

Announcements and Acknowledgments

This editorial announces recent policy and personnel changes and acknowledges services to the *Journal of Propulsion and Power (JPP)*.

Length Limitations. All AIAA journals have implemented a policy of no length limitations for full-length papers, although all manuscripts should be as *brief and concise* as proper presentation of the ideas will allow. Length limitations on Technical Notes (maximum of nine double-spaced manuscript pages) and Technical Comments (maximum of four double-spaced manuscript pages) continue, since these short manuscripts are intended for prompt disclosure of information having relatively limited scope. The detailed requirements for all types of manuscripts can be found in the Information for Contributors to Journals of the AIAA, which appears on the inside back cover of each issue of the journal.

Celebration of the 100th Anniversary of Flight. In recognition of the Centennial of Flight, the *JPP* will publish a series of feature articles throughout the year 2003, covering the histories of key technologies in all aspects of aerospace propulsion and power. Fifteen individuals who have made extraordinary contributions to the field are preparing these specially invited review papers. The topics include propeller-driven propulsion, gas-turbine engines, ramjet and scramjet engines, supersonic civil transport, solid-propellant rockets, liquid-propellant rockets, electric propulsion, advanced and futuristic propulsion, propellants and fuels, and aerospace power generation, conversion, and storage. Much progress has been made in the past 100 years, but there remains much to be done. The *JPP* will take this opportunity to lead the way in consideration of the future and review of the past.

Editorial Advisory Board. The Board has been reconstituted, including distinguished research scientists and leaders in technology from academia, industry, and government organizations around the world. Its primary functions are 1) to help define editorial policy and operation, 2) to provide advice to the Editor-in-Chief, 3) to promote emerging technologies and related research and development, and 4) to help recruit Associate Editors. The 14 charter members of the Editorial Advisory Board are as follow: Mike J. Benzakein, GE Aircraft Engines; Sebastien Candel, Ecole Centrale Paris; Jim C. I. Chang, Army Research Office; Fred E. C. Culick, California Institute of Technology; Edward M. Greitzer, Massachusetts Institute of Technology; Anthony K. Hyder, Notre Dame University; Wolfgang Koschel, German Aerospace Research Establishment; Chung K. Law, Princeton University; Pong-Jeu Lu, National Cheng Kung University; Robert L. Sackheim, NASA Marshall Space Flight Center; Robert J. Santoro, The Pennsylvania State University; Bryon K. Wood, Rocketdyne/Boeing Company; Jian-Zhong Xu, Chinese Academy of Sciences; and Ben T. Zinn, Georgia Institute of Technology. Their biographies and photographs are listed in the following pages, together with those of the *JPP* Associate Editors. The contribution of these individuals in helping to develop the quality of the journal is deeply appreciated.

Reappointed Associated Editors. Readers of the *JPP* are indeed fortunate to have a strong group of Associate Editors (AEs) processing the reviews of manuscripts. We are fortunate this year that Ashwani K. Gupta, University of Maryland; Carlson C. Pian, Alfred University; and Gregory G. Spanjers, Air Force Research

Laboratory, have agreed to serve another three-year term as AEs. All of them have been very professional in their service and will help maintain the editorial continuity of the journal. Their exemplary work is greatly appreciated.

Newly Appointed Associate Editors. The *JPP* was fortunate to have Quinn Brewster, University of Illinois; Tom I. Shih, Michigan State University; and Kenneth H. Yu, University of Maryland, join the editorial team as AEs last May. Their service has significantly improved the efficiency and quality of manuscript review, especially in the areas of solid rocket propulsion, computational turbomachinery, and air-breathing combustion. Two names are being added to the masthead. Edgar Choueiri, from Princeton University, is widely recognized for his research in electric propulsion and advanced space propulsion concepts. Gavin J. Hendricks, from Pratt & Whitney Engines, is an acknowledged expert in turbomachinery and gas-turbine engine dynamics and has extensive contacts with the research and technology communities. I welcome these outstanding individuals and thank them for agreeing to serve.

Continuing Associate Editors. Individuals who will continue their service as AEs for the coming year are C. Thomas Avedisian, Cornell University; P. Barry Butler, University of Iowa; Daniel J. Dorney, NASA Marshall Space Flight Center; Winfred A. Foster, Auburn University; Alec C. Gallimore, University of Michigan; Hans Immich, Astrium GmbH; Jan Lepicovsky, NASA Glenn Research Center; James L. Mace, Boeing Company; Lourdes Q. Maurice, U.S. Air Force; and Roger M. Myers, General Dynamics Space Propulsion. The dedication of these individuals to the journal is greatly appreciated.

Retiring Associate Editors. Special thanks are due to our retiring Associate Editors: Rodney D. W. Bowersox, University of Alabama; James J. Fang, Boeing Company; David W. Riggins, University of Missouri-Rolla; and M. Frank Rose, NASA Marshall Space Flight Center. Among them, Frank deserves special mention for contributing six years (two terms) to the *JPP*. The service of these individuals is an essential part of the review and publication process. I have been fortunate to have worked with them, and wish to acknowledge their valuable efforts and outstanding contributions.

Acknowledgments. I wish to express my sincere thanks to Roger L. Simpson (Vice President-Publications), as well as to the editorial staff of the AIAA for their invaluable assistance and effective management, as follows: Norma J. Brennan (Director of Publications); and Aimeé D. Munyan and Jennifer Samuels (Managing Editors, *JPP*). The publications staff at TechBooks, coordinated by Angela Weaver, is gratefully acknowledged. Special thanks are due to Lourdes Q. Maurice and Mark J. Lewis for their great effort in preparing the special issue on Hypersonics, which was published in November 2001. The volume covers a wide variety of studies in the many disciplines that are contributing to the development of air-breathing hypersonic flight. Finally, we owe a large debt of gratitude to all of the authors in preparing the fine papers presented here. The individuals who provided their time and expertise toward reviewing the manuscripts deserve special recognition. Their names appear in the following pages.

