

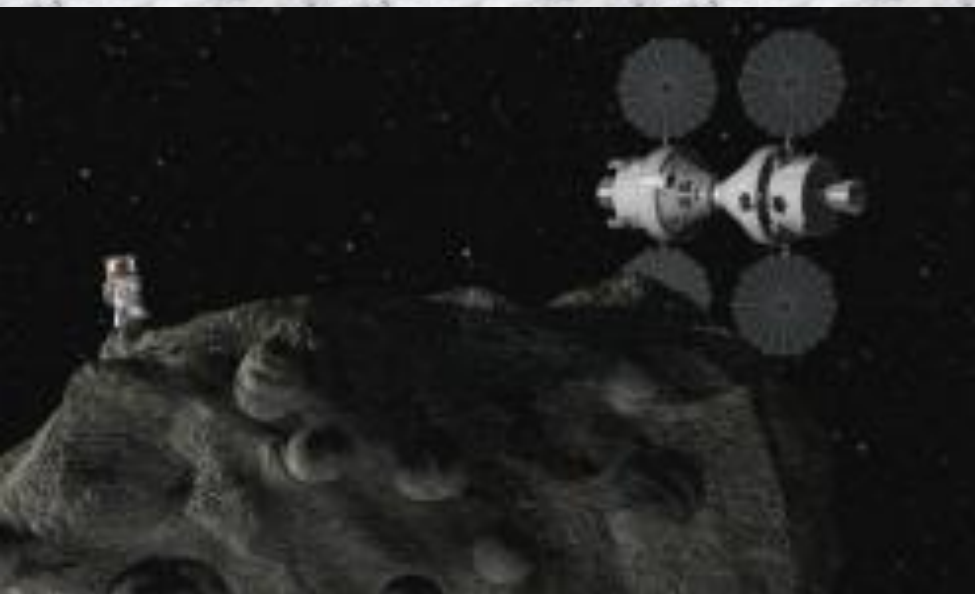
Human Health and Performance Considerations for Exploration of Near-Earth Asteroids (NEA)

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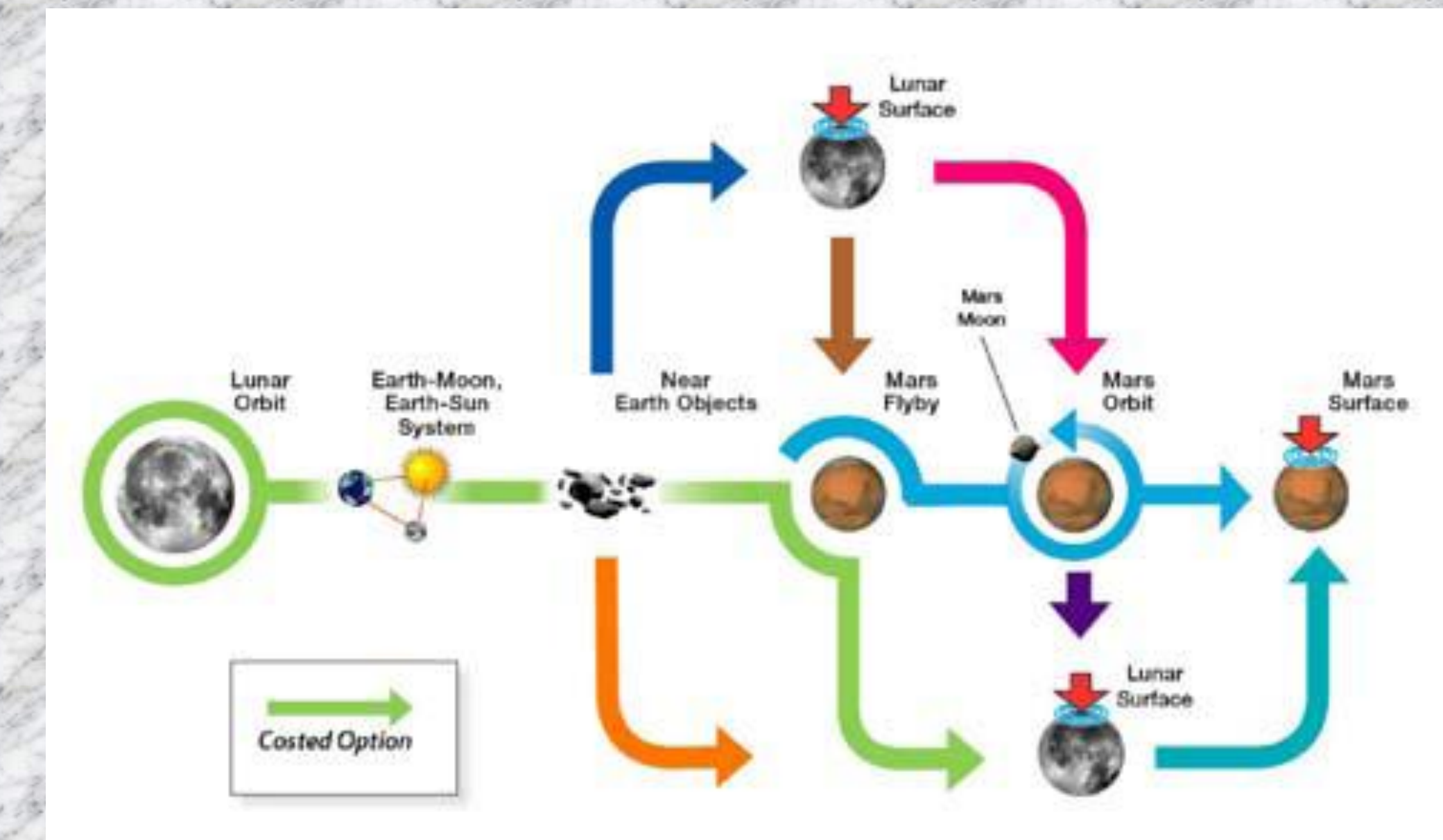


