

## Announcements and Acknowledgments

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

**Web-Based Manuscript Submittal and Tracking System.** On March 3, 2003, the AIAA launched a Web-based manuscript submittal and tracking system, <http://www.writetrack.net>. All submissions received since then have been exclusively handled by WriteTrack. The new system utilizes start-of-the-art information technologies to streamline the review and revision processes for archival journal publication, with all the correspondence transmitted electronically through the Internet. In spite of its overwhelmed success in the first year, the AIAA will continue to improve and maximize the effectiveness of WriteTrack. Any comments and suggestions leading to further improvement will be greatly appreciated.

**A Century of Aerospace Propulsion and Power.** In celebration of the 100th anniversary of powered flight, the *JPP* published a series of feature articles in December 2003 and January 2004, discussing the histories of key technologies in all aspects of aerospace propulsion and power. Twenty individuals who have made extraordinary contributions to the field were invited to provide comprehensive reviews of the technological evolution over the past century in their areas of expertise. The topics covered include liquid-propellant rockets, solid-propellant rockets, electric propulsion, gas-turbine engines, ramjet and scramjet engines, supersonic civil transport, propellants and fuels, aerospace power generation, conversion, and storage, and advanced and conceptual propulsion technologies. Each paper focuses on the development of a specific aspect of propulsion and power systems, and is incorporated into the volume as part of a cohesive whole. This undertaking thus represents not only a chronicle of events, but also an engagement with the personalities and the conceptual and technological advances that have driven the development of flying machines and rockets from Kitty Hawk to the upper atmosphere and beyond.

**Special Sections.** It is a general policy of the AIAA that a focused journal issue dedicated to a specific topic will be discouraged, since it may contain no papers of interest to subscribers involved in specialties outside the scope of the topic covered. Such a dedicated issue will be considered *only* if (1) the theme represents a milestone contribution to aerospace science and technology, and (2) a well-rounded publication plan in terms of quality and quantity can be implemented. Furthermore, any special issue must be approved by AIAA's Vice President–Publications. If important scientific and technical subjects deserve in-depth treatment, but do not fulfill the above-mentioned requirements, a special section encompassing a small number of high quality papers will be considered in the place of a special issue.

The *JPP* published a special section on lean-premixed prevaporized (LPP) gas-turbine combustion dynamics in September 2003, edited by Tim Lieuwen and Keith McManus. This is a timely contribution since combustion dynamics is one of the two most important issues in developing gas turbine combustors today (the other is emissions). The section includes nine papers contributed by well-known experts from around the world.

**Editorial Advisory Board.** We are indebted for the continuing services of the Editorial Advisory Board, whose 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 biographies and photographs of the sixteen board members, representing most, if not all, of important disciplines in aerospace propulsion and power, 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 gratefully acknowledged.

**Reappointed Associate 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 C. Thomas Avedisian, Cornell University; Quinn Brewster, University of Illinois; Alec D. Gallimore, University of Michigan; Tom I. Shih, Iowa State University; and Kenneth H. Yu, Maryland University, have agreed to serve another three-year term as AE. 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.** Two names are being added to the masthead. Liping Xu, from Cambridge University, is widely recognized for his research in gas-turbine turbomachinery, aeroacoustics, and computational fluid dynamics. Joseph C. Oefelein, from the Sandia National Laboratories Combustion Research Facility, is an acknowledged expert in large-eddy simulations of turbulent reacting flows, high-pressure combustion, and multiphase phenomena. I welcome these outstanding individuals and thank them for agreeing to serve.

**Continuing Associate Editors.** Individuals who will continue their service as AE for the coming year are: Edgar Choueiri, Princeton University; Winfred A. Foster, Auburn University; Ashwani K. Gupta, University of Maryland; Gavin J. Hendricks, Pratt & Whitney Engines; Hans Immich, EADS Space Transportation; Feng Liu, University of California; Lourdes Q. Maurice, Federal Aviation Administration; Roger M. Myers, Aerojet Gen-Corp.; Carlson C. Pian, Alfred University; Joseph M. Power, University of Notre Dame; and Gregory G. Spanjers, Air Force Research Laboratory. The dedication of these individuals to the journal is greatly appreciated.

