Design Research Center in 1986. After 11 years of NSF funding, that center became the very successful Institute of Complex Engineered Systems. As dean, Herb Toor was particularly proud of increasing the numbers of women and minority students in the engineering school.

Herb's main interests were his work, his family, and his garden. He also had a keen interest in history, politics, and energy problems. As for gardening, he often said that perhaps the most useful thing he had done in his life was "turning a Pittsburgh clay backyard into great soil for growing vegetables through forty years of composting." Some of Herb's happiest times were family camping and backpacking trips in the United States and the Canadian Rockies and sailing and snorkeling trips over spring break in the Caribbean or the Yucatan.

Herb is survived by his wife of 60 years, Beth Toor, of Middlebury; his sister, Marlene Wenograd, of West Hartford, Connecticut; his daughter, Helen Toor, of Charlotte, Vermont; his sons and daughters-in-law, John and Margaret Kiernan Toor of Palo Alto, California, and Will Toor and Mariella Colvin of Boulder, Colorado; his grandchildren—Milo, Maren, Nicky, and Tera Toor and Cead Kiernan; and many cousins, nieces, nephews, great-nieces, and great-nephews.

Herb Toor, a true giant in the field of chemical engineering, will be sorely missed by his family and colleagues.



MILTON H. WARD

1932–2011

Elected in 1994

"For leadership in developing, building, and operating major mineral production facilities in remote and challenging environments."

BY JEFF WARD AND TERRY MCNULTY

MILTON "MILT" HAWKINS WARD, a prominent mining engineer and corporate leader, died on October 13, 2011, at age 79.

Dad came from a very poor family. We have photos of him in school with no shoes. As a child, he was often cold; therefore, our home and his offices were always warm. Scouting had the single most important impact on Dad's early life. At 14 my father left scouting and started working full time at a service station, changing tires, working on cars, and driving a tow truck. In college he worked for a mining professor, who became a mentor, and at a chemical company.

Dad enjoyed tennis and, later in life, golf, but his passion was running a large mining organization. He loved the challenge of implementing management systems and the process of solving operational problems.

Dad believed that the best preparation for a mining executive was to work up through operations: from miner to foreman to superintendent to vice president of operations to president and finally to chief executive officer and chairman. This path provided Dad with a profound understanding of a wide range of technical and managerial issues ranging from initiating a block cave to keeping a mine union-free to financing some of the largest mines in the world.

Dad believed that problems had to be solved in the field, not in a corporate office. Continuously, he was visiting mines. His jets often had the highest flight hours per year in their class. These hours were not logged en route to Vail or Aspen but rather to the likes of Magadan or Arequipa. This philosophy of solving a problem by intimately involving yourself with the mine was drilled into me and is much of the reason for my success.

In addition, Dad was a big believer in facing up to problems. He would tell me that there were times when he would pray for a heart attack and he would hear the word of God saying, "Get off your ass and get out there and work through the problem." I never heard those words from God, but I got pretty close by hearing them from my dad.

Dad was an extremely hard worker. He slept only three hours a night and was always working. The greatest thing for us, as a family, was that he totally integrated us into his work. At the age of 6, I started going underground with him and together we visited mines around the world. He never hesitated to take us along. Dad understood family. I remember him negotiating with tribal chiefs in Irian Jaya. He was sympathetic to their wishes, knowing that they wanted what we all want: food, a home, and a better life for our children.

Finally, Dad was an ethical businessman. He believed in honoring his word. The Golden Rule—*treat others as you wish to be treated*—truly was golden to him.

Milt earned a B.Sc. in mining engineering and an M.Sc. in general engineering from the University of Alabama and, later in life, an M.B.A from the University of New Mexico. In 1994 he was awarded an honorary doctorate of engineering from the Colorado School of Mines. He was a true scholar and was extraordinarily knowledgeable about all aspects of mineral production. His extensive library contained texts dealing with not only mining methods, mining engineering, and rock mechanics but also geology, geophysics, mineral processing, hydrometallurgy and smelting, marketing, and mineral economics. Those who worked for Milt always expected to be asked tough questions in their own disciplines and to be grilled about the accuracy of their responses. He was an innovator and was willing to take risks, but only after he had ensured that all risks were clearly identified and that mitigating measures were fully understood and capable of implementation. As a manager he was dedicated to cost control, performance improvements, the safety of his employees, and helping subordinates grow in their work. He led by example and made tough jobs easier because of his quick wit, fine sense of humor, and endless supply of jokes and stories.

Milt's first employer in the mining industry was the San Manuel Copper Corporation in southern Arizona, where he worked as underground miner, shift boss, engineer, and supervisor. He then joined Kerr-McGee Corporation and was general superintendent of mines for the uranium division. Remaining involved with the Grants, New Mexico, uranium district, he went on to become general manager of the United Nuclear-Homestake Partners mining and milling operation and then vice president of operations for Ranchers Exploration & Development Corporation. He worked with industry giants, including Maxie Anderson, Dean McGee, and "Jim Bob" Moffett; like them, he was a visionary.

In 1974 he joined Freeport Minerals Company as corporate vice president. He quickly rose to become president and chief executive officer, director, and member of the Office of the Chairman of Freeport McMoRan, Inc. During his 18 years with Freeport, he led the establishment of important expansions and diversifications and is best known for direction of exploration, discovery, and development of the Grasberg ore deposit in a remote part of Papua, Indonesia. Under his leadership, Grasberg became the world's largest copper and gold mine in terms of reserves. Besides being a huge copper producer, Grasberg's flotation concentrates usually contain enough gold, typically over 2 million ounces annually, to cover all operating costs. During his tenure as chairman and CEO of P. T. Freeport Indonesia, Milt led a dedicated and highly skilled organization that developed a mine on a 12,000-foot mountaintop, built a concentrator and peripheral facilities in a rain forest, and constructed a 60-mile-long slurry pipeline over tricky terrain to a coastal shipping terminal. This was done despite incredible challenges presented by geography, weather, and a rebellious Indonesian workforce.

