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Guest Editorial

Special Issue: Richard J. Goldstein Memorial Issue—Transformative and Innovative Advancements in Heat and Mass Transfer

A Lifetime of Path-Breaking Scholarship That Spans Gas-Turbine Cooling to Transport Processes and Critical Diagnostic Tools for Convective Heat Transfer and More

Professor Richard J. Goldstein (March 27, 1928–March 6, 2023) was perhaps one of the “tallest” colleagues in our field with a career spanning over seven decades, during which he contributed extensively to a gamut of heat and mass transfer topics and his work has impacted nearly all areas of thermal science. He was a pioneering innovator and his scholarship influenced the way scientists and engineers solve the world’s contemporary engineering problems and technological challenges. This has been particularly evident in thermal science frontiers relating to novel diagnostics in temperature measurements, cooling technologies for high-performance gas turbines, innovative evaluation techniques for thermal convection, and visionary leadership on the global stage in energy engineering.

While the lifetime contributions of Dick Goldstein are too numerous to comment upon in this brief preface, a few noteworthy cases are instructive of his path-breaking work. The development of a novel optical system that enables laser-Doppler velocimetry (or LDV) for velocity and temperature measurements has not only been pioneering but also has revolutionized the diagnostic tools used by scientists and engineers in the broad thermal energy field. He was the first to establish the use of a reference laser beam in the precision quantification of LDV, which he then pioneered for high-fidelity measurements in laminar flow systems as well as characterization of fluid turbulence. The first optical interferometer, using reference laser beams, for the characterization of temperature distribution in liquid-surface heat transfer was also developed by him. This has undeniably made possible new investigations in heat transfer processes that were hitherto inaccessible to diagnostic evaluation by prevailing techniques. Another transformational example is that of his large body of work on film-cooling of advanced gas turbines. Dick was the first to develop shaped film cooling holes in turbine blades so as to reduce jet-induced liftoff of the gas blanket from the surface and also enhance the cooling process. This has allowed gas-turbine operations to breach some higher-temperature limits so as to significantly increase their efficiency and thus conserve energy (or fuel) substantively.

The visionary leadership that Dr. Goldstein provided to the energy engineering community in general, and mechanical

engineering and its thermal energy science domain, in particular, has likewise been truly exemplary. This has ranged from design and development consulting roles with prominent industry (NASA, General Electric, Pratt and Whitney, Lockheed Aircraft, and Space Technology Lab, to list a few) and influential leadership roles in ASME and other such professional societies. He was President (1996–1997) of ASME and had previously been a member of its Board of Governors as well as the Basic Engineering Group Operating Board. He led the US-China Heat Transfer Workshop that was sponsored by the National Science Foundation, US-Japan Joint Heat Transfer Conference Assembly, World Assembly of International Heat Transfer Conferences of the International Center for Heat and Mass Transfer, and the National Academy of Engineering Program Advisory Committee, among many other such engagements. Moreover, his role as an advisory committee member of leading universities (Cornell University, Georgia Institute of Technology, University of Wisconsin – Madison, and Michigan State University) has influenced curricular development in the energy engineering domain. In addition, to cap all these multifaceted contributions and achievements, his exceptional philanthropic leadership and vision in endowing the ASME Goldstein Energy Lecture Award has been truly exemplary!

It is, thus, no surprise that Dick Goldstein had been the recipient of numerous high honors for his extensive contributions in thermal science, energy engineering, and leadership. Among many other awards and recognitions, they include being elected to the National Academy of Engineering, Foreign Fellow of the Royal Academy of Engineering, member of the European Academy of Science, corresponding member of National Academy of Engineering – Mexico, Honorary Member of the Associazione Termotecnica Italiana, Honorary Member of ASME, and the ASME Medal. He was also recognized with honorary doctorates by the Israel Institute of Technology and Instituto Superior Tecnico (Portugal).

In commemorating the lifetime contributions of this stalwart of our global thermal-fluids science and engineering community, many prominent researchers have contributed to the publications in this

special memorial issue of the *ASME Journal of Heat and Mass Transfer*. They cover a wide spectrum of topics that reflect Dick Goldstein's own research interests and the emerging problems and unresolved issues thereof. Experimental investigations as well as theoretical analyses or computational simulations dealing with gas-turbine cooling, free or natural convection, thermal energy conversion, enhancement of heat transfer, building cooling system, boiling heat transfer, and phase-change material based thermal energy storage have been reported. Several papers have provided new internal cooling strategies for gas turbines that include different film cooling arrangements and convection enhancement methods for improved performance. Another set of theoretical or computational simulation work has addressed natural convection in a variety of domains with or without porous media. Investigations that have explored potential convective heat transfer enhancement incurred with the use of a variety of techniques (roughness-promoting inserts, jet impingement and/or sprays, and such), conduction issues in a thermoelectric device, application of multiscale modeling, and drop-surface interactions in metallic spray coating processes are also reported. Refinement of computational modeling methods for boiling bubble dynamics and an experimental study of flow boiling and associated performance of an enhanced-surface cold-plate for electronics cooling are the subject of two papers. Another pair of excursions, one experimental and one computational simulation, has demonstrated the efficacy of compact heat exchangers and small-length-scale encasement of phase-change material for deploying high energy-density thermal energy storage systems. In addition, to round out the complement of publications, the application of liquid crystal thermography and its efficacy in evaluating transient thermal characteristics of radiant floor cooling in buildings is presented in one paper. All of these contributions to the archival literature are not only significant in their currency but also are a fitting tribute to the diversity and enduring impact of the scholarly legacy of Dick Goldstein.

With an illustrious career of more than 65 years in academia, Professor Richard J. Goldstein blazed a remarkable trail of prolific scholarship, engaged education with diverse sets of students, professional service that was marked with caring for colleagues, and endearing philanthropy. His lifelong professional endeavors produced more than 300 publications, which include archival research papers and books that address both fundamentals and

applications-oriented reports, and they continue to inform of critical design questions for researchers as well as engineering students. His legacy and learning antecedents are enunciated in the ensuing personal biographical editorial, and the papers published in this special issue not only memorialize this legacy but also celebrate its contemporary relevance in the hope of engendering a role-model path for newer generations of scholars and students. On a personal note, and as so pointed out in the obituary published (March 8, 2023; *Star Tribune*) after his passing, Dick "loved black coffee, the *Minnesota Vikings*, the theatre and classical music, traveling with his children, and chasing solar eclipses." Needless to add that the solar eclipse this year (April 8, 2024) is perhaps a fitting celestial eulogy for an exemplary colleague and friend who will be dearly missed!

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