

A Ninth Successful Year for *JTHT*

SUPPORT from the thermophysics and heat transfer community for the *Journal of Thermophysics and Heat Transfer (JTHT)* continues to be strong. Between October 31, 1994 and November 1, 1995, 160 papers were submitted to *JTHT*, with 31% originating from technical meetings. During this same time period, over 420 reviews were completed by volunteers to ensure the quality of *JTHT*. The average time between the receipt of a manuscript and the Associate Editor's decision to accept or revise was 3.7 months for articles appearing in 1995. The average time between final acceptance and publication was 6.2 months. The total number of pages was 816, and all four issues of volume 9 were on schedule.

A Full-Spectrum Publication

It should be re-emphasized that *JTHT* is a full-spectrum publication in the field of thermophysics and heat transfer, a breadth illustrated by the following list of pertinent topics:

Aerothermodynamics

Re-entry
Thermal protection
Low density
Laser interaction
Ablation
Plumes
Computational

Radiative Heat Transfer

Surface interchange
Absorbing-emitting media
Multiple scattering
Nongray analysis
Multidimensional
Coupled with conduction
Coupled with convection

Thermal Control

Heat pipes
Thermal modeling
Electronics cooling
Large space structures
Contamination
Cryogenics
Insulation

Conduction/Phase Change

Contact conductance
Composite materials
Inverse problems
Conjugate problems
Nonlinear problems
Analytical techniques
Melting/solidification

Nonintrusive Diagnostics

IR signatures
Remote sensing
Laser techniques
Particle sizing
Scattering techniques

Convective Heat Transfer

Forced convection
Natural convection
Mixed convection
Internal/external flows
Boiling/condensation

Thermophysical Properties

Thermodynamic
Transport
Optical/radiative

Numerical Heat Transfer

Finite difference
Finite element
Parallel processing

A discipline-oriented publication, *JTHT* presents both original contributions of a fundamental nature and application-type papers. Analytical, numerical, and experimental approaches are all encouraged. Papers on the topics of aerothermodynamics, thermal control, and numerical heat transfer are especially encouraged. Although *JTHT* is published by AIAA, papers are not restricted to aerospace topics. Authors from the international thermophysics and heat transfer community are invited to submit papers.

Accuracy and Ethics

The AIAA Publications Committee approved the following: "The AIAA journals will not accept for publication any paper reporting (1) numerical solutions of an engineering problem that fails to adequately address accuracy of the computed results or (2) experimental results unless the accuracy of the data is adequately presented." The purpose of this statement is to reiterate the desire to have high-quality investigations with properly documented results published in the AIAA journals, and to clarify acceptable standards for presentation of numerical and experimental results. The editors and reviewers will remain the final judges. An ethical

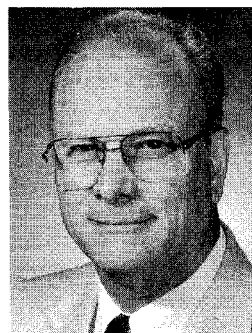
standards document was also approved by the Publications Committee and is reproduced in its entirety on page 8. Prospective authors and reviewers are encouraged to study it carefully.

Manuscript Disks

Authors are requested to prepare their manuscripts electronically to reduce publication delays. AIAA vendors can convert virtually any disk (3 $\frac{1}{2}$ -, 5 $\frac{1}{4}$ -, or 8-in.) directly to type, thus avoiding rekeyboarding and subsequent introduction of errors. Examples of easily converted software programs include TEX and LATEX. Please retain the disk until the review process has been completed and final revisions have been incorporated in your paper. If you have any questions or need further information, please telephone Richard Gaskin, AIAA Electronic Publications, at (202) 646-7496.

1995 AIAA Thermophysics Award Recipient

Dr. Fred R. DeJarnette, Director, Mars Mission Research Center,



North Carolina State University, was selected as the 1995 recipient of the AIAA Thermophysics Award. Dr. DeJarnette was chosen for his significant contributions to re-entry technology through the development of computationally efficient methods for predicting three-dimensional aerodynamic heating. The AIAA Thermo-physics Award is presented for an outstanding singular or sustained technical

or scientific contribution by an individual in thermophysics, specifically as related to the properties and mechanisms involved in thermal energy transfer and the study of environmental effects on such properties and mechanisms. This award was presented to him at the 30th AIAA Thermophysics Conference in June at San Diego, California.

