NASA MINDS

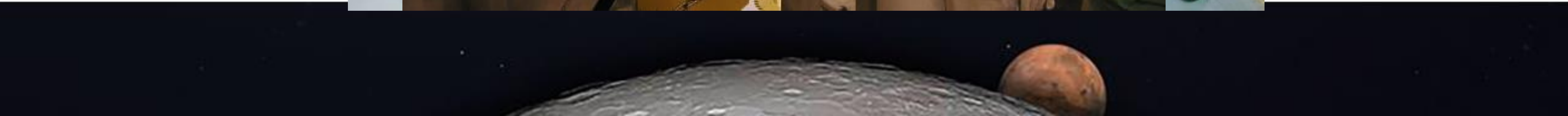
WEBINAR WILL BEGIN AT 3:00PM EASTERN TIME

MEET: Theresa Martinez

Graduated UCF May 1991
Bachelors Science Electrical Engineering
Graduated high school 1978
at age 16 with a 4.0
(no AP/honors available)

- Interned at KSC (Pathways)
- First (and only) in my family to get degree
- First Hispanic female engineer hired at KSC

NASA MINDS



MEET: Theresa Martinez

WHAT IS NASA MINDS?

MUREP = Minority University Research and Education Project

NASA MINDS = NASA MUREP Innovative New Designs for Space

NASA MINDS is a multi-semester undergraduate level activity that supports NASA's Artemis mission. Students' skills, creativity and innovation are challenged as they are asked to design and build technologies needed for NASA's Artemis mission, with the support of their faculty. It provides **$1,500** to a team for parts and materials an **$1,000** Faculty Stipend.

One of the most unique aspects of NASA MINDS is student teams conceive, design, and build their own project that supports NASA's Artemis Mission.

APPLICATION DEADLINE: October 18, 2022

https://nasaminds.org/application

WHAT IS MUREP

Minority University Research and Education Project (MUREP)

NASA MINDS is funded by MUREP. MUREP investments enhance the research, academic and technology capabilities of Minority Serving Institutions through multiyear cooperative agreements. Awards assist faculty and students in research and provide authentic STEM engagement related to NASA missions. Additionally, awards provide NASA-specific knowledge and skills to learners who have historically been underrepresented and underserved in STEM. MUREP investments assist NASA in meeting the goal of a diverse workforce through student participation in internships and fellowships at NASA centers and the Jet Propulsion Laboratory (JPL).

MUREP PROGRAMS

K-12 Educator Professional Development
MUREP Aerospace Academy (MAA)
Educator Professional Development Collaborative (EPDC)

Community College and Tribal College Engagement
NASA Community College Aerospace Scholars (NCAS)
MUREP Innovations in Space Technology Curriculum (MISTC)
MUREP for American Indian and Alaska Native STEM Engagement

Student Contests, Challenges and Experiential Learning
NASA MINDS Undergraduate Student Design
MUREP Innovation Tech Transfer Idea Competition (MITTIC)
NASA Community College Aerospace Scholars (NCAS)
Internships
NASA Fellowships Activity
Artemis Student Challenges

Research Infrastructure and Capacity Building
MUREP Institutional Research Opportunity (MIRO)

MUREP Aerospace High-Volume Manufacturing and Supply Chain Management Cooperative (MUREP HighVolume)

Partnerships and Sustainability
NASA and NSF Partnership to Broaden Participation in Engineering
MUREP Sustainability and Innovation Collaborative (MUSIC)
MUREP Space Technology Artemis Research (M-STAR) Planning Grant

Learn more about MUREP at:
http://www.nasa.gov/stem/murep

WHAT IS THE ARTEMIS MISSION

Artemis is the Greek goddess who was the twin sister of Apollo.

Apollo was the NASA Mission that landed astronauts on the moon in 1969.

Artemis will return astronauts to the moon and establish a sustainable presence there. Many technologies will be needed to allow astronauts to “live off the land” of the moon.

