



*Warren E. Stewart*

# WARREN EARL STEWART

1924–2006

Elected in 1992

*“For leadership in chemical engineering research and the application of advanced mathematical and numerical methods.”*

BY R. BYRON BIRD, W. HARMON RAY,  
AND EDWIN N. LIGHTFOOT

WARREN EARL STEWART, McFarland-Bascom Professor Emeritus of Chemical and Biological Engineering at the University of Wisconsin, died on March 27, 2006, after a long and distinguished career. Warren was born in Whitewater, Wisconsin, on July 3, 1924, to Earl and Avis Stewart. He received both B.S. and M.S. degrees at Wisconsin, in 1945 and 1947, and the Sc.D. in 1951 at Massachusetts Institute of Technology (MIT). All of his degrees were in chemical engineering. While an undergraduate at Wisconsin, he gained fame as the first student in the history of the College of Engineering to graduate with a straight-A academic record. His MIT experience introduced him to numerical analysis and computational techniques, which proved to be essential at the dawn of the electronic computer age.

In World War II, Warren enlisted in the U.S. Naval Reserve (1944–1946). He returned to Wisconsin as a Navy engineering trainee under the V-12 Program, and after graduation served as a communications officer on the aircraft carrier *USS Midway*. In 1947 he married Jean Durham Potter, who later was alderman for the city of Madison for 16 years (1977–1993). They had six children and 18 grandchildren.

After five years at the Sinclair Research Laboratories, Warren Stewart joined the faculty of the Department of Chemical Engineering at the University of Wisconsin in 1956, where he taught until 1997. As chairman of the department (1973–1978), he re-

cruited and nurtured several young faculty members who went on to become international leaders in their fields as well as NAE members. He supervised many Ph.D. students and postdoctoral fellows who today hold responsible positions in universities and industrial research laboratories around the world.

His research publications are indicative of the breadth of his interests and knowledge. How many chemical engineers could write significant contributions on such widely varying topics as prediction of vapor pressures, reciprocal variational principles, kinetics of benzene hydrogenation, chemical kinetics and reaction engineering, multicomponent diffusion, orthogonal collocation, measurement of diffusivities, droplet vaporization, kinetic theory of rigid dumbbell suspensions, tokamak reactors, thermal diffusion, catalysis, corrosion, parameter estimation, Bayesian statistics, strategies for process modeling and parameter estimation, viscoelastic fluid dynamics, insulation qualities of animal fur, sensitivity analysis, and distillation column design? Whereas most professors tend to become very specialized, Warren Stewart was an impressive generalist. When he served as department chairman, he was able to discuss with all faculty members the details of their ongoing research programs. No other department chairman in the last half-century has been able to do that.

Warren published well over 100 research papers, many containing an impressive amount of detail. He wrote several systematically organized series of reviews of many important transport problems, invariably using his facility in applied mathematics. The first of these series dealt with the boundary-layer theory for momentum, heat, and mass transfer in laminar, multicomponent systems. Then came a series of papers in *AIChE Journal* dealing with forced convection in three-dimensional flows: I (1963); II (1970); III (1983); IV (1988); the second of these is the famous paper dealing with transport across mobile interfaces, co-authored with J.B. Angelo and E.N. Lightfoot. Then in 1974, there was a series of four papers with J.P. Sørensen dealing with computation of forced convection in slow flow through ducts and packed beds, published in *Chemical Engineering Science*.

Among Warren Stewart's most important technical contribu-

tions was his development of new mathematical and computational methods for modeling chemical phenomena and chemical processes. His work in this area led to better design and safer operation of chemical processes involving chemical reactions, transport of heat and mass, and the complex flow of fluids. His research results, which have been adopted around the world, increased the fundamental understanding of chemical phenomena and significantly influenced industrial practice.

In addition, there were many publications dealing with the analysis of diffusion experiments and the collection and correlation of diffusivities for various gaseous and liquid systems. In 1964 he and Richard Prober wrote a paper about the matrix approximations for multicomponent mass transport in *Industrial and Engineering Chemistry Fundamentals*; this work was followed by an article in *AIChE Journal* dealing with multicomponent diffusion in turbulent flow in 1973. An analytical solution of which he was particularly proud was that of the Fourier analysis of energy transport in turbulent tube flow at large Prandtl numbers, which appeared in *AIChE Journal* in 1987. The work on multicomponent diffusion and on turbulent heat transfer were included in the second edition of *Transport Phenomena*, by R.B. Bird, Warren E. Stewart, and E.N. Lightfoot (2002), §22.9 and §13.6, respectively.