Milt joined Cyprus Minerals Company in 1992 as chairman, president, CEO, and director. He presided over a merger with Amax, Inc., forming Cyprus Amax Minerals Company, and engineered spin-offs of noncore businesses, including aluminum and iron ore. He led acquisitions and/or grassroots development of many copper- or gold-producing operations in South America and the former Soviet Union. He encouraged the adoption of improved exploration and mine planning tools and new technologies for the treatment of ores and concentrates. He retired in 1999 with a legacy of many globally competitive mineral enterprises.

During his career, Milt was an active member and director of many mining industry organizations, including the American Mining Congress, American Institute of Mining Engineers (AIME), Mining and Metallurgical Society of America, Canadian Institute of Mining and Metallurgy, International Council on Metals and the Environment, and Advisory Council on International Investments. AIME awarded him the Saunders Gold Medal, its highest honor for mining executives and mine developers. In 1993 he was inducted into the American Mining Hall of Fame by the Mining Foundation of the Southwest.

Milt was also intensely involved in and dedicated to education and the arts. He served on the Board of Administrators (Trustees) of Tulane University and was president and trustee of the New Orleans Museum of Art, besides being active in the guidance of many civic institutions, museums, and hospitals. An Eagle Scout as a young man, Milt served as national president of the Boy Scouts of America.

Milt Ward was a dominant figure in the global mining industry, a fine human being, and a credit to his profession. He will be long remembered and missed by many.

RICHARD N. WHITE

1933–2009

Elected in 1992

"For advancing understanding of the behavior of structures, for innovations in engineering education, and for leadership in concrete technology."

BY WILLIAM McGUIRE

RICHARD NORMAN WHITE, James A. Friend Family Distinguished Professor of Engineering at the Cornell University School of Civil and Environmental Engineering, died on October 3, 2009.

Dick was born on December 21, 1933, in Chetek, Wisconsin, and grew up on several different dairy farms. His father alternated farm ownership with operation of a small contracting firm. Work on the farms, helping his father in construction, and his classroom interests made civil engineering Dick's clear choice while still in high school.

He received his civil engineering education at the University of Wisconsin, Madison, earning his B.S. in 1956 and M.S. in 1957. Then, after six months of active duty service in the U.S. Army Corps of Engineers, he returned to the University of Wisconsin to study for his Ph.D., which he received in 1961. While studying for the doctorate he worked part time as a structural engineer for a consulting firm and served as an instructor at the university, with responsibility for several undergraduate courses. As an undergraduate he had met Margaret Howell, also a student at the university. They were married in 1957, and Marge completed her undergraduate program while he worked on his doctorate. These formative years were the firm base for his later career and his accomplishments as a teacher, a writer, an administrator, a professional leader, and a community servant.

In 1961, Dick joined the Cornell University School of Civil and Environmental Engineering faculty as an assistant professor. He was soon recognized as an exceptional teacher, winning the engineering college's Outstanding Teacher Award in 1965—a promise to be confirmed in later years by the same award in 1996 and as a three-time winner of civil engineering's Chi Epsilon Award. He was also the lead author of the White, Gergely, and Sexsmith three-volume set of textbooks *Structural Engineering* (New York: Wiley, 1972), which integrated aspects of mechanics, analysis, behavior, materials, and design. It was widely successful and had a broad influence on undergraduate education in civil engineering. As his research interests started to lean toward concrete structures and the need to appreciate their physical behavior, Dick conceived, designed, and built a structural models laboratory for instruction and research in concrete systems. It, too, had a successful history and has recently been succeeded by a 21st-century facility founded on the same principles and named in his honor as the Richard N. White Instructional Laboratory.

As is almost inevitable in academia, a person of Dick's talent and vision is drawn into administration. Dick had several appointments. One of the most influential was that of director of the School of Civil and Environmental Engineering from 1978 to 1984. His most outwardly visible accomplishment was in the physical plant. When he came into office, the hydraulics research laboratory was small and inadequately equipped. The need for improvement was clear. Dick took the lead in planning, fund-raising, and construction of a 5,000-square-foot addition to the engineering school's building, a facility that was completed in 1983 and named the Joseph H. DeFrees Hydraulic Laboratory in honor of its major donor. Dick was also an efficient manager of the day-to-day affairs of the engineering school.

In these and his other administrative roles what came across most memorably was the nature of the man himself. As colleagues said in recording and reflecting on Dick's many accomplishments and the awards and recognition he received throughout his career: "We particularly acknowledge the statesmanlike . . . he performed as a distinguished member of the Cornell University faculty—a role that infused and yet transcended his specific area of research and which demonstrated his personal warmth, knowledge, compassion and commitment to students, staff and faculty in Civil Engineering and in every aspect of the University in which he participated. Dick was uniformly admired and respected."

Beyond the university, Dick was active nationally in professional affairs, most notably with the American Concrete Institute. From his initial membership in the 1950s to a term as president in 1997, he was active at all levels of the institute. He was on numerous technical committees and at various times was chairman of the Technical Activities Committee and the Standards Board and a member of the Board of Directors. He also received the institute's Joe W. Kelly Award for leadership in education in 1992, the Wason Medal for Most Meritorious Paper in 1993, and honorary membership in 2006.

Dick also maintained a part-time consulting practice. In the course of his career he advised dozens of organizations—structural engineering firms, manufacturers, national laboratories, government agencies, universities, and publishers—on a variety of topics, such as structural analysis design and research, project evaluation, and editorial policy.

In 1988, Dick was named James A. Friend Family Distinguished Professor of Engineering at Cornell. He was elected to the National Academy of Engineering in 1992 and to honorary membership in the American Society of Civil Engineers in 2001.

He started to receive widespread recognition for his writing, research, and professional activity while still in his 30s. Until he was incapacitated by illness in 2005, he was in demand off-campus as a lecturer, ambassador of the American Concrete Institute, and venerated mentor of foreign graduate students.

