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

Tuesday 2:00 pm
Human Exploration and Precursors:
Power and Propulsion

- 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