1996 Editorial Team

The editorial team includes Associate Editors and members of the Editorial Advisory Board. The Associate Editors are responsible for the technical evaluation of manuscripts, and the burden of maintaining quality rests predominantly with them. Photographs and biographies of the 1996 team are included in this issue. Mike Yovanovich has been added to the Editorial Advisory Board, and Bud Peterson has replaced Gerry Schneider as Associate Editor. I encourage you to discuss your views of *JTHT* with members of the editorial team.

Appreciation

I would like to express my personal thanks to the authors who have chosen *JTHT* as the vehicle for their research work. I also want to thank the reviewers who have contributed their time to ensure the success of *JTHT*. Their names are listed in this issue. Finally, I would like to express my appreciation to Jacqueline Dupree (Production), Jason Peak (Managing Editor), Bob Elliott (Easton Publishing Services, Inc.), and Norma Brennan (AIAA Publications) for their help in keeping *JTHT* on schedule.

Alfred L. Crosbie
Editor-in-Chief

Editor-in-Chief



ALFRED L. CROSBIE, Curators' Professor of Mechanical Engineering at the University of Missouri—Rolla, received his B.S. from the University of Oklahoma in 1964, his M.S. in 1966, and his Ph.D. in 1969 from Purdue University, all in mechanical engineering. He joined the faculty of the University of Missouri—Rolla in 1968, where he was promoted to Professor in 1975. He has been an active researcher in the field of radiative heat transfer since 1964. His current research interests include multidimensional radiative heat transfer, multiple scattering, numerical heat transfer, and laser interaction. Dr. Crosbie has served as a member of the AIAA Thermophysics Technical Committee (1976–78), Technical Program Chairman for the AIAA 15th Thermophysics Conference (1980), Editor of two thermophysics volumes in the AIAA *Progress in Astronautics and Aeronautics* book series (1981), Associate Editor for the *AIAA Journal* (1981–83), and Chairman of the AIAA Thermophysics Technical Committee (1984–86). He is a Fellow of AIAA, a Fellow of ASME, a recipient of the AIAA Thermophysics Award (1987) and the ASME Heat Transfer Memorial Award (1990), and an Associate Editor for the *Journal of Quantitative Spectroscopy and Radiative Transfer* (1979–96). Dr. Crosbie is the author or coauthor of over 70 papers in archival journals.

Associate Editors



GRAHAM V. CANDLER, Associate Professor of Aerospace Engineering and Mechanics at the University of Minnesota, received his B.Eng. in mechanical engineering from McGill University in 1984 and his M.S. and Ph.D. in aeronautics and astronautics from Stanford University in 1985 and 1988, respectively. Before joining the University of Minnesota in 1992, he held positions at NASA Ames Research Center (1988–89) and North Carolina State University (1989–92). His research interests include numerical simulation of nonequilibrium reacting flows, high temperature gas dynamics, and re-entry and hypersonic aerodynamics. He is a recipient of the 1990 AIAA Award for Best Technical Paper in Thermophysics. Dr. Candler is the author or coauthor of more than 50 publications.



TA-SHEN CHEN, Curators' Professor of Mechanical Engineering at the University of Missouri—Rolla, received his B.S. from National Taiwan University in 1954, his M.S. from Kansas State University in 1961, and his Ph.D. from the University of Minnesota in 1966, all in mechanical engineering. He joined the faculty of the University of Missouri—Rolla in 1967, where he was promoted to Professor in 1973 and to Curators' Professor in 1991. His recent research centers on natural convection, mixed convection, heat transfer in separated flows, heat transfer in filmwise condensation, heat transfer in porous media, and wave and thermal instability of convective flows. Dr. Chen was a member of the AIAA Thermophysics Technical Committee (1986–88) and is a Fellow of ASME and Associate Fellow of AIAA. He is the author or coauthor of over 115 journal articles and 60 technical papers. He has also contributed a chapter each to the *Handbook of Single-Phase Convective Heat Transfer* and the *Handbook of Numerical Heat Transfer*.



