JOURNAL OF PROPULSION AND POWER
Vol. 17, No. 6, November–December 2001

Preface

THE term "hypersonic" conjures the quintessential romance and excitement of flight that has lured many into the field of aerospace engineering. Hypersonic flight generally refers to flight exceeding Mach 5, though there is technically no fixed Mach number beyond which flow can be definitively identified as hypersonic. As Maurice Rasmussen has pointed out in his comprehensive textbook on the subject, the approach to hypersonic conditions is gradual with increasing supersonic Mach number, and is a function of vehicle geometry as well as ambient conditions. What is definitive, however, is that at hypersonic speeds the governing flow equations are fundamentally nonlinear; embedded shockwaves, chemistry, and real-gas physics, as well as viscous coupling, assume significant or even dominant roles. Thus, hypersonic flight can push the limits of our understanding of the basic nature of fluid physics and chemistry.

Hypersonic flight became a reality when the upper stage of a two-stage Bumper-WAC research rocket launched from White Sands, New Mexico exceeded Mach 5 on 24 February 1949. Colloquially, however, the term has become associated with high-speed flight employing some element of airbreathing propulsion, and this remains an elusive goal. The collection of over 30 articles presented in this Special Issue of the *Journal of Propulsion and Power* deals with "hypersonic" according to this colloquial definition.

The Air Force historian, Dr. Richard Hallion, contends that notable pioneers and advocates in the history of rocketry believed that the first flight vehicles into space would be winged, hypersonic designs evolving from an aircraft heritage. However, both the United States and the Soviet Union opted for the more quickly achievable ballistic-missile-lofted blunt-body reentry vehicle in their quest to win the space race. Today's operational hypersonic vehicles are still rocket-powered blunt-body designs. Nevertheless, the dream of winged airbreathing powered hypersonic flight remains very much alive, for these vehicles hold the promise of merging the air and space continuum, ultimately enabling routine aircraft-like access to the space frontier.

Hypersonic airbreathing flight transcends the traditional scope of the *Journal of Propulsion and Power*. The genesis of this Special Issue was an attempt to couple in one archival volume studies in the many disciplines that are contributing to the development of airbreathing hypersonic flight. Airbreathing propulsion is the key enabling technology for sustained hypersonic flight within the atmosphere. However, the propulsion system must be intimately integrated with the vehicle airframe, and complete system design coupling and multidisciplinary optimization becomes vital. The thermal loads on the vehicle are higher, growing with roughly the cube of the speed, and thermal management systems—which may use the fuel as a coolant—will be essential. Accounting for the real behavior of the close coupling among fluid, chemistry, and structure interactions in hypersonic flows is also of primary importance. All of these challenges are addressed here in timely and relevant articles by a diverse group of premier researchers.

An examination of any subject is best considered with a sound historical perspective. The lead article by Tom Curran traces the history of scramjet development, in which the quest for airbreathing hypersonic flight is grounded. A collection of program overviews and case studies follows. Data never before published in the open literature is made available to the scholar. A series of papers on performance analyses and concept studies follows, highlighting the numerous approaches that could lead to a practical airbreathing hypersonic vehicle. Papers on fundamental mechanisms of combustion, fuel management, inlets, and nozzles shed light on the complexity and challenges of airbreathing hypersonic flight. The closing group of papers focuses on testing technologies and flight experiments, for it will take ingenuity to develop these elusive vehicles. Ultimately it may require a three-pronged approach combining flight testing/experimentation, computational fluid dynamics (CFD), and ground testing as predicated by Dan Marren and colleagues.

In closing, we wish to extend many thanks to Dr. Woody Wasche and Dr. Tom Curran for originally conceiving this Special Issue. Thanks also to our Editor-in-Chief, Dr. Vigor Yang, for his help and support. The invaluable assistance of Dr. Dave Riggins and Dr. Ashwani Gupta for handling the review of several papers included in this Special Issue is gratefully acknowledged. It has been an incredible privileged to work with the many talented contributing authors and reviewers. And our utmost respect, admiration, and gratitude to our Managing Editor, Jen Samuels, our Production Editor, Angela Weaver and the skilled team at TechBooks, and the steadfast AIAA Headquarters Staff, who ensured that the Special Issue meets the high standards to which our readers are accustomed.

We hope that in some way this collection of archival articles will inspire the breakthroughs that will inevitably make airbreathing hypersonic flight a reality.

Lourdes Maurice
Mark Lewis

Dr. LOURDES Q. MAURICE of the Air Force Research Laboratory's Air Force Office of Scientific Research is presently attending Senior Military Joint Professional Education at National Defense University's Industrial College of the Armed Forces. She received her B.S. in chemical engineering and M.S. in Aerospace engineering from the University of Dayton and her Ph.D. in mechanical engineering from the University of London's Imperial College of Science, Technology, and Medicine. She previously served as the Deputy for Defense Research Sciences and Propulsion in the Office of the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering. In this capacity she managed the $220 million Basic Research and $230 million Propulsion Science and Technology portfolios at the Secretariat Level. Previously (1983–1999) she was employed by the Air Force Research Laboratory's Propulsion and Power Directorate. Her areas of expertise include aviation fuels, combustion kinetics, and hypersonic propulsion and fuels. She is serving her second term in 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 60 publications and is an Associate Fellow of AIAA.

Reviewers