Dick and Marge enjoyed travel and the associated opportunities to meet people, and his professional travel plus sabbatical leaves from Cornell enabled them to see and experience many places. He had terms as a visiting professor at the universities of California at Berkeley, Puerto Rico at Mayaguez, Durham, and Southwestern Jiaotong. Other engagements covered much of the civil engineering worlds of Latin America, China, the Middle East, and Northern Africa.

Dick was an outstanding photographer. He always carried a camera on trips, recording the scenery, people, foods, and life wherever he was. He particularly enjoyed taking pictures of birds, animals, and flowers. His work was shown extensively, both in group exhibitions and one-man shows.

Locally, the White's first real Ithaca home, in the Ellis Hollow section, was a Tech-Built house finished off by Dick and his father. In the years they lived there, Dick and Marge were leaders in the community, cochairs of the 25th Anniversary Ellis Hollow Fair, and hosts of many gatherings of neighbors and colleagues featuring fine food and wine.

Dick suffered the first of two strokes when he was 72 and he died four years later. He was denied gentle twilight years. But he was remarkably successful in everything he undertook, and the legacy of his good work remains.

He is survived by his wife, Margaret; daughter, Barbara Ann Shaffer (William) (of Arlington, Virginia); granddaughter, Natalie Apseloff; grandson, Nicholas Apseloff; son, David Charles White (fiancee, Soeung Brenda Oeun) and children, Kuyheang Sok, Layheang Sok, Mary Sok, Andy Sok, and Michael Daniel Oeun (of Ithaca, New York); a beloved sister, Joyce Mortt (of Eau Claire, Wisconsin); three nieces, Susan Nelson (Mike), Madelyn, and Cynthia Lamb (J. P. Bowersock), and sons, Eli and Oliver; and Jennifer (Mark) Johnson and son, Peter; brothers-in-law Charles Howell (Mary) and Robert Howell (Kathy); a niece, Kim Dutter (Roy) and her children, Mathew, Kailey, and Kasey; and a nephew, Dan Howell, and his sons, Jacob and Jeremy.


Charles R. Wilke

CHARLES R. WILKE

1917–2003

Elected in 1975

"For contributions to research on molecular diffusion, development of microbiological processes, and engineering education."

BY JOHN M. PRAUSNITZ

CHARLES (CHARLIE) R. WILKE, one of the founders of the Department of Chemical and Biomolecular Engineering at the University of California, Berkeley, died on October 2, 2003. He was 86 years old.

Born in Ohio, Wilke attended the University of Dayton. To meet expenses he organized a dance band in which he played trombone. Following his B.S. degree, Charlie went to Washington State University, where he received a master's degree working with Professor Otto Redlich, who later was a distinguished chemical thermodynamicist at Shell Development Company in Emeryville, California. Following retirement from Shell, Otto served many years as a lecturer in chemical engineering at Berkeley.

Charlie received a Ph.D. in chemical engineering from the University of Wisconsin, Madison, in 1944, where he worked with Professor Olaf Hougen, one of the leading academic chemical engineers in the country at the time. With Hougen, Wilke established a correlation for mass transfer in systems in which fluids flow through a bed of solid particles like catalysts. This classic correlation is used today all over the world.

Following a brief stint at Union Oil Company, Charlie joined the faculty of the College of Chemistry of the University of California, Berkeley, in 1946. Although many major universities had established departments of chemical engineering much earlier, it was not until 1946 that the Berkeley campus established a program in chemical engineering. The program was administered by the Division of Chemical Engineering within the chemistry department. A chemical engineering department was not established until 1957. The name was changed to the Department of Chemical and Biomolecular Engineering in 2010. After chairing the Division of Chemical Engineering from 1953 to 1957, Charlie became the first chair of the new Department of Chemical Engineering, a position he held until 1963.

Following his work with Hougen, Charlie's main research interests at Berkeley focused on mass transfer, that is, the rate of transport of molecules from one phase to another as encountered in numerous chemical engineering operations such as distillation and extraction. Charlie's research in this area produced numerous publications in which he showed how fundamental science can be usefully applied in chemical process design. Charlie's work was recognized with some of the highest awards of his profession, including the Colburn Award and the Walker Award of the American Institute of Chemical Engineers (AIChE) and election to the National Academy of Engineering. In 1983, Wilke was included in a list of 30 eminent chemical engineers on the occasion of AIChE's 75th Diamond Jubilee Celebration.

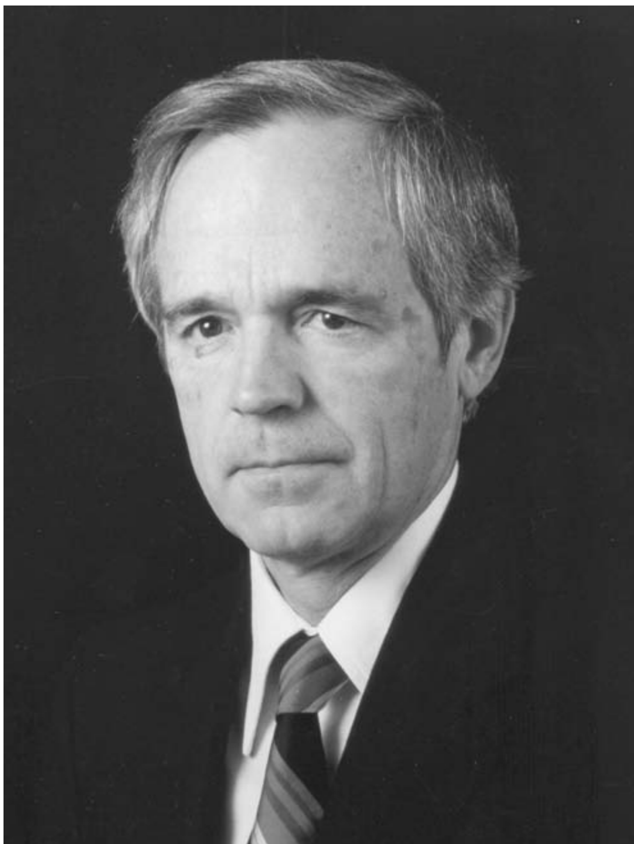
In the early 1960s, Charlie's research interests shifted to what was then the very early period of biochemical engineering. Initially, his studies concerned the kinetics of microbial growth and of oxygen dissolving in biochemical reactors. Later, he gave attention to making synthetic fuels (ethanol) from solid wastes such as old newspapers. In his engineering-oriented research during the 1970s, Charlie was 25 years ahead of his time. Thanks to his early initiatives in biochemical engineering, Berkeley is now an internationally acclaimed center for research in that area. At present, the Department of Chemical and Biomolecular Engineering has five faculty members whose primary interests are in applying chemical engineering science to advance the frontiers of biotechnology.

