

Behavior and Performance Research Enabled by the Lunar Environment

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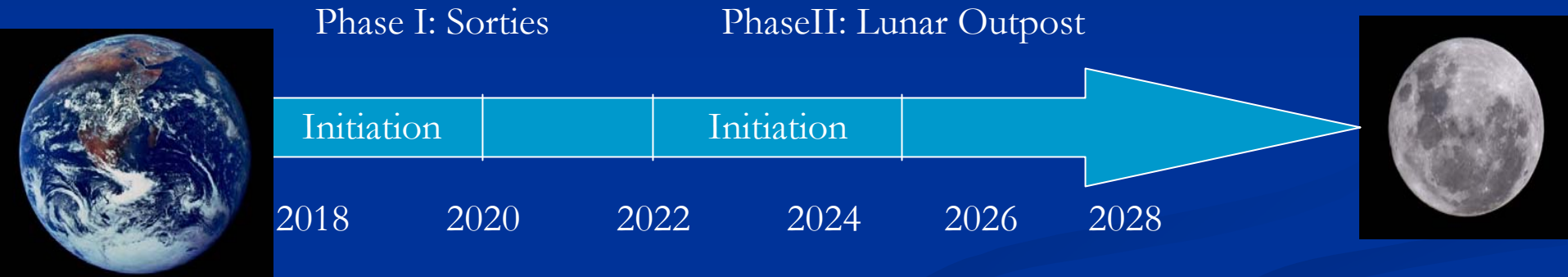


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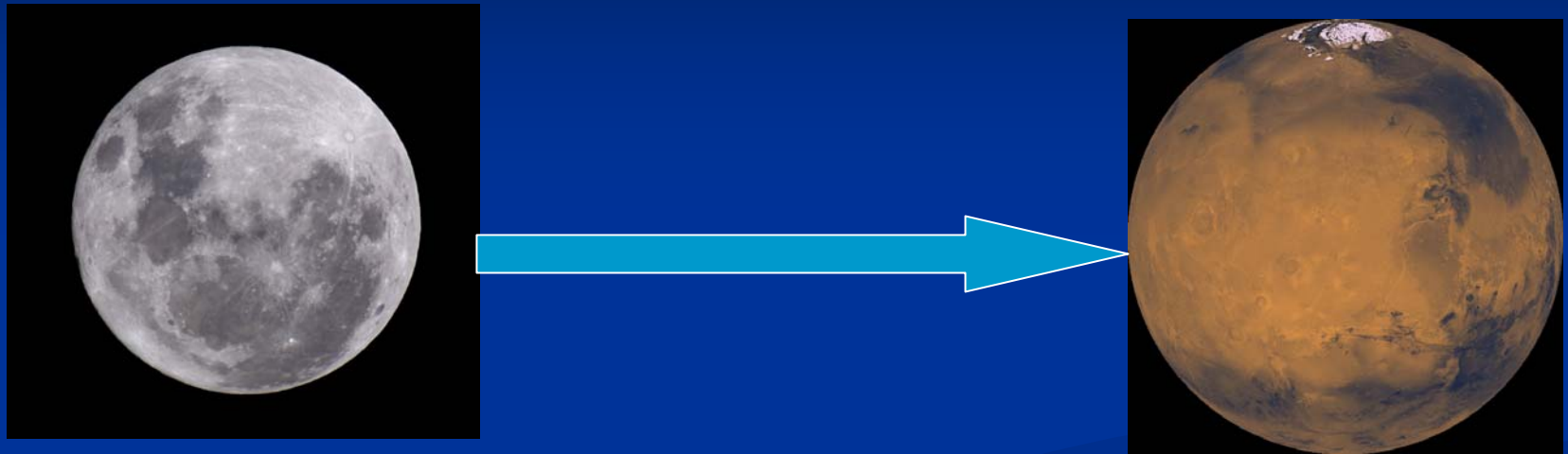
Lunar Expeditions



Duration: 7-30 days
Frequency: 2 per year
Crew size: 4

6 month rotations
continuous
variable

Why do B&P Research on the Moon?



- To identify and mitigate risks to and improve performance of lunar expeditioners.
- To create a space behavioral science laboratory for understanding risks and developing countermeasures for an expedition to Mars

Why do B&P Research on the Moon?

- Earth and ISS are limited as B&P analogs to the moon
 - Neither can simulate $1/6$ g
 - Unique conditions of isolation and confinement
 - Moon is further away from family and friends
 - Moon is less spatially confining than ISS, more confining than Earth
 - Communications blackouts lasting 1-10 days per month (NASA, 2006).



Why do B&P Research on the Moon?