Artemis also seeks to lay the groundwork for a crewed mission to Mars. Launch windows for Mars missions (when the planet is closest to Earth) come only every 26 months, so any round-trip Mars mission would *have* to involve some time waiting for this window to open up again. Learning how to live on the Moon for extended periods will allow us to develop technologies needed for Mars.

ARTEMIS TIMELINE

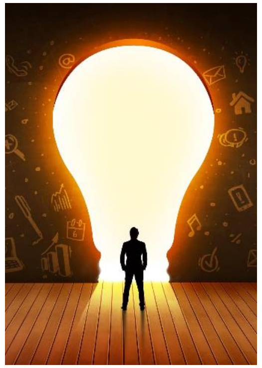
September 27, 2022 -11:37 AM EDT
Artemis 1 - NASA will launch an SLS and an Orion together on two flight tests around the moon to check performance, life support, and communication capabilities.

2024 Artemis II - NASA will fly with crew by 2024

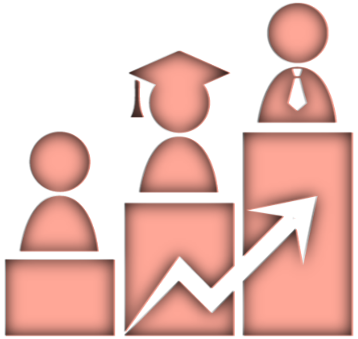
2025 Artemis III - NASA will land the first man and woman to the lunar South Pole of the moon. Astronauts will collect samples and conduct a range of science experiments over the course of nearly seven days.

NASA has Artemis missions planned through **2030**

HOW NASA MINDS SUPPORTS ARTEMIS



BIG IDEA - NASA MINDS seeks Minority Serving Institutions to pursue innovative ideas to assist NASA's quest for technologies needed to return and live on the moon. While developing a breakthrough technology would be an amazing accomplishment for everyone involved, this is not the program mandate.



PIPELINE - NASA MINDS is focused on building a pipeline for the future workforce Artemis will need. Imagine what will happen if we get today's students studying, designing and working on technologies needed for lunar exploration. When they enter the aerospace workforce they will leaps ahead and can hit the ground running.

NASA MINDS ELIGIBILITY

YOUR SCHOOL MUST BE A MINORITY SERVING INSTITUTION

- [ ] Asian American and Native American Pacific Islander (AANAPSI)
- [ ] Alaska Native and Native Hawaiian (ANNH)
- [ ] Historical Black Colleges and Universities (HBCU)
- [ ] Hispanic Serving Institution (HSI)
- [ ] Native American Serving Non-Tribal Institution (NASNTI)
- [ ] Predominately Black Institution (PBI)
- [ ] Tribal College or University (TCU)

NASA MINDS ELIGIBILITY

HOW TO CHECK IF YOUR SCHOOL IS A MINORITY SERVING INSTITUTION

Check with your school's Office of Institutional Research or Office of Sponsored Research

OR

Check the NASA website
https://msiexchange.nasa.gov/institutions

NASA MINDS ELIGIBILITY

YOUR TEAM MUST HAVE A FACULTY MENTOR

- Faculty must submit a signed letter indicating they are willing to mentor a team for the duration on the project, and that students will have access to university/college infrastructure to support the project (as available during this time).
- Faculty can opt to make NASA MINDS part of their courses. However, it is not required.
- Colleges and universities can have multiple teams.
- Faculty members are responsible for making sure that the project progresses, the $1,500 provided to the team is spent properly, and that project reaches successful completion. Faculty members will be awarded a $1,000 stipend upon successful completion. Faculty members are allowed to mentor multiple teams at a school, however they will only earn a maximum of $1,000 total.

Don't forget your faculty Letter!

