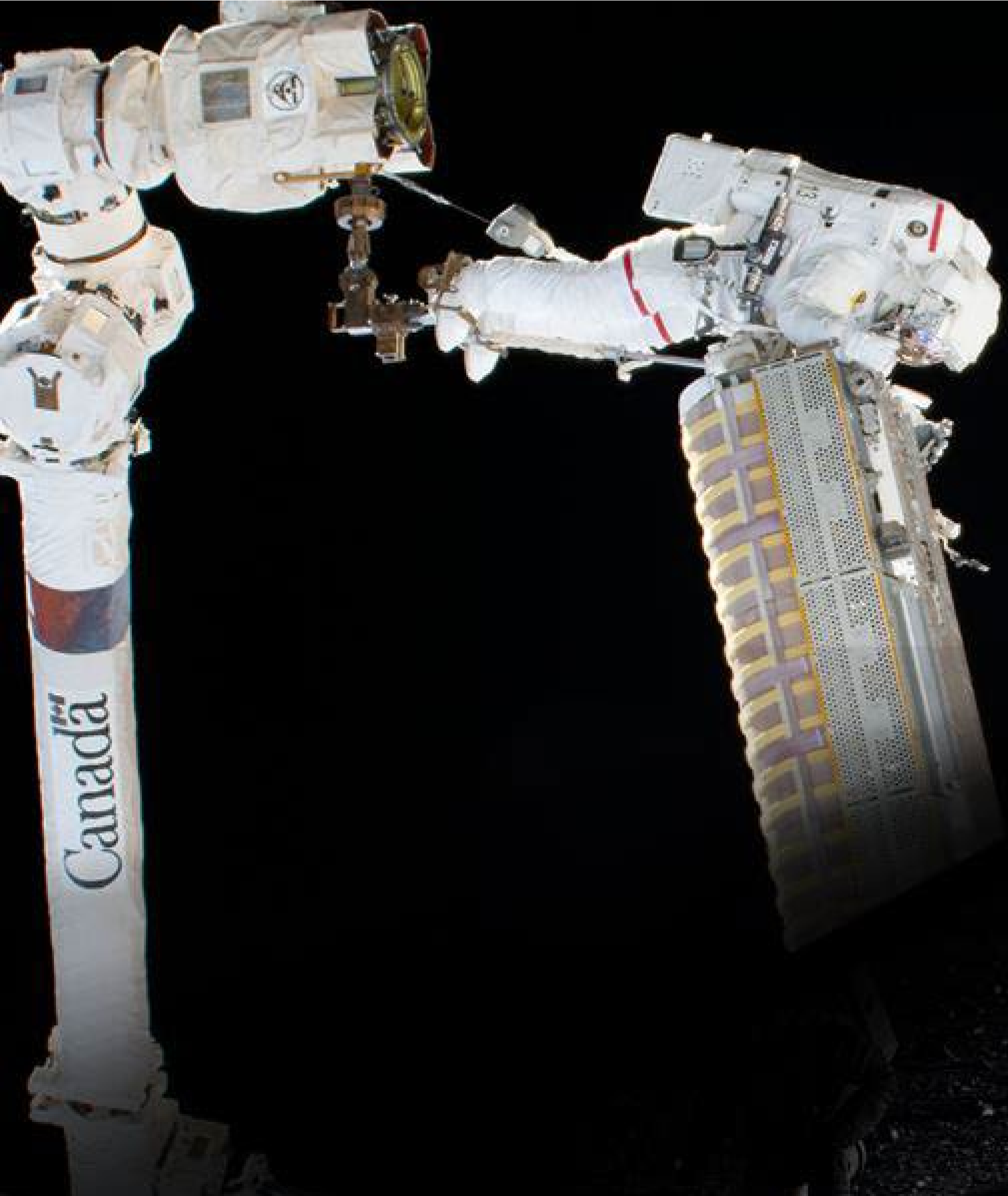
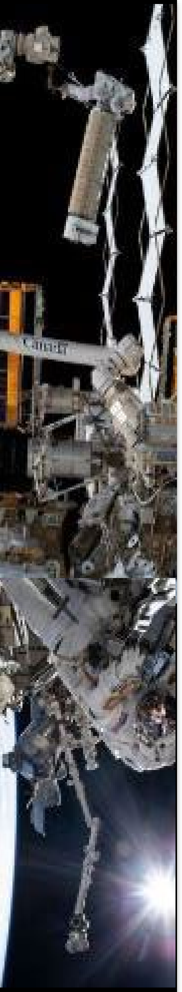