**Retiring Associate Editors.** Special thanks are due to our retiring Associate Editors: Daniel J. Dorney, NASA Marshall Space Flight Center, and Jan Lepicovsky, NASA Glenn Research Center. Their service 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 the editorial staff of the AIAA for their invaluable assistance and effective management, as follows: Roger L. Simpson (former Vice President Publications); David S. Dolling (Vice President–Publications); Norma Brennan (Director of Publications); and Amanda Maguire (Managing Editor, *JPP*). The publication staff at Techbooks, coordinated by Angela Weaver, is gratefully acknowledged. Special thanks are due to Tim Lieuwen and Keith McManus for their great effort in preparing the special section on the combustion dynamics in lean-premixed prevaporized (LPP) gas turbines in September 2003. 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 also deserve special recognition. Their names appear in the following pages.

V. Yang  
Editor-in-Chief

## Editor-in-Chief

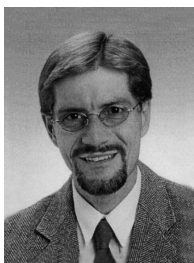


**VIGOR YANG**, Distinguished Professor of Mechanical Engineering at the Pennsylvania State University, received his B.S. from the National Tsing Hua University and Ph.D. from the California Institute of Technology. His research interests include combustion instabilities in propulsion systems, chemically 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 thirty-six Ph.D. and fifteen M.S. theses. He is the author or co-author of more than one hundred and ninety technical papers in the areas of propulsion and combustion, and has published seven comprehensive volumes on solid and liquid rocket propulsion. He was the recipient of the Penn State Engineering Society Outstanding Teaching and Research Awards 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*, the *Russian Journal of Combustion, Explosion, and Shock Waves*, and the *Journal of the Chinese Institute of Engineers*. 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 AIAA Best Paper Awards for research on droplets and sprays, and the James Harry Potter Gold Medal (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 to 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 Mechanical Engineering 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 U.S. Department of Energy Accelerated Strategic Computing Initiative center.



**EDGAR CHOEIRI**, Director of the Engineering Physics Program at Princeton University where he also heads the Electric Propulsion and Plasma Dynamics Laboratory. He is Associate Professor in Applied Physics at Princeton's Mechanical and Aerospace Engineering Department and 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.



**WINFRED A. FOSTER JR.**, Professor in the Department of Aerospace Engineering at Auburn University, received his B.S. (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. He also serves as Chair of the History Subcommittee.



**ALEC D. GALLIMORE**, is an Associate Professor of Aerospace Engineering and of Applied Physics at the University of Michigan where he 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 MPD thrusters, and has implemented a variety of probe, microwave, and optical/laser plasma diagnostics. Professor Gallimore is the author of two book chapters and more than one hundred and thirty journal and conference papers on electric propulsion and plasma physics. He has been the recipient of a number of University of Michigan prizes including the *Outstanding Accomplishment Award in Aerospace Engineering* in 2002, a *Faculty Career Development Award* in 2000, the *Class of '38E Prize* for research, teaching, and service in 1996, and *Sigma Gamma Tau* teacher of the year awards in 1996 and 1994. In 1994 he was awarded the *Crystal Image Science Educator of the Year Award* by the National Technical Association and received the *Best Paper in 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 AIAA Propellants and Combustion Award and Energy System Award, George Westinghouse Gold Medal of American Society of Mechanical Engineers (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 publication of 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 Society of Automotive Engineers 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. 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 (ASME) 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 to 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.



**FENG LIU**, Professor of Mechanical and Aerospace Engineering at the University of California (UC), Irvine, received his B.S. (1982) from Northwestern Polytechnic University in Xi'an, China; his M.S. (1984) from Beijing University of Aeronautics and Astronautics; and his Ph.D. (1991) from Princeton University. His research interests include computational fluid dynamics; transonic, reactive, and two-phase flows; turbomachinery aerodynamics; aeroelasticity; and gas-turbine engine cycle innovation. He is the author or coauthor of more than 50 journal and conference papers. He was the recipient of the Outstanding Engineering Professor Award from the class of 2000 at UC Irvine. Dr. Liu is an Associate Fellow of the AIAA and a Member of the American Society of Mechanical Engineers. He serves on the AIAA Airbreathing Propulsion Technical Committee.



