MARS HUMAN MISSION CHARACTERISTICS AND DEFINITION: J. F. JORDAN, JPL

1.0 WORK DESCRIPTION AND RELEVANCE TO HUMAN SPACEFLIGHT PRIORITIES

Summary: This work will define innovative and relevant advanced systems leading toward an incrementally increasing agency readiness to eventually initiate a Human Mission to Mars. Agency readiness issues are addressed through a series of sub-activities listed here:

1. Identify key characteristics and criteria for human landing sites on the surface of Mars and its satellites. This activity must take into account safety and risk, mission architecture constraints, and human experience optimization (science, etc.).
2. Determine and fully characterize the gap between what we know about Mars through SMD missions and what must be specifically characterized about the environment for all future human activities. This includes ensuring safe flight through Martian EDL, the surface stay and takeoff.
3. Examine current (DRA5) and evolving human mission architectures to identify needed new system capabilities which require testing at (or inflight to) Mars.
4. Develop and execute a program of early to mid (TRL-5) instrument development and technical demonstration system development for prototype h/w implied by Tasks 2 and 3.
5. Working with SMD (and international partners), identify missions-of-opportunities for flight of the instruments and/or technical demonstrations, and recommend discussions aimed at actual arrangements for flight of the systems on SMD missions.
6. Develop a (notional) program of eventual, required dedicated precursor flights to Mars for advance concept testing and landing site specific observations.

Primary Goal: The goal of the effort is to insure a paced, but affordable, approach to HSF readiness improvements through appropriate measurement instrument and technology demonstration systems which would require robotic flights to Mars on either missions of opportunity or eventually, dedicated flights. Another goal is to leverage the existing spacecraft around and on Mars while they are still operational, even though admittedly it is early in the HSF Mars activities.

The overview goal is to keep a continuing NASA focus on its ultimate destination, and to not miss affordable and wisely-picked opportunities to move incrementally forward toward a readiness to achieve this destination. A three-year effort is proposed in this transmission.

2.0 TECHNICAL APPROACH AND INNOVATION

Task 1, 2 and 3 will be approached through the assemblage of expert agency center staff working groups. Working group deliverable products are listed below by task number.

Task 1:

FOMs for eventual Mars surface landing site selection
Preliminary Landing List of regions which are consistent with the FOMs and the data sets/analysis that support the analysis

Task 2:

List of measurement needs and performance requirements that are required at Mars (beyond current expected SMD mission measurement progress)

a. Request recommendations for measurements from active SMD Mars missions
b. Potential for measurements/demonstrations from planned SMD Mars missions
c. List of Earth observation needs, with the general nature of these being identified

Task 3:

List of technology demonstrations requiring precursor flights to Mars
List of technology areas requiring terrestrial analog and other test venues

An overriding goal of these working groups is to both determine and prioritize the most important items relevant to eventual human flights to Mars, but also to separate out only those requiring Mars flights as hosts. Earth analog and flight venues required for measurements or testing will be considered and listed, but not pursued in subsequent tasks below.

Task 4 will be approached by the application of expert workforce at the centers (including JPL) to designated development of prototype systems to the TRL-5 technology readiness level. Many of these instrument types are not expected to be developed under traditional SMD technology maturation programs due to their specialized ESMD measurement goals. At this technology level, each developed system can be considered by a flight mission project, at the mission concept review (CDPA) point, to be both appropriate (from Task 1, 2 and 3) and mature enough for addition to the project baseline. Note that this proposed work extends prototype development to TRL-5 and does not include flight quality module development.

A candidate list of potential measurement categories and technology demonstration areas is provided below:

Aero/flight

Measurement

- Measurement during flight to characterize physical atmospheric properties of entry/flight environment and systems response.
- Atmospheric E-field conductivity

Demonstration

- Pinpoint landing (sensors, control)

Surface

Measurement

- Meteorological (winds, climate, pressure, etc.)

Radiation environment, mitigation
Demonstrations
Toxicity of dust, regolith and atmosphere
Conductivity of E-fields, dust charge
Biological detection
Regolith based ISRU mineral/chemical identification

Demonstration

- Atmosphere and Regolith based ISRU

Materials degradation (long-term)

Orbit

Measurement

- Landing site high-resolution surveys

Radiation (orbital)
Mapping of water/ice
Determine special regions

Demonstration

- High BW telecom

Deliverable products from Task 4 include:

Integrated instrument and technology system development plan
Phase A level prototypes (TRL-5) for a selected list of instruments and technology demonstration systems

Task 5 will be approached as a strategic management function, with participation of the proposed Project Steering Group (see management section below), and the management in both ESMD and SMD. Deliverable products of Task 5 include:

Cross-Directorate Memoranda of Understanding
Project Integration (SMD-EMD) Plans

A list of SMD Mars missions, both active and planned, is provided below. These missions represent target hosts for both recommended measurements with existing instruments on active missions and measurements with ESMD-provided instruments on future flights.

ODY – Currently active, in orbit
MRO – Currently active, in orbit
MER – Currently active, on surface
MSL – Lander/Rover, landing 2012
MAVEN – Orbiter, planned launch 2013
Future Missions – Under current planning effort

Task 6, a future oriented continual mission planning function, will be approached with center/JPL workforce, aggregated into small multi-center teams, augmented with a few supporting JPL Team-X exercises. This task is small and oriented to the future. Deliverable products include future dedicated mission descriptions, defined payloads, spacecraft systems, mission design and estimated costs. Workforce by Center, cost, and three-year schedule available upon request.

This plan provides an affordable but systematic method to determine the highest priority, must do, activities which are required to pave the way toward eventual human missions to Mars. Only expert consensus recommendations are pursued here, not random, single-source concepts. Thus unneeded efforts, with their likelihood of wrong direction and unnecessary costs, will be avoided. This effort also represents a true innovation of seeking synergy between robotic science endeavors and the needs of the human flight program. There is much to be leveraged by the use of robotic science programs for the benefit of the agency as a whole. We seek here to maximize that leverage and overall benefit with the flight recommendations and prototype systems developed within this project.