Human Exploration and Precursors

Panel Summary by
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Tuesday 10:00 am
Human Exploration and Precursors:
In-Situ Resource Utilization

• Incorporating ISRU into human or robotic missions requires a shift in mindset
  – Current: “Everything you need is launched with you from Earth”
  – Proposed: “You don’t need to bring everything with you. Resources exist at your
destination that can be extracted and used”.
• ISRU and MSR are a natural fit. ISRU will significantly reduce the launch and entry mass of a
MSR mission, and may enable new mission modes (such as direct return) not possible with
current technologies
• Human systems, including ISRU, need to be tested at relevant scales prior to being used in
the critical path of human missions
• Link human and robotic exploration strategies as early as possible
• New ISRU products, which offer new mission possibilities and alternatives, are under study:
  – Methane
  – Magnesium
  – Perchlorates
  – Sulfur
• ISRU is loved by some, and misunderstood or feared by others
• ISRU based missions (such as direct return MSR) need to be studied at a true mission design
level to understand them in more than a parametric way
The robotic and human exploration programs should increase collaboration of Power and Propulsion systems

Solar Electric Propulsion may expand the options available for near-term MSR missions (for Earth-Mars and Mars-Earth transit)

Further investigation is warranted on recent propulsion technologies (Pulsed Inductive Thruster, Micro Electro Fluidic Spray)

Interest in systems that scale from near term robotic mission to human scale

NTP is currently judged to more compatible with human Mars missions than EP (high thrust, reduced trip time)
  – SEP/NEP is an option, but further challenges human research technology
  – NTP will enable very large scale planetary science missions (JIMO example)

New small nuclear concepts, potentially valuable for surface scientific mission

Fission power systems will be needed for human Mars surface missions
Wednesday 8 am
Human Exploration and Precursors: Humans on or Near Mars

Key points of agreement
1. There are new technologies for controlling dust accumulation.
2. There are new, highly capable instruments for measuring radiation in-situ.
3. Novel ideas for ISRU for construction based on core-drilled bricks.
4. New highly capable instruments for biomarker assay.
5. Both MSR and human Mars missions comprise a RANGE of missions and activities, and should not be treated as point milestones.

Key Discussion: What is the suitable role for humans in the exploration of Mars?
• Teleoperation from Earth using emerging technologies (by the time we get to Mars, we will no longer need to go).
• Teleoperation from Mars orbit either in orbit or on Phobos.
• On the surface of Mars and teleoperation to other locations.
• No resolution.
Wednesday 1 pm  
Human Exploration and Precursors:  
Meteorological and Atmospheric Investigations

- Beyond scientific interest, important for both robotic and human entry, descent, and landing. Majority of EDL errors arise from atmospheric uncertainty.
- Different aspects important for each—low altitude conditions (winds, density, etc.) relevant to small payloads under parachutes; mid–high altitude density important for high ballistic coefficient human-scale vehicles
- Desire for global measurements
- Continuous orbital information available for over a decade; concern about continuing that record
- Mature, low-cost, (a.k.a. feasible) concepts for orbital and surface-network measurements
- Want to understand drivers—dust, clouds, etc.—and transport
- Highly-capable surface met station network concepts viable as small secondary payloads; climate modeling community would prefer several (e.g. eight to twelve) locations across the surface
Thursday 8 am
Human Exploration and Precursors: Entry, Descent and Landing

Key Points of Agreement

- Desire to improve and expand current EDL capabilities and technologies
- We should be pursing entry, descent, and landing concepts that can scale up from current robotic scales to large human landers.
  - TRN – no scaling, use the same system
  - HD – scalable by lander footprint
  - SRP – (no consensus, more work required)
  - Rigid decelerators (TBD)
  - Flexible decelerators (TBD)
  - Parachutes do not scale to human-class Mars missions
- There is a diverse set of entry and descent options relevant to human missions (e.g. multiple types of deployable accelerators, mid-L/D vehicles, supersonic retro-propulsion, navigation and control options), and we need to explore that space through analysis and testing, including flight testing.
- The scalable options are valuable for robotic missions, too, aiding in fully exploiting current launch options, and should be factored into near-term robotic landers.
- Specifically, terrain relative navigation and hazard avoidance are within reach for a near-term mission for little additional expense, are very valuable for both human and robotic missions, and should be pursued
- Transitions between entry systems constitute a significant risk
- Mars EDL technologies can benefit other science missions (e.g., Venus entry)
- Robotic and human exploration benefits from advanced EDL technologies – OCT should view both communities as primary customers