**LOURDES Q. MAURICE**, is presently the Chief Scientific and Technical Advisor for Environment in the Federal Aviation Administration's Office of Environment and Energy. She serves as the agency technical expert for basic and exploratory research, and advanced technology development focused on aircraft environmental impacts and its application to noise and emissions certification. She previously served as the 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 Basic Research Sciences and Propulsion Science and Technology portfolios at the Air Force Secretariat. She also worked at the Air Force Research Laboratory's Propulsion and Power Directorate from 1983 to 1999 planning and executing basic, exploratory, and advanced development propulsion science and technology programs, focusing on state-of-the-art aviation fuels and propulsion systems. Her areas of expertise include pollutant formation chemistry, combustion kinetics, hypersonic propulsion, and aviation fuels. She received her B.Sc. in Chemical Engineering and M.Sc. in Aerospace Engineering from the University of Dayton in Dayton, Ohio and her Ph.D. in Mechanical Engineering from the University of London's Imperial College at London, United Kingdom. She is also a Distinguished Graduate of National Defense University's Industrial College of the Armed Forces, where she earned a M.Sc. in National Resource Strategy. Lourdes has served in a National Research Council committee, serves on the Board of the International Journal of Aeroacoustics, and is an Associate Editor for the American Institute of Aeronautics and Astronautics' (AIAA) Journal of Propulsion and Power; she is serving a second term on AIAA's Propellants and Combustion Technical Committee. Lourdes has authored over 90 publications and is a Fellow of AIAA, as well as a member of Tau Beta Pi Honorary Engineering Society, the American Association for the Advancement of Science (AAAS), and the American Chemical Society (ACS).



**ROGER M. MYERS**, is the Director of Systems and Technology Development at Aerojet-Redmond Rocket Center (RRC), where he leads development, qualification, and first-article production efforts in chemical and electric propulsion systems. He received his B.S. in aerospace engineering from the University of Michigan in 1984 and his Ph.D. in mechanical and aerospace engineering from Princeton University in 1989. 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. He left Nyma for Primex Aerospace (now Aerojet-RRC) later that year, serving as Director, Electric Propulsion until 2000, when he assumed the broader role as Leader for Systems and Technology Development. He has worked on a wide range of propulsion technologies, spacecraft integration assessments, and missions/systems analyses. The propulsion systems include Hall thrusters, arcjets, ion thrusters, pulsed plasma thrusters, magnetoplasmadynamic thrusters, and both conventional and advanced monopropellant and bipropellant chemical rockets. The spacecraft integration assessments and mission analyses have included a wide range of spacecraft and missions, from small LEO communications satellites to large interplanetary spacecraft. He has authored over 70 publications on spacecraft propulsion, was Chair of the AIAA Electric Propulsion Technical Committee from 1998 to 2000, has been an Associate Editor of the *Journal of Propulsion and Power* since 1992, and co-teaches the AIAA Electric Propulsion short course.



**JOSEPH C. OEFELEIN**, received a Doctorate in Mechanical Engineering from The Pennsylvania State University, a Master of Science Degree in Mechanical Engineering from Penn State, and a Bachelor of Science Degree in Mechanical Engineering (with highest honors) from Rutgers University. He is currently employed as a Senior Member of Technical Staff at the Sandia National Laboratories Combustion Research Facility. His research interests are interdisciplinary, with focus on the theory, numerical modeling and analysis of complex fluid flows where turbulence, combustion, high-pressure phenomena and (or) multiphase phenomena play a controlling role. Concurrent interests are focused in the general area of numerical methods for partial differential equations, with emphasis placed on computational fluid dynamics (CFD), applied numerical analysis, large-scale scientific computing and parallel processing. He has extensive experience in the development and application of the large-eddy-simulation (LES) technique and the related subgrid-scale models to both fundamental flows and device-scale components such as liquid-rocket injectors, gas-turbine combustors and internal combustion engines.