PING CHENG, Professor and Head of Mechanical Engineering at the Hong Kong University of Science and Technology (HKUST), received his B.S. in mechanical engineering from Oklahoma State University in 1958, his M.S. in mechanical engineering from the Massachusetts Institute of Technology in 1960, and his Ph.D. in aeronautics and astronautics from Stanford University in 1965. Before joining HKUST in 1995, he held positions at New York University (1965–67), NASA Ames Research Center (1967–68), and National Taiwan University (1968–70) and the University of Hawaii (1970–95). His recent research centers on convection, boiling and condensation in porous media as well as reciprocating flow and oscillatory heat transfer. Dr. Cheng was a member of the AIAA Thermophysics Technical Committee (1988–89) and is a Fellow of ASME. He is the author or coauthor of over 125 publications. He has also contributed chapters on heat transfer in geothermal systems and porous media to *Advances in Heat Transfer*, and the *Handbook of Heat Transfer Applications*. He is a member of the editorial board of *Numerical Heat Transfer*.



DARRELL W. PEPPER, Associate Professor of Mechanical Engineering at the University of Nevada, Las Vegas, received his B.S. in mechanical engineering in 1968, his M.S. in aerospace engineering in 1970, and his Ph.D. in mechanical engineering in 1973, all from the University of Missouri—Rolla. He is also Co-founder and Chairman of Advanced Projects Research, Inc. (APRI) and conducts the home study courses on the finite element method for AIAA. Before starting APRI, he was Chief Scientist at the Marquardt Company (1987–90) and he worked for E.I. DuPont de Nemours at the Savannah River Laboratory in Aiken, South Carolina (1974–87). His research interests include numerical heat transfer, finite element methods, and computational fluid mechanics. Dr. Pepper is a Fellow of ASME and Associate Fellow of AIAA. He is also Chairman of ASME Heat Transfer Division's Ad Hoc Committee on Computational Heat Transfer and a member of the AIAA Thermophysics Technical Committee. He is the author or coauthor of numerous technical publications, including two books. He has also contributed two chapters to the *Handbook of Numerical Heat Transfer*.



GEORGE P. "BUD" PETERSON, Head and Tenneco Professor of Mechanical Engineering at Texas A&M University, received his B.S. in mechanical engineering in 1975, his B.S. in mathematics in 1977, and his M.S. in engineering in 1980, all from Kansas State University, and his Ph.D. in mechanical engineering from Texas A&M University in 1981. He joined the faculty of Texas A&M University in 1981, where he was promoted to Professor in 1990, Tenneco Professor in 1991, and Head of Mechanical Engineering in 1993. He served as Program Director of Thermal Transport and Thermal Processing at the National Science Foundation (1993–94). His research interests include phase change heat transfer, thermal control, conduction, and thermal contact resistance. He was a member of the AIAA Thermophysics Technical Committee (1986–89) and AIAA representative to the National Heat Transfer Conference (1990–93). He was an Associate Editor of the *Journal of Energy Resources Technology* (1986–92), and Editor of *Heat Transfer - Recent Contents* (1992–95). Dr. Peterson is a fellow of ASME, an Associate Fellow of AIAA, and a recipient of the AIAA Award for Best Technical Paper in Thermophysics (1991). He is the author or coauthor of over 90 papers in archival journals and a textbook on heat pipes.



ROBERT SIEGEL, Senior Research Scientist at NASA Lewis Research Center, received his B.S. in 1950 and M.S. in 1951 from the Case Institute of Technology, in mechanical engineering, and his Sc.D. in mechanical engineering from the Massachusetts Institute of Technology in 1953. Before joining NASA in 1955, he worked for General Electric as a heat transfer engineer and analyst. He has been an active researcher in heat transfer since 1950. The majority of his research revolves around convective heat transfer, radiative heat transfer, and solidification heat transfer. He is a recipient of the ASME Heat Transfer Division's Memorial Award (1970) and the AIAA Thermophysics Award (1993). He served as an Associate Technical Editor for the *Journal of Heat Transfer* (1973–83) and received the NASA Exceptional Scientific Achievement Medal (1986) and a Space Act Award (1993). Dr. Siegel is a Fellow of AIAA and ASME and is the author or coauthor of 155 publications, including a textbook on thermal radiation heat transfer now in its 3rd edition. He is a member of the Honorary Editorial Advisory Boards of the *International Journal of Heat and Mass Transfer* and *International Communications in Heat and Mass Transfer*.

