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Homework #2

Mars Express – Mission Scope and Concept of Operations

Mission Scope

Need Statement[1]
Photograph and analyze the Martian surface and atmosphere using a robotic mission created exclusively by the European Space Agency (ESA)

Goals[1]

- Search for water below the Martian surface from orbit
- Deploy a lander on the Martian surface (note: the lander did not deploy successfully on the Martian surface and was declared lost on February 6, 2004)

Objectives[1]

- Take high-resolution global photographs to learn about the Martian surface and geology
- Take super-resolution photographs of selected areas
- Create a 3-Dimensional subsurface survey using ground-penetrating radar
- Determine the precise Martian atmospheric composition and circulation
- Analyze geochemistry and photobiology of the Martian surface using the *Beagle 2* lander
- Evaluate the interaction between the Martian surface and atmosphere
- Act as a communications relay for other Martian landers

Primary Mission Description[1,2,3]
An orbiter and lander will be transported to Mars using a Soyuz/Fregat booster. Once in orbit, the lander will separate, de-orbit, and analyze the Martian surface while the orbiter remains in orbit to study the Martian surface, subsurface, and atmosphere in search of water.

Assumptions[1]

- Mission will be run entirely by ESA
- Orbiter and rover will fit in existing launch vehicle
- All technology requirements can be met (use technology from failed Mars 96 mission)

Authority and Responsibility
The authority was divided among the European Space Agency as follows:

- **ESA Payload Support Team (PST)**
  The PST is located in the Research and Scientific Support Department at ESA/ESTEC, the Research and Technology Center, in Noordwijk, Netherlands.

- **Orbiter Principal Investigators (PI) and Experiment Managers (EM)**

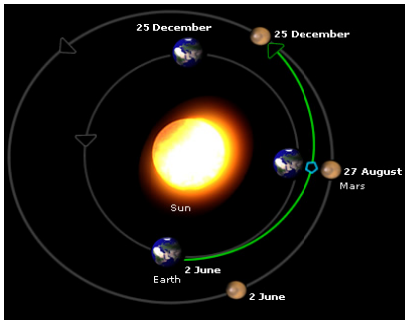
The PI and EM team has responsibility for managing experiments and instruments on board both the orbiter and lander.

- **Payload Operations Service (POS) Team**
  The POS Team is located at the Rutherford Appleton Laboratory in Chilton, UK. It contributes to running the scientific operations for the mission's duration.

Constraints[1]

- The Mars transfer orbit must be launched by June 2, 2003 to utilize the close proximity between Earth and Mars.
- Initial Mars Express budget is 150 million Euros.
- The total mass budget including the spacecraft bus, lander, payload, propellant, and launch mass is not to exceed 1276 kg.
- The total power budget for the spacecraft and the payload is not to exceed 1270 Watts.

Concept of Operations

1. Launch/ Earth Parking Orbit/Mars Transfer Orbit T_0 = 0:00, T_{MTO} = T_0 + 1.5 hr 	2. Launcher Separation/ Deployment of Solar Arrays T_{LVsep} = T_0 + 3 min 	3. Interplanetary Cruise T_{IC} = 5 months 
4. Lander Separation T_{Lsep} = T_{LVsep} + months 	5. Lander Descent T_{LD} = T_{Lsep} + 6 days 	6. Mars Orbit Insertion T_{MOI} = 5 days 
7. Lander Data Collection T_{data} ~ 2 years 	8. MARSIS Deployment T_{MARSIS} = 2 months 	9. Communication with Lander and Earth T_{comm} ~ 4 years, T_{end} = T_0 + ~6 yrs 

The concept of operations of the Mars Express mission begins with the launch phase. It takes approximately 1.5 hours from lift-off to place the Mars Express orbiter in an Earth parking orbit. The launcher booster (Fregat booster) then places the Mars Express orbiter into a Mars transfer orbit. Once the orbiter is injected into a Mars transfer orbit, the booster separates from the satellite and the solar arrays unfold. Mars Express is now on an interplanetary cruise lasting approximately five to six months. As soon as the Mars Express orbiter nears a Mars capture orbit, the Beagle 2 lander is released. It takes Beagle 2 approximately six days to land on the Martian surface. After Beagle 2 is deployed, the Mars Express orbiter fires its thrusters and engines to maneuver itself into an orbit around Mars. After landing, Beagle 2 opens up and deploys four solar panels to provide the necessary power to charge Beagle's batteries and perform all robotic activities. Beagle 2 begins examining the Martian surface and taking ground samples, searching for organic matter and water within the Martian soil. In the meantime, the Mars Express orbiter deploys two 20 meter-long radar booms for its MARSIS (Mars Advanced Radar for Subsurface and Ionosphere Sounding) experiment. The large antennas send low-frequency signals that penetrate the surface of Mars, looking for signs of water or ice. The Mars Express orbiter continues to orbit Mars, communicating with both Beagle 2 and Earth for two Martian years.

References

[1] http://sci.esa.int/science-e/www/area/index.cfm?fareaid=9
[2] http://en.wikipedia.org/wiki/Mars_Express
[3] http://solarsystem.nasa.gov/missions/profile.cfm?InFlight=1&MCode=MarsExpress