V. Yang
Editor-in-Chief

Editor-in-Chief



VIGOR YANG, Professor of Mechanical Engineering at the Pennsylvania State University, received his B.S. from the National Tsing Hua University in 1976, his M.S. from the Pennsylvania State University in 1980, and his Ph.D. in Jet Propulsion and Mechanical Engineering from the California Institute of Technology in 1984. His research interests include combustion instabilities in propulsion systems, chemically reacting flows in air-breathing and rocket engines, combustion of energetic materials, high-pressure thermodynamics and transport, and active combustion control for gas-turbine engines. He has supervised 34 Ph.D. and 14 M.S. theses. He is the author or co-author of more than 100 technical papers in the areas of propulsion and combustion, and has published five comprehensive volumes on solid and liquid rocket propulsion. He was the recipient of the Penn State Engineering Society Outstanding Teaching and Research Award in 1989 and 1992, respectively, and the Best Paper Award from AIAA in 1995 for research on supercritical combustion. Dr. Yang also serves on the Editorial Advisory Boards of the *AIAA Progress in Astronautics and Aeronautics* and the Russian *Journal of Combustion, Explosion, and Shock Waves*. He has been a consultant to many U.S. rocket and gas-turbine engine companies as well as various government organizations. Dr. Yang is a Fellow of the AIAA and American Society of Mechanical Engineers.

Associate Editors



C. THOMAS AVEDISIAN, Professor in the Sibley School of Mechanical and Aerospace Engineering at Cornell University, is currently interested in research including droplet and spray combustion, particulate emissions and control during combustion of fuel droplets, impingement of droplets and fluid jets, thermal analysis of composite materials, and rapid evaporation of liquids. He was previously a member of the technical staff at AT&T Bell Laboratories (Holmdel, New Jersey), a Visiting Scientist at the National Institute of Standards and Technology (Gaithersburg, Maryland), and a Visiting Professor at Brown University. He is the recipient of three Best Paper Awards from AIAA for research on droplets and sprays, and the James Harry Potter Gold Medal in 1999 from the American Society of Mechanical Engineers (ASME) for eminent scientific achievements in the thermal sciences. He received his B.S. (1972) from Tufts University, his S.M. (1974) from Massachusetts Institute of Technology, and his M.A. (1977) and Ph.D. (1980) from Princeton University. He has been at Cornell since 1980. He is a Fellow of ASME and was Chair of the ASME Heat Transfer Visualization Committee from 1993-1997. He is a Member of the Combustion Institute and is a Fellow of AIAA, where he is a member of the AIAA Terrestrial Energy Committee.



QUINN BREWSTER, Hermia G. Soo Professor of Mechanical Engineering at the University of Illinois at Urbana-Champaign (UIUC), received his Ph.D. in Mechanical Engineering at the University of California at Berkeley in 1979. Before joining the ME department at Illinois, he conducted research at Kyoto University, the Air Force Rocket Propulsion Laboratory, and the University of Utah. His research in radiative heat transfer and solid propellant combustion has been recognized by a 1984 National Science Foundation Presidential Young Investigator Award, a 1987 Office of Naval Research Young Investigator Award, and a 1993 UIUC University Scholar Award. He is the author of a graduate textbook, *Thermal Radiative Transfer and Properties*, and currently serves as Group Leader for Combustion and Energetic Materials at the UIUC Center for Simulation of Advanced Rockets, a DOE Accelerated Strategic Computing Initiative (ASCI) center.



P. BARRY BUTLER, Professor of Mechanical Engineering and Dean of the College of Engineering at the University of Iowa, received his B.S. and M.S. degrees in Aeronautical and Astronautical Engineering and his Ph.D. in Mechanical Engineering from the University of Illinois at Urbana-Champaign. Dr. Butler is active in a number of aerospace-related instructional and research activities at the University of Iowa, where he also serves as Campus Coordinator of the Iowa Space Grant Consortium. His current research interests include multi-phase reactive flows, shock initiation of energetic materials, and combustion of solid propellants and pyrotechnics. Dr. Butler has worked as a visiting research Fellow for the U.S. Navy and Sandia National Laboratories where he conducted research in the area of solid propellant and energetic materials modeling. In addition to his editorial duties with the *AIAA Journal of Propulsion and Power*, Dr. Butler is an Associate Fellow. In 1991, he was awarded the Society of Automotive Engineers' Ralph R. Teetor Educational Award from the Aerospace Division, and the American Society of Mechanical Engineers' Outstanding Professor Award from the student chapter at the University of Iowa.



EDGAR CHOEIRI, Director of Princeton University's Electric Propulsion and Plasma Dynamics Laboratory, is an Assistant Professor in Applied Physics at the Mechanical and Aerospace Engineering Department of Princeton University and is Associated Faculty at the Department of Astrophysical Sciences (Program in Plasma Physics). He holds a Ph.D. from Princeton University and is the author of numerous analytical, experimental, and numerical papers on electric and plasma propulsion, plasma physics and dynamics, instabilities and turbulence in collisional plasmas, plasma thruster numerical modeling, and applied mathematics. He is an Associate Fellow of AIAA and is the Chairman of the AIAA Electric Propulsion Technical Committee for 2002-2004.