Human Research Program (HRP)

- ✓ Crew health & performance are critical to human exploration beyond low Earth orbit.
- ✓ HRP provides knowledge and tools to mitigate risks to health and performance.
- ✓ HRP's robust portfolio of risks applies to all missions in the current "flexible path" for exploration



HRP Risks Organized by the aspect of the mission they affect the most: Destination, Duration, Distance, and Design	Lunar	NEA (notional)			Mars
		Months			
		6 m	12m	18m	
NEA-Dependent: Specific properties such as geology, chemistry, angular rotation, g level, and lighting affect task design, regolith handling, & sensorimotor issues.					
Risk of adverse health effects from (lunar) dust exposure	A	A	A	A	n/a
Risk of errors due to poor task design	C	A	A	A	A
Risk of impaired control of spacecraft, associated systems and immediate vehicle egress due to vestibular/sensorimotor alterations associated with space flight	C	A	A	A	A
Mission Duration: Conditions continue to worsen with time of exposure to the flight environment (ex. microgravity, radiation, confined living).					
Risk of microgravity-induced visual alterations/ ICP	U	U	U	U	U
Risk of radiation carcinogenesis	A	U	U	U	U
Risk of degenerative tissue or other health effects from radiation exposure	A	A	U	U	U
Risk of impaired performance due to reduced muscle mass, strength & endurance	A	A	U	U	U
Risk of reduced physical performance due to reduced aerobic capacity	A	A	U	U	U
Risk of adverse behavioral conditions and psychiatric disorders	C	A	A	U	U
Risk of acute & late central nervous system effects from radiation exposure	A	A	A	A	A
Risk of acute radiation syndromes due to solar particle events (SPEs)	C	A	A	A	A
Risk of early-onset osteoporosis due to space flight	C	A	A	A	A
Risk of crew adverse health event due to altered immune response	C	C	A	A	A
Distance: Distance affects communication and evacuation.					
Risk of inability to adequately recognize and treat an ill or injured crew member	A	A	A	U	U
Risk of performance decrements due to inadequate cooperation, coordination, communication, psychosocial adaption within a team	C	A	A	A	A
Vehicle/System Design: Risk related to vehicle or subsystem design; medical issues not related to mission duration.					
Risk of inadequate nutrition & Risk of performance decrement and crew illness due to an inadequate food system	C	C	A	A	U
Risk of compromised EVA crew health and performance due to inadequate EVA suit systems	A	A	A	A	A
Risk of cardiac rhythm problems	C	A	A	A	A
Risk of orthostatic intolerance during re-exposure to microgravity	C	A	A	A	A
Risk of intervertebral disc damage	C	A	A	A	A
Risk of adverse health effects due to alterations in host-microorganism interaction	C	A	A	A	A
Risk of error due to inadequate information	C	C	A	A	A
Risk of reduced safety and efficiency due to an inadequately designed vehicle, environment, tools or equipment	C	C	A	A	A
Risk of therapeutic failure due to ineffectiveness of medication	C	C	C	A	A
Risk of renal stone formation	C	C	C	C	C
Risk of bone fracture	C	C	C	C	C
Risk of performance errors due to fatigue resulting from sleep loss , circadian desynchronization, extended wakefulness, and work overload	C	C	C	C	C