**CARLSON C. P. PIAN**, received his B.S., M.S., and Ph.D. in aerospace engineering from the University of Michigan. He is currently Professor and Chair of the Mechanical Engineering Division at Alfred University. Previously, he was Researcher at Molten Metals Technologies, and he later served on the Faculty of the Diagnostic Instrumentation and Analysis Laboratory at the Mississippi State University. There, he was 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 Director of Commercial MHD Component Development, responsible for programs involving the research and development of MHD power generators. Prior to joining Avco, Dr. Pian was Research Engineer at the NASA Lewis Research Center. Dr. Pian is an Associate Fellow of AIAA and a Member of the Plasmadynamics and Lasers Technical Committee.



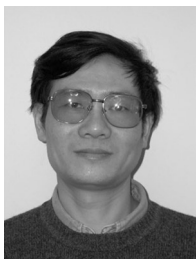
**JOSEPH M. POWERS**, Associate Professor of Aerospace and Mechanical Engineering at the University of Notre Dame, received his B.S., M.S., and Ph.D. in mechanical engineering from the University of Illinois at Urbana-Champaign in 1983, 1985, and 1988, respectively. His research interests include detonation theory, pyrotechnic combustion, highspeed propulsion, transition to detonation in solid propellants, high speed flows in reactive porous media, numerical and theoretical methods for multiscale phenomena, and systematic reduction of large systems of chemical kinetics. He is the author of several papers in the archival literature and has supervised many M.S. and Ph.D. students since joining the faculty in 1989. He held summer appointments at NASA Glenn Research Center and the U.S. Air Force Wright Laboratories at Eglin AFB and at Los Alamos National Laboratory. He is the recipient of the University of Notre Dame's Amoco-College of Engineering Outstanding Teacher of the Year Award in 1994, and Department Faculty Award in 1997. He received a NASA Innovative Technology Award in 1999. Dr. Powers is a Member of Society for Industrial and Applied Mathematics, American Society of Mechanical Engineers, American Society for Engineering Education, and the Combustion Institute. He is an Associate Fellow of AIAA.



**TOM I-P. SHIH**, is currently Professor and Chair of Aerospace Engineering at Iowa State University. Previously, he was Professor at Michigan State University (1998–2003), Professor at Carnegie Mellon University (1988–98), Associate Professor at the University of Florida (1982–88), and Research Engineer at NASA—Lewis (now Glenn) Research Center (1981–82). He received his B.S.E. degree (1976) from the National Cheng Kung University in Taiwan, 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 and error estimation in CFD. In using CFD, Dr. Shih and his students have studied shock-wave/boundary-layer interactions with bleed and blowing, aerodynamics of iced airfoils, internal and film cooling of turbine components, particle-particle/particle-fluid interactions, thermoelectric power generation, flow in torque converters, and piston and rotary engine flow fields. In this endeavor, he has authored and co-authored 160 technical papers and presented 92 invited seminars, lectures, or workshops.



**GREGORY G. SPANJERS**, is currently Program Manager for PowerSail at the Air Force Research Laboratory (AFRL) Space Vehicles Directorate, Kirtland Air Force Base, New Mexico. The PowerSail program is researching structures to accommodate high-power photovoltaic arrays while minimizing dynamic interactions with the spacecraft. Dr. Spanjers received his B.S. in physics and his B.S. in mathematics from the University of Minnesota in 1986. He received his M.S. in 1990 and his Ph.D. in 1992 from the University of Washington, where he performed plasma physics research for magnetic fusion. After working in industry and academia, he joined the AFRL Electric Propulsion Laboratory, Edwards Air Force Base, as 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 and has nine patents pending for advanced spacecraft thrusters. He is a Member of the AIAA Electric Propulsion Technical Committee and is serving on National Academy of Sciences NRC Review Panels.



