Systems Engineering
HW 2
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Mission Scope: Mars Science Laboratory

Need: The Mars Science Laboratory (MSL) is needed to perform scientific analysis on Mars to assess the planet as a potential habitat for life, past or present, and help verify if human explorers could exist there in the future.

Goals:

- Determine whether life ever arose on Mars.
- Characterize the climate of Mars.
- Characterize the geology of Mars.
- Prepare for human exploration.

Objectives:

Biological Objectives:

- Determine the nature and inventory of organic compounds.
- Inventory the chemical building blocks of life (carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur).
- Identify features that may represent the effects of biological processes.

Geological/Geochemical Objectives:

- Investigate the chemical, isotopic, and mineralogical composition of the Martian surface and near-surface geological materials.
- Interpret the processes that have formed and modified rocks and soils.

Planetary Process Objectives:

- Assess long-timescale (i.e., 4-billion-year) atmospheric evolution processes.
- Determine present state, distribution, and cycling of water and carbon dioxide.

Surface radiation objective:

- Characterize the broad spectrum of surface radiation, including galactic cosmic radiation, solar proton events, and secondary neutrons.

Mission: Continue the study of Martian geology from the surface and pave the way for a possible future sample return.

Operational Concept: Launch the laboratory from Earth on an Atlas V launch vehicle into trajectory for Mars. The spacecraft will separate from the launch vehicle after leaving Earth orbit. Spacecraft will undergo trajectory correction maneuvers as needed and prepare for insertion into the Martian atmosphere. Spacecraft will land on Mars using the first of a new generation of smart landers. The spacecraft will be controlled by small rockets during descent through the Martian atmosphere. The MSL will be slowed by a large parachute. Again, small rockets will control the spacecraft's descent until the rover separates from its final delivery system. The sky crane system will lower the rover to a "soft landing" on the surface of Mars. With higher clearance and greater mobility, MSL will maneuver on the surface of Mars collecting, grinding, distributing, and analyzing samples of soil and rock. MSL will communicate with the Deep Space Network on Earth in two ways. The Low-Gain X-Band antenna will be used until the position and attitude are known. The High-Gain X-band antenna will transmit more data in the same amount of time using smaller, shorter wavelengths.

Assumptions:

- All technology needs are achievable.
- Instruments will be provided by NASA and international partners.
- Will lead the way for future Mars and human exploration by showing ability to land a large rover precisely, collect data, and have long-range mobility.

Constraints:

- Launch by September 2009 and land on Mars by September 2010.
- All geological studies must be completed within 1 Martian year.
- Meet targeted budget of $950 million.

Authority and Responsibility:

- The Mars Science Laboratory is managed for NASA's Science Mission Directorate, Washington, D.C., by JPL, a division of the California Institute of Technology, Pasadena. At NASA Headquarters, Mark Dahl is the Mars Science Laboratory pro-gram executive and Dr. Michael Meyer is program scientist. In Pasadena, Richard Cook of JPL is project manager and Dr. Edward Stolper of Caltech is project scientist.
- Scientific instruments will be provided by the international community. The Canadian Space Agency will provide the Alpha-particle X-ray spectrometer. The Russian Federal Space Agency will provide Dynamic Albedo of Neutrons. The Spanish Ministry of Education and Science will provide the Rover Environmental Monitoring Station. An extra-terrestrial physics group in Germany will provide the Radiation Assessment Detector.
- NASA (with minimal assistance from other concerned space agencies) will have the responsibility to carry out the mission and analyze the samples.