The author of more than 150 scholarly papers, Charlie taught hundreds of undergraduate students and mentored more than 100 M.S. and Ph.D. students. He also served for several years as assistant to the chancellor for academic affairs and was active on many campus committees. In addition to his university appointment, he was a faculty investigator at the Lawrence Berkeley National Laboratory.

Charlie is justly known as the father of chemical and biomolecular engineering at Berkeley. He instilled an unusually strong spirit of cooperation among his colleagues as he guided the growth of the department from 5 faculty members to 16. He also played a key role in making Berkeley's chemical engineering department preeminent at a time when the discipline was evolving toward the social and economic importance it enjoys today.

Charlie was a superb chair and an outstanding department leader. He had a clear vision of where the department should go. It was during his years as chair that Berkeley chemical engineering quickly rose to prominence. In 1953, Berkeley chemical engineering was virtually unknown in the academic world. Ten years later, thanks to Wilke's firm yet gentle guidance, it had achieved an enviable worldwide reputation.

Charles Wilke retired in 1987. In recognition of his remarkable contributions to the chemical engineering profession, to chemical engineering educators, and to the University of California, at the graduate exercises in May 1988 the chancellor of the Berkeley campus awarded Charlie Wilke its highest honor—the Berkeley Citation.



Sam B Williams

SAM B. WILLIAMS

1921–2009

Elected in 1986

"For outstanding engineering achievements in advancing small gas-turbine-engine technologies, and for major contributions to aeronautical and automotive propulsion."

SUBMITTED BY THE NAE HOME SECRETARY

SAM B. WILLIAMS, an aerospace pioneer who left his mark on both military and civil aviation, died on June 22, 2009, at the age of 88.

Sam was born in Seattle, Washington, on May 27, 1921, and grew up in Columbus, Ohio. After earning a mechanical engineering degree from Purdue University in 1942, he worked for Chrysler, designing and developing the engine for its turbine car. When Chrysler's enthusiasm for turbine cars began to wane, Sam left in 1955 to found Williams Research (later renamed Williams International). He was convinced that if his new company developed small, simple, affordable turbines, new markets would follow.

Turbine technology had advanced rapidly since its invention in the run-up to World War II, but most of the progress was in large, complicated engines for fighter planes, and then airliners. Sam steered turbine technology in a new direction, developing miniature turbines that were far simpler thanks to his genius for replacing many parts that each perform one function with a single part that performs many functions.

New markets did follow. Thanks to Williams, turbojets were now small enough, and affordable enough, that they powered drones the U.S. Navy used for target practice. And once Williams demonstrated a fuel-efficient twin-spool turbofan engine small enough to be worn like a backpack, the U.S. Department of Defense was persuaded that this same technology could make long-range cruise missiles possible.

Sam pursued his lifelong dream of making jet travel safe, convenient, and affordable, and his team certified its first man-rated turbofan engine, the FJ44-1, in 1992. By 2010 more than 4,000 FJ44 engines had entered service, powering a new class of cleaner, quieter, more affordable light jets.

Sam's role in creating new technologies earned him and his team four of the highest awards in aerospace—the Collier Trophy, the Wright Brothers Memorial Trophy, the National Medal of Technology, and the National Aviation Hall of Fame.

Sam could see things others couldn't—simpler solutions, the flow of air, a future of small jet planes. His gift for the unseen was great. Maybe this gift was compensation for his poor eyesight or maybe it just reflected his creative mind. But whatever its source, there was no disputing his vision, because Sam had the drive to realize the things he imagined. His legacy included revolutionary products, 72 patents, and a continuous quest for the next invention.

Dr. Williams also applied his gift for innovation to the many charities he supported, especially through his promotion of inventors and inventions in medical research for cancer and degenerative eye diseases—one of the most notable being his cofounding of Second Sight Medical Products, Inc., which developed and is now producing the world's first visual prosthetic device, or "bionic eye."

Sam Williams is survived by his wife of 54 years, Barbara Gibson Williams, two sons and a daughter, and three grandchildren. His son Gregg, who had been president and chief executive officer of Williams International for many years, assumed the title of chairman after his father's death.

JOHN F. YARDLEY

1925–2001

Elected in 1977

"For contributions to engineering theory and practice and leadership of organizations that pioneered major space programs."

BY CHRISTOPHER KRAFT

JOHN F. YARDLEY was one of many great engineers and scientists who contributed to the success of the U.S. manned spaceflight program, but few had more of an impact than him. He died on June 26, 2001, at the age of 76.

John was born in St. Louis, Missouri, on February 1, 1925, to F. A. and Johnnie (Patterson) Yardley. He served in the U.S. Navy as an ensign from 1943 to 1946, during which time he received a B.S. in aeronautical engineering from Iowa State University. In 1946 he married Phyllis Steele and started work as a stress analyst with the McDonnell Aircraft Corporation in St. Louis.

