



# Human Planetary Landing System (HPLS) Capability Roadmap

## Wrap Up

**Rob Manning - NASA Chair**

**May 4, 2005**

# Challenges

- **Delivery of large masses and volumes to Mars orbit & surface and safe return of astronauts to Earth.**
  - Large, human-rated Mars systems (hypersonic ->supersonic, subsonic, terminal)
  - Decelerating from supersonic to subsonic speeds before touchdown at Mars
  - Mars thin, variable atmospheric structure, local winds and dust storms
  - Pin point landing & low altitude winds drives need for late position compensation.
- **Using combined Manned and Robotic program, flights, test missions and resources to effectively develop aeroassist vehicles and systems capabilities to reduce risk and cost.**
  - Building on the significant body of previous aerocapture and related work to develop an aerocapture capability.
  - Understanding and modeling the variations in Mars natural environment
  - Building system commonality across robotic and piloted AEDL missions
  - Providing continuity of resources – skilled people, tools, practices, and facilities to accomplish the NASA's HPLS functions
  - Development of aerodynamic and aero-thermodynamic design and verification capabilities including simulation tools, ground and flight measurements
  - Development of light weight human-rated Thermal Protection Systems for large aeroshells
  - Development of light weight human-rated TPS systems
  - Development of new terminal descent and touchdown systems.
- **Accommodating human safety and AEDL-mission interaction.**
  - Safety and resiliency drives size and complexity of the AEDL & Ascent system.
  - Understanding how to best incorporate humans in the loop for AEDL

# Summary of Top Level Capability: Key Questions

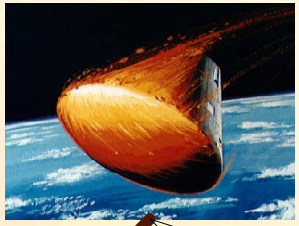
Advanced Planning & Integration Office

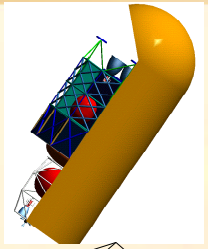
- "When and how does the full scale system and subsystems need to be qualified & Human-rated for flight?"
  - Answer: No later than '29. Full scale AEDL Flight Tests can and should be done at Earth (need to get fast turn around between multiple tests).
- "Do we need a "Full Scale Validation Flight Test" at Mars?"
  - Answer: Not, specifically, but the AEDL community is very uncomfortable with the notion of the very first full scale AEDL being piloted. The full scale unpiloted AEDL advance cargo mission that immediately precedes the human landing could do the trick.
- "What kind of precursor AEDL Flight Tests are needed at Mars?""
  - Answer: We need to validate our performance & aerodynamic models by flying a scaled (1/10th?) version of the Full Scale Mission by '22.
- "When and how do we decide on the AEDL system to fly?"
  - Answer: No later than 2015 (earlier is harder). We need to do multi-path full scale flight simulations and subscale / component development testing starting ASAP.
- If we find an AEDL for a landing mass of 40 MT, will this same architecture and technology paradigm extend to landing 80 MT? 120 MT? Is there another break point?"
  - Answer: We do not know yet.

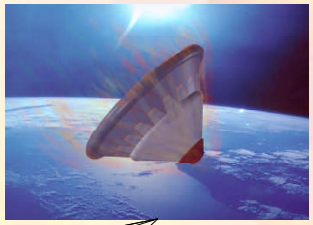
# More Key Questions

- **"What Mars Environmental data are missing for AEDL?"**
  - **Answer: In order to get the system reliability up, we need validated models of the Mars atmosphere. Instrumented robotic landers are essential but insufficient. We need a long-term atmosphere observer mission.**
- **"What Human Factors data are missing?"**
  - **Answer: A lot, human physiological and behavioral constraints, yet to be determined, could be key drivers for many decisions including the EDL architecture.**
- **"What can the CEV & Lunar missions do to advance Mars AEDL?"**
  - **Answer: These missions could develop and retire risk in Mars terminal descent propulsion systems, aerocapture/entry guidance & aerodynamics, large scale TPS, human-EDL interaction systems, human physiological performance assessment & Earth entry instrumentation.**

# Which will it be?







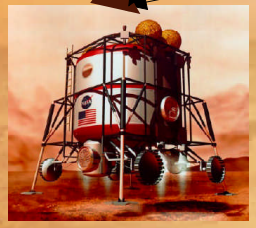
Options for Hypersonic Decelerators

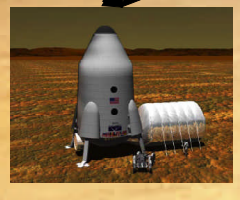
Today's Viking Baseline (will not work)

QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.

Options for Supersonic Decelerators

Options for Subsonic Decelerators





Options for Terminal Descent Systems

# Summary Remarks

- We are a long way from understanding what the Mars AEDL system will look like. Significant near-term work is required to baseline a design for a Human Scale Mars AEDL system.
  - If NASA waits until 2015 to initiate design and development of the Mars AEDL systems and scaled subsystems, it is unlikely that human Mars landings could be flown in the 2030's.
- A near-total absence of data on Human physiological and psychological post-entry deceleration performance forces conservative assumptions on the design of the human-AEDL system.
  - NASA should begin taking performance measurements now before the shuttle & ISS retires.
- A near-total absence of measurements that validate the variation of the Mars atmosphere forces very conservative or prohibitive design requirements on the AEDL system to get human-rated reliability.
  - NASA should initiate a program to acquire the data on the variations so that these systems can be built.
  - NASA should ensure that robotic EDL and surface assets have adequate atmosphere, aerothermal and aerodynamic instrumentation.
- The US AEDL community and infrastructure is small and aging.
  - NASA needs to grow and invigorate this field to enable the HPLS capability.
- Despite its small numbers, the technical capabilities developed by the historic manned and on-going robotic EDL community may be exploited to begin design and detailed assessment of human scale AEDL systems.

# Forward Work

Advanced Planning & Integration Office

## Work to go:

- 2nd NRC Review will address 4 additional questions:
  - Are there any important gaps in the capability roadmaps as related to the strategic roadmap set?
  - Do the capability roadmaps articulate a clear sense of priorities among various elements?
  - Are the capability roadmaps clearly linked to the strategic roadmaps, and do the capability roadmaps reflect the priorities set out in the strategic roadmaps?
  - Is the timing for the availability of a capability synchronized with the scheduled need in the associated strategic roadmap?