DANIEL J. DORNEY, Aerospace Engineer at NASA Marshall Space Flight Center in Huntsville, Alabama, received his B.S. and M.S. degrees in Aeronautical and Astronautical Engineering from the University of Illinois at Urbana-Champaign, and his Ph.D. in Aerospace Engineering from the Pennsylvania State University. His current research interests include unsteady flows in turbomachinery, aerodynamics, and computational fluid dynamics. Dr. Dorney has seven years academic experience, including two years as Associate Professor (with tenure) at Virginia Commonwealth University, one year as Assistant Professor at GMI Engineering and Management Institute, and three years as Assistant Professor at Western Michigan University. Dr. Dorney has also spent six years in industry, including five years at United Technologies Research Center as Associate Research Engineer and one year at Pratt and Whitney as Project Engineer. Dr. Dorney's research has led to two Best Paper Awards, a NASA Space Act Award, and 50 journal articles.



WINFRED A. FOSTER, JR., Professor in the Department of Aerospace Engineering at Auburn University, received his B.S.A.E. (1967), M.S. (1969), and Ph.D. (1974) from Auburn University. He has been a member of the Aerospace Engineering faculty since 1974. His research has been primarily in the area of solid rocket motor performance prediction and finite element structural analysis. He has published over 60 technical documents and has made numerous presentations in these and related areas. He is an Associate Fellow of AIAA and is currently a member of the AIAA Solid Rocket Technical Committee and serves as the Chair of the History Subcommittee.



ALEC D. GALLIMORE, Associate Professor of Aerospace Engineering and of Applied Physics at the University of Michigan, directs the Plasmadynamics and Electric Propulsion Laboratory. Professor Gallimore is also the Director of the NASA-funded Michigan Space Grant Consortium. He received his B.S. in Aeronautical Engineering from the Rensselaer Polytechnic Institute in 1986, and his M.A. and Ph.D. in Aerospace Engineering from Princeton University in 1988 and 1992, respectively. His primary research interests include electric propulsion, plasma diagnostics, space plasma simulation, and electrode physics. He has experience with a wide array of electric propulsion technologies including Hall thrusters, ion engines, arcjets, and optical/laser plasma diagnostics. The author of more than 100 journal and conference papers on electric propulsion and plasma physics, Professor Gallimore was the recipient of the University of Michigan Faculty Career Development Award in 2000; the Class of '38E Prize for teaching, service, and research in 1996; and teaching awards from Sigma Gamma Tau in 1994 and 1996. In 1994, he was awarded the Crystal Image Award for Technical Achievement by the National Technical Association for science educator of the year, and received the Best Paper on Electric Propulsion Award for work presented at the 1998 Joint Propulsion Conference. Professor Gallimore serves on the AIAA Electric Propulsion Technical Committee, the United States Air Force Scientific Advisory Board, and is an Associate Fellow of AIAA.



ASHWANI GUPTA is a Professor of Mechanical Engineering at the University of Maryland. His academic experience includes six years as member of the research staff at MIT in the Energy Laboratory and Department of Chemical Engineering, three years as senior research associate and independent research worker at Sheffield University in the Department of Chemical Engineering and Fuel Technology, and seventeen years at the University of Maryland. He spent four months in Japan as a consultant to several companies. Presently he serves as an international consultant on a major project sponsored by the Japanese Government. He is the author of over 150 publications in the areas of combustion, swirl flows, diagnostics, fuel sprays, hazardous waste thermal destruction, pollution, and alternative fuels. He has coauthored two books and edited seven books. Presently he is co-editor of the Energy and Environmental Series of books published by CRC Press. He has been the recipient of the Propellants and Combustion Award and Energy System Award of AIAA, George Westinghouse Gold Medal of ASME, and four Best Paper Awards from AIAA and ASME. Dr. Gupta received his Ph.D. from Sheffield University in 1973. He was awarded his D.Sc. from Sheffield University in 1986 for international recognition and published high-quality original research. Dr. Gupta is the AIAA Deputy Director of Energy and was previously the chair of the AIAA Terrestrial Energy, and Propellants and Combustion Technical Committees. Dr. Gupta is a Fellow of AIAA, ASME, and the Institute of Energy, U.K., and a member of SAE and the Combustion Institute.



GAVIN J. HENDRICKS, Technical Fellow at Pratt & Whitney, is interested in combustor stability, compressor aerodynamics and stability, and fluid mechanics within mechanical systems of gas turbine engines. He received his B.S. in Mechanical Engineering at the University of Cape Town in South Africa in 1981, and he conducted his graduate studies in Mechanical Engineering at the California Institute of Technology, where he received his M.S. and Ph.D. degrees in 1983 and 1986, respectively. Prior to joining Pratt & Whitney, Dr. Hendricks spent two years on the Faculty of the University of Cape Town, two years as a Research Fellow at the Massachusetts Institute of Technology, and seven years at the United Technologies Research Center. He was awarded the American Society of Mechanical Engineers IGTI Gas Turbine Award in 1993 and the ASME IGTI Diagnostics and Controls Committee Best Paper Award in 1994 for his work on modeling and control of compressor instabilities.