Webinar

South Pole Safety: Designing the NASA Lunar Rescue System

NASA Johnson Space Center, Houston TX
Technology integration: Katrien Morgan
EVA Development: Ben Greene
Human Systems Integration: Jerri Stephenson
Crew Survival Safety: Anne Vaughan
Operations: Fiona Antkowiak

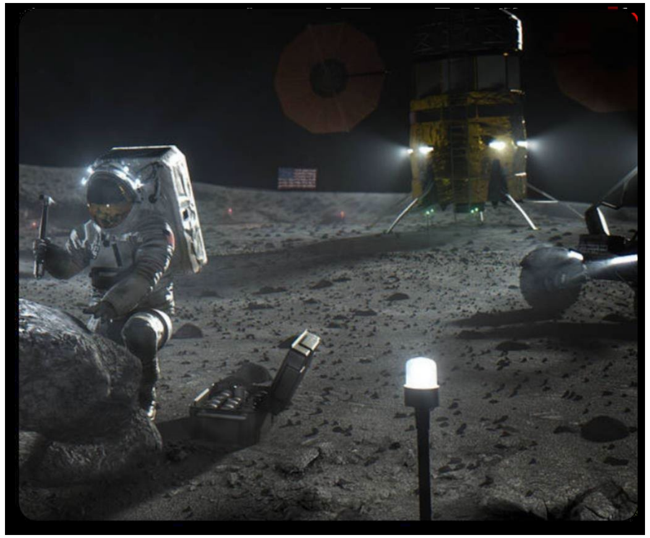
Outline



- **Background**
- **“Designing the NASA Lunar Rescue System” Challenge Overview**
- **Performance Criteria**
  - Must-have requirements
  - Nice-to-have features
- **Judging Criteria**
- **Q&A Session**

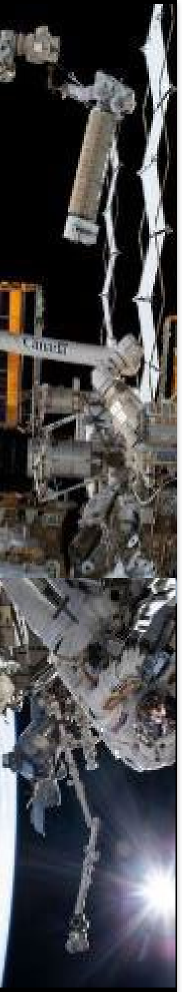
Background - Initial Artemis Missions Overview

- **Initial Artemis missions will focus on lunar surface operations, science sample return, testing of new technologies for long-term lunar human presence, and gathering data for future Mars exploration.**
- **Initial Artemis missions will include the following aspects and parameters:**
  - Artemis III mission is scheduled for mid-2027.
  - Missions will take place in lunar daylight (near the Lunar South Pole)
  - Landing sites remain undefined (9 potential sites for Artemis III)
  - Four crewmembers will fly to cislunar orbit
    - Two crewmembers will stay in cislunar orbit while
    - The other two crewmembers will land and explore lunar surface
  - Surface stay duration: 6.5 days
  - Total number of EVAs: 2 - 4
  - EVA* Duration: 4 to 8-hour excursions (limited by suit consumables)
  - EVA excursions may take the crew up to 2 km away from their lunar lander
  - No access to Lunar Rover(s) (prior to Artemis V+)



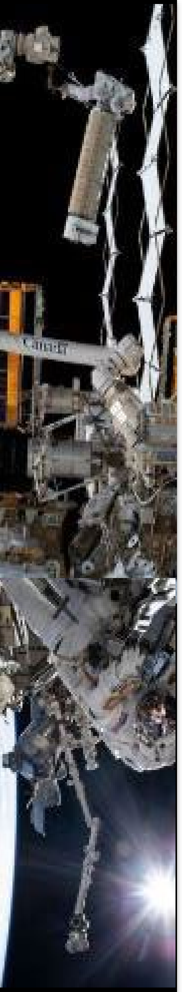
* - Extra Vehicular Activity (EVA) is a moon walk with crew in spacesuit.

