

High Priority New Ideas From Concepts and Approaches for Mars Exploration, Group 4, Missions and Future Perspectives

New Concepts for Mars Exploration

- ***Commercial Space Initiatives***

“X-prize approach”: offer a monetary reward for accomplishing certain tasks that would be required for a successful Mars exploration program. NASA could choose tasks that have other commercial relevance for those who accomplish the tasks, e.g. key commercial spin-off technologies that result from attempting or accomplishing the task(s), and other commercial customers for results stemming from the accomplished task. NASA could encourage and facilitate these wider commercial connections by not only choosing appropriate tasks, but establishing programs that encourage wider commercial applicability.

- ***Deep Space Rendezvous***

Recommend conducting systems trade, cost-benefit analysis, risk analysis, for various options under consideration: Mars Orbit Rndz (current baseline), Deep Space Rndz (per LPI L-M Paper), Near Earth Rndz, Direct Earth Return.

Thoughtful Analysis and Strategy for Mars Exploration

- ***Framework or Process for Thoughtful Analysis and Strategy for Mars Exploration at Program Level to which dedicated funds (e.g. 10%) are applied to exercise on a regular basis or as needed.***

This process/framework would enable a systems approach to defining an optimal Mars Exploration Program, including near and far term objectives, and would be done prior to the implementation of the various Program Phases.

Examples might be a decision tree approach, or something like what’s being done now (4 threads feeding into a synthesis effort) to be done every opportunity or even annually.

Features of the framework/process might be:

- *Flexibility* such that the effort could range from minor refinements to complete re-planning, especially in light of new factors
- *A Comprehensive Mars Database* characterizing the Martian System, as with Earth System Science, lead to a "Digital Mars"?
- *Improved mechanisms for international involvement*
- *Standardized mission analysis/evaluation tools* to be made available to other
- *‘Signed off’ Program Plan* prior to implementation of the Program phases

New Ideas for Advanced Technology

- ***Terabyte Memory Chip Return***

Return very small memory chip to get around data rate constraints.

Would need to be traded with the mass available for sample returns, and the value of the in-situ measurements/data.

Terabyte memory capabilities also enables advanced navigation techniques such as biomimetic vision.

Priority 2 Ideas (Group 4, LPI Workshop)

New Concepts for Mars Exploration

- *Low cost access via dedicated use of excess defense capabilities and secondary payloads* (E.g. DIDS - SSP secondary payload, ASAP – Ariane V secondary payload, SS-18, etc.)

Thoughtful Analysis and Strategy for Mars Exploration

- *Generic process for small competed science/technology missions as formal part of Mars Program* (E.g. Discovery, SMEX, New Mill).

Themes and Trends

- *Treat Mars as a system, including moons and space weather* (e.g. effects of solar wind). Suggests the importance of *non-surface* sample return strategies such as atmospheric sample return (e.g. with or without dust) and samples from moons. Suggests importance of Distributed Approach/Network Missions (e.g. Netlander, constellations, Pascal).

Other Important Ideas for Consideration

Important Enabling Technologies

- **ISRU Enabling Mobility** (self-refueling hopper/rover, advanced km-class rovers, aerial recon, sounding rockets, and ISRU SR).
- **Immersive Environments** leading eventually to forms of virtual exploration that enhance discovery process and public engagement.
- **Selective Orbital or Aerial Deployment** for precise targeting of small payloads during a mission.

Programmatic Suggestions

- **New Test Methodologies** enabling ETE verifications: balloons, sounding rockets, secondary payloads have much to offer here. Risk analysis - programmatic testing strategy.
- **Robotic Outpost** as key long-term goal could facilitate tighter robotic/human exploration integration and would enhance scientific investigations and infrastructural deployment.
- **Human Exploration of Mars as Goal** could help integrate robotic and HEDS programs and increase support for Robotics Program.
- **Standard Environmental Impact Statements** (nuclear power issues for launch and other applications, planetary protection, ISRU).
- **Facilities Approach** could result in a standardized buses, encourage reusability, could more easily apply a secondary payloads approach, stockpiling and sharing spares, and economy of scale could be obtained. May not be enough missions to realize gains.
- **Aero-entry Data Package**, e.g. transmit data from black-box (enhanced to provide engineering data for future missions) upon landing.
- **Increase Public Engagement** and Educational Outreach activities: E.g. Exchange students (more freedom of science and technology exchange, ISU could participate), Rhodes Scholar for Mars? ISU could kick this off also.

Doing Already and Worth Emphasizing

- **Aerocapture** - potential for significant cost reduction.
- **Highly Durable Ballistic Earth Entry Vehicle** makes return of samples to earth much less of an obstacle than previously thought.
- **Nuclear Power** for long-lived missions - essential for better science return, enabling for human missions.
- **Advanced Comm Systems**: data compression, flexibility (e.g. reconfigurable, s/w radios, and autonomous systems distribution).
- **Advanced Information Systems Technology** - Focus on autonomy distribution and anticipate, plan for and design to accommodate expected advances, e.g., Moore's Curves.