Robert Bromberg

ROBERT BROMBERG

1921–1999

BY PETER STAUDHAMMER

ROBERT BROMBERG, thermodynamicist, pioneer architect of atmospheric reentry, and leader in aerospace engineering, died on January 25, 1999, at the age of seventy-seven.

Bob was elected to the National Academy of Engineering in 1969 with the citation: *For engineering achievements in space systems, plasma and microwave processes, remote sensing, instrumentation and their application to commercial systems.* Because of concern with military secrecy at the time, Bob's most significant contributions to the understanding and development of missile reentry systems remained silent in his citation. His work was not only of immediate value to the national defense but also provided the basic understanding for the later development of reentry vehicles to return astronauts from space missions. For his direct technical contributions and his subsequent engineering leadership, he was recognized by election as a fellow of both the American Institute of Aeronautics and Astronautics and the American Association for the Advancement of Science and by membership in the National Academy of Engineering.

Bob was born in Phoenix, Arizona, on August 6, 1921, to Max and Rae Bromberg, both emigrants from Russia. Early on, Bob developed an interest in mechanics and electronics and became a ham radio operator. From these early interests stemmed a strong desire to pursue a career in engineering. When he graduated from Phoenix Union High School in 1939, his family moved

to Berkeley, California, so that he and his brother, Harold, could attend the University of California, Berkeley.

At Berkeley, Bob majored in mechanical engineering, with emphasis on thermodynamics and heat transfer. He worked under L.M.K. Boelter, later to be the founding dean of the College of Engineering at the University of California, Los Angeles. In 1943 he graduated with a B.S. degree. That same year he married Hedwig Ella Remak, an émigré from Germany, whom he had met while a student at Berkeley. Bob and Hedy had their first daughter, Robin Jean, in 1945. The following year, Bob received his M.S. degree in mechanical engineering from UC-Berkeley and then moved to UCLA as a lecturer and Ph.D. candidate. He continued his work in heat transfer, concentrating on thermal radiation, boiling, and associated instrumentation. He also became the project leader for the design and construction of an analog thermal analyzer capable of simulating and solving complex conductive, convective, and radiative thermal transport problems.

While at UCLA, Bob and Hedy continued to build their family with a second daughter, Janice Lynn, born in 1948, followed by a son, Kenneth, in 1951. The family was to remain the inspiration and the single most important part of Bob's life.

In 1951 Bob received his Ph.D. in engineering from UCLA. His thesis, titled, *A Thermodynamic Analysis of Some Thermoelectric Systems,* foreshadowed his lasting interest in energy conversion and in the application of thermodynamics to a wide range of engineering problems. He remained at UCLA as assistant and then associate professor of engineering for the next three years. He also served as assistant director of the UCLA Institute of Industrial Cooperation, with oversight for a wide range of externally supported research activities in the College of Engineering.

In 1954 Bob joined the Ramo-Wooldridge Corporation (later to become TRW) as a member of the technical staff. This was a critical time for the defense of the United States. The USSR had achieved making its own atomic bombs and was then embarked on building an intercontinental ballistic missile (ICBM) for bomb delivery to the U.S. mainland. In response, the United States

started its own ballistic missile development program and charged Ramo-Wooldridge with systems engineering and technical direction. Bob came to join that national effort.

One of the most difficult and unresolved problems of the ICBM was reentry of the missile back into the earth's atmosphere. At that time, aircraft had flown a little above Mach 1, but reentry required some twenty times as high a Mach number, with shock-induced temperatures far above the capability of any solid materials. The challenge was to understand—from theory, as no experimental data existed—what the reentry conditions would be and how the nose cone could survive.

Though part of a larger team, Bob was at the center of the issue, developing models for shock dynamics, thermochemistry, and convective and radiative heat transfer. Bob was particularly central to calculating boundary layers and heat transfer in the presence of ablation and ionization. His work was significant in completing the reentry vehicle development on schedule, thereby giving the U.S. a ballistic missile capability more than a year ahead of the USSR —a crucial advantage that kept the Cold War cold.

The understanding of hypersonic flow and heat transfer from the ballistic missile reentry problem formed the foundation for the design of the reentry bodies later used on the Mercury, Gemini, Apollo, and space shuttle vehicles. It also contributed greatly to the development of the theory of hypersonic boundary layers, reacting flows, high-density plasmas, and ablation.

Beyond his direct personal contributions, Bob also demonstrated his abilities for engineering leadership. In fact, what really set Bob apart throughout his career was his keen ability to see the crux of issues, to imagine constructive approaches, and to motivate teams to work together. He rose rapidly in management positions at TRW, first in direct technical management and later in general management. He had his first supervisory position in 1957. By 1962 he was appointed vice-president, first of the Mechanics Division, and progressed to the Applied Technology Division that encompassed aerosciences, propulsion, software, and information systems and TRW's central research laboratory. Under his management, the company developed the

Apollo Lunar Module Descent Engine that soft-landed the U.S. astronauts on the moon, the Viking Biology Instrument that searched for life on Mars, various other instruments for Venus, Mars, Jupiter, Saturn, and Earth observation, and through the research laboratories launched TRW's work in high-energy lasers, high-speed gallium arsenide microelectronics, optoelectronics, and superconductive electronics. In each of these areas, the company achieved leading national stature. Bob retired from TRW in 1982 as vice-president for research and engineering of TRW's Space and Defense Group, where he guided the overall planning and direction of the group's research and development program and served as its principal interface to the external community.

Throughout his life, Bob was deeply concerned with engineering education. As reflected in his own work, Bob advocated broad, fundamental understanding as the core of engineering practice. He was a member of the American Society of Engineering Education, a trustee of the UCLA Foundation, and chairman of the University of California Engineering Advisory Council. He was honored by being named the 1969 UCLA Engineering Alumnus of the Year.

To all of us who worked with Bob Bromberg, he was a constant inspiration. His enormous breadth and depth across practically all fields of engineering made him both a sought-after counselor and a formidable opponent, should there be a difference in views. But it was just these differences that created new understanding and learning for us all. It is with great personal sadness, but also with extreme professional pride, that we observe his passing.