HANS IMMICH, currently Manager of New Rocket Propulsion Programs and Technologies at the Propulsion Business Unit of the Space Infrastructure Division of Astrium (formerly DaimlerChrysler Aerospace), is responsible for new technology developments in the field of launch vehicle rocket propulsion. Before joining DaimlerChrysler Aerospace in 1985 he was with Asea Brown Boveri Company, Baden, Switzerland from 1979–1985. There, he was responsible for fluid mechanical development of large steam turbines and for development of combustion chambers for large gas turbines. Dr. Immich received his Ph.D. in the area of Fluid Mechanics from the Technical University in Munich in 1979. In addition, he received the “Habilitation” (lectureship qualification) in Fluid Mechanics from the Technical University in Munich in 1986. Dr. Immich is a member of the AIAA Space Transportation Technical Committee. He is the author of 32 journal articles and conference papers.



JAN LEPICOVSKY is a Senior Project Manager and Head of the Turbomachinery Analysis Section at QSS Group, Inc., an on-site contractor at the NASA Lewis Research Center (LeRC) in Cleveland, Ohio. He has 30 years of experience in fluid dynamics and turbomachinery experimental research. He received his Ph.D. and M.S. degrees from the Czech Technical University in Prague, Czech Republic. He worked as a researcher and the Thermodynamic Lab leader at the Propulsion Division of the Aeronautical Research and Test Institute in Prague until 1979. He was in charge of development testing on components of a small turboprop engine. After his move to the U.S., he worked as a scientist in the Aeroacoustic group of the Lockheed-Georgia Company in Marietta, Georgia, from 1980–1988. His major involvement there was with experimental research of mixing enhancement of free jets and propeller flows. In 1988 he worked for Textron-Lycoming in Stratford, Connecticut, where he was responsible for experimental studies in turbine cooling. Since 1989 he has been associated with the Propulsion Division at NASA LeRC. His major engagement is application of nonintrusive measurement techniques to fan and turbine experimental research. His expertise involves laser velocimetry, pressure and temperature sensitive paints, and thin-film thermocouples. He has authored more than 40 technical papers. He is an Associate Fellow of AIAA and a former member of the AIAA Ground Testing Technical Committee. He served as an Associate Editor of the *AIAA Journal* and on several AIAA Technical Committees. He is a member of the American Society of Mechanical Engineers.



JAMES L. MACE, Technical Fellow at Phantom Works, The Boeing Company, St. Louis, Missouri, received his B.S.A.A. and M.S.A.A. Engineering degrees from Ohio State University in 1971 and 1972, respectively, and his Ph.D. in Aerospace Engineering from University of Michigan in 1984. Since 1986, Dr. Mace has filled numerous technical and management positions at Boeing dealing with aircraft and propulsion system development. He has been Program Manager of a number of CRAD programs for the government and engine companies, as well as managing propulsion IRAD programs. During 1985 and 1986, Dr. Mace was a Staff Scientist for the Lockheed Advanced Aeronautics Company supporting advanced aircraft studies. From 1972 to 1985, Dr. Mace worked at the Air Force Flight Dynamics Laboratory with the Airframe/Propulsion Integration Group and the Computational Fluid Dynamics Group. He was Program Manager for a number of propulsion integration CRAD projects and related in-house experimental and computational research activities. Dr. Mace has authored or co-authored 21 papers. He is an Associate Fellow of AIAA and has been Chairman of AIAA Air Breathing Propulsion Technical Committee.



LOURDES Q. MAURICE presently attends National Defense University's Industrial College of the Armed Forces (ICAF). The mission of ICAF is to prepare selected military officers and civilians for strategic senior leadership and staff positions by conducting postgraduate, executive-level courses of study and associated research dealing with national security strategy and the resource component of national power, with special emphasis on jointness between the Department of Defense and other agencies. She previously served as Air Force Deputy, Basic Research Sciences and Propulsion Science and Technology in the office of the Deputy Associate Secretary of the Air Force for Science and Technology. In this position, she managed the \$220 million basic Research Sciences and \$240 million Propulsion Science and Technology per annum portfolios at the office of the Air Force Secretariat. She also worked at the Air Force Research Laboratory's Propulsion and Power Directorate from 1983 to 1999. Her areas of expertise include aviation fuels combustion kinetics, hypersonic propulsion, and aviation fuels. She received her B.S. in Chemical Engineering and M.S. in Aerospace Engineering from the University of Dayton at Dayton, Ohio and her Ph.D. in Mechanical Engineering from the University of London's Imperial College at London, United Kingdom. She is serving her second term on the Propellants and Combustion Technical Committee and is the U.S. Chair for the AIAA/ICAS International Conference in Celebration of the Centennial of Flight. She has authored over 70 publications and is an Associate Fellow of AIAA.



ROGER M. MYERS, Director of Systems and Technology Development at General Dynamics Space Propulsion Systems, received his B.S. in Aerospace Engineering from the University of Michigan and his Ph.D. in Mechanical and Aerospace Engineering from Princeton University. He joined the NASA Lewis Research Center Group of Sverdrup Technology in 1988 and became Supervisor of the Space Propulsion Technology Section in 1989. He continued to serve in this capacity with Nyma, Inc., becoming Deputy Director of Aerospace Technology in early 1996, and he left Nyma for Primex Aerospace later that year. He has worked on a wide range of propulsion systems including solid propellant pulsed plasma thrusters, pulsed and steady-state magnetoplasmadynamic thrusters, arcjets, ion thrusters, Hall current thrusters, and small chemical rockets. The spacecraft integration assessments and mission analyses have included a wide range of spacecraft and missions, most recently focusing on small satellite applications and large commercial communications satellites. He has authored over 70 publications, served as Chair of the AIAA Electric Propulsion Technical Committee, and is an Associate Fellow of AIAA.



