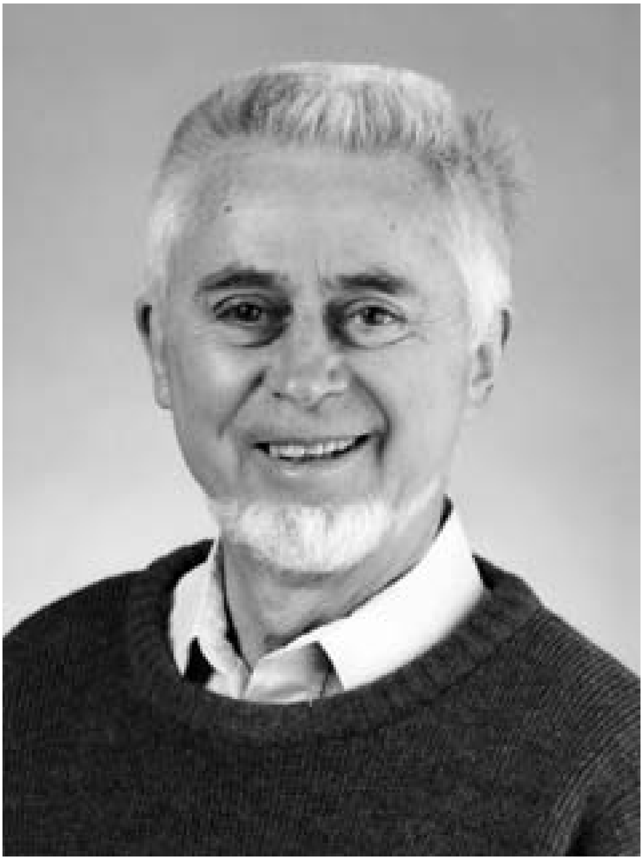

MILTON D. VAN DYKE

1922–2010

Elected in 1976

"For solving complex problems in aerodynamics, specifically in designs of airplanes and missiles."

BY LEONARD SCHWARTZ, PETER BRADSHAW, AND WALTER G. VINCENTI

MILTON DENMAN VAN DYKE, emeritus professor of engineering at Stanford University, died of complications of Parkinson's disease on May 10, 2010, at the age of 87.

First at the National Aeronautics and Space Administration's (NASA) Ames Research Center and then at Stanford, Milton made many contributions to fluid mechanics, especially the mathematical/computational analysis of compressible flow. In the early 1950s he solved the very difficult numerical problem of calculating hypersonic flow and heat transfer over a blunt-nosed body. His program was used in the design of all Mercury, Gemini, and Apollo reentry modules. It was one of many cases in which he carried out a subtle mathematical analysis before devising a method of numerical solution. He was the founding coeditor of *Annual Review of Fluid Mechanics* and the compiler and publisher of *An Album of Fluid Motion* (Parabolic Press, 1982).

Milton was born on August 1, 1922 in Chicago, the son of James and Ruth Van Dyke. His father, with a degree from Pennsylvania State University, was a teacher of mechanical engineering, and his mother was a Phi Beta Kappa mathematics graduate of the University of Minnesota. The Depression of the 1930s made it difficult for either of them to find satisfactory permanent employment, and the family moved frequently.

Milton spent his three high school years, grades 10–12, in the small town of Portales, New Mexico. He said that much of the credit for his subsequent successes was due to the good education he received there. In 1940, Milton won the scholarship that Harvard awarded each year to students in a handful of poor states, including New Mexico.

Milton completed his course in engineering science in three years, graduating summa cum laude. He was elected to Phi Beta Kappa in his junior year. He used to point out that his shortened time at Harvard was due, in some measure, to the U.S. entry into World War II during his sophomore year. Engineering students were encouraged to finish quickly so that their skills could be used in the war effort.

Milton's job choices included working as a mathematician and code breaker in Washington, D.C., or going to the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics (NACA, now NASA Ames Research Center), which cohabited Moffett Field, California, with the U.S. Navy until the naval air base was closed in 1994. Milton chose to go to Ames. Men of military age in occupations that were important for the war effort could have their call-up "deferred" but only for a limited time. Therefore, the aerodynamicists were all inducted into the "Ames Detachment" of the U.S. Navy and then assigned back to their day jobs, but with some naval duties. Milton was ultimately promoted to the rank of lieutenant junior grade.

Milton always regarded himself as an engineer rather than a mathematician, and indeed his first assignment was to assist Harvey Allen and Walter Vincenti with experimental work in the newly built 1-foot by 3.5-foot transonic wind tunnel.

The famous Ames compilation of basic information and numerical results for compressible flow (the 70-page NACA Report 1135, issued in 1953, and now available online) was a group effort and was attributed to anonymous members of the Ames staff. In fact, Milton was responsible for the material on flow of perfect gases in thermodynamic equilibrium (up to a rather hopeful $M = 100$), which forms the major part of the report. Note that all of the numerical results were generated by Milton's assistants using mechanical desk calculators. This report became NACA's all-time best seller, and its presentation of formulas and figures has been followed in many textbooks on compressible flow.

In 1946, after leaving the Navy, Milton won a National Research Council scholarship for graduate study at the California Institute of Technology. By June 1949 he had received an M.S. and a Ph.D. (magna cum laude). His thesis was on the delicate problem of second-order supersonic flow theory. His advisor was Paco Lagerstrom. After a postdoctoral year with Lagerstrom, he returned to the NACA Ames Laboratory in 1950.

