MICRO-G NEXT 2020 DESIGN CHALLENGES

List of Micro-g NExT 2020 Design Challenges

Challenge 1: Orion Crew Safety – Surface Autonomous Vehicle for Emergency Response (SAVER)……………………………………….………………..............2

Challenge 2: Lunar Surface Operations – Dust Tolerant Pivot Mechanism……......4

Challenge 3: Lunar Surface Operations – Dust Tolerant Loose Sample Device………………………………………………………….……………………..5

Challenge 4: Lunar Surface Operations – Initial Sample Collection Device.....…...6

Challenge 5: Lunar Surface Operations – Lunar Sample Coring Device …..…...…7

NASA Micro-g NExT

Orion Crew Safety -
Surface Autonomous Vehicle for Emergency Rescue
(SAVER)

Background

NASA has been challenged to go forward to the Moon by 2024 with our Artemis Program, using Orion as the spacecraft. In the event of an unplanned egress (launch abort, contingency landing, etc.), Orion crewmembers will be exiting the crew vehicle and using a life raft. Each astronaut will be equipped with a 406 MHz emergency distress beacon to ensure they can be located should they individually be separated from the life raft and Orion capsule. The SAVER vehicle will assist with long-range Search and Rescue efforts by acting as a force-multiplier, assisting current efforts to tend to survivors on the scene immediately. The current ability to drop a lifeboat from rescue assets allows on-scene rescuers to immediately tend to survivors in the main life raft while SAVER autonomously searches for any isolated victims.

Objective

Design a surface vehicle capable of assisting astronauts in distress in a maritime environment, through the location and delivery of crew survival aids.

Assumptions

- For testing purposes, the vehicle will be powered by an umbilical in the NBL.
- To address requirement #4, the team may use commercially available 121.5 MHz homing equipment, or develop a unique solution for use with the NASA-provided beacon.

Requirements

1	The vehicle shall be capable of being dropped from a 10-15 foot height into the maritime environment.
2	The vehicle shall be capable of being carried on a Group 1 (small) or Group 2 (medium), Close-range UAV.
3	The vehicle shall be capable of transporting (carrying or towing), at a minimum, the following items to the victim: a. Water (1 liter minimum - 2.5 Liters max per Human Systems Integration Standard) b. Medical kit (Orion 0.6 lb kit) c. Spare Life Preserver Unit (LPU)* d. Contingency/Spare 406 MHz Second-Generation Beacon (ANGEL) e. Survival Radio Optionally, the following may also be included: f. Inflatable life raft (taking into account size/mass considerations) *Note: A pair of Orion LPU lobes with an existing, integrated ANGEL beacon may be used in lieu of other options for requirement c.
4	The vehicle shall be capable of using existing equipment to detect the ANGEL beacon 121.5 MHz homing signal in order to guide the vehicle toward the beacon.
5	The vehicle shall be capable of traveling to the person in distress via the most direct route in an autonomous manner, including:

	a. Unmanned operation (no local or remote human intervention) b. Self-guided operations to move to the GNSS position c. Programmed with mission profiles to address specifics of rescue scenario
6	The vehicle shall include protections in software/hardware to ensure no harm to the crew upon arrival in their vicinity.

NASA Micro-g NExT

Lunar Surface Operations

Dust-Tolerant Pivot Mechanism

Background

NASA has been challenged to go forward to the Moon by 2024 with our Artemis Program. A new requirement for lunar surface tools is compatibility with the harsh lunar dust environment to ensure they can be used repeatedly in a mission without mechanisms binding, jamming, or becoming too difficult to actuate. Lunar dust is likely to get into the mechanisms of geology sampling devices during operations and limit the effectiveness of the tool. Some tools require a pivot mechanism to change the angle of the tool head (a scoop is an example of this). On a scoop, continual functionality of the pivot mechanism is important to allow for multiple uses of the tool. When the scoop head is at 90° from the handle, it can be used to collect samples. When the scoop head is in-line with the handle (0°) it can be used as a trenching tool.

Objective

Design a dust-tolerant pivot mechanism for a lunar surface scoop. The focus should be on the pivot mechanism and the dust tolerance, therefore the scoop head and handle design should be a simple as possible.

Assumptions

- The subject will be weighed out to lunar gravity (1/6th of Earth's) and can walk on the bottom of the pool.

Requirements

1	The scoop head shall be able to pivot to 0°, 45°, and 90° and lock in place at each position. Other positions between 0° and 90° are acceptable but not required.
2	The pivot mechanism shall be operable with one hand (the other hand can be used to rotate the scoop head or stabilize the handle).
3	The device shall be able to function as intended after being fully submerged in lunar dust simulant. The device will be fully submerged, removed from the lunar dust simulant, and then cycled 10 times.
4	The device shall use only manual power.
5	The device shall be a minimum of 30" and a maximum of 35" in length (in the 90° position) to allow the subject to use the scoop without bending over.
6	The device must be operable with EVA gloved hands (like heavy ski gloves).
7	The total weight of all parts you provide should be less than 3 lbs.
8	Tools must not have holes or openings which would allow/cause entrapment of fingers.
9	Tools should be made from Aluminum 6061, Aluminum 7075, Stainless Steel (any series), or Teflon. Any other materials must get prior approval from the EVA Tools POC*.
10	Lubricants must be selected from the NBL approved lubricant list or a waiver must be granted (Approved Materials List).
11	There shall be no sharp edges on the tool.
12	Pinch points should be minimized and labeled.

*NOTE: If 3D-printing is necessary due to financial or other reasons, please contact the EVA Tools POC with rationale. An additional load test or drop test will be required for the device.