CARLSON C. P. PIAN received his B.S., M.S., and Ph.D. degrees from the University of Michigan in Aerospace Engineering. He did post-doctoral work in the field of MHD power conversion at the Eindhoven Technical University in The Netherlands. Dr. Pian is currently a professor in the Mechanical Engineering Division at Alfred University. Previously, he was a researcher at Molten Metals Technologies, and later, on the faculty of the Diagnostic Instrumentation and Analysis Laboratory at the Mississippi State University, involved in research and development of plasma torches and remediation technologies for hazardous waste treatment. At Textron Defense Systems' Everett Laboratory (formerly the Avco Everett Research Laboratory), Dr. Pian was the Director of Commercial MHD Component Development. He was also the manager of MHD Integrated Topping Cycle Program, responsible for the technical direction and administration of the program, including research and development, and the design and fabrication of MHD power generators. Prior to joining Avco, Dr. Pian was a research engineer at NASA Lewis Research Center where he has engaged in research and analysis relevant to MHD power generator and systems. Dr. Pian is an Associate Fellow of AIAA and previously served on both the Plasmadynamics and Lasers and the Terrestrial Energy Systems Technical Committees. Dr. Pian has authored or co-authored over 70 technical papers related to power conversion and space plasma.



TOM I-P. SHIH, Professor of Mechanical Engineering at Michigan State University, was previously Professor at Carnegie Mellon University (1988-98), Associate Professor at the University of Florida (1982-88), and Research Engineer at NASA Lewis Research Center (1981-82). He received his B.S.E. degree (1976) from the National Cheng Kung University, and his M.S.E. (1977) and Ph.D. (1981) degrees from the University of Michigan at Ann Arbor. Dr. Shih is a Fellow of ASME and an Associate Fellow of AIAA. Dr. Shih's research centers on computational fluid dynamics (CFD), both in developing and improving it as a tool and in using it to study physical problems. He and his students have developed a number of algorithms and codes for grid generation and the study of compressible and incompressible flows. Current focus is on grid-quality measures, error estimation, and knowledge extraction. In using CFD, he and his students have studied shock-wave/boundary-layer interactions with bleed and blowing, internal and film cooling of turbine components, gas-turbine combustors, particle-particle/particle-fluid interactions, spray forming, and piston and rotary engine flow fields.



GREGORY G. SPANJERS, Technical Advisor for the Spacecraft Propulsion Branch, and Group Leader for the Electric Propulsion Laboratory at the Air Force Research Laboratory (AFRL), Edwards AFB; received the degrees of B.S. Physics and B.S. Mathematics from the University of Minnesota in 1986. He received his M.S. degree (1990) and his Ph.D. (1992) from the University of Washington performing plasma physics research for magnetic fusion. Principle Scientist in 1995, becoming Group Leader in 1998 and Branch Technical Advisor in 1999, he is the author of over 50 journal and conference papers, has nine patents pending for advanced spacecraft thrusters, and is a Member of the AIAA Electric Propulsion Technical Committee.



KENNETH H. YU, Associate Professor of Aerospace Engineering at the University of Maryland, College Park, received his B.S. (1985), M.S. (1988), and Ph.D. (1989) degrees in Mechanical Engineering from the University of California at Berkeley. Prior to joining faculty at the University of Maryland in 1999, he was an Aerospace Engineer at NASA-Ames Research Center (1985), a Post-doctoral Scientist/Visiting Professor at Ecole Centrale Paris in France (1989-1990), and a Physical Scientist at the Propulsion Research Lab, Naval Air Warfare Center in China Lake, CA (1990-1999). He is an Associate Fellow of AIAA and is currently serving as the Vice Chair/Chair Elect of the AIAA Propellants & Combustion Technical Committee. His current research interests include various time-dependent phenomena involving turbulent shear flow, supersonic mixing enhancement, liquid-fuel injection, passive and active combustion control, and other thermo-acoustic processes in ramjets and scramjets for improving aeropropulsion performance. He has authored or co-authored over 100 journal and conference papers, and has five patents, some of which are now pending. His work has resulted in three conference Best Paper Awards.

Editorial Advisory Board



MIKE J. BENZAKEIN, General Manager, Advanced Engineering Programs at GEAE, received his Mechanical Engineering Degree in 1960. He received an MSME in 1963 and a Ph.D. in Engineering Mechanics in 1967. He joined General Electric in 1967 where he served in a number of positions in Advanced Technology and Project and Product Engineering. He led the CFM56 Engineering Program from 1984 to 1993 and the GE90 Engineering Program from 1993 to February 1995. In February 1995, Dr. Benzakein became General Manager for Engine Systems Design and Integration. In this capacity, he had the responsibility for engineering leadership and technical oversight of GE Evendale Commercial and Military Aircraft Engines. In January 1996, Dr. Benzakein took over the position of General Manager, Advanced Engineering Programs. He is responsible for leading the technology development efforts and ensuring that the customer expectations as well as the needs of GEAE Multigeneration Product Plans are met. Dr. Benzakein is responsible for GEAE front-end initiatives in driving technology maturation, strengthening the linkage between preliminary design and engine systems, and production hardware design.