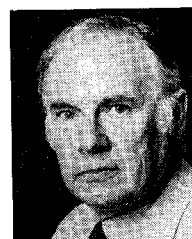


ALLIE M. SMITH, Dean of Engineering and Professor of Mechanical Engineering at the University of Mississippi, received his B.S. in mechanical engineering from North Carolina State University in 1956, and his M.S. in 1961 and his Ph.D. in 1966 from North Carolina State University, in mechanical and aerospace engineering. Before joining the University of Mississippi in 1979, he worked for ARO for 14 years as a thermal physics supervisor and as a research manager. His research work has been in the area of radiative heat transfer, particularly the experimental and theoretical understanding of cryodeposits. Dr. Smith has been active in the AIAA thermophysics community: member of the AIAA Thermophysics Technical Committee (1973–75, 1985–88), Chairman of the AIAA Thermophysics Technical Committee (1976–77), and General Chairman of the 10th AIAA Thermophysics Conference (1975). He served as an Associate Editor of the *AIAA Journal* (1975–77), Editor for two thermophysics volumes in the *AIAA Progress in Astronautics and Aeronautics* book series (1976, 1977), General Chairman of the 17th Aerospace Sciences Meeting (1979), and Chairman of the AIAA Terrestrial Energy Systems Committee (1981–82). Dr. Smith is a Fellow of AIAA and ASME, and recipient of the AIAA Thermophysics Award (1978) and the AIAA Hermann Oberth Award (1985). He is the author or coauthor of over 75 publications.

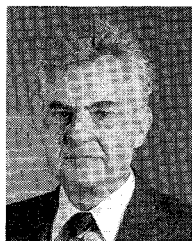


THEODORE F. SMITH, Professor of Mechanical Engineering at the University of Iowa, received his B.S. in 1963, M.S. in 1965, and Ph.D. in 1972 from the University of Illinois, all in mechanical engineering. He joined the faculty of the University of Iowa in 1971 and was promoted to Professor in 1981. He has been an active researcher in the field of radiative heat transfer since 1964. His current research interests include radiant interchange between surfaces and multidimensional radiative transfer in participating media. Dr. Smith was a member of the AIAA Thermophysics Technical Committee (1972–75) and has been a member of ASME Heat Transfer Division's committee on Aerospace Heat Transfer since 1975. He has organized and chaired eleven technical sessions on radiation heat transfer at National Heat Transfer Conferences. He is the author or coauthor of over 50 publications.

Editorial Advisory Board



GRAEME A. BIRD, Professor Emeritus of Aeronautical Engineering at the University of Sydney and Managing Director of GAB Consulting Pty Ltd., received his B.Sc. in 1951, his B.E. in 1953, his M.E. in 1959, and his Ph.D. in 1963, all from the University of Sydney. Before joining the University of Sydney in 1960, he served as scientific officer for the Australian Defence Scientific Service. He has held temporary appointments at the College of Aeronautics in Cranfield (1955), at the Royal Aircraft Establishment in Farnborough (1956), at the University of Manchester (1964) and at the California Institute of Technology (1969). He has made many significant contributions to the development of the direct simulation Monte Carlo method for simulating real gas flows for re-entry and space applications. He is a Fellow of AIAA and of the Australian Academy of Technological Sciences and Engineering, the Australian Institution of Engineers, and the Royal Aeronautical Society. Dr. Bird is a recipient of the AIAA Thermophysics Best Paper Award (1987), the AIAA Thermophysics Award (1988), and the NASA Exceptional Scientific Achievement Medal (1988).



