Mars Observer Project: An Introduction

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MARS Observer, the first of the observer series of planetary exploration missions recommended by the Solar System Exploration Committee, is planned for a September 1992 launch. Its principal objective is to study the geoscience and climate of Mars. A series of articles in this issue of the *Journal of Spacecraft and Rockets* describes elements of the Mars Observer project. This introduction provides a brief historical perspective for the project and describes the storyboard for the articles that follow.

Historical Perspective

The Solar System Exploration Committee (SSEC) was formed in 1980 by the NASA Advisory Council to develop a plan for planetary exploration that would be responsive to the cost pressures of the 1980s and to the scientific strategies developed by the Space Science Board's Committee on Lunar and Planetary Exploration. In 1983 the SSEC proposed the core program for planetary exploration through the year 2000.[1] The report made several recommendations, two of which are relevant to Mars Observer.

First, the SSEC report proposed a series of deep-space missions to effect a broad set of scientific investigations. The missions were further divided into two major classes. The first class, the Observer Program, was to focus on the terrestrial planets and near-Earth asteroids and was to trace its spacecraft bus heritage to Earth-orbiting missions [e.g., Defense Meteorological Satellite Program (DMSP), Satellite Communications (SATCOM)]. The second mission class, the Mariner Mark II Program, was to focus on the outer planets, comets, and asteroids. This program would develop a new modular spacecraft bus suitable for adaptation to a "series of missions beyond Mars."[1] Naturally, the suite of instruments for an Observer or Mariner Mark II mission could be selected to satisfy the particular objectives of that mission.

Second, the SSEC recommended an approach to flight operations and data handling. Specifically, the team responsible for conducting the postlaunch operations must be capable of supporting all of the core program's missions. In addition, data archiving and distribution were to be brought into general agreement with the Space Science Board's Committee on Data Management and Computation (CODMAC).[2]

The Mars Geoscience/Climatology Orbiter (MGCO) was ranked second, behind the Venus Radar Mapper, in the set of initial core missions recommended by the SSEC. Several precursor studies had shown that the geoscience and the climatology objectives at Mars could be achieved by a single low-altitude Mars orbiter. MGCO, later shortened to Mars Observer, was approved as a new start in fiscal year 1985. The NASA Office of Space Science and Applications assigned management responsibility for Mars Observer to the Jet Propulsion Laboratory. The launch, aboard a space transportation system (STS) flight, was originally scheduled for August 1990, but after the Challenger accident it was postponed to the 1992 Mars opportunity.

Project Description: An Overview

Investigation and instrument selection were completed in April 1986. Then in August 1988, one investigation, the visual and infrared mapping spectrometer, was deselected and a second instrument, the radar altimeter and radiometer, was changed to a laser altimeter.

From a development perspective, the instruments fall into two broad classes. Facility instruments are developed by an institution and are used by an experiment team to conduct its investigation. Included in this class are the gamma-ray spectrometer developed by NASA's Goddard Space Flight Center and the ultrastable oscillator developed by the Jet Propulsion Laboratory. The latter instrument supports the radio science requirement for a stable spacecraft radio frequency during the Earth occultation ingress and egress periods.

The second class of instrument, comprising the principal investigator-supplied instruments, includes the Mars Observer camera built by the California Institute of Technology, the magnetometer and Mars Observer laser altimeter built by the Goddard Space Flight Center, the electron reflectometer and Mars Balloon Relay receiver built by the Centre National d'Etudes Spatiales, the pressure modulator infrared radiometer built by the Jet Propulsion Laboratory, and the thermal emission spectrometer built by the Santa Barbara Research Center.

General Electric Astro-Space Division (formerly RCA Astro Electronics Division) was selected in March 1986 to design and fabricate the spacecraft bus, to integrate the payload, and to support integration of the bus with the upper stage and launch vehicle. In keeping with the SSEC recommendations, the bus and its electronics are traceable to the SATCOM-K and DMSP/Television and Infrared Observation Satellite (TIROS) spacecraft. Following the slip in the launch date to 1992, NASA directed a change from the STS to the Titan III.

Overview of Articles

The nine articles that follow describe the major elements of the Mars Observer Project. In the first of the series, Palocz presents an overview of the mission and spacecraft system.

The project's science objectives and measurement strategies are outlined by Albee and Palluconi in the second article, "Mars Observer: The Next Mars Mission." It also describes the link between the science and characteristics of the mission and payload. The contributions of the instruments to the geoscience and climatology objective noted earlier are presented here.

The third article, "Mars Observer Instrument Complement," provides a detailed description of the mechanical and electrical characteristics and the functional capabilities of the Mars Observer instruments. As the article demonstrates, the instruments will allow observation over a broad set of particle energies and wavelengths. Liberal use of microprocessors makes possible significant onboard processing by the instruments.

The Mars Observer spacecraft is described in the fourth article, "Mars Observer Spacecraft Description," by Potts. The article describes the spacecraft operating modes and func-

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tional capabilities, its inheritance from Earth-orbiter spacecraft, its payload interfaces, and its mode of implementation.

In the fifth article, "Mars Observer Trajectory and Orbit Design," Beerer and Roncoli describe the characteristics of the Mars Observer trajectory. During the mission the spacecraft traverses four phases: launch, interplanetary cruise, orbit insertion (including the transition to the mapping orbit), and the mapping orbit (i.e., the orbit used to acquire the primary science data). The article shows how the launch, interplanetary, and orbit-insertion trajectories were designed to maximize the on-orbit dry mass. In addition, the orbit-insertion phase design must achieve the desired relationship of the mapping orbit with the Sun. Finally, the mapping orbit design reflects the desire for planet coverage to a resolution reasonably consistent with the instruments' fields of view and the navigation orbit control capabilities.

Blume et al. present the plan for conducting the mission in the sixth article, "Mars Observer Mission Plan." The article describes the data capabilities and acquisition strategies necessary to accommodate engineering, radio science, and the balance of the science measurements. The plan is described using event timelines for the four phases of the mission. The article also presents the preliminary plan for supporting the return of data from the Soviet Mars 1994 balloon investigation.

The seventh article, "Mars Observer Orbit Determination Analysis," by Esposito et al., describes the navigation capabilities and challenges, in particular the challenge presented by the near-circular, low-altitude orbit. In this orbit the spacecraft will continuously experience atmospheric drag and the irregularities of the Martian gravity field. The article shows that, by solving for an improved gravity field model early in the mapping phase, the mean daily atmospheric effects on the orbit can be satisfactorily estimated.

The orbit estimation problems mentioned also impact the mapping orbit control problem. The eighth article, "Mars Observer Trajectory and Orbit Control," by Halsell and Bollman, describes the orbit control strategy and estimated capabilities for the interplanetary, orbit-insertion, and mapping phases of the mission. At each step, the requirement for and size of each maneuver are identified.

The final article, by Erickson and McKinley, describes the "Mars Observer Mission Operations." The classical functions of mission control in the new multimission environment using a distributed data system are the focus of this article. To a measurable extent, the CODMAC recommendations are reflected in the operations system.

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References

[1]Solar System Exploration Committee, NASA Advisory Council, "Planetary Exploration Through Year 2000—A Core Program," Washington, DC, 1983.

[2]Space Science Board Committee on Data Management and Computation, Assembly of Mathematics and Physical Science, National Research Council, *Data Management and Computation, Vol. 1: Issues and Recommendations,* National Academy Press, Washington, DC, 1982.