SÉBASTIEN CANDEL, Professor of Aerospace Engineering and Head of Mechanical and Aerospace Studies at Ecole Centrale Paris, received his Ph.D. degree from the California Institute of Technology in 1972 and the Doctorat d'Etat from U. Paris 6 in 1977. He was a Research Scientist at ONERA (the French Aerospace Research Office) from 1973 to 1987, and an Assistant Professor at University of Compiègne from 1975 to 1978. Since 1978 he has been a Professor at Ecole Centrale Paris, where he is the leader of the combustion group of the EM2C laboratory (CNRS). In 2001 he was appointed as a Senior Member of Institut Universitaire de France. His current research interests include aeroacoustics, turbulent combustion, combustion dynamics, combustion control, and propulsion. He is the recipient of the d'Aumale Price (1987), and of the Marcel Dassault Grand Prix (2000) from the French Academy of Sciences. He was awarded the silver medal of CNRS in 1993, promoted as "Officier des Palmes Académiques" in 1998, and elected as "Chevalier de la Légion d'Honneur" in 2000. He has been a corresponding member of the French Academy of Sciences since 1994 and a member of the Academy of Technology since 2000. He is currently the Vice-President of the Combustion Institute, and the Chairman of the Supersonic Aircraft Research Network in France (2000). He has also served as a Deputy Editor of *Combustion and Flame* since 2000, and an Associate Editor of *the Comptes Rendus de l'Académie des Sciences* since 1994. He is a Member of the editorial boards of *Combustion Science and Technology* and *Progress in Energy and Combustion Science*. He is the author or co-author of two books and more than 260 articles and papers.



JIM C. I. CHANG serves in a dual-hatted position; Deputy Director for Basic Science, Army Research Laboratory (ARL), and Director of the Army Research Office (ARO). The ARL is the Army's corporate laboratory with sites throughout the U.S. and has a budget of about \$670 million. As ARL Deputy Director for Basic Science, he is the senior science and technology executive charged with oversight of the entire ARL basic research (6.1) program. As ARO Director, he leads an organization of scientists who manage a \$250 million extramural research program in the physical and engineering sciences conducted mostly in universities. He entered federal service in 1978 and was appointed to the Senior Executive Service (SES) in 1990. He has served as Director of the Aerospace and Materials Sciences Directorate of the Air Force Office of Scientific Research, Chief Scientist at the Naval Air Systems Command, Program Manager with NASA, and Branch Head at the Naval Research Laboratory. Dr. Chang received his Ph.D. in Theoretical and Applied Mechanics from Cornell University. He has published over 40 publications, served as an Associate Editor and reviewer for several professional journals, and has received recognition for his technical, science, and technology management contributions.



FRED E. C. CULICK joined the faculty of the California Institute of Technology after receiving his Ph.D in Aeronautics and Astronautics from Massachusetts Institute of Technology in 1961. He is currently Richard L. and Dorothy M. Hayman Professor of Mechanical Engineering and Professor of Jet Propulsion. Dr. Culick's Ph.D. dissertation treated combustion instabilities in liquid rockets. Much of his research has been concerned with problems of unsteady motions in combustion chambers generally. He began working on solid rocket combustion instabilities in 1965; since 1979, he has been addressing the problem in air-breathing systems. Dr. Culick is a Fellow of AIAA and of the International Academy of Astronautics. In 1981, he received the AIAA Pendray Aerospace Literature Award and in 1988 the JANNAF Combustion Subcommittee Recognition Award. From 1977-1986, Dr. Culick was a member of the AGARD Propulsion and Energetics Panel, resuming that position in 1994. He has been a consultant to all of the major U.S. rocket companies as well as to various government organizations. For nine years until 1995 he was a member of the Technical Advisory Council for Sverdrup Technology, Inc., primarily concerned with operation of the propulsion test facilities at AEDC, Tullahoma, Tennessee.



EDWARD M. GREITZER, H. N. Slater Professor and Associate Head of the Department of Aeronautics and Astronautics at Massachusetts Institute of Technology, received his A.B., S.M., and Ph.D. from Harvard University. Prior to joining MIT in 1977 he was with United Technologies Corporation. More recently (1997-1998), he was on leave at United Technologies Research Center as Director, Aeromechanical, Chemical, and Fluid Systems. From 1984-1996, Dr. Greitzer was the Director of MIT's Gas Turbine Laboratory. He is a three-time recipient of the American Society of Mechanical Engineers Gas Turbine Award for outstanding gas turbine paper of the year, an ASME Freeman Scholar in Fluids Engineering, a recipient of publication awards from AIAA and the Institution of Mechanical Engineers, and a recipient of the Aircraft Engine Technology Award from the ASME International Gas Turbine Institute (IGTI). He has been a member of the U.S. Air Force Scientific Advisory Board and the NASA Aeronautics Advisory Committee. He was Chair of the IGTI Board of Directors from 1996-1997. Dr. Greitzer is a Fellow of ASME and AIAA and was elected to the National Academy of Engineering in 1995.



ANTHONY K. HYDER, Professor of Physics and Associate Vice President for Graduate Studies and Research at the University of Notre Dame, received his B.S. in Physics from Notre Dame and his M.S. in Space Physics and Ph.D. in Nuclear Physics from the Air Force Institute of Technology. Following the award of his Doctorate, he was a Research Physicist at the Aerospace Research Laboratory in Dayton, Ohio, and then served on the Physics faculty at the Air Force Academy. From 1981 to 1982, he was Scientific Advisor to the Director for Research, Office of the Secretary of Defense (Research and Advanced Technology). Then, he joined Auburn University as a Faculty Member in Physics and Aerospace Engineering while serving as the Associate Vice President for Research. In 1985 he became the founding Director of the Space Power Institute at Auburn, and in 1986 served as the founding Director of the Auburn University Center for Advanced Technologies. In 1991 he returned to Notre Dame to become the Associate Vice President for Graduate Studies and Research and a Professor of Physics. He is an AFIT Ph.D. Fellow and the recipient of the 1974 Air Force R&D Award. He has served on the Air Force Scientific Advisory Board and is currently serving on the Defense Intelligence Science and Technology Advisory Board, the Army Science Board, and the NATO RTO Sensors and Electronics Technology Panel.