TEAM ELIGIBILITY

- Only teams from Minority Serving Institutions are eligible to participate
- A team is defined as at least 2 students, but we encourage you to have more.
- Teams of 6 to 10 students have proven to allow members to dive deeper into specific areas within a project. It is also feasible that an entire class of 30+ students might wish to form a team. If this is the case you may wish to create internal teams.
- If you have one or more Senior students on your team, your team will have different deliverables and will be scored in a different category with different rubrics.

WHAT DO TEAMS DO?

1 IDENTIFY TOPIC

Students should research the NASA Artemis Mission and find a technological topic they are interested in and their school might have some capabilities in.

2 APPLY

Team should submit an application at https://nasaminds.org/application

3 DESIGN Semester 1

Students spend the Fall semester planning and mapping out their project. They will create a detailed design concept, utilizing trade off analysis, simulated failure analysis, and computer simulations. The concept will be mapped out within a **Preliminary Design Review** document.

WHAT DO TEAMS DO?

4 BUILD Semester 2

After submitting a passing **Preliminary Design Review**, teams will be provided with $1,500 to build their design at the start of the Spring semester. Team submit a **Technical Poster** and either a **Systems Engineering Paper** or **Technical Paper**.

5 NASA REVIEWS

All projects will be reviewed by NASA Subject Matter Experts and assessed using rubrics. Top scoring teams will be invited to move on to make **LIVE online presentations** to NASA reps.

6 AWARDS

NASA will award SENIOR CATEGORY:
$5,000 for 1st, $2,500 for 2nd, $1,000 for 3rd

NASA will award UNDERCLASSMAN CATEGORY:
$2,500 for 1st, $1,500 for 2nd, $750 for 3rd

HOW TO IDENTIFY TOPICS

Students should pursue technologies that inspire them
and potentially align with capabilities at their school

ARTEMIS INFORMATIONAL RESOURCES

- NASA Artemis Site - https://www.nasa.gov/specials/artemis/
- NASA Artemis Page - https://www.nasa.gov/what-is-artemis
- NASA Artemis Plan - https://www.nasa.gov/sites/default/files/atoms/files/artemis_plan-20200921.pdf

GENERAL NASA TECHNOLOGY INFORMATIONAL RESOURCES

- NASA Technology Taxonomy https://www.nasa.gov/sites/default/files/atoms/files/2020_nasa_technology_taxonomy_lowres.pdf
- NASA Game Changing Program - https://gameon.nasa.gov/projects/
- NASA SBIR / STTR – Solicitation - https://sbir.nasa.gov/solicit-detail/79614