NASA Micro-g NExT

Lunar Surface Operations

Dust-Tolerant Loose Sample Device

Background

NASA has been challenged to go forward to the Moon by 2024 with our Artemis Program. One of the sample types that the science community is interested in collecting from the lunar surface is called a float sample, which is a small, loose rock that is laying on the surface. A sampling device is needed that will allow crew members to collect these float samples without having to bend down and pick them up. A new requirement for lunar surface tools is compatibility with the harsh lunar dust environment to ensure they can be used repeatedly in a mission without mechanisms binding, jamming, or becoming too difficult to actuate.

Objective

Design a sampling device that allows a crew member to pick up float samples from the lunar surface and tolerates the lunar dust environment.

Assumptions

- The subject will be weighed out to lunar gravity (1/6th of Earth's) and can walk on the bottom of the pool.

Requirements

1	The device shall be able to pick up float samples ranging 0.5" to 3" in diameter.
2	The device shall be able to function as intended after being fully submerged in lunar dust simulant. The device will be fully submerged, removed from the lunar dust simulant, and then cycled 10 times.
3	The device shall use only manual power.
4	The device shall be a minimum of 30" and a maximum of 35" in length to allow the subject to collect a float sample without bending over.
5	The device must be operable with EVA gloved hands (like heavy ski gloves).
6	The total weight of all parts you provide should be less than 3 lbs.
7	Tools must not have holes or openings which would allow/cause entrapment of fingers.
8	Tools should be made from Aluminum 6061, Aluminum 7075, Stainless Steel (any series), or Teflon. Any other materials must get prior approval from the EVA Tools POC*.
9	Lubricants must be selected from the NBL approved lubricant list or a waiver must be granted (Approved Materials List).
10	There shall be no sharp edges on the tool.
11	Pinch points should be minimized and labeled.

*NOTE: If 3D-printing is necessary due to financial or other reasons, please contact the EVA Tools POC with rationale. An additional load test or drop test will be required for the device.

NASA Micro-g NExT

Lunar Surface Operations

Initial Sample Collection Device

Background

NASA has been challenged to go forward to the Moon by 2024 with our Artemis Program. To ensure at least one sample is collected from the lunar surface, the first crew member to descend from the lander onto the surface will immediately collect a float sample (a sample laying on the surface). This action ensures that at least one sample is returned, even in the case a contingency occurs and the mission is cut short. The crew member will need to have this contingency sample device stored on their suit while in the lander, be able to access it quickly once on the surface, and then be able to stow it on their suit once the sample is collected.

Objective

Design a sampling device that can be stored on an EVA suit, easily accessed and stowed by the crew member, can collect one sample from the lunar surface and is very lightweight.

Assumptions

- The subject will be able to kneel on one knee.
- The stowage location on the suit would be a pocket on the outside of one leg. The subject during the NBL test will have a similar pocket to stow the device.
- The subject will be weighed out to lunar gravity (1/6th of Earth's) and can walk on the bottom of the pool.

Requirements

1	The device shall be able to collect one float sample ranging 0.5" to 2" in diameter.
2	The device shall use only manual power.
3	The crew member shall be able to un-stow the tool, pick up the sample, and stow the tool within 2 minutes.
4	The device must be operable with EVA gloved hands (like heavy ski gloves).
5	The total weight of all parts you provide should be less than 1.5 lbs.
6	The device shall be able to pack within 6" x 6" x 2" volume.
7	Tools must not have holes or openings which would allow/cause entrapment of fingers.
8	Tools should be made from Aluminum 6061, Aluminum 7075, Stainless Steel (any series), or Teflon. Any other materials must get prior approval from the EVA Tools POC*.
9	Lubricants must be selected from the NBL approved lubricant list or a waiver must be granted (Approved Materials List).
10	There shall be no sharp edges on the tool.
11	Pinch points should be minimized and labeled.

*NOTE: If 3D-printing is necessary due to financial or other reasons, please contact the EVA Tools POC with rationale. An additional load test or drop test will be required for the device.

NASA Micro-g NExT

Lunar Surface Operations

Lunar Sample Coring Device

Background

NASA has been challenged to go forward to the Moon by 2024 with our Artemis Program. Artemis will send astronauts and robots to obtain samples from new locations of the lunar surface, including the lunar South Pole which contains ice. Taking a sample is critical for scientific research, yet drilling and capturing a pristine sample is challenging. Designing an appropriate coring bit, which fits existing tools, which can drill and capture a small core, is important for testing on the Moon and designing sampling mechanisms for other worlds.

Objective

Design and manufacture a coring bit, stabilizing jig, and sample containment mechanism able to drill into and retrieve a sample core.

Assumptions

- This device will be driven by a NASA provided underwater drill held by divers – example: https://www.nemo-underwatertools.co.uk/product/underwater-divers-drill/
- The subject will be weighed out to lunar gravity (1/6th of Earth's) and can walk on the bottom of the pool.

Requirements

1	The device shall be able to collect cylindrical core samples 0.5" in diameter and 3" deep from concrete or ice.
2	The device shall not extend beyond the plane of the drill chuck toward the diver (all components must be below the drill chuck).
3	The device shall mechanically interface with a 13mm (0.512") drill chuck.
4	The device shall not be externally powered or pressurized.
5	The device shall drill a core, capture the core, and contain the core when the drill is removed from the sample target.
6	The device (all parts, in stowed configuration) shall fit within a 6" diameter x 6" long cylinder.
7	The device (all parts) shall operate underwater.
8	The device (all parts) shall have a dry weight less than 3 lbs.
9	The device shall be compatible with a chlorine water and a salt-water environment.
10	The device shall operate within an environment from 23^{o}F to 86^{o}F (-5^{o}C to 30^{o}C).