WOLFGANG W. KOSCHEL, University Professor for Jet Propulsion at the University of Technology of Aachen (RWTH Aachen) and Director of the Space Propulsion Institute of the German Aerospace Center (DLR), received his Diploma Engineer degree from the Technical University of Berlin in 1964. He received his Ph.D. in Mechanical Engineering at the Technical University of Berlin in 1970, and received the Venia Legendi in Aerospace Engineering from the University of Technology of Aachen (RWTH Aachen) in 1980. Since 1982 he has become University Professor at the Institute for Jet Propulsion and Turbomachinery of RWTH Aachen. In 1995, he was delegated to the rocket test center of the German Aerospace Center (DLR) at Lampoldshausen. His former activities covered diagnostics and health monitoring of aeroengines and life extension of turbine components. He was engaged for many years on ramjet and scramjet activities in the former German Hypersonics Technology programme. Since 1996, he has been a national delegate of the Executive Committee of the International Society of Airbreathing Engines. From 1996 to 1997, he was a member of the Advisory Board for Space Transportation Systems of the General Advisory Council of the former German Space Agency (DARA now DLR). He currently serves on the Industry and Research Committee of the Federal German Industry and Commerce Association (DIHK), the Advisory Committee for Space Infrastructure of DLR, and the Haut Conseil Scientifique of the Office National d'études et de Recherches Aérospatiales, France. His present research activities are linked to liquid rocket propulsion and associated space transportation topics. He is the author or co-author of more than 120 scientific publications on turbomachinery, airbreathing, and rocket propulsion.



CHUNG K. LAW received his B.S. in Physics from the University of Alberta in 1968, his M.A.Sc. in Aerospace Studies from the University of Toronto in 1970, and his Ph.D. in Engineering Physics from the University of California at San Diego in 1973. He was on the faculty of Northwestern University from 1976 to 1984 and the University of California at Davis from 1984 to 1988. In 1988, he joined Princeton University where he is now the Robert H. Goddard Professor of Mechanical and Aerospace Engineering. His research interests are in combustion, propulsion, heat and mass transfer, energy, and the environment. He is a recipient of the Curtis W. McGraw Research Award of the American Society for Engineering Education (1984); a Silver Medal of the Combustion Institute (1990); the Propellants and Combustion Award of AIAA (1994); the Heat Transfer Memorial Award, in Science, of the American Society of Mechanical Engineers (1997); the Energy Systems Award of AIAA (1999); and an Outstanding Alumnus Award from the University of California at San Diego (2000). Presently he is a Deputy Editor of *Combustion and Flame*, the President of the Combustion Institute, and the Chair of the Disciplinary Working Group of NASA's microgravity combustion program. He is a Fellow of AIAA and ASME.



PONG-JEU LU, Professor of Aeronautics and Astronautics and Director of Heart Science Research Center at the National Cheng Kung University in Taiwan, received his B.S. in 1976 and M.S. in 1978 from the National Taiwan University. He earned his Ph.D. in Mechanical and Aerospace Engineering from Princeton University in 1984. He then joined the faculty of the Institute of Aeronautics and Astronautics at the National Cheng Kung University, where he was promoted to the rank of Professor in 1992 and served as the Institute Director in 1998-2001. His current research interests include computational fluid dynamics, aeroelasticity, aeroacoustics, turbomachinery flow instability, engine condition monitoring and diagnostics, artificial neural network, and bio-engineering applied to artificial heart design. Professor Lu has been a prime mover of the aeroindustry in Taiwan and participated deeply in the National Flight Safety Improvement Program. He now serves on the Boards of Directors of the Chinese Society of Aeronautics and Astronautics, the Chinese Society of Civil Aviation, and the Aeronautical and Space Industry Development Association in Taiwan. As an advocate for international collaborations between the Pacific Rim and North America, he initiated the first Industrial Cooperation Program between the U.S. gas-turbine engine manufacturers (e.g., Pratt & Whitney) and universities in Taiwan and China. Professor Lu has published more than 50 articles and papers, and was the recipient of the Best Paper Awards of the National CFD Conferences in Taiwan in 1999 and 2000.



ROBERT L. SACKHEIM, Assistant Director and Chief Engineer for Propulsion at NASA's George C. Marshall Space Flight Center (MSFC), holds a B.S. degree from the University of Virginia and a M.S. degree from the Columbia University. He has completed all doctoral coursework in Chemical Engineering at the University of California in Los Angeles. He joined MSFC after 35 years in various technical and management positions with TRW Space and Electronics Group. His awards and honors include the AIAA James Wyld Award for outstanding technical contributions to the field of rocket propulsion, as well as 12 NASA Group Achievement Awards. While at TRW he received three annual Chairmen's Awards and a TRW patent of the year award. He is a Fellow of AIAA and was elected in 2000 to the National Academy of Engineering. He also received the AIAA Sustained Service Award in 2000. The Alabama/Mississippi section of the AIAA awarded him the Martin Schilling Award for outstanding service to the section. In 2001, he was awarded the NASA Medal for outstanding technical leadership. Mr. Sackheim was formerly the Chairman of the AIAA Liquid Propulsion Technical Committee and the Chairman of the Los Angeles section of AIAA, and was recently the Chairman of the Mississippi/Alabama section of AIAA. He has served on a number of NASA boards, including the Shuttle Independent Assessment Team, the Mars Climate Orbiter Mishap Investigation Board, and the Mars Polar Lander Mishap Board. He has authored more than 140 technical papers. He holds seven patents for spacecraft, launch vehicle propulsion, and control systems technology.