From 1946 to 1958, John contributed to numerous McDonnell aircraft designs and took on increasing responsibilities for structural analysis and design, serving as chief strength engineer from 1955 to 1958. In 1950 he earned an M.S. in applied mechanics from Washington University. The aircraft programs he contributed to included the FH-1 Phantom, the F-2H Banshee, the F-101 Voodoo, and several experimental aircraft. For a time he headed McDonnell's Structural Research/Structural Methods Group and was responsible for developing advanced analytical methods.

In the very early days of the establishment of the first man in space project, John became an intimate part of the team at McDonnell Aircraft Corporation that proposed to the National Aeronautics and Space Administration (NASA) a spacecraft capable of putting men in space, orbiting Earth, and returning them safely. John recognized early on that the job of building a manned spacecraft was very different from the previous flying vehicles that his company had been building. He saw that the task was more one of system engineering and that it would require the melding of the entire gamut of systems required to support the life of a pilot in an entirely new environment of zero gravity and a near-perfect vacuum. It was this recognition and design approach that won the NASA contract for McDonnell to build the first manned spacecraft that flew Alan Shepard and John Glenn into space. From 1958 to 1960, John served as Project Engineer for the Mercury spacecraft design.

In addition, many new areas of technology had to be assembled to carry out the objectives of orbiting Earth. These included environmental support systems, attitude control systems, navigation devices, heat protection materials, retrofire devices, and pilot pressure suits and contoured seats for withstanding the high temperatures and g-forces of reentry. Along with his NASA counterparts, John created this new flying machine in a relatively short period of time under great political and scientific pressures.

After delivery of the first spacecraft to Cape Canaveral for launch into space, McDonnell and NASA recognized the need for people to prepare and operate the systems for launch and to assure that the spacecrafts were indeed ready to fly. In 1960, Yardley was selected as the launch operations manager for Mercury and led this group at Cape Canaveral for the entire Mercury project. He was also active as a participant in support of the in-flight activity and the flight control team that conducted the flight operations.

As the Mercury project unfolded and President Kennedy challenged the country to send men to the Moon, Yardley was again called on by McDonnell to design and build a space vehicle capable of conducting the many facets of spaceflight operations necessary to formulation of the operations concepts being developed to travel to the Moon, land on the Moon, and return safely to Earth. Utilizing the lessons learned on Mercury, McDonnell and Yardley proposed and were awarded a contract to build the Gemini spacecraft for carrying out the extensive spaceflight operations necessary for preparations to travel to and from the Moon. From 1964 to 1968, John served as Gemini's technical director. The Gemini program, although it had many difficult problems and less than spectacular results at times, produced the operational experience absolutely essential to carrying out the lunar landing program.

John Yardley was a major contributor to these exploratory missions. The program produced a large number of firsts, which the Apollo program then utilized to build its success. Gemini conducted a series of rendezvous maneuvers to determine the most effective techniques to rendezvous two vehicles in space. This required the development of space radar systems to determine range and range rate, computer programs to compute the maneuvers required, an onboard computer for making calculations, devices for displaying information to the pilots, and docking mechanisms to bring the space vehicles together. In addition, the program developed such new systems as fuel cells to provide electric power and the ability to perform a controlled entry path to a specific landing area through an automatic control system guided by means of an onboard computer. Also, Gemini brought about the first U.S. extravehicular activity by an astronaut and a long-duration flight of 14 days by two men to assure that humans could work and survive at zero gravity for the length of time required to travel to and from the Moon.

Starting in 1968, John became vice president and deputy general manager of the Eastern Division of McDonnell Douglas Astronautics. During the Apollo program, he served the nation as an expert in many fields as the program progressed through testing and development. At the time of the tragic accident on the launch pad in 1967, Yardley was called on to aid in the review of the accident's cause and his knowledge and experience were very helpful in bringing about a rapid and technically sound solution to the problems found. During this period, John's responsibilities included the Apollo Applications program (Skylab).

As the nation sought to construct a follow-on space program, the Nixon administration, along with NASA and the Congress, decided the next affordable step to exploring outer space required a lower-cost space transportation system capable of transporting large and heavy masses into orbit. After considerable study, debate, and haggling, a consensus was arrived at with the Space Shuttle program, which consisted of a partially reusable space transportation system.

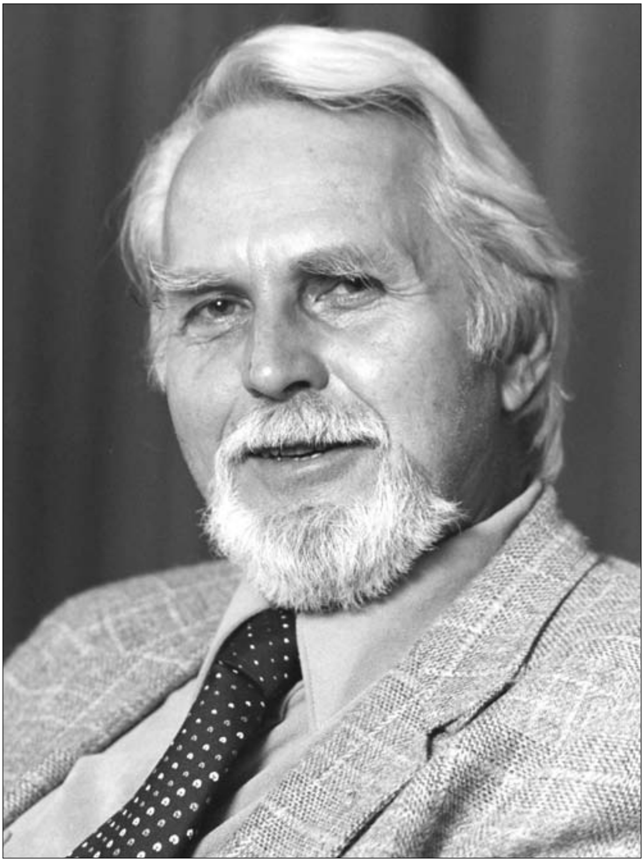
NASA started the program with a team of government and industry organizations and, because of the scope of this group, established a management scheme to be led by a group at the headquarters level reporting directly to the NASA administrator. As the program began to develop, NASA sought an experienced engineering manager from the aerospace industry to lead the effort. In 1974 the NASA hierarchy prevailed on John Yardley to leave his post at the McDonnell Douglas Corporation and join NASA to become associate administrator for manned space flight. This was an extremely daunting task given the political and budgetary circumstances surrounding the space program in the 1970s. In addition to the Space Shuttle program, the position included overall management responsibility for Spacelab, Skylab, and NASA's expendable launch vehicles.