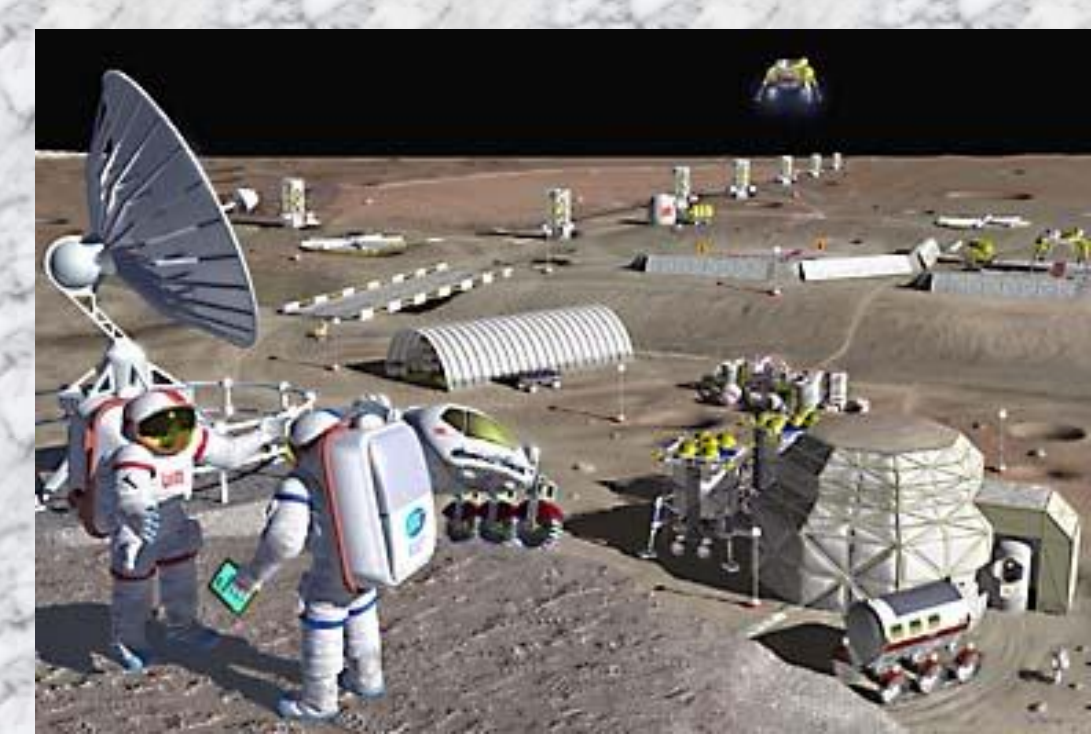
From: Seeking a Human Spaceflight Program Worthy of a Great Nation, Human Spaceflight Review Of U.S. Plans Committee 2009

- ✓ The state of knowledge about a risk is different for each mission scenario

HRP characterizes the risks in terms of a Criticality Rating:

- **U**nacceptable (It is necessary to quantify & reduce the risk's expected value and/or uncertainty of the risk prior to a mission)
- **A**cceptable (It is important but not necessary to quantify & reduce the expected value and/or uncertainty of the risk prior to a mission)
- **C**ontrolled (It would be helpful to quantify & reduce the expected value and/or uncertainty of the risk prior to a mission)

The Criticality Ratings of the lunar outpost mission and the Mars mission have been formally adopted by HRP; the NEA ratings shown are notional only.



Detailed information about HRP risks can be found at: <http://humanresearchroadmap.nasa.gov>