Midcourse Space Experiment: Guest Editor's Introduction

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The Midcourse Space Experiment (MSX) Program began at APL in late 1988 as a follow-on to the Ballistic Missile Defense Organization (BMDO) (formerly SDIO) Delta 180, 181, and 183 programs. As described in the first article of this issue by Mill and Guilmain, the purpose of MSX is to make simultaneous calibrated measurements over a wide range of wavelengths in support of the BMDO mission. A secondary purpose is to transfer the technology of MSX processes to other programs with similar requirements, and also to share the information gathered.

This is the first of two issues of the *Digest* devoted to describing the highly capable MSX Spacecraft Observatory. This issue focuses on the MSX mission and system-level design and development. The next issue will be devoted to subsystem and instrument descriptions. In addition, a future issue is being planned to present the scientific results of the MSX mission.

While reading these *Digest* issues, the broad range of cooperation between government agencies and university and industry participants that was necessary to design, fabricate, test, launch, and operate MSX will become apparent. Without this cooperation, MSX would not be a reality.

The article by Stair, in addition to that by Mill and Guilmain, describes specific scientific results expected to be achieved by the MSX Observatory to meet BMDO requirements. Although MSX was designed to meet the BMDO mission, its carefully calibrated sensors have a "dual-use" capability to augment existing data sets for both military and civilian use. Paxton et al. describe some of the civilian uses of the information expected to be derived from the MSX data.

Certainly with a spacecraft the size and complexity of MSX, it is necessary to manage, coordinate, and control the flow of work, as well as to measure progress so that the program stays on track to meet critical milestones. As the largest of more than 50 spacecraft designed and processed by APL, MSX was indeed a significant effort. The techniques used to coordinate the various MSX participants, both within and external to APL, are described by Pardoe.

MSX incorporates the Spatial Infrared Imaging Telescope III (SPIRIT III) infrared sensor, cryogenically cooled by solid hydrogen. Conservation of the cryogen to obtain maximum data from that sensor had a profound effect on the system design of MSX. System considerations that evolved during the mission design phase regarding SPIRIT III and the Ultraviolet and Visible Imagers and Spectrographic Imagers (UVISI) and the Space-Based Visible (SBV) sensors onboard MSX required a design and operating concept that was "episodic" in nature, as opposed to "steady state." This aspect of the design, as well as other system details, is described in the article by Huebschman.

MSX normally resides in a "parked" mode (or attitude), which keeps the SPIRIT III dewar pointed away from the Sun and other sources of heat to minimize unnecessary depletion of cryogen. When acquiring data, the tracking and attitude control system moves MSX from the parked mode to any orientation desired by the scientific investigators. The spacecraft systems then

collect the necessary information, and the spacecraft returns to the parked mode to recharge the batteries and return to thermal equilibrium. Krein and Mehoke describe the unique thermal design that was necessary to assure that MSX would operate efficiently in any attitude and present results obtained from thermal vacuum testing.

Packaging the SPIRIT III, UVISI, and SBV sensors (Skullney et al.) presented a significant challenge to the mechanical design group. The sensor fields of view are required to remain co-aligned to within 0.1° for all orientations and thermal conditions after surviving the launch environment. Additionally, it was necessary to develop a design that isolated the instrument sensing elements (which work most efficiently at cold temperatures) from the "warmer" instrument and spacecraft support electronics, find a place to attach the packages, and minimize the length of interconnecting wires to reduce the possibility of electromagnetic interference.

Panneton and Jenkins present details of the MSX power system, which must support widely varying loads ranging from standby operation in the parked mode to full power operation while collecting data associated with the midcourse phase of an intercontinental ballistic missile flight. In addition to the varying load requirements, it was necessary to consider the effects of the space radiation environment, temperature extremes, and required lifetime of the mission. The design was accomplished with a 1300-W solar array, a 50-A·h nickel–hydrogen battery, distributed power converters, and a microprocessor-based power management system.

To avoid contamination and a loss in sensitivity of the optical sensors on MSX, it was necessary to develop a comprehensive contamination control plan. Control of spacecraft contamination (Cranmer et al.) began early in the program with the selection of low outgassing materials, and concluded with monitoring and control of the launch processing environment. Stringent control of contaminants throughout all phases of spacecraft and instrument processing was accomplished without driving schedule or cost excessively. For MSX, all these widely varying processing environments were successfully navigated by blending common sense with engineering expertise and scientific analysis.

To operate an observatory as flexible and capable as MSX requires a significant planning effort to assure that scientific data return is maximized. Nordeen et al. describe the operations concept for MSX, as well as the facilities and organizations that will operate MSX. As the primary command, control, and data recovery site, APL operations responsibilities include interfacing with principal investigators to plan and execute data collection events, monitoring the "health" of the spacecraft, and recovering data from the MSX onboard data storage via a 10-m antenna system operating at X-band. Additionally, APL's Mission Processing Center will perform initial processing of the raw data prior to distribution to individual instrument processing and analysis centers.

Finally, while reading these articles, it should be recognized that MSX represents a masterful melding of science and engineering. Many meetings were held with scientists describing their desires for data collection to engineers who evolved the MSX design into an observatory that optimized weight, power, and volume with data collection ability.

THE AUTHOR

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