John assembled a group of engineers and managers to help manage the three NASA centers and the numerous aerospace companies in the detailed design and manufacturing of the first reusable spacecraft. He had to continuously interact with Congress and the White House to assure both political support and continued budgetary support. The biggest problem was the ever-decreasing funding which forced the schedule to be continuously extended. These delays also had a damaging effect on the progress of the construction of new factories and thereby delayed many of the technical and construction decisions from being made in a timely manner. Yardley was a fiercely competitive manager in this environment and with the help of his colleagues brought the first Space Shuttle to the launch pad. After the first successful flight in 1981, John returned to St. Louis as president of McDonnell Douglas Astronautics, with responsibility for space, missile, and electronics programs. He retired in 1989.

The success of the Space Shuttle program cannot be overpraised. Its accomplishments were truly outstanding. Such equipment as the Hubble Space Telescope, numerous U.S. Department of Defense payloads that support intelligence efforts, numerous commercial satellites, other complex scientific satellites, and eventually the delivery and assembly of the International Space Station are testimony to the significance of the Space Shuttle program.

John received many honors and awards during his distinguished career. In addition to his election to the National Academy of Engineering in 1977, he was elected a fellow of both the American Institute of Aeronautics and Astronautics and the American Astronautical Society. He received NASA Public Service awards for contributions to the Mercury and Gemini programs in 1963 and 1966, respectively. In 1973 he was awarded the Spirit of St. Louis Medal by the American Society of Mechanical Engineers. He also received alumni citations from his alma maters—Iowa State (1970 and 1976) and Washington University (1975). NASA awarded him a Special Achievement Award and its Distinguished Service Medal in 1981, and in 1983 the National Space Club awarded him the Goddard Trophy.

John Yardley was a first-class engineer, a great manager of complex engineering programs, a highly respected leader, and a fine supporter of the fundamental fabric required to keep our country great. At the time of his death, he was survived by his wife Phyllis, four daughters, a son, nine grandchildren, and several great-grandchildren.



OLGIERD C. ZIENKIEWICZ

1921–2009

Elected in 1981

"For outstanding contributions to development of finite element method theory and dissemination of knowledge concerning its application to engineering practice."

BY ROBERT L. TAYLOR

In May 2011, I attended the 19th International Conference on Computer Methods in Mechanics held in Warsaw, Poland. As I sat in a main lecture hall of the Warsaw University of Technology for the opening session, I could not help but recall my good friend Olgierd Cecil Zienkiewicz, who died on January 2, 2009, in Swansea, Wales, after a brief illness. In the summer of 1939, Olek (as his friends knew him) was in Warsaw preparing to take the entrance examination to enter the Technical University to study civil engineering. The events of September 1939 changed the course of his career and undoubtedly that of the field of computational mechanics.

At the time of his death, Olek was professor emeritus and director of the Institute for Numerical Methods in Engineering at the University of Wales, Swansea, and held the United Nations Educational, Scientific and Cultural Organization chair of numerical methods in engineering at the Universitat Politecnica de Cataluña in Barcelona, Spain. During his long career he was a great engineer in the construction of hydroelectric projects, author of many books and technical articles, cofounder of technical journals, and a leader in the field of civil engineering. He was also an avid sailor, enjoyed snorkeling, and was an adventurous gourmet.

Olek was born on May 18, 1921, in Caterham, Surrey, England, the son of a Polish father, Kasimierz, and an English mother, Edith. At the age of 2, his family relocated to Poland. During the next few years the family moved several times, which often interrupted his studies. Thus, at an early age Olek developed the ability to learn new subjects from reading on his own and personal tutors. He had a phenomenal memory and could, in late life, clearly recall poems of the Iliad learned from his Latin tutor, sing the Polish songs of Wladyslaw Szpilman, and recall salient points from any of his publications.

In the early 1930s the family settled in Katowice, where his father had attained a position as a judge in the regional court. To prepare for university, Olek was sent to a boarding school in Rydzyna, where he studied science subjects, literature, and learned the art of boat building. In June 1939, he completed his high school studies in the fields of mathematics, descriptive geometry, and physics. During the summer of 1939 he was able to complete a sailboat he had started in Rydzyna and learned the art of sailing. His love of sailing instilled in him a desire to study naval architecture at university. However, none of the three polytechnic universities in Poland offered the subject. Thus, Olek chose civil engineering and was in Warsaw preparing for entrance exams to the university when the Second World War began. In early December his father was able to obtain visas for the family to go to Italy. Shortly thereafter they secured visas to enter France, where the Polish government in exile was situated. They remained in France until mid-1940, when France fell to the German advance and they finally left for England. By the summer of 1940 the family was settled in London, and Olek attained a scholarship as a Polish student to attend Imperial College, where he received his bachelor of science degree in 1943. He continued with postgraduate studies and completed his doctoral thesis in mid-1945 with Professor Richard Southwell (later Sir Richard) performing research with "relaxation methods" to study the uplift pressures on dams.

In August 1945 he secured employment with the firm of Sir William Halcrows & Partners as an engineer in charge of a survey party for the design of hydroelectric schemes in Scotland. For the next few years he worked on the design and construction of the hydroelectric schemes at Glen Affric and Mullardoch. In 1949 he accepted his first academic appointment as a lecturer at Edinburgh University.