Beyond influencing his own research students, he was an inspiring teacher and valuable consultant for many students and professors in the Chemical Engineering Department. Furthermore, Warren was a co-author of the 1958 green paperback, *Notes on Transport Phenomena*, which served as a preliminary edition for the 1960 textbook, *Transport Phenomena* (published by John Wiley & Sons). This textbook changed the direction of chemical engineering teaching everywhere in the world. It was translated into Spanish, Russian, Italian, Czech, and Chinese. After 64 printings of the first English edition, a second edition was prepared by the same trio of authors. The new edition appeared in 2002 and has been translated into Chinese, Portuguese, and Spanish.

In the preparation of this textbook, Warren displayed important characteristics that were invaluable: very high standards for

writing technical material, a photographic memory of the technical literature, and an insistence that there be no spelling or grammatical errors (this last quality earned him the nickname “gimlet eye”). Furthermore he didn’t allow any question marks to be missed (he would say “I think we’ve missed a little ‘button-hook’ at the end of the penultimate sentence”).

At the time of his death, Warren had almost completed *Computer-Aided Modeling of Chemically Reactive Systems* (by Warren E. Stewart and Michael Caracotsios), along with accompanying software. This book provides an overview of chemical kinetics and reactor modeling, as well as an extensive description of strategies for parameter estimation based on noisy and incomplete data sets. An interactive software package is included that can perform modeling and parameter estimation calculations based on the problem details supplied by the user.

Despite his quiet demeanor and modesty, Warren received many awards for his research and teaching: Elected Fellow of the American Institute of Chemical Engineers (AIChE) (1973); Citation Classic status for *Transport Phenomena* (see *Current Contents*, 17 September 1979); Citation Classic status for “Solution of Boundary Value Problems by Orthogonal Collocation” (see *Current Contents*, 21 September 1981); Alpha Chi Sigma Research Award of AIChE (1981); Benjamin Smith Reynolds Award for Excellence in Teaching, University of Wisconsin College of Engineering (1981); Chemical Engineering Division Lectureship Award, American Society of Engineering Education (1983); Honorary Member of Phi Beta Kappa (1983); McFarland-Bascom Professorship (1983); Computing in Chemical Engineering Award, CAST Division of AIChE (1984); E.V. Murphree Award in Industrial and Engineering Chemistry, American Chemical Society (1989); Byron Bird Award for Outstanding Research Publication, University of Wisconsin College of Engineering (1991); and membership in the National Academy of Engineering (1992). The hallmark of Warren’s career was understated excellence in his work and unfailing kindness to students and colleagues.

He was given honorary membership in Phi Beta Kappa for his exceptional scholarship and his extensive contributions to

Chemical Engineering in Mexico and South America. He was a visiting professor at the Universidad Nacional de La Plata in Argentina in 1962, at the Universidad Nacional Tecnológico de Celaya in Mexico in 1983, and at the Universidad Autónoma de México in 1985. At these institutions he lectured in Spanish. For 18 years he was an editorial advisor for the *Latin-American Journal of Chemical Engineering and Applied Chemistry*. Following that, he held a similar position for *Latin-American Applied Research*.

Warren Stewart was well known for his sly sense of humor and his ability to produce, instantly, jokes on just about any topic. He loved puns and had a warning sign on his desk given to him by colleagues: "Incorrigible punster—don't incorrigé."

Warren loved his family and was devoted to them. He is survived by his wife, Jean; six children, Marilyn (Jim) Weaver, David, Douglas, Carol (David) Ray, Margaret (Kurt) Straus, and Maru Jean (Bruce) Glasgow; 18 grandchildren, Katherine, Thomas, and Rebecca Weaver, Jenny Kershner-Stewart, Joanna, Andrea, Rachel, Daniel, Susanna, and Abigail Ray, Gretchen, Eric, Madeline, and Zachary Straus, Johathan, Caroline, Andrew, and Jeffrey Glasgow. He is also survived by two sisters-in-law, Virginia and Helen Stewart, and one brother-in-law, John Potter; many nieces and nephews, cousins, and other relatives.