DONALD K. EDWARDS, Professor Emeritus of Mechanical Engineering at the University of California, Irvine, received his B.S. in 1954, M.S. in 1956, and Ph.D. in 1959 from the University of California, Berkeley, all in mechanical engineering. In 1959 he joined the faculty of the University of California, Los Angeles, where he was promoted to Professor in 1968 and served as Chairman of Chemical, Nuclear, and Thermal Engineering (1975–78). At UCI he served as chairman of Mechanical Engineering and Associate Dean of Engineering before retiring in 1991. He received the ASME Heat Transfer Division's Memorial Award (1973) and was the first recipient of the AIAA Thermophysics Award (1976). He was a Technical Editor for the *Journal of Heat Transfer* (1975–81) and an Associate Editor for the *International Journal of Solar Energy* (1983–85). He is a Fellow of AIAA, a Fellow of ASME, and a member of the Editorial Advisory Board for the *International Journal of Heat and Mass Transfer*.



JOHN T. HOWE, Chief Scientist at NASA Ames Research Center, received his B.S. from the University of Michigan in 1950 and his M.S. in 1956 and the degree of Engineer in 1958 from Stanford University, all in engineering mechanics. He teaches Hypervelocity Atmospheric Flight and Real Gas Phenomena at Stanford University. After a brief period with Stanford Research Institute, he joined the Ames Laboratory of NACA. During his 38 years with NASA, he has served as Senior Staff Scientist, Head of Aerothermodynamics, Assistant Chief for the Physics Branch, and Branch Chief for Fluid Dynamics. He is known for his pioneering research contributions to the aerothermodynamics of planetary atmospheric entry, including radiative energy transfer, reactive gas flows, and innovative thermal protection systems. He has also worked in ocean upwelling along the west coast of North America. He was a member of the AIAA Thermophysics Technical Committee (1982–84) and an Associate Editor for the *Journal of Spacecraft and Rockets* (1982–84). He is a recipient of the AIAA Thermophysics Award (1986) and a Fellow of AIAA.



TOM J. LOVE, George Lynn Cross Professor Emeritus of Aerospace, Mechanical, and Nuclear Engineering, and Halliburton Professor of Engineering at the University of Oklahoma, received his B.S. from the University of Oklahoma in 1948, his M.S. from the University of Kansas in 1956, and his Ph.D. from Purdue University in 1963, all in mechanical engineering. In 1956 he joined the faculty of the University of Oklahoma, where he was promoted to Professor (1965) and served as Director of the School of Aerospace, Mechanical, and Nuclear Engineering (1963–72). He was a member of the AIAA Thermophysics Technical Committee (1970–72), an Associate Editor for the *AIAA Journal* (1972–75), and an Associate Editor for the *ASME Journal of Bioengineering* (1976–79). He is a Fellow of AIAA and a Fellow of ASME. Dr. Love is a recipient of the AIAA Thermophysics Award (1984) and of the ASME Memorial Heat Transfer Award (1989).



JAMES N. MOSS, Senior Research Engineer for Aerothermodynamics at the NASA Langley Research Center, received his B.S. in engineering science from the Tennessee Polytechnic Institute in 1962, his M.S. in aerospace engineering from the University of Virginia in 1968, and his Ph.D. in aerospace engineering from Virginia Polytechnic Institute and State University in 1972. He also received an M.S. in engineering administration in 1988 from George Washington University. Dr. Moss joined NASA in 1962, where his early research assignments dealt with ablating systems. His current research concerns transitional and rarefied flows. Dr. Moss has been active in the AIAA thermophysics community: member of the AIAA Thermophysics Technical Committee (1978–80), Technical Program Chairman of the 16th AIAA Thermophysics Conference (1981), General Program Chairman of the 20th AIAA Thermophysics Conference (1985), Co-Editor of a thermophysics volume in the *AIAA Progress in Astronautics and Aeronautics* book series (1986), Chairman of the AIAA Thermophysics Technical Committee (1986–88), and Associate Editor of the *Journal of Thermophysics and Heat Transfer* (1986–89). He is a Fellow of AIAA and a member of the International Advisory Committee on Rarefied Gas Dynamics. Dr. Moss is a recipient of the AIAA Thermophysics Award (1989) and the NASA Exceptional Engineering Achievement Medal (1990).