During his period in Edinburgh, Olek continued to work on problems related to hydraulic and structural problems encountered in hydroelectric projects. His studies were both experimental and analytical. In 1951 he met Helen Fleming at a dance. After a one-year courtship they were married in December 1952. In the second year of their marriage, Olek and Helen welcomed their first son, Andrew. A second son, David, was born in 1955.

In January 1958 the family moved to the United States, where Olek had accepted an offer as a visiting professor at Northwestern University. Then in March they welcomed the arrival of their daughter, Krysia. Olek's research at Northwestern focused on structural problems, many still related to the behavior of dams. He continued to apply relaxation solution methods to finite difference equations throughout this period. At this time he also heard about what was to become known as the finite element method from Professor Ray Clough (NAE member) of the University of California, Berkeley. At the time Olek believed finite difference methods could solve all elasticity problems equally well, but that finite element methods offered a way to solve shell problems associated with arch dams if appropriate bending elements could be developed.

In 1961, Olek was appointed chair of the civil engineering department at the University of Wales, Swansea. At the time of his appointment the civil engineering department consisted of five faculty members. During the next few years Olek appointed several additional staff who would later become well known to the computational mechanics community. It was in Swansea that Olek started research on finite element methods. By 1962 he and his students had succeeded in devising a thin plate element of rectangular form that converged for known plate solutions. In 1965, working with Bruce Irons, who was then an engineer at Rolls-Royce, Olek produced a triangular plate-bending element that was fully conforming. A little later he was successful in bringing Irons to Swansea as a lecturer. This was a fortuitous appointment as Bruce was aware of much work being performed in the aeronautics industry, including that of Ian Taig on direct construction of quadrilateral elements. At Swansea this evolved into the family of isoparametric elements that were successful in generalizing element forms for use in two- and three-dimensional problems of elasticity and of other subjects. The introduction of isoparametric elements was a major advancement to the finite element method and greatly simplified the development of computer software.

Olek devoted a significant portion of his activities to the solution of real engineering problems. One of the first dams he analyzed was the Clywedog Dam in Wales. According to Olek, this was the first time that finite elements had been used as part of the design of a new dam. He also traveled extensively to attend conferences and give lectures at universities and industrial centers. Through these he quickly became known as the "Ambassador of Finite Elements"!

Olek wrote the first book devoted to the finite element method. *The Finite Element Method in Structural and Continuum Mechanics,* published by McGraw-Hill Publishing Company Limited, London, 1967, consisted of some 270 pages. The book was an immediate success and firmly established Olek worldwide as a leader in finite element theory and practice. The book has appeared in five subsequent editions, with the current edition, published in 2005, consisting of three volumes numbering nearly 1,800 pages.

By the late 1960s Olek realized that publication of numerical finite element research required a new outlet, since the available journals in mechanics were more interested in theory than solution methods. Together with Professor Richard H. Gallagher (deceased NAE member) as coeditor, he established the *International Journal for Numerical Methods in Engineering,* which was first published quarterly in 1969. The journal grew rapidly over the years to its present 48 issues per year. From his travels around the world, Olek also recognized a need for an international organization devoted to numerical methods. Through his efforts the International Association of Computational Mechanics was founded in 1986 and he served as its first president for four years.

During the next 25 years, Olek and his colleagues and students developed and applied finite element methods to solve a wide range of applications—from problems in solid mechanics to problems in fluid dynamics to problems in electromagnetism. The topics Olek addressed during his career resulted in almost 600 papers and 13 books.

After a career spanning five decades, Olek retired in 1988 as head of civil engineering at Swansea. Following this retirement, he served as director of the Institute for Numerical Methods in Engineering at Swansea, where he continued his research and supervision of doctoral students.

Through his research and associations with scholars throughout the world, Olek achieved an international reputation as a leader in the development of finite element methods. In recognition of his achievements, he was elected a fellow of both the Royal Society in Great Britain and the Royal Academy of Engineering in 1979. Shortly after his retirement, Queen Elizabeth II awarded him the title of Commander of the British Empire in recognition of his lifetime accomplishments. In 1981, Olek was elected as a foreign member of the National Academy of Engineering. He was also a foreign member of the Accademia Nazionale dei Lincei (Rome), the Chinese Academy of Sciences, and the Polish Academy of Sciences. In 2005, he received the Prince Philip Medal of the Royal Academy of Engineering.

The adage that "behind every great man is a great woman" was especially true for Olek. His wife Helen was his teammate and acted as hostess to the many students, colleagues, and friends who visited their home in Swansea. She was a loyal partner throughout all of his activities.

Olek leaves a legacy in the form of his books and writings as well as in the many students and collaborators who benefited from his advice and tutoring. He was indeed a distinguished scholar and a good friend to many. He is greatly missed but not forgotten! He is survived by his wife, Helen, and their children, David and Krysia. His firstborn son, Andy, died a year after his father. Olek is also survived by his grandchildren—Ami, Adam, Jaimie, and Kate. Krysia's son Jon tragically died at the age of 11 from leukemia.

Andrew wrote in his eulogy for his father the following:

> My Dad was a sailor, determined to enjoy himself. Some of his happiest photos are in the middle of Swansea Bay. Many sailed with him, or learned how to sail with him, or just got roped into boat maintenance. He didn't usually plan a sail, but was happy to see which way the wind was blowing and what looked interesting.
>
> As children growing up, we all got used to wandering day trips or holidays, full of diversions to whatever looked interesting. Long walks on Gower, which he loved and kept him anchored in Swansea. Climbing up sea cliffs, often with no choice as the tide rose behind us. Long snorkeling adventures in the Mediterranean, returning with edible fish or an octopus or just something with poisonous spines. Sailing across the channel to France and working out the best use of custom allowances.
>
> While traveling he would spot a dam or bridge under construction, or recently collapsed, and then to his children's cringing embarrassment, march up to the security gate and never fail to talk his way in. And we would see wonderful things, huge civil engineering projects, research labs, inside other people's houses. He knew that people like to talk about what they do and he let them know that he wanted to hear about it.
>
> Intellectually, any question could start a discussion, sometimes a lecture, on science, maps, history, math, religion. If he did not know, then we would be sent to get the big books and do research. I remember him ringing up a priest in the middle of the evening because we could not figure out the ethical point of a parable.
>
> Gastronomically, he would try anything. And we got the benefit of that, learning to love food from France, Yugoslavia and Poland and what to do with anything found in the sea.