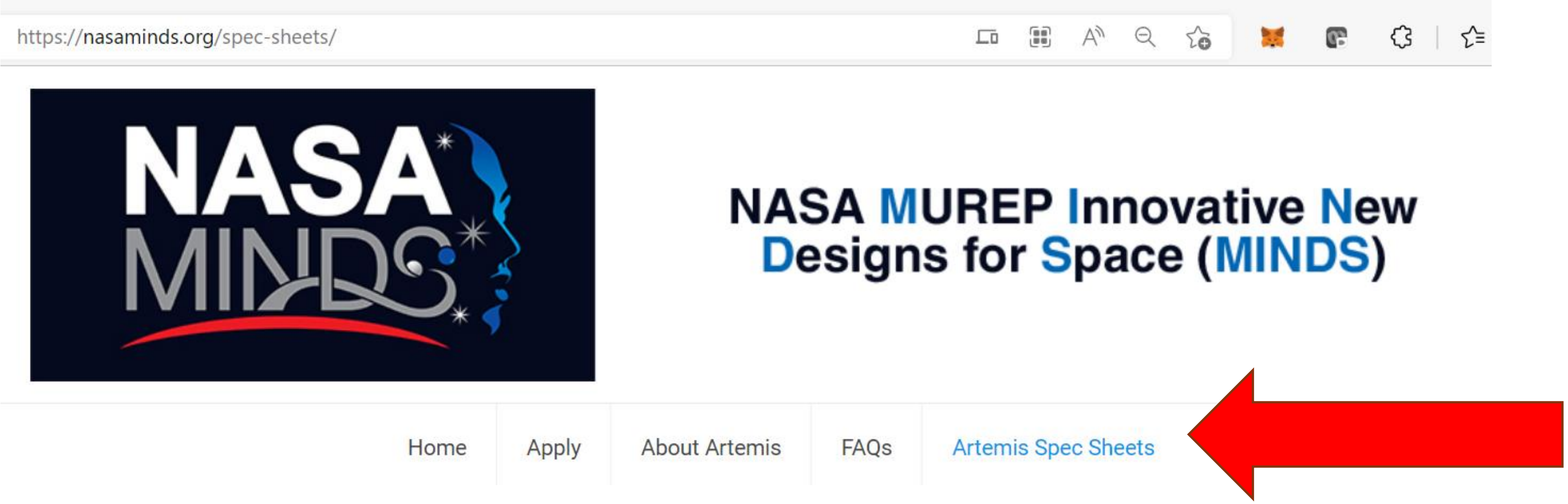
EXAMPLES OF PAST NASA MINDS PROJECTS

2021 https://nasaminds.org/2021-nasa-minds-teams/ 2022 https://nasaminds.org/2022-nasa-minds-teams/