CHANG-LIN TIEN, A. Martin Berlin Professor and Chancellor at the University of California, Berkeley, received his B.S. from National Taiwan University in 1955, his M.M.E. from the University of Louisville in 1957, and his M.A. and Ph.D. in 1959 from Princeton University. He joined the University of California, Berkeley, in 1959, where he was promoted to Professor in 1968 and was appointed A. Martin Berlin Chair Professor in 1987. He served as Chairman of Mechanical Engineering (1974–81) and as Vice Chancellor-Research (1983–85). Dr. Tien moved to the Irvine campus in 1988 and returned to the Berkeley campus in 1990. He was a member of the AIAA Thermophysics Technical Committee (1970–72), General Chairman of the 7th AIAA Thermophysics Conference (1972), General Chairman of the AIAA 12th Aerospace Sciences Meeting (1974), Editor of a volume in the *AIAA Progress in Astronautics and Aeronautics* book series (1973), and an Associate Editor for the *Journal of Quantitative Spectroscopy and Radiative Transfer* (1971–92). He is a recipient of the ASME Heat Transfer Division's Memorial Award (1974), the ASME Gustus L. Larson Memorial Award (1975), the AIAA Thermophysics Award (1977), and the ASME/AIChE Max Jakob Memorial Award (1981). He is an AIAA Fellow, an ASME Fellow and Honorary Member, and a member of the National Academy of Engineering. He is Editor of the *Annual Review of Heat Transfer*, Editor for the *International Journal of Heat and Mass Transfer*, and Editor-in-Chief of *Experimental Heat Transfer*.



RAYMOND VISKANTA, W.F.M. Goss Distinguished Professor of Engineering at Purdue University, received his B.S. from the University of Illinois in 1955, and his M.S. in 1956, and Ph.D. in 1960 from Purdue University, all in mechanical engineering. After a brief period with Argonne National Laboratory he joined the faculty of Purdue University, where he was promoted to Professor in 1966. He was a member of the AIAA Thermophysics Technical Committee (1972–75), General Chairman of the 2nd AIAA/ASME Thermophysics and Heat Transfer Conference (1978), and Editor of two volumes in the AIAA *Progress in Astronautics and Aeronautics* book series (1979). He is a recipient of the ASME Heat Transfer Division's Memorial Award (1976), the AIAA Thermophysics Award (1979), the ASME Senior Research Award (1984), the ASME/AlChE Max Jakob Memorial Award (1986), the ASME Melville Medal (1988), and 1991 Nusselt-Reynolds Prize of the Assembly of World Conferences on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics. Dr. Viskanta is a Fellow of ASME and AIAA, a member of the National Academy of Engineering and a Dr.-Ing. E.h. (Honorary Doctor of Engineering Degree) from Technical University of Munich. He was an Associate Editor for the *Journal of Quantitative Spectroscopy and Radiative Transfer* (1969–72), an Associate Technical Editor for the *Journal of Heat Transfer* (1981–87) and *Experimental Heat Transfer* (1987–90) and the Technical Editor of the *ASME Journal of Heat Transfer* (1990–95). He is a member of the Editorial Advisory Boards of the *International Journal of Heat and Mass Transfer*, *International Journal of Heat and Fluid Flow*, *Numerical Heat Transfer*, and *JSME International Journal, Series B*.



M. MICHAEL YOVANOVICH, Professor of Mechanical Engineering at the University of Waterloo, Ontario, Canada, received his B.S. from Queen's University in 1963, his M.S. from the State University of New York at Buffalo in 1963, and his M.E. and Sc.D. from Massachusetts Institute of Technology in 1965 and 1967, respectively. After a brief period with the University of Poitiers in France, he joined the faculty of the University of Waterloo where he was promoted to Professor in 1972. He was a member of the AIAA Thermophysics Technical Committee (1971–74, 85–88, 91–94), General Chairman of the first AIAA/ASME Thermophysics and Heat Transfer Conference (1974), and Editor of a thermophysics volume in the AIAA *Progress in Astronautics and Aeronautics* book series (1975). He is a recipient of the AIAA Thermophysics Award (1984) and the AIAA Award for Best Technical Paper in Thermophysics (1983 and 1994). Dr. Yovanovich is a fellow of AAAS, AIAA, and ASME. He was an Associate Technical Editor of *ASME Journal of Heat Transfer* (1984–86) and Associate Senior Editor of *ASME Journal of Electronic Packaging* (1988–93). He is a member of the Editorial Advisory Boards of the *Transactions of the Canadian Society of Mechanical Engineers* and the *International Journal of Heat and Fluid Flow*.