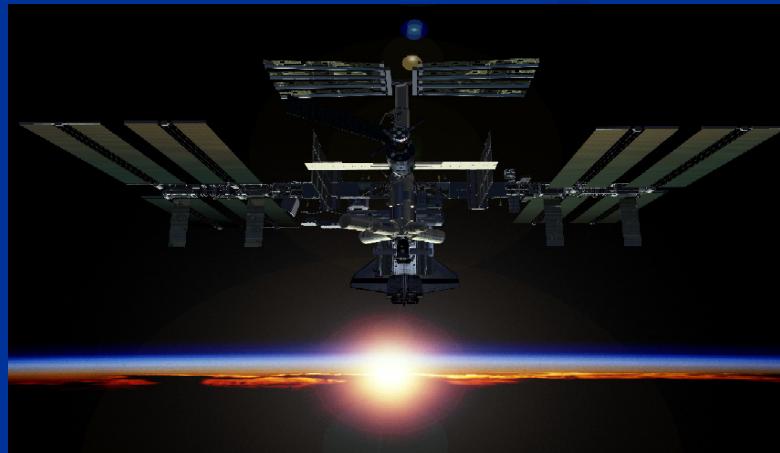


- Earth and ISS are limited as B&P analogs to the moon
 - Unique environmental hazards (radiation, dust, thermal extremes) influence human performance and psychological well-being
 - Nature of mission hard to replicate elsewhere



Why do B&P Research on the Moon?

- Offers advantages to conducting similar research aboard ISS
 - Larger sample sizes
 - In outpost phase, astronauts will have more time to participate in research



Space Behavior and Performance Research Priorities

- National Research Council
 - *A Strategy for Research in Space Biology and Medicine in the New Century* (1998)
 - *Review of NASA's Biomedical Research Program* (2000)
- Institute of Medicine
 - *Safe Passage: Astronaut Care for Exploration Missions* (2001)
 - *A Risk Reduction Strategy for Human Exploration of Space: A Review of NASA's Bioastronautics Roadmap* (2006)
- NASA
 - *NASA Bioastronautics Roadmap* (2007)
 - *Lunar Exploration Objectives* (2006)

NASA Bioastronautics Roadmap

- 24 Human Performance Failure Due to Poor Psychosocial Adaptation
- 25 Human Performance Failure Due to Neurobehavioral Problems
- 26 Mismatch between Crew Cognitive Capabilities and Task Demands
- 27 Human Performance Failure Due to Sleep Loss and Circadian Rhythm Problems

Lunar Exploration Human Health Objectives

- mHH2: Understand the effects of the lunar environment, in particular partial gravity, on human performance and human factors
- mHH3: Understand the impact of extreme isolation on individual psychological health and group dynamics

Lunar B&P Research Priorities

- Human Performance Failure Due to Poor Psychosocial Adaptation
 - Assessment of risks specific to lunar operations
 - Psychological responses to lunar-specific stressors
 - Social tension/conflict in lunar expeditions/crews
 - Countermeasure validation in operational Setting
 - Monitoring of mental health through optical computer and voice pattern recognition and real-time assessment of cognitive function
 - Crew training in mental health self-care and self-treatment and teamwork and group living
 - Development of new countermeasures
 - Select-In Screening Metrics (SISM)
 - Implementation of Evidence-Based Practices for Mental Health

Lunar B&P Research Priorities

- Human Performance Failure Due to Neurobehavioral Problems
 - Assessment of risks specific to lunar operations
 - Changes and stability in individual physiological patterns in response to psychosocial and environmental stress
 - Countermeasure validation in operational settings
 - Monitoring of mental health through optical and voice pattern recognition and real-time assessment of cognitive function
 - Development of new countermeasures
 - Evaluation of screening for stress response and coping strategies as countermeasure to stress-induced neurobehavioral problems
 - Evaluation of techniques for stress reduction (SIT, biofeedback)

Lunar B&P Research Priorities

- Mismatch between Crew Cognitive Capabilities and Task Demands
 - Assessment of risks specific to lunar operations
 - Studies of task overload during sortie phase and task underload during outpost phase.
 - Psychosocial and engineering constraints to ground-crew interactions
 - Countermeasure validation in operational settings
 - Monitoring of cognitive performance in real-time (WinSCAT, MiniCog)
 - Work/rest/sleep schedules
 - Development of new countermeasures
 - Countermeasure development that integrates behavioral and engineering solutions to human factors issues such as ground-crew communication and tension.
 - Nutritional and pharmacologic interventions to reduce cognitive performance decrements (tyrosine, thyroid supplementation)

Lunar B&P Research Priorities

- Human Performance Failure Due to Sleep Loss and Circadian Rhythm Problems
 - Assessment of risks specific to lunar operations
 - Effects of continuous exposure to bright light on circadian rhythms and performance.
 - Effects of lunar diurnal cycle on circadian rhythms and performance.
 - Countermeasure validation in operational settings
 - Work/rest/sleep schedules
 - Blue-enriched light to entrain circadian pacemaker
 - Development of new countermeasures
 - Melatonin injections
 - Light pulses

Reduction of Return Mass

- Technology
 - For collection of behavioral data
 - Active: laptop computers, PDAs, video cameras, audio recordings, actiwatches
 - Passive: pre-post mission psychological evaluations conducted on earth
 - For collection of biological data
 - Noninvasive techniques that do not require storage or real-time analysis of biological samples



Reduction of Return Mass

- Telemetry and Telemedicine
 - Real-time uplinks for ongoing monitoring of performance
 - 1.5 sec delay allows for ongoing/periodic observation of behavior by mission control
 - Use of telemedicine technology for data collection coincident with medical operational requirements.