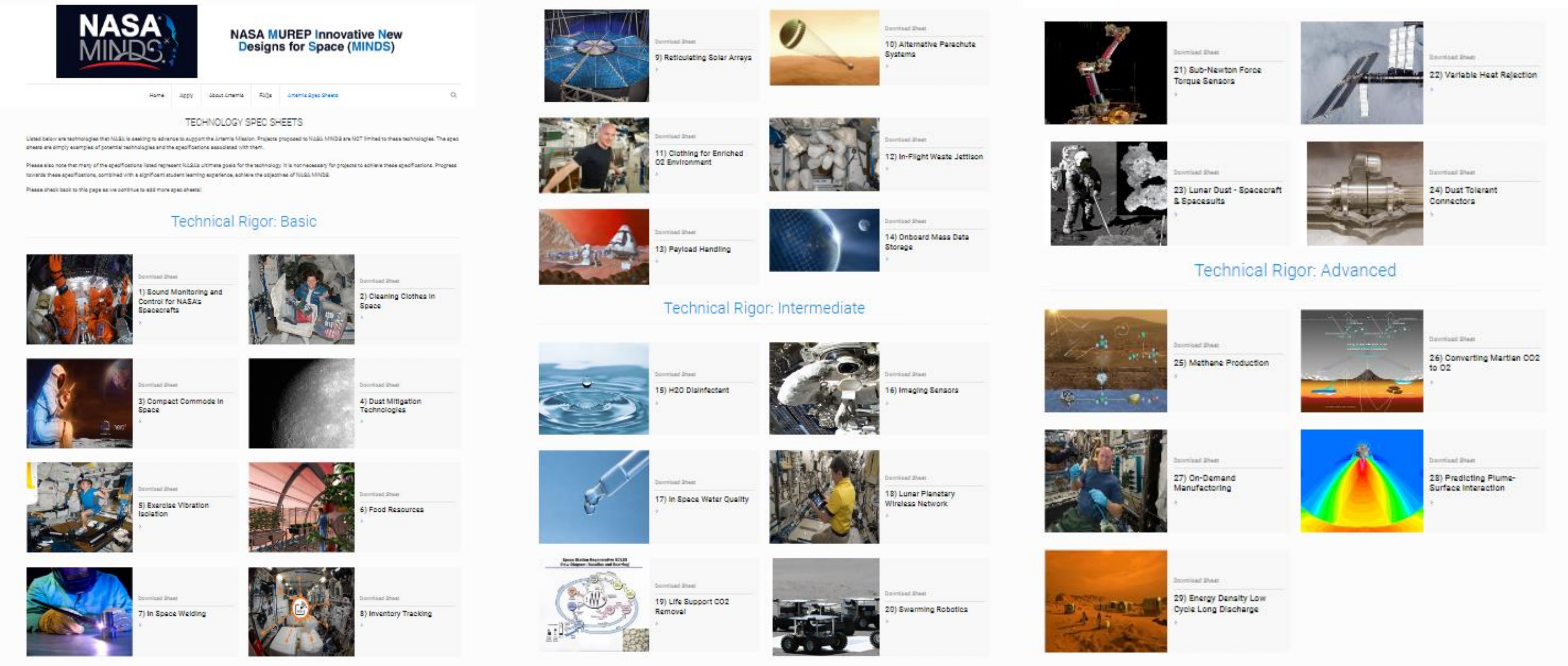
HOW TO IDENTIFY TOPICS

NASA MINDS SPEC SHEETS

https://nasaminds.org/spec-sheets/



29 DIFFERENT SPEC SHEETS!



HOW TO IDENTIFY TOPICS

NASA MINDS SPEC SHEETS

- The 29 Spec Sheets were created from a review of more than 300 NASA Artemis Technology Gaps.

- They cover a wide array of technical topics ranging from dust filtration, to swarmimg robotics, to washing clothes in space, etc.

- The Spec sheets identity a specific gap, and potentially multiple challenges within it. **However, they DO NOT recommend a specific solution**. The sheets are **NOT project guides**. Instead, they serve as the starting point for the **"why"** for your project. The **"what"** type of technological approach you select to solve it, and the **"how"** you will implement your solution is up to your team.

HOW TO IDENTIFY TOPICS

NASA MINDS SPEC SHEETS

We have ranked the spec sheets by level of Technical Rigor:

BASIC

INTERMEDIATE

ADVANCED

DISCLAIMER

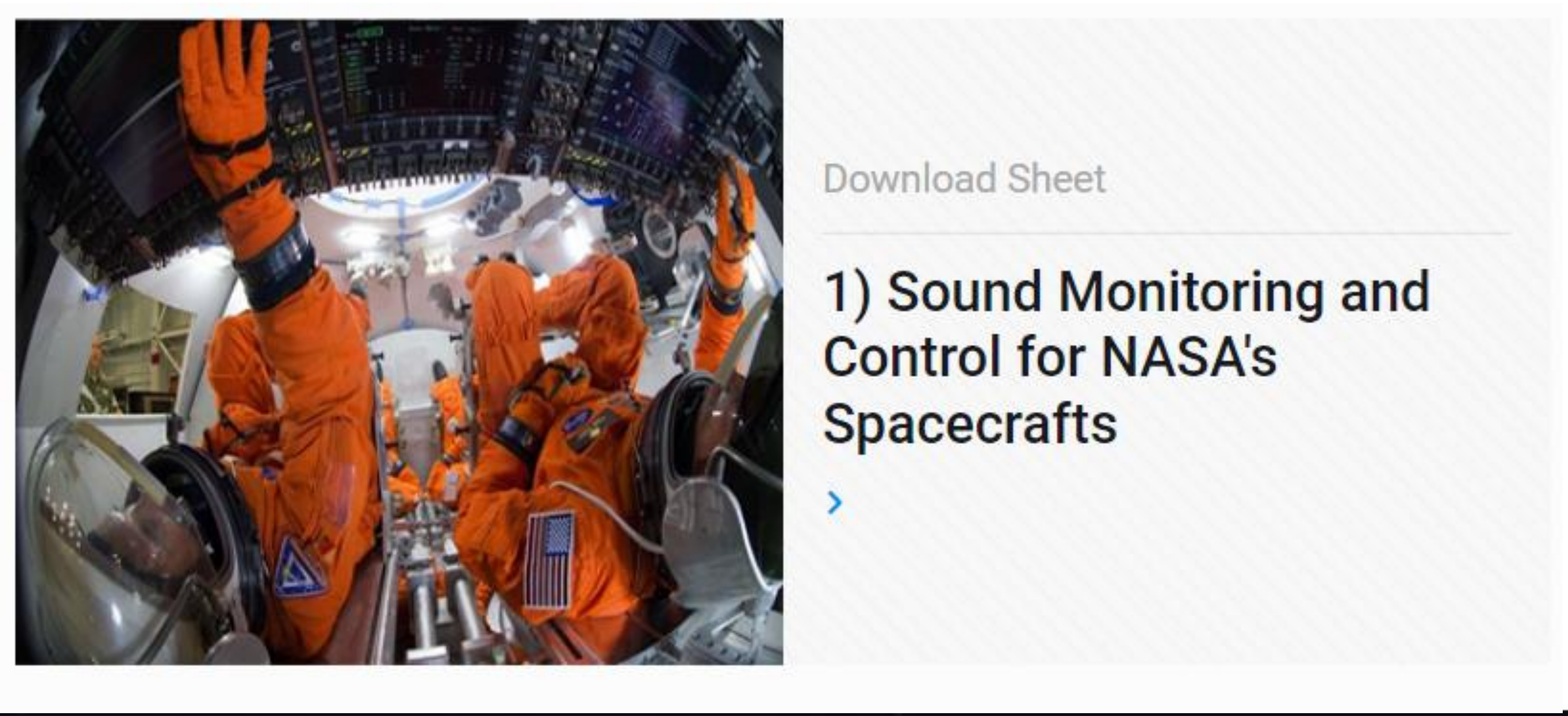
Ranking the spec sheets by technical rigor is VERY subjective.

