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## In Memoriam: Richard J. Goldstein



We report with great sorrow the passing of Professor Richard J. Goldstein on 6 March 2023 at the age of 94. He was truly a giant in the fields of thermal sciences research, engineering, and education, and is well known to everyone reading this memoriam. He was a friend and mentor to many throughout the world.

Professor Goldstein made major advances in optical measurement systems for fluid velocity and temperature, development of cooling designs widely used in high-performance gas turbines, and novel and important measurements in thermal convection. He pioneered laser Doppler velocimetry and hot-wire anemometry measurements and a variety of high-precision mass transfer based techniques to study free and forced convection. He was the first to experimentally confirm the critical Rayleigh number for instabilities in Rayleigh-Bénard convection with shear-free boundaries. His research has been presented across more than 300 scientific publications. His many studies on film cooling, including his ingenious use of shaped holes for film cooling of surfaces, along with his numerous investigations on jet impingement cooling, led to increased efficiency and reliability of high-performance gas turbines for power generation and aircraft propulsion. Many consider him to be the “father of film cooling.”

Professor Goldstein was born in New York City and graduated from Stuyvesant High School in 1944. After receiving his B.S. in Mechanical Engineering from Cornell University in 1948, he went on to pursue his M.S. degree in Mechanical Engineering (1950) and Physics (1951) from the University of Minnesota Twin Cities. Subsequently, he joined the Oak Ridge National Laboratory as a Development Engineer in 1951. After a brief stint in the US Army as a first lieutenant, he returned to the University of Minnesota Twin Cities in 1956 to pursue a Ph.D. degree in Mechanical Engineering under the guidance of Dr. Ernst R. G. Eckert. During his doctoral pursuits, he was a recipient of the Honeywell Fellowship (1955–57) and worked as an engineer for Lockheed Aircraft Corporation. After obtaining his doctorate (1959), Professor Goldstein joined the College of Engineering at Brown University as an Assistant Professor. Following a year at Brown University, he joined Centre National de la Recherche Scientifique as a NATO Postdoctoral Fellow (1960). He ultimately returned to the University of Minnesota Twin Cities in 1961 as an Associate Professor in the Department of Mechanical Engineering, wherein he progressively served as an Associate Professor (1961–1965), Professor (1965–1990), Department Head (1977–1997), Regents’ Professor (1990–2018), and Regents’ and James J. Ryan Professor Emeritus (2018–2023). He had

a deep passion for teaching and creating opportunities for others. During his six-decade-long academic career, he mentored 74 doctoral and 82 master’s students, as well as several visiting and post-doctoral scholars.

Professor Goldstein established a very long record of service to the scientific and engineering community both domestically and internationally, including major leadership roles, such as President of the Assembly for International Heat Transfer Conferences, President of the American Society of Mechanical Engineers (ASME), and President of the International Centre for Heat and Mass Transfer (ICHMT). He served as an honorary member of the Associazione Termotecnica Italiana (2006) and as the chairman of the honorary editorial advisory board for the International Journal of Heat and Mass Transfer and the International Communications in Heat and Mass Transfer for several years.

Professor Goldstein’s honours and recognitions include honorary doctoral degrees, visiting professorships, fellowships/memberships in prestigious professional and honorary societies, and honorary editorial advisory board memberships in esteemed journals. His distinguished contributions to the field of heat transfer were recognized through many prestigious awards such as the ASME Heat Transfer Memorial Award (1978), the AIChE/ASME Max Jakob Memorial Award (1990), the ICHMT Luikov Medal (1990), the Nusselt–Reynolds Prize (1993), the ICHMT Fellowship Award (2004), and the ASME Medal (2006). He was also bestowed fellowships in reputed societies such as the American Association for the Advancement of Science (1986), the American Physical Society (1989), the American Society for Engineering Education (1997), the American Society of Mechanical Engineers (1999), and the Royal Academy of Engineering (1999). He was a member of the United States National Academy of Engineering (1985), the National Academy of Engineering–Mexico (1991), the European Academy of Science and Arts (2016), and the Pan American Academy of Engineering (2019). In recognition of his pioneering contributions to the field of energy, the ASME established the Richard J. Goldstein Energy Lecture Award in 2019. More recently, the ICHMT established the ICHMT Hewitt–Goldstein Young Investigator Award in recognition of Geoff F. Hewitt and Richard J. Goldstein, pioneering members of the ICHMT and outstanding leaders in the field of heat transfer and energy.

Professor Goldstein’s most important contributions do not come with awards or medals, but are felt in the hearts of the many students, young faculty members, colleagues, and other acquaintances whom he mentored and otherwise influenced through their careers. Though often stated to him throughout his career, many written and spoken heartfelt comments of appreciation were presented in 2018 at a celebration of his 90<sup>th</sup> birthday.

Professor Goldstein was a major leader in the international heat and mass transfer and energy engineering communities for many years. His passion for scholarship and engineering, leadership, guidance, and support for his friends, colleagues and students, and never-ending enthusiasm and kindness will be greatly missed by scientists and engineers around the world.

We offer our deepest condolences.

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