Most of all he showed us there was a big world out there. A world, most of which he visited, some of which he showed us and an awful lot of which passed through our living room in the form of his friends and colleagues. He enjoyed sailing with all of them.

APPENDIX

Members	Elected	Born	Deceased
Irving L. Ashkenas	1992	September 3, 1916	April 10, 2011
S. George Bankoff	1996	October 7, 1921	July 13, 2011
Paul Baran	1996	April 29, 1926	March 26, 2011
Thomas D. Barrow	1974	December 27, 1924	January 27, 2011
Jordan J. Baruch	1974	August 21, 1923	October 26, 2011
Kenneth B. Bischoff	1988	February 29, 1936	August 27, 2006
Donald J. Blickwede	1976	July 20, 1920	April 24, 2011
George Bugliarello	1987	May 20, 1927	February 18, 2011
Moustafa T. Chahine	2009	January 1, 1935	March 23, 2011
John W. Coltman	1976	July 19, 1915	February 10, 2010
Harry W. Coover	1983	March 6, 1917	March 26, 2011
Frank W. Davis	1967	December 6, 1914	July 15, 2001
William C. Dietz	1982	April 17, 1919	July 31, 2006
Edsel D. Dunford	1989	May 7, 1935	October 3, 2008
Walter A. Elmore	1998	October 2, 1925	January 20, 2010
Bob O. Evans	1970	August 19, 1927	September 2, 2004
James R. Fair	1974	October 14, 1920	October 11, 2010
Daniel J. Fink	1974	December 13, 1926	June 1, 2012
Lee S. Gaumer	1992	May 27, 1926	July 24, 2010
William C. Goins, Jr.	1990	December 22, 1920	May 22, 2009
Robert W. Gundlach	1994	September 7, 1926	August 18, 2010
Arnold Hall	1976	April 23, 1915	January 9, 2000
Arthur G. Hansen	1976	February 28, 1925	July 5, 2010
Donald E. Hudson	1973	February 25, 1916	April 24, 1999
Arthur Kantrowitz	1977	October 20, 1913	November 29, 2008
Robert W. Keyes	1976	December 2, 1921	April 5, 2010
Willem J. Kolff	1989	February 14, 1911	February 11, 2009
Anthony D. Kurtz	2008	May 3, 1929	February 9, 2010
Christian J. Lambertsen	1977	May 15, 1917	February 11, 2011
David S. Lewis, Jr.	1971	July 6, 1917	December 15, 2003
Harvey F. Ludwig	1969	December 4, 1916	April 24, 2010
Max V. Mathews	1979	November 13, 1926	April 21, 2011
Duane T. McRuer	1988	October 25, 1925	January 24, 2007
Dade W. Moeller	1978	February 27, 1927	September 26, 2011
Peter Murray	1976	March 13, 1920	July 26, 2009
Wesley L. Nyborg	1996	May 15, 1917	September 24, 2011
Donald J. O'Connor	1978	November 7, 1922	April 18, 1997
Jorj O. Osterberg	1975	January 18, 1915	June 1, 2008
Un-Chul Paek	1998	December 2, 1934	May 3, 2011
Joseph A. Pask	1975	February 14, 1913	June 14, 2003
Donald O. Pederson	1974	September 30, 1925	December 25, 2004

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Members	Elected	Born	Deceased
Max S. Peters	1969	August 23, 1920	June 20, 2011
Amir Pnueli	1999	April 22, 1941	November 2, 2009
Joseph B. Reagan	1998	November 26, 1934	August 14, 2011
Lymon C. Reese	1975	April 27, 1917	September 14, 2009
Louis W. Riggs	1987	June 29, 1922	June 12, 2002
James E. Roberts	1996	November 24, 1930	July 6, 2006
Nicholas Rott	1993	October 6, 1917	August 10, 2006
Joseph E. Rowe	1977	June 4, 1927	October 23, 2002
Robert W. Rummel	1973	August 4, 1915	October 17, 2009
Mark Shepherd, Jr.	1970	January 18, 1923	February 4, 2009
Ronald Smelt	1971	December 4, 1913	February 17, 2005
Joe Mauk Smith	1975	February 14, 1916	June 7, 2009
Glenn W. Stagg	1997	August 28, 1923	August 27, 2009
Chauncey Starr	1965	April 14, 1912	April 17, 2007
Robert C. Stempel	1990	July 15, 1933	May 7, 2011
Clarence A. Syvertson	1981	January 12, 1926	September 13, 2010
Al F. Tasch, Jr.	1989	May 12, 1941	November 30, 2004
Leo J. Thomas	1984	October 30, 1936	April 11, 2011
R. Bruce Thompson	2003	July 18, 1941	March 7, 2011
Klaus D. Timmerhaus	1975	September 10, 1924	February 11, 2011
Herbert L. Toor	1990	June 22, 1927	July 15, 2011
Milton H. Ward	1994	August 1, 1932	October 13, 2011
Richard N. White	1992	December 21, 1933	October 3, 2009
Charles R. Wilke	1975	February 4, 1917	October 2, 2003
Sam B. Williams	1986	May 27, 1921	June 22, 2009
John F. Yardley	1977	February 1, 1925	June 26, 2001
Olgierd C. Zienkiewicz	1981	May 18, 1921	January 2, 2009