Space Shuttle Guidance and Control

THE NASA Space Shuttle in its space missions routinely touches many areas of applications of interest to the fields of guidance, control, and dynamics. The Shuttle ascent flight phase has all the elements of the classic rocket guidance and control with added factors of an aerodynamic and asymmetric configuration. In space the Orbiter operates as a spacecraft. On return flights the Orbiter transitions from exoatmospheric flight to hypersonic through subsonic Mach regimes. The system energy is managed to achieve landing as an unpowered airplane. The guidance and control activity on the Space Shuttle has also encompassed a broad spectrum of our AIAA community. Experts from many organizations over a large area of the country have contributed to Space Shuttle guidance and control.

For the special section of this issue of the *Journal of Guidance, Control, and Dynamics* devoted to the subject of the Space Shuttle, a selection of articles was made which is representative of both the technical and the community spectrum.

The first paper, by Sunkel and Olsen, surveys the ascent phase of the Shuttle mission. A description of the ascent guidance and control function and its implementation in hardware and software is followed by the results from early flight experience. The on-orbit phase of the mission is treated by the next three papers. The paper by Smith, Campbell, Blucker, Manry, and Saulietis describes the inertial measurement unit, star tracker, and navigation base hardware and software. The basis for the system design and design approach provides insight which is common to much of the Shuttle. The description of the use of the system provides an overview of the Shuttle guidance and control on-orbit functions.

The on-orbit paper by Kubiak and Martin discusses a practical application in the presence of real-world uncertainties of a reaction jet control system. A new design was developed to reduce the impact of large measurement uncertainties in the rate signal during attitude control. The paper by Penchuck and Croopnick addresses the orbital maneuvering system control system, a linear thrust vector control autopilot, detailing its design and flight performance. The paper by Harpold and Gavert describes entry guidance objectives, and control concepts utilized to accomplish orbiter atmospheric re-entry while maintaining landing site ranging requirements. The paper also includes test procedures and comparisons with actual flight results. The next paper, by Ashkenas, Hoh, and Teper, analyzes results from the Orbiter approach and landing test series, concentrating on handling qualities of the Orbiter and pilot-induced oscillation tendencies. A final paper, by Epple and Altenbach, gives an insight into the dynamic stability characteristics of the Orbiter and describes a new kind of dynamic test used to verify flexible stability analysis.

These papers touch a few highlights of the Shuttle guidance and control flight spectrum from ascent to landing but represent only a portion of the literature available in the Space Shuttle guidance and control story. Over the years, this major national space effort has challenged countless engineers, scientists, professors, and students in many disciplines. This issue collects only a few results of these efforts. As the Shuttle enters its operational era, its payloads and experiments should equally excite our technical community. I look forward to seeing the results of those efforts.

The 1982 summer conferences in San Diego, together with normal submittals during the same period, resulted in roughly five dozen submittals to this publication alone on Space Shuttle topics. We decided at that time to publish a special issue on the subject. The time-consuming and difficult task of sorting through this wealth of technical information and assisting the editors in bringing this issue to publication was done by Dr. John Peller and Mr. William Schleich of Rockwell International's Space Transportation Systems Group. I'd like to personally thank them for their efforts on behalf of this Journal.

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Editor-in-Chief