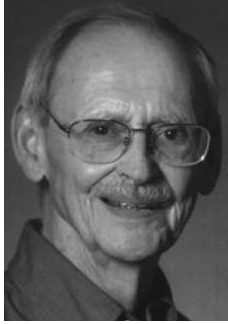


## In Memoriam: Professor Richard H. Pletcher (1935–2015), Who Advanced Computational Fluid Mechanics and Heat Transfer



It is with great sadness that we share with you the loss of a dear colleague and friend, Dr. Richard H. Pletcher. He was one of the pioneers and an internationally renowned expert in computational fluid mechanics and heat transfer, and was not only inspirational in directing the careers and lives of so many of us, but a mentor, who was extremely supportive and kind to all. Richard, or Dick, as we all personally and collegially addressed him, passed away on Saturday, Sept. 12, 2015, having been

diagnosed with terminal cancer. His 80 years of life are marked with multifaceted contributions to engineering, as his work helped advance computational techniques to solve challenging problems in aerospace and mechanical engineering. Dick is remembered for his large body of work in heat transfer, fluid mechanics, buoyant jets and plumes, turbulence modeling, separated flows, viscous–inviscid interactions, computational fluid mechanics and heat transfer, and large eddy simulation (LES) of complex turbulent flows.

Richard was born in Elkhart, Indiana, on May 21, 1935 to Raymond Harold Pletcher and Annabelle Mary Pletcher. He attended Purdue University and graduated with a Bachelor of Science in Mechanical Engineering in 1957. He married Carol Robbins on Jun. 9, 1957 in Elkhart and the couple soon thereafter moved to California so that he could report for active duty in the U.S. Navy. Dick proudly served as Ensign and Lieutenant (junior grade) for three years with amphibious forces in the Pacific. He served as engineering officer of a landing craft utility division and assistant gunnery officer on a landing ship dock. After military service, Dick attended graduate school at Cornell University where he received M.S. (1962) and Ph.D. (1967) degrees. During his doctoral studies, he was employed as an instructor by Cornell University for three years. He also worked as a senior research engineer in propulsion at United Aircraft Research Laboratories in Hartford, CT (1965–1967), and subsequent to doctoral graduation he joined the faculty in the Department of Mechanical Engineering at Iowa State University (ISU) in 1967.

During Professor Pletcher's tenure at ISU, he left a legacy of affable collegiality, excellence in teaching, and path-breaking scholarship in computational modeling of complex fluid dynamics and heat transfer systems. His expertise centered on computational fluid dynamics (CFD), whereby he developed and taught courses for over 40 years in this new and emerging field. With Professor Dale Anderson and Professor John C. Tannehill in the Department of Aerospace Engineering at ISU, a two-course sequence in computational fluid mechanics and heat transfer was developed in 1972. These courses were among the first in the U.S. in that specialty, which was born from the computer age. Papers based on numerical simulations carried out by Professor Pletcher appeared as early as 1965, a time when computer use for simulation in engineering was in an infant state. The early teaching activities in CFD were accompanied by research in algorithms and applications by the group at ISU. As a result, the program gained national recognition and many early international leaders in this field were trained there. The early leaders who trained at ISU included several branch chiefs and a division head at NASA, an entrepreneur who founded his own company, and several others who gained recognition as scholars in the field. Most of these individuals have already received ISU Alumni Awards. Even today, one of the computer systems at the NASA Ames Research Center carries the name Steger for Joseph Steger, an ISU alumnus who suffered an untimely death a few years ago.

Steger was responsible for several creative concepts in CFD published in the 1970s and 1980s.