Background - Issue



- **Historically, EVAs are considered one of the Top 3 risk events in Human Spaceflight**
- **During a lunar EVA, one of the two crewmembers could become fully incapacitated because of:**
  - Space Suit hardware failure
  - Crew physical injury caused by a fall
  - Decompression Sickness
  - Other illness, etc.
- **The imminent risk of a fully incapacitated crew leading to a catastrophic event during a lunar EVA requires urgent and thorough planning, flawless execution, and the proactive implementation of comprehensive risk mitigation strategy including assistive systems and <u>tools.</u>**
- **NASA is excited to engage the public for innovative and forward-thinking ideas to help solve this very important challenge.**

"Designing the NASA Lunar Rescue System" - The Challenge

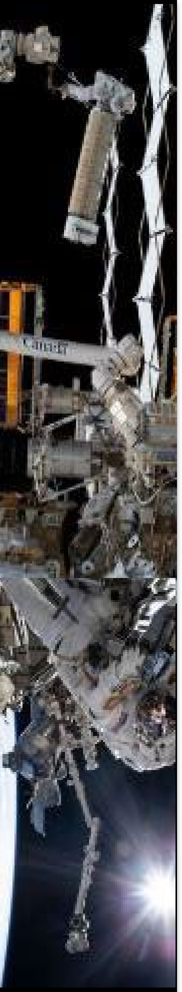


- ## The Problem
  - "The Lunar South Pole presents extreme challenges, including:
    - Rugged terrain,
    - Temperature fluctuations
    - Low-angle lighting, and
    - Reduced gravity,

    increasing the risk of crewmember incapacitation.
  - Early Artemis missions require rescue capability that would allow a single crewmember to transport a fully incapacitated crewmember (up to 755 lbs. (terrestrial weight)) up to 2 kilometers across the lunar terrain to the lunar lander without relying on a lunar rover."
- ## The Challenge
  - **"Create a compact, efficient system for astronaut rescue on the lunar surface - helping ensure swift, safe evacuation in extreme conditions."**

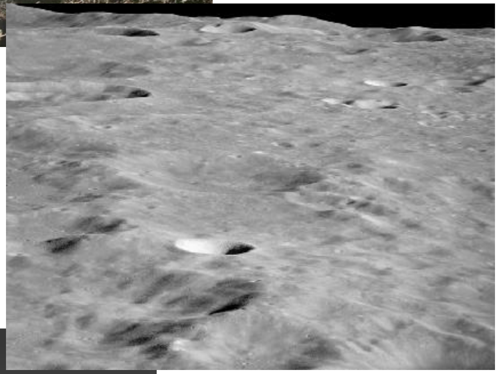
YOU can play a vital role in enhancing the safety measures for our future lunar explorers!

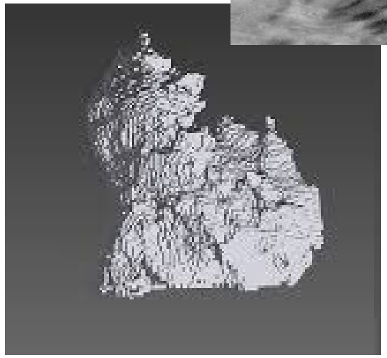
"Designing the NASA Lunar Rescue System" - Lunar-specific Challenges



The South Pole Environment

- Extreme temperature variations, with sunlit areas reaching **130°F (54°C) and shaded areas dropping to -334°F (-203°C)**
- **Poor lighting** - Low-angle sunlight and long shadows. Sun could be between 2 and 7 deg above horizon depending on time of year
- Lunar terrain is rugged with:
  - Rocks ranging from 0,15 meters up to 20 meters in diameter,
  - Craters ranging from 1 meter up to 30 meters, and
  - Slopes of up to 20 degrees (up, down and cross slope)
- Lunar **gravity is on-sixth of Earth gravity**.
- Lunar dust **"Regolith"** is sharp and electrostatically charged.
- **Lack of atmosphere**.



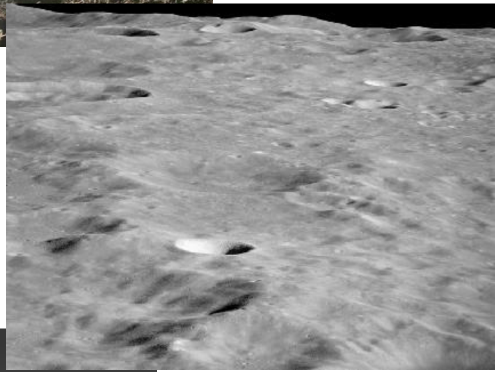


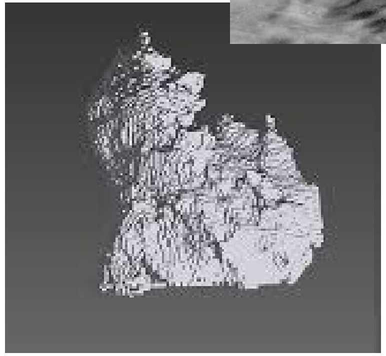
Note: **Copy of** *Design Specification for Natural Environments (DSNE) is provided in the Challenge Resources tab*