ROBERT J. SANTORO, Distinguished Professor of Mechanical Engineering and Director of the Propulsion Engineering Research Center at The Pennsylvania State University, received his Ph.D. degree in Physics from Boston College in 1975 where he also held a one-year position as a Lecturer. He then joined the Fuels Research Laboratory in the Department of Mechanical and Aerospace Engineering at Princeton University as a Research Engineer, where his research emphasized the study of hydrocarbon oxidation and flame spread over liquids and solids. In 1978, he joined the National Bureau of Standards (NBS) in Washington, DC, where he remained until 1986. At NBS, Dr. Santoro developed research efforts in the areas of particle formation in flames, laser tomography, and spray combustion research. In 1985, he was awarded the U.S. Department of Commerce Silver Medal for his research in soot particle formation. In 1986, he joined the Pennsylvania State University as an Associate Professor of Mechanical Engineering and was promoted to Full Professor in 1990. In 1994, Dr. Santoro was appointed to the position of Director of the Propulsion Engineering Research Center, where he currently serves. In 2000, Dr. Santoro was promoted to Distinguished Professor of Mechanical Engineering. His research interests include studies of rocket propulsion, soot formation in flames, liquid spray combustion, laser diagnostics, diesel engine combustion, gas turbine combustion, combustion instability, chemical kinetics, and materials processing.



BYRON K. WOOD, with nearly 40 years of experience in the field of launch vehicle propulsion, is responsible for directing many space-related activities, including the main engines for NASA's Space Shuttle and booster engines for several Expendable Launch Vehicles (ELV's). Wood joined Rocketdyne in 1963 from the Lawrence Radiation Laboratory in Berkeley, California. His initial work included development of the J-2 engine for NASA's Saturn Launch Vehicle. In 1969, he began a long association with the Space Shuttle Main Engine (SSME). He drove the Rocketdyne SSME program toward a team-oriented organization, resulting in significant cost reductions and improved product quality. Other innovations include implementing a product/process organization approach in which engineering processes support product and technology improvement and development. These efforts resulted in the first all-commercially-developed large rocket engine in the United States, the RS-68. He has served as Vice President and General Manager of Rocketdyne Propulsion & Power since 1998. Wood is a graduate of the University of California at Berkeley with degrees in Physics and Mathematics. He is a fellow of AIAA and a member of the American Astronautical Society. Wood has been honored with many awards, including NASA's Exceptional Engineering Achievement medal (1982), NASA's Public Service medal (1988), and San Fernando Valley Engineers' Council Engineer of the Year (1994). From 1994 through 1996, he served on the Board of Directors of the Ohio Aerospace Institute. Currently, Wood serves on the NASA Advisory Council.



XU JIAN-ZHONG, Member of the Chinese Academy of Sciences (CAS) and Professor of the Institute of Engineering Thermophysics of CAS, received his B.S. degree from the University of Science and Technology of China in 1963, and finished his postgraduate study in Engineering Thermophysics at the Institute of Mechanics of CAS in 1967. He was on the faculty of the Institute of Mechanics in 1967-1980, before joining the Division of Propulsion and Power at the Institute of Engineering Thermophysics of CAS, where he became a Professor in 1986. His current research interests include fluid dynamics and heat transfer of turbomachinery, multiphase flows, micro engines, and space solar power. Professor Xu was awarded the second-class National Natural Science Prize, the first-class Science and Technology Achievement Prize of CAS, the second-class Natural Science Prize of CAS, and several science and technology prizes and awards. He was conferred the title "National Outstanding Scientist" in 1984 and elected as a CAS Member in 1995. He is presently Chairman of the Scientific Degree Committee of the Institute of Engineering Thermophysics, Member of the National Invention Awards Committee, Vice President and Secretary-General of the Chinese Society of Engineering Thermophysics, Deputy Editor-in-Chief of the *Chinese Journal of Engineering Thermophysics*, and Editor of the *Chinese Journal of Aeronautics and Astronautics* and the *Chinese Journal of Computational Mechanics*. Prof. Xu is the author or co-author of more than 150 papers and articles.



BEN T. ZINN, David S. Lewis, Jr., Chair of Aerospace Engineering and Regents' Professor, joint appointment with the George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, received his B.S. in Mechanical Engineering (cum laude) from New York University in 1961, his M.S. in Mechanical Engineering from Stanford University, and his M.A. and Ph.D. in Aerospace and Mechanical Sciences from Princeton University in 1963 and 1965, respectively. He joined the faculty at Georgia Institute of Technology in 1965 where he was promoted to Regents' Professor in 1973. Dr. Zinn was appointed to the Lewis Chair in 1992. Over the years, Dr. Zinn has made research contributions in the areas of combustion instabilities, pulse combustion, combustion, acoustics, fire safety, and active control of combustion processes. Dr. Zinn served on the AIAA Propellants and Combustion Technical Committee and was Associate Editor of the *AIAA Journal*. He also served on the Editorial Board of *Progress in Energy and Combustion Science* and currently serves on the Editorial Board of *Combustion Science and Technology*. Dr. Zinn's awards include membership of the National Academy of Engineering, the AIAA Pendray and Combustion and Propellants awards, Fellow of the AIAA and American Society of Mechanical Engineers, Honorary Professorship at Beijing University of Aeronautics and Astronautics, and Georgia Tech's Outstanding Professor Award. He has advised the research activities of more than 35 Ph.D. students and many M.S. and undergraduate students. Some of these studies have won national and regional awards. Dr. Zinn is author or co-author of 395 articles and papers.