In the 1980s, when NASA decided to encourage the development of educational programs in CFD by funding centers, ISU was selected as one of the five (eventually expanded to seven) national centers. Professor Pletcher was a Co-Principal Investigator of the proposal that won the Center for ISU. Other universities selected for center sites eventually included Stanford, MIT, NYU/Princeton, Penn State, the University of Cincinnati, and the University of Arizona. By this time, the CFD activities at Iowa State were internationally recognized and many very good students were attracted to participate in the graduate program in CFD. In addition to CFD, Professor Pletcher had strengths in experiments, and also taught mechanical engineering courses related to instrumentation and measurements. His experiences with both experimental and computational methods made him the outstanding engineer that we knew. Before he retired in 2008, he had taught more than 25 courses at Iowa State. He was recognized for his teaching and received the ISU Award for Excellence in Teaching.

Professor Pletcher served as Principal Investigator for numerous research grants and contracts from sponsors such as the Air Force Office of Scientific Research, the Army Research Office, Allison Gas Turbines, John Deere, the Department of Energy, National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). He was also a consultant to both industry and government, including Arnold Research Organization, Inc., Caterpillar Tractor Company, Delevon Gas Turbine, and General Electric Company. He was registered and licensed in the State of Iowa as a Professional Engineer.

Dr. Pletcher authored or co-authored over 100 refereed journal and proceeding papers and over 20 technical reports with students and colleagues. He was instrumental with advising 33 Ph.D. and 17 M.S. students. He was recognized for his research accomplishments and received the David R. Boylan Eminent Faculty Award for Research and the Distinguished Faculty Award for Significant Contributions to CFD, which were both awarded by ISU. He was one of the first to demonstrate the use of boundary-layer computational methods to compute flows in separated regions [1]. He has also been a leader in the application of viscous–inviscid interaction methods to flows with heat transfer [2], the application of preconditioning methods to compressible flows at low Mach numbers [3], the application of LES methods to turbulent flows with significant property variations [4–7], and the prediction of turbulent flows using the partially parabolized Navier–Stokes equations [8–11]. Professor Pletcher was also instrumental in employing a wide array of turbulence models to predict turbulent flows when this approach was at its infancy. For example, he used a variable property finite-difference calculation procedure to predict turbulent flow and heat transfer parameters in annular passages [12–14]. Of the several turbulence models that Malik and Pletcher [14] considered, they used one utilizing transport equations for turbulence kinetic energy and characteristic mixing length scale, which not only gave the best overall performance, but was especially crucial for accurately predicting the temperature distribution for flows with heat transfer at Reynolds numbers greater than 110,000.

While Professor Pletcher's work was overwhelmingly computational in nature, a significant piece of his contributions to fluid mechanics and heat transfer was experimental. Through a multi-year grant from the NSF, he and his students investigated turbulent shear flows with heat transfer in a water channel with applications to environmental discharges [15–19]. In the 1980s, there was a significant interest in understanding turbulent jets and plumes discharging into the atmosphere from smoke stacks as well as those discharging from power plant condensers into rivers

and lakes. The Environmental Protection Agency funded many investigations in this area over a number of years. The experimental work that Professor Pletcher performed was partially used to verify the many computational investigations he performed with his students in the same area (see, for example, Madni and Pletcher [20,21])

Professor Pletcher was extremely active with the research community, and had a prominent contributing presence in professional societies that included the American Society of Mechanical Engineers (ASME), and the American Institute of Aeronautics and Astronautics (AIAA). He served on the ASME Heat Transfer Division Committee on Honors and Awards, the K-20 Committee on Computational Heat Transfer, the K-12 Committee on Aerospace Heat Transfer (Chairman 1980–1983), and the Fluids Engineering Division Coordinating Group on CFD. He also served as Chairman of the Advisory Board for *Heat Transfer—Recent Contents*, a publication of ASME. He had been recognized during his long and successful career with numerous accolades. He was a Fellow of ASME (and was elected to Life Fellow in 2001) and an Associate Fellow of AIAA. His extensive work related to aerospace applications received a Certificate of Recognition for Creative Development of a Technical Innovation from NASA. Most recently he received the ASME Heat Transfer Memorial Award in Science in 2009. His involvement with both the ASME Heat Transfer and Fluids Engineering Divisions reflected his ardent desire to partake in technical committees so as to share ideas as well as disseminate research. In this effort, he organized more than 25 technical sessions at various conferences. He was also an Associate Editor of the ASME *Journal of Heat Transfer* and served on the Editorial Advisory Board of *Numerical Heat Transfer*. He co-edited the *Handbook of Numerical Heat Transfer*, which is considered a landmark reference in this area of heat transfer. He also co-authored a chapter in the handbook and contributed a chapter to the *Handbook of Forced Convection*, among the several book chapters he authored or co-authored. He lectured at NASA Research Centers on several occasions and presented seminars at the University of Minnesota, the University of Illinois, the University of Pennsylvania, Cornell University, RPI, and Clemson among others. He participated in three workshops on computational issues sponsored by NSF. While on faculty improvement leave in 1976–1977, he lectured at the Imperial College in London. In 1978 he was an invited lecturer for an NATO sponsored Advanced Study Institute held in Turkey on Turbulent Forced Convection in Channels and Rod Bundles. In 1983, he was a member of the U.S. delegation to the 7th Indian National Heat Transfer Conference in Kharagpur, India, which was sponsored by NSF. He visited several universities in India and presented a short course on Turbulence Modeling. In 1983 he was co-author of a “cover” article for *Mechanical Engineering*, “Computers in Analysis and Design.” He gave a keynote address at the 2nd International Symposium on Transport Phenomena in Turbulent Flows in Tokyo, Japan in 1987. On the same trip, he gave three lectures at the Korea Advanced Institute of Science and Technology. He has also been an invited lecturer at three workshops on Supercomputing in Fluids held in Japan in 1989, 1991, and 1997. In 1985, he was selected as the lecturer for the Southwest Symposium on Thermal Sciences whereby lectures were given at the University of Texas at Austin, Texas Tech University, the University of Texas at Arlington, and the University of Oklahoma. In 1988, Professor Pletcher was one of the 20 people invited to write a review article for the 50th anniversary of the ASME Heat Transfer Division which was published in a special issue of the *Journal of Heat Transfer*.

The most notable contribution for which Professor Pletcher is remembered is the textbook *Computational Fluid Mechanics and Heat Transfer*, which he co-authored with Professors John C. Tannehill and Dale A. Anderson, and was first published in 1984. The book was widely adopted (more than 90 schools at one time) and translated into Russian in 1990. It was one of the first comprehensive texts in this new field. The second edition appeared in

1997. This textbook is now in its third edition and is used worldwide as a leading authority on finite-difference and finite-volume methods. It was one of the first texts available once computers became a viable resource for a tractable solution of coupled partial differential equations.

On a more personal note, there was more to Professor Pletcher than his career as he was also a strongly dedicated family man. He is survived by his wife of 58 years, Carol; his sister Judy; three children, Douglas, Laura, and Cynthia; and six grandchildren. For those that had the opportunity to join Dick and his family for dinner, they can recount how down-to-earth he was, and how he enjoyed being surrounded by his family and Brittany dogs. He loved to hunt (especially pheasant hunting) and fish with his children, and regularly ran with his dogs. He was an active member of Collegiate Presbyterian Church, Town and Country Kiwanis, and an avid fan of ISU women’s basketball. The Heat Transfer and Fluid Mechanics community and his many friends and colleagues worldwide will miss him dearly.

**S. A. Sherif**

**Fellow ASME**

**Department of Mechanical and Aerospace Engineering,  
University of Florida,  
Gainesville, FL 32611**

**F. Battaglia**

**Fellow ASME**

**Department of Mechanical Engineering,  
Virginia Tech,  
Blacksburg, VA 24061**

**R. M. Manglik**

**Fellow ASME**

**Department of Mechanical and Materials Engineering,  
University of Cincinnati,  
Cincinnati, OH 45221**

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