“Designing the NASA Lunar Rescue System” - Lunar-specific Challenges

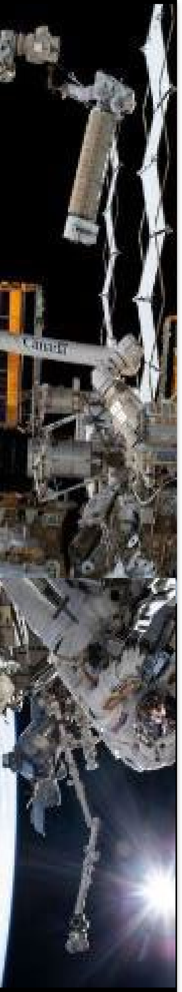
The Challenges of the South Pole Environment

- **Temperature** variations: equipment and suits must be able to perform across this wide temperature range.
- **Unique lighting conditions** create navigation challenges and impair depth perception, increasing the risk of falls.
- Traversing the **rugged Lunar terrain** requires careful planning.
- Lunar **gravity** affects mobility and object handling. Inertia is a concern and poses challenges for movement and equipment manipulation.
- **Lunar “regolith”** could damage equipment or impact movement.
- **Lack of atmosphere** exposes crewmembers to solar radiation and micro-meteoroid impacts.





Challenge Performance Criteria



A successful design concept should consider the following must-have requirements:

- **Low Mass and Minimal Volume:** Aim for total mass (terrestrial weight) no greater than 23 kilograms (~50 pounds). The lighter the design solution, the better. Design should also minimize stowed volume for ease of transport.
- **Effectiveness in Safe Transportation:** Design solution should enable a single crewmember to transport a fully incapacitated crewmember a range of up to 2 kilometers with up to 20 degrees lunar terrain slope. The design should also facilitate a prompt return to the entry point of the lunar lander, considering limited EVA consumables.
- **Ease of Deployment and Use:** Design solution should be deployable and operable by a single suited crewmember; as well as be capable of rapid deployment in an emergency situation with limited dexterity.
- **Compatibility with Lunar Environment:** Design solution should integrate materials that can withstand extreme temperatures, lunar dust, and vacuum conditions, and capable of functioning through rugged terrain.
- **Safety and Reliability:** Design solution should not introduce additional risks during deployment or operation. Functions consistently without failure or hazards under expected lunar conditions.
- **Minimal Impact on Suit Design:** Design solution should require minimal to no modifications to AxEMU spacesuit. Use of attachment points on Spacesuit is acceptable – details cannot be shared at this time

Challenge Performance Criteria (Continued)

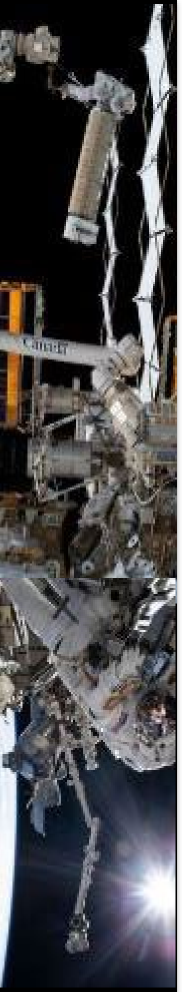
The following nice-to-have features will enhance your submission:

- **Collapsibility and Storage Efficiency:** Design solution can be collapsed or folded for minimum and efficient stowage needs during transport to the Moon.
- **Adaptability:** Design solution can accommodate various incapacitation scenarios and can adjust to different mission requirements.
- **Anthropometric Accommodation:** Design solution can accommodate crewmembers across a broad range of body sizes and shapes (1st to 99th percentile male/female).
- **Ease of Manufacturing:** Design solution utilizes materials and manufacturing processes that are practical and cost-effective with current technology.
- **Multi-functionality:** Design solution serves other purposes beyond casualty evacuation, adding value to the mission.

Judging Criteria

Criterion	Sub-criterion	Weight
Innovation **(20% Total)**	N/A	20%
Performance Requirements **(55% Total)**	Mass/Volume	17%
	Safe Transportation	12%
	Ease of Deployment/Use	7%
	Compatibility with Lunar Environment	7%
	Safety/Reliability	7%
	Impact on Suit Design	5%
Nice-to-have features **(25% Total)**	Collapsibility/Storage Efficiency	7%
	Adaptability	6%
	Anthropometric Accommodation	5%
	Ease of Manufacturing	4%
	Muti-functionality	3%

Q&A Session



- **Selected Questions & Answers (Q&As) responses from the Forum**
- **Open Discussion**

Thank you for your interest in this Challenge and for attending the webinar. We are excited to see your innovative and forward-thinking ideas and look forward to reviewing them!