**LIPING XU**, is a University Lecturer in turbomachinery in the Department of Engineering, University of Cambridge, UK. He received his B.Sc. from Beihang University (then Beijing Institute of Aeronautics and Astronautics), Beijing, China and a Ph.D. from University of Cambridge. His major research and teaching area is three-dimensional and unsteady flows in turbomachinery, especially fan aerodynamics. Prior to the appointment at Cambridge, he had a Chair in Turbomachinery at Beihang University, where he served on the University Council as a member and deputy director from 1989–1996 and on its Academic Board as Secretary General from 1993–1996. He was the Associate Chair of the Turbomachinery Subcommittee of the Chinese Aeronautical Society. In China and U.K. he has been working very closely with the aeroengine and gas-turbine industries and is active in the Turbomachinery Committee of ASME's International Gas Turbine Institute. He received jointly with Prof. John Denton the Best Paper Award (1990) from the IGTI Turbomachinery Committee, and the Water Arbitration Prize from the Institution of Mechanical Engineers (1999). He is a specialist member of the Chinese Aeronautical Society and a member of the Chinese Society of Engineering Thermophysics. He also serves on the editorial board of the *Chinese Journal of Aerospace Power*.



**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. He is also the Director of Aerospace Engineering Honors Program at the University of Maryland. Prior to joining the faculty at the University of Maryland in 1999, he worked as a Physical Scientist at the Propulsion Research Lab, Naval Air Warfare Center in China Lake, CA (1990–1999), as a Post-Doctorate/Visiting Professor at Ecole Centrale Paris, France (1989–1990), and as an Aerospace Engineer at NASA-Ames Research Center (1985). His current research interests include combustion control, turbulent compressible mixing, air-breathing propulsion, and combined cycle engines for access to space. He has authored or co-authored over 130 journal and conference papers in various subject areas, including combustion instabilities, active control, supersonic mixing enhancement, plume afterburning, waste incineration, and other thermoacoustic processes involving ramjets and scramjets. His work has resulted in seven U.S. patents and three conference Best Paper Awards. He is an Associate Fellow (since 2001) of AIAA and is currently serving as the Chair (2002–2004) of the AIAA Propellants & Combustion Technical Committee.

## Editorial Advisory Board



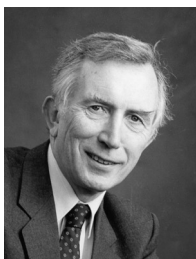
**MIKE J. BENZAKEIN**, received his Mechanical Engineering Degree in 1960. He received an MSME in 1963 and a Ph.D. in Engineering Mechanics in 1967. He joined General Electric in 1967 where he served in a number of positions in Advanced Technology, Project and Product Engineering. He led the CFM56 Engineering Program from 1984 to 1993 and the GE90 Engineering Program from 1993 to February 1995. Dr. Benzakein in February 1995 became General Manager for Engine Systems Design and Integration and 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. He is responsible for leading the Technology Development efforts and the Certification/Qualification of New Engine Products. His charter is to ensure 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, engine systems and production hardware design. Dr. Benzakein has been elected as a Member of the National Academy of Engineering in 2001. That year he received the Gold Medal Award from the Royal Aeronautical Society. He has been elected a Fellow of the Royal Aeronautical Society in 2002.



**SÉBASTIEN CANDEL**, Professor of Aerospace Engineering and Head of Mechanical and Aerospace Studies at Ecole Centrale Paris, received his engineering degree from Ecole Centrale Paris in 1968, DEA from U. Paris 6 also in 1968, Ph.D. from the California Institute of Technology in 1972, and the Doctorat d'Etat from U. Paris 6 in 1977. He was research scientist at ONERA (the French Aerospace Research Office) from 1973 to 1987 and assistant professor at University of Compiègne from 1975 to 1978. Since 1978 he has been a professor at Ecole Centrale Paris. In 2001 he was appointed as a senior member of Institut Universitaire de France. He is the recipient of the d'Aumale Prize (1987) and the Marcel Dassault Grand Prize (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 vice-president of the Combustion Institute, and a member of the High Scientific Council of ONERA and the launchers committee of CNES. He was the Chairman of the Supersonic Aircraft Research Network (2000). In addition, he has been 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 also serves on the editorial boards of *Combustion Science and Technology*, *Progress in Energy and Combustion Science* and the *Journal of Propulsion and Power*. He is the author or co-author of two books and of more than 260 articles and papers.