Harvey (Harry Julian or H. Julian) Allen had discovered that a round-nosed body should be better able than a sharp-nosed body to withstand the high temperatures that occur during hypersonic reentry into the atmosphere. This was a remarkable, counterintuitive result. Allen later became director of the NASA Ames Research Center (1965–1969): coincidentally, he was the subject of the first Memorial Tribute in the first volume of this series, written by Nicholas Hoff in 1979. The vacuum-tube digital computers of the 1950s did not have the power to calculate the hypersonic flow over a given body directly, and "inverse" methods, in which an assumed shape of the bow shock wave was adjusted until the right body shape appeared, had failed to converge. The problem was assigned to Milton, whose contribution was twofold. First, he provided a clear mathematical explanation for the failure of previous "inverse" computations. Second, in collaboration with Helen Gordon, he created a successful inverse algorithm.

It was only in the 1970s, after computer power had increased by about three orders of magnitude (and after the U.S. manned lunar program had been abandoned) that Milton's inverse scheme was replaced by truly direct schemes. Thus, the predictions of fluid flow and heat transfer during ballistic reentry of the three generations of U.S. spacecraft (Mercury, Gemini, and Apollo) were all made using the Van Dyke–Gordon algorithm.

While still at NACA Ames, Milton was awarded a

Guggenheim Fellowship and a Fulbright grant to spend the 1954–1955 academic year with George Batchelor at Cambridge University. During this sabbatical year Milton lectured extensively in Western Europe. In Cambridge he became well acquainted with G. I. Taylor. It was a friendship that continued until "G.I." died in 1975. Milton was especially proud of the fact that he wrote appendixes to two of G.I.'s papers during the 1960s.

Paul Germain (NAE 1979) invited Milton to spend the academic year 1958–1959 as a visiting professor at the University of Paris. Milton gave a 23-lecture course on hypersonic flow theory—in French, which he taught himself in six months. He also supervised a Vietnamese Ph.D. student, and Germain alleged that he developed a Vietnamese accent. The Van Dyke family remembers Germain as a valued friend. (In 1965, Milton spent three months at A. A. Dorodnitsyn's computing center in Moscow and again learned the language sufficiently well that he was able to lecture in Russian.)

While he was in Paris, Milton was invited to join the faculty of the newly opened Aeronautics Department at Stanford, as a full professor, and he arrived in 1959. He introduced a course on perturbation methods, leading to his book, *Perturbation Methods in Fluid Mechanics* (Academic Press, 1964), which contained much original work, and two other courses, one on symmetry and similitude in fluid mechanics and the other on hypersonic flow theory. His appointment was held jointly in the aeronautics department and the applied mechanics group of the mechanical engineering department. He continued to work on supersonic/hypersonic flow and on higher-order boundary-layer theory. He was an enthusiastic and innovative teacher. When told of his death, a former Ph.D. advisee of one of Milton's Stanford colleagues—now a prominent figure in computational aerodynamics—said simply, "He was my hero." Milton's own 40-odd Ph.D. students would say much the same, as would the many academic friends to whom he gave a helping hand in times of professional, personal, or political trouble. It was said of him that if he felt that a wrong had been committed, no matter how small or how large, he was absolutely stubborn about seeing that it was made right. Milton nominally retired in 1992 but kept an office on campus until his last illness.

Milton, with W. R. Sears (then of Cornell University) was invited by Annual Reviews Inc. to edit a new series, and the first volume of *Annual Review of Fluid Mechanics* appeared in January 1969. In the Preface the editors stated that it "stems from the conviction that fluid mechanics is now such a broad subject, with implications in so many areas of science and technology, as to require, periodically, expository reviews by specialists in its various branches." The list of contributors is impressive and a tribute to the editors' powers of persuasion: nearly all the names are instantly recognizable even after 40 years. Milton, with various colleagues, remained an editor for 30 years.

Milton believed strongly that textbooks should be sold as cheaply as possible. He refused to let the publisher of *Perturbation Methods in Fluid Mechanics* (Academic Press, 1964). increase the price, and when the publisher let the book go out of print, Milton published an annotated edition himself for the original price of $7 under the imprint of Parabolic Press (1975). The press began to publish wholly new books because of an apparently trivial incident. Milton had once seen, in a little bookshop on the Left Bank in Paris, a beautiful collection of black-and-white photographs from optical research and realized that students of fluid mechanics needed a similar collection. So, many years later, Parabolic Press published *An Album of Fluid Motion* (1982), which Milton designed himself. It contains about 400 photographs selected from 1,000 sent to him by friends all over the world (another tribute to his persuasive powers). Many of these photographs are intrinsically beautiful, and black-and-white prints make a pleasant change from contour plots in primary colors. The album is sold at no more than cost price. To date, over 40,000 copies have been sold, and a pleasant custom has arisen, not only at Stanford: a lecturer will give the top student in a class a copy, as an informal prize. Another Parabolic Press book is *Stories from a 20th-Century Life* (1994), the lighthearted autobiography of Milton's *Annual*

Review collaborator, the late Bill Sears, written "with malice toward none, with charity for all" (except airport managers: Bill logged nearly 8,000 hours as a private pilot).

As well as receiving several fellowships for research abroad, Milton received the Otto Laporte Award of the American Physical Society in 1986 and the Fluid Dynamics Award of the American Institute of Aeronautics and Astronautics in 1997. He is also remembered for three outstanding works of public service—NACA Report 1135, *Annual Review of Fluid Mechanics*, and the "Album."

Milton's private interests included music—he played violin in a Harvard orchestra—and all kinds of outdoor activities from camping to mountain climbing. He was also good at making things, including much of the furniture in his first house.

He is survived by his wife of 48 years, Sylvia, who nursed him at home until his death; his sons Russell, Eric, Christopher, Brooke, and Byron; his daughter, Nina; and nine grandchildren.