Teams may formulate a very complex and effective solution to a simple problem. Or teams, may formulate a very simple and effective solution to a very complex problem.

Ultimately, your team determines the technical rigor of your proposed solution/project.

HOW TO IDENTIFY TOPICS

EXAMPLE OF A SPEC SHEET



Name of Technology:
Acoustic Monitoring and Control

Participating NASA Centers:
JSC(Lead); ARC, GRC

Technological Area:
O3.06 Advanced Acoustic Monitoring Technologies

Vision for the Technology:
Noise levels on the International Space Station (ISS) frequently exceed the hazard level threshold for brief durations due to operational hardware such as fans, vacuum cleaners, etc. as well as failing hardware and maintenance activities. Acoustic monitoring is conducted once per month and provides only a snapshot of the acoustic environment on the ISS. Low-mass solutions for acoustic monitoring and control are needed to better understand and control the acoustic environment, to protect crew hearing, and to enable communication and alarm audibility.

Challenges:
Currently, acoustic monitoring is performed by using a hand-held sound level meter (SLM) that is moved to 60 different locations where a 15 second measurement is collected. Each SLM survey session takes 2 hours of crew time, and the survey is performed once every 2 months. Therefore, it is important to reduced crew time to perform this task. The crew will continue to be exposed to high levels of noise without recognizing the risk. This could result in temporary or long-term hearing loss. Lack of quieter fans and light-weight sound blocking materials will increase the mass and volume of noise controls on spacecraft/stations on Lunar and Mars missions.

NASA Seeks to Meet the Following Specs:
An acoustic monitoring and control system is needed to be:

1. Development of sound blocking materials capable of demonstrating >30 dB insertion loss at 125 Hz, from sound blocking materials,
2. Development of small fans that produce sound levels <54 dBA at 2 ft,
3. Development of prime mover fans that produce duct-borne sound power levels <75 dB of without acoustic treatment,
4. Demonstration of an acoustic monitoring system that provides (nearly autonomous) measurement frequency of >30 times per month.

Overview of Student Project:
Innovative low-mass solutions for acoustic monitoring and control are needed to better understand and control the acoustic environment, to protect crew hearing, and to enable communication and alarm audibility. Passive, light-weight sound techniques and materials are needed to dampen sound.

Innovative Areas Student Projects Can Address:
- Autonