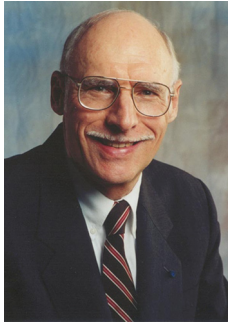


## In Memoriam: Professor Arthur E. Bergles (1935–2014), the Pioneering Advocate of Enhanced Heat Transfer and Energy Conservation



To accentuate the imperatives of tackling the multitude of engineering as well as socio-economic issues attendant to the energy–water nexus, he would often paraphrase the dilemma of the poet Samuel T. Coleridge,<sup>1</sup> “Energy and water everywhere, but not a drop.....” The viability of heat transfer, and therefore *enhancement* or *augmentation* of heat transfer, in addressing the engineering challenges of this “energy crisis,” to use the popular idiom of the 1970s, was foremost on his mind, and

he tirelessly advocated the need for conservation along with research and application of advanced enhancement techniques in all heat and mass transfer systems. Because of his own pioneering work, which was extensive and spanned the spectrum of very small (micro/miniscale heat sinks, compact exchangers, etc.) to very large (power boilers, steam condensers, refrigerant heat exchangers, etc.) thermal systems, the field of heat transfer enhancement grew rapidly [1] and came to be regarded globally as a *second-generation heat transfer technology*.<sup>2</sup> Arthur E. Bergles, or Art as he was known to us and his multitude of friends and colleagues all over the world, passed away on Monday, March 17, 2014, after an extended battle with a malignant brain tumor. He was 78 and leaves us a legacy of an exemplary, more than five-decades-long career marked with educational innovations, seminal and path breaking scientific contributions, and extensive professional service.

Art was born in New York City on August 9, 1935, to Edward and Victoria Bergles, who had immigrated to the USA from Austria. A self-taught engineer, Edward and his family moved to Rhinebeck, NY, where he completed building a hydroelectric power plant in 1938, which ran almost continuously for 47 years, with Art’s help, producing 25 kW power; clearly Art’s introduction to and interest in engineering developed at a very early age. After schooling at a one-room schoolhouse, and subsequently the Rhinebeck Central School System, where he graduated as a valedictorian and earned his Eagle Scout, Art joined Massachusetts Institute of Technology (MIT) in 1953 to study Mechanical Engineering. At MIT, he received his combined SB and SM degrees in 1958, and subsequently his Ph.D. in 1962, all in Mechanical Engineering, with an intervening year spent as a Fulbright Scholar at the Technical University in Munich, Germany. While at MIT, he met his future wife, Priscilla (Penny) Maule, who was then working in the Magnet Laboratory, and they got married in 1960. He earned his P.E. (Mechanical Engineering) in the State of Massachusetts in 1965.

Art started his academic career at MIT, first as Research Staff at the National Magnet Laboratory, and in 1963 as the Ford Assistant Professor in Mechanical Engineering before moving to the Georgia Institute of Technology as Professor in 1969. In 1972, he became Chair of Mechanical Engineering at Iowa State University (ISU) and was named the Anson-Marston Distinguished Professor of Engineering in 1981. After stepping down as chair in 1983, he continued to direct the Heat Transfer Laboratory at ISU until his move to Rensselaer Polytechnic Institute (RPI) in 1986. At RPI, he was appointed Clark and Crossan Professor of Engineering and later served as Dean of Engineering (1989–1992), but in 1997, ill health forced him to retire. In the preceding year, he was felicitated with a *Festschrift* [4] and a 2-day symposium in his honor at Georgia Tech. Even in his so-called “retirement,” however, Art remained very active as the Clark and Crossan Professor of Engineering, Emeritus, at RPI, with an adjunct appointment as Glenn L. Martin Institute Professor of Engineering at the University of Maryland, and as Senior Lecturer in Mechanical Engineering at MIT. He continued to write papers, give seminars, interact with researchers around the world, travel to conferences, and much more, and would often remark, “I’m still doing what I was doing before I retired, but now I don’t get paid for it.”

Art’s research in heat transfer was multifaceted and multidisciplinary and covered a variety of engineering systems and all modes of heat transfer processes. Most significantly, in his pioneering and extensive work on enhanced heat transfer, many of his fundamental experimental and theoretical investigations were always conducted in the context of practical applications, and the need to move research results to industrial practice. He was a very early investigator of, and advocate for, improved microelectronics cooling. He worked in boiling, condensation, and laminar and turbulent single-phase flows, and his passion for fundamental and applied research was further anchored by a strong interest in history; he wrote several papers on the history of heat transfer [5]. Besides his many seminal, ground breaking original research articles, his writings also included numerous well-received review papers that provided guidance for other researchers who were seeking newer directions.

Relative to this latter effort and highlighting Art’s conviction of encouraging younger colleagues and for ensuring a meaningful future of heat transfer education and research, he and the late Professor Warren Rohsenow (MIT) very generously endowed and established the Bergles–Rohsenow Young Investigator in Heat Transfer Award in 2003. This ASME society-level annual award has been given to 10 outstanding young professors to date. Moreover, Art and Penny endowed the Bergles Professorship in Thermal Science in 1997 in the Department of Mechanical Engineering at Iowa State University to attract or retain an outstanding senior faculty member. This shared commitment to scholarship and research, with gifts from friends, faculty, colleagues, and corporations, also led to the endowment of the Dr. Arthur E. Bergles Scholarship in 1996 upon the occasion of his retirement from Rensselaer. His passion for education and fostering the careers of young scientists is eminently reflected in the fact that he was an advisor for 82 thesis students, and that he also volunteered his time to serve on numerous fellowship and award selection committees. Art’s research with students and colleagues resulted in more than 400 papers, 26 books, and over 400 invited lectures around the world.

Art Bergles was acknowledged as one of the world’s leading experts in the thermal sciences, and numerous honors, awards,

<sup>1</sup>“Day after day, day after day, /We stuck, nor breath nor motion; /As idle as a painted ship /Upon a painted ocean. //Water, water, everywhere, /And all the boards did shrink; /Water, water, everywhere, /Nor any drop to drink.” The Rime of the Ancient Mariner, in Seven Parts by the English poet Samuel Taylor Coleridge, written in 1797–1798 and published in the first edition of Lyrical Ballads, W. Wordsworth and S. T. Coleridge, printed for J. & A. Arch, etc., London, 1798 (also see later edition published by Duckworth, London, 1920).

<sup>2</sup>In fact, the present day advanced enhancements represent a third-generation heat transfer technology [2], with exciting new frontiers yet to be explored and is indeed a growing field [3] that has in essence truly been defined by Professor Bergles.

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and felicitations marked his distinguished career. Besides being elected to the NAE (1992), he was also inducted in the Polish Society of Theoretical and Applied Mechanics (1987), UK Royal Academy of Engineering (2000), Academy of Sciences and Arts of Slovenia (2001), and Italian National Academy of Sciences (2003). He was Fellow of the ASME, AAAS, AIChE, ASEE, and ASHRAE, and associate Fellow of AIAA; was awarded four honorary professorships (University of Ljubljana, Slovenia, 1997; Technical University of Denmark, 1998; Beijing Polytechnic University, 2001; and St. Petersburg State Polytechnic University, Russia, 2008); and received Honorary Doctorates from the University of Porto, Portugal (1998), Rand Afrikaans University, South Africa (1999), and Sapienza – Università di Roma, Italy (2009). He was honored with all the major awards in heat transfer that included the ASME Heat Transfer Memorial Award, AIChE D. Q. Kern Award, ASME-AIChE Max Jakob Award, ICHMT Luidkov Medal, Nusselt–Reynolds Prize, ITherm Achievement Award, ASHRAE’s F. Paul Anderson Medal and Holladay Distinguished Fellow Award, and the International SFT Award by the French Thermal Society, among many others. Underscoring the very high esteem that his many friends and colleagues held for Art, he was felicitated multiple times in celebration of his birthdays [6–9] and extensive contributions to research, education, and service.

Not only did Art pursue education and research passionately but he also gave back to the community by being very active in professional organizations. He was named a Life Member of ASEE and ASHRAE, and 50-Year Member of ASME. Moreover, some of his achievements and recognitions in professional service included: President of ASME (1990–1991); Honorary Member of ASME (1996) (its highest recognition); ASME Medal (2000); ASME Board of Governors; and ASEE Benjamin Garver Lamme Medal (1987), among others. He served a 6-year term as the National Research Council (NRC) Liaison for the Mechanical Engineering Section of the NAE. He was a regular member of the NRC panel to select Ford Doctoral Fellows, a member of the Visiting Committee in Mechanical Engineering at Maryland, a member of the Engineering Advisory Committee at the University of Connecticut, chaired numerous committees in ASME, AIChE, ASHRAE, ASEE, ICHMT, and the National Science Foundation, and served as editor or editorial board member of virtually all the prominent archival journals in heat transfer and thermal science engineering. Moreover, He served on the Board of Directors of the MIT Club of Cape Cod for 4 years, cochaired the MIT Class of 1957 50th Reunion, and was elected President of the Class. Art also served as the President of the Osterville, MA, Rotary Club for 2010–2011. In an insightful reflection of the past and contemporary times for thermal sciences and engineering, Art had constantly held “the future to be bright for heat transfer,” and especially for enhancement of heat transfer, as the essential role of the associated advanced research and engineering is unquestionable in the renewed global urgency of addressing energy and energy–water nexus issues.

On a more personal note, Art Bergles is survived by his wife Penny, two sons (Eric and Dwight), and five grandchildren. Art

and Penny had celebrated their 50th wedding anniversary on June 19, 2010, and while he was also an avid golfer and enjoyed driving his vintage Corvette, they had shared interests in swimming, snorkeling, skiing, and gardening. He was always in the midst of change, embraced it, and engaged in it with remarkable alacrity. More than a decade ago, while equating his life’s journey with the *art* of riding a bicycle, he had commented that “if you do not keep peddling, you will fall.” He surely pedaled far in a truly exceptional and inspirational journey; RIP Arthur E. Bergles!

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