**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.



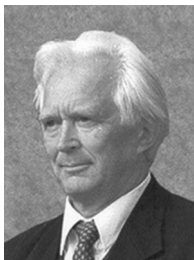
**NICHOLAS A. CUMPSTY**, is Chief Technologist for Rolls-Royce plc. Until the end of 1999 he was Professor of Aerothermal Technology in the University of Cambridge and Director of the Whittle Laboratory. He received his B.Sc. from Imperial College in Mechanical Engineering and his Ph.D. in the University of Cambridge for work on three-dimensional boundary layers. After a period as a research fellow in Cambridge, Dr. Cumpsty worked for Rolls-Royce in the area of noise until returning to the University of Cambridge to join the teaching staff in 1972. He was the Hunsaker Visiting Professor in the Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, from 1991–1992. He has received the ASME Gas Turbine Award of two occasions and the George Stephenson Medal of the Institution of Mechanical Engineers. As well as many technical papers Dr. Cumpsty has written two major books: *Compressor Aerodynamics* was published in 1989 (and is to be reprinted in 2004) whilst the second edition of *Jet Propulsion* appeared in 2003. Dr. Cumpsty is a Fellow of the AIAA and ASME as well as a Fellow of the Royal Academy of Engineering.



**EDWARD M. GREITZER**, is the H. N. Slater Professor of Aeronautics and Astronautics at MIT. He received his A.B., S.M., and Ph.D. from Harvard University. Prior to joining MIT in 1977 he was with United Technologies Corporation, and more recently 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 ASME 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 and the IGTI Board of Directors (Chair 1996–1997). He is lead author of the book *Internal Flow: Concepts and Applications*, to be published in 2004. Dr. Greitzer is a Fellow of AIAA and ASME and a member of the National Academy of Engineering.



**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.



**BORIS I. KATORGIN**, General Director and General Designer of the Research and Production Association of Power Engineering named after Academician V. Glushko (Joint Stock Company "NPO Energomash"). He graduated with a first-class honor degree from Bauman High Engineering School in 1958. He made his way up from mechanical and design engineer to General Director and General Designer of OAO "NPO Energomash" (from 1992 to present). Under his leadership OAO "NPO Energomash" made many breakthroughs in the field of liquid propellant rocket engines (LPRE), won the competition in the USA in 1996 and delivered two RD-180 engine modifications, which provided successful launches of commercial satellites on launch vehicles Atlas III and V. Other significant innovations include developments of large LPRE for the new launch vehicle Angara, engine modernization for launch vehicles Soyuz, Proton, Zenit. OAO "NPO Energomash" has also conducted activities in the development, research, and application of chemical laser. Boris I. Katargin is an Academician of the Russian Academy of Sciences, a Doctor of Engineering, and a Professor. He has practiced teaching for more than 30 years and is currently in charge of Chair of "Energy and Physical Systems" of the Moscow Aviation Institution. He is an author of 320 scientific papers including 160 inventor certificates and patents as well as 7 US patents. He has been awarded "Badge of Honor," "Motherland's Distinguished Service" Orders and is the Russian Government Prize Laureate and the Honored Scientist of the Russian Federation. For many years Katargin has headed the Board of Directors of industrial companies of Khimki district, Moscow region, and is a member of League Presidium of Defense Companies as well as a member of editorial boards of scientific and technical journals *Engines* and *Flight*.

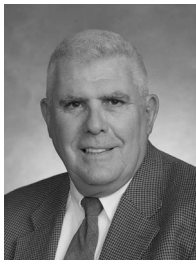


**CHUNG K. LAW**, received a B.S. in Physics from the University of Alberta in 1968, an M.A.Sc. in Aerospace Studies from the University of Toronto in 1970, and a Ph.D. in Engineering Physics from the University of California at San Diego in 1973. Since graduation he has been associated with the General Motors Research Laboratories, Princeton University, Northwestern University, and the University of California at Davis. In 1988 he returned to Princeton University, where is the Robert H. Goddard Professor of Mechanical and Aerospace Engineering. Law's research interests cover various physical and chemical aspects of fundamental combustion phenomena. He is a fellow of the AIAA and the American Society of Mechanical Engineers, a member of the National Academy of Engineering, the current president of the Combustion Institute, and a recipient of a number of professional and best paper awards for technical contributions. He is author or coauthor of over 300 journal publications.





**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**, the 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, and the Herman Oberth Award from AIAA "For Outstanding Individual Scientific Achievement in the Fields of Astronautics and Space Sciences," and he recently received an award from the Association of Aeronautics and Astronautics of France for "High Quality Contributions to the Propulsion Field." 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 the AIAA, and was recently the chairman of the Mississippi/Alabama section of the AIAA. He has served on a number of NASA boards, including the Shuttle Independent Assessment Team (SIAT), the Mars Climate Orbiter Mishap Investigation Board, and the Mars Polar Lander Mishap Board. He has authored more than 150 technical papers. He also holds eight patents for spacecraft and/or launch vehicle propulsion and/or control systems technology.



**WILLIAM A. SIRIGNANO**, serves as Professor of Mechanical and Aerospace Engineering and of Chemical Engineering and Materials Science at the University of California, Irvine. He received the B. Aero. Engineering degree from Rensselaer Polytechnic Institute and the M.A. and Ph. D. from Princeton University. He has served as Dean, School of Engineering, University of California Irvine; George Tallman Ladd Professor and Department Head, Carnegie-Mellon University; and Professor, Princeton University. His major research and teaching interests include spray combustion, turbulent combustion and ignition, aerospace propulsion, fluid dynamics, and applied mathematics. He has over 400 research papers and about 250 research seminars and presentations. Sirignano's awards and recognitions include National Academy of Engineering membership; Fellow status in AIAA, ASME, AAAS, and APS; AIAA Propellants and Combustion Award; ASME Freeman Scholar Award; AIAA Pendray Aerospace Literature Award; The Combustion Institute Alfred C. Egerton Gold Medal; IDERS Oppenheim Award; American Electronics Association, Orange County Council, Award; President's Award for Engineering Excellence in Service to Higher Education, Orange County Engineering Council; UC Irvine Alumni Distinguished Research Award; and United Aircraft Research Fellow. His professional service has included Chair, Microgravity Research Committee of Space Studies Board, National Research Council; NASA Space Science and Applications Advisory Committee; AIAA Publications Committee; Chairman, AIAA Solid Rockets Technical Committee; Executive Committee, Treasurer, and Board of Directors, The Combustion Institute; President, Institute of the Dynamics of Explosions and Reactive Systems; Series Editor, Combustion Science and Technology, Taylor and Francis; and Editorial Advisory Boards for Combustion Science and Technology, Combustion and Flame, Atomization and Sprays, Numerical Heat Transfer, Progress in Energy and Combustion Science, and Archivum Combustionis.



**TONY STRAZISAR**, is the Chief Scientist of the NASA Glenn Research Center. He earned his B.S., M.S., and Ph.D. in Engineering from the Case Western Reserve University and joined NASA-Glenn in 1976. His early work focused on the acquisition and analysis of laser anemometer measurements in high-speed rotating machinery to advance the basic understanding of turbomachinery fluid mechanics and for turbomachinery CFD code validation. His more recent work has focused on the development of fluid injection schemes to control compressor stall and to increase the aerodynamic loading of compressor blading. He has received the NASA Exceptional Engineering Achievement Medal. He is a three-time recipient of NASA-Glenn's Best Publication award, and has also received publication awards from AIAA and ASME. He is a Fellow of ASME and a member of the Board of Directors of the International Gas Turbine Institute.



**JUE WANG**, graduated from the Xian Jiao-Tong University. He joined the Beijing Aerospace Propulsion Institute in 1982, and currently the first deputy general director of the institute and the vice chief designer of the Long March III launch vehicles. He is also a professor of astronautical engineering at the Beijing University of Aeronautics and Astronautics. His initial work involved the system design and analysis of cryogenic rocket engines for Long March III. He has been responsible for the development of key technologies of China's new generation of cryogenic rocket engines since 1995. He has served as the leader of an expert group of a national high-tech aerospace committee since 1998, managing a wide variety of research and development projects in rocket and air-breath propulsion at the national level. Mr. Wang has made substantial contributions to the field of rocket engine design and analysis. He has been active in various scientific and professional societies in China. He is a member of the executive council of the Chinese Society of Astronautics, and a co-chair of the Liquid Rocket Propulsion Committee of the Chinese Society of Astronautics.



**BYRON K. WOOD**, With 40 years of experience in the field of launch vehicle propulsion, Byron Wood 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 the 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 2003), 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. Wood served on the NASA Advisory Council from 2001 to 2003.



**JIAN-ZHONG XU**, 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. Prof. 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 the chairman of the Scientific Degree Committee of the Institute of Engineering Thermophysics, a member of the National Invention Awards Committee, the vice president and secretary-general of the Chinese Society of Engineering Thermophysics, the deputy editor-in-chief of the Chinese Journal of Engineering Thermophysics, and the member of the editorial committee of the Science in China (Scientia Sinica), the Chinese Journal of Aeronautics and Astronautics and the Chinese Journal of Computational Mechanics. Prof. Xu is the author or coauthor of more than 150 papers and articles.



**BEN T. ZINN**, is the David S. Lewis, Jr. Chair of Aerospace Engineering and Regents' Professor with a Joint appointment at the George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology. Dr. Zinn received his B.S. in ME (cum laude) from New York University in 1961, M.S. in ME from Stanford University, 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 is presently serving as Director of the recently awarded NASA University Research, Engineering and Technology Institute at Georgia Tech (URETI) on Aeropropulsion and Power. Dr. Zinn has 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: Recipient of the 2002 Alfred C. Egerton Gold Medal of the Combustion Institute "For distinguished continuing and encouraging contributions to the field of combustion," Membership of the National Academy of Engineering, the AIAA Pendray and Combustion and Propellants awards, Fellow of the AIAA and ASME, 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 students have won national and regional awards. Dr. Zinn is author or coauthor of over 400 articles and papers.

## Editorial Policy Statement on Numerical Accuracy and Experimental Uncertainty

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. Recently there has been considerable concern with the quality of published numerical solutions. Also the practice of including error bars on experimental results is often lacking. In response to these problems, a succinct policy statement on these items is as follows:

*The AIAA journals will not accept for publication any paper reporting (1) numerical solutions of an engineering problem that fails adequately to address accuracy of the computed results or (2) experimental results unless the accuracy of the data is adequately presented.*

The implementation of this policy will be at the discretion of the Editors and Associate Editors of the journals.

The accuracy of the computed results is concerned with how well the specified governing equations in the paper have been solved numerically. The appropriateness of the governing equations for modeling the physical phenomena and comparison with experimental data is not part of this evaluation. Accuracy of the numerical results can be judged from grid refinement studies, variation of numerical parameters that influence the results, comparison with exact solutions, and any other technique the author selects. The validity of the accuracy estimation will be judged by the reviewers of the paper. An estimate of accuracy of the numerical results must be presented when comparisons with other numerical and experimental results are given,

and when new results of the author will likely become data for future comparisons. Since accuracy of various computed results obtained from a numerical solution can vary significantly, the accuracy of the result being used must be stated. Accuracy of results from a validated code must still be established to show that proper input parameters have been used with the code.

Estimates of experimental uncertainty are required for all plotted or tabulated data obtained by authors. If data from other workers are used, they require no uncertainty. Unless otherwise stated and properly referenced, it is assumed that the uncertainty of authors' output data is estimated by the small-sample method<sup>1</sup> with assumed odds 20:1. All reported data must show uncertainty estimates if used in text or tables; for example,  $T = 642 \pm 8$  K. All figures reporting new data should contain uncertainty estimates either on the figure with error bars in both coordinate directions or in the caption; for example, uncertainty in  $T = \pm 8$  K at 20:1 odds. Investigations with limited data should present tabulated results in the paper while extensive data should be available elsewhere in tabulated form for use by other workers.

Finally, the accepted documentation procedures for a technical investigation must be used. For computational papers, the author must provide an adequate description of the numerical solution procedure, if not documented elsewhere. In addition, the complete governing equations must be specified with sufficient detail along with the input parameters to the code so that a reader could reproduce the results of the paper. For papers concerned with experimental test, thorough documentation of the experimental conditions, instrumentation, and data reduction techniques is required.

<sup>1</sup>Kline, S. J., and McClintock, F. A., "Describing Uncertainties in Simple-Sample Experiments," *Mechanical Engineering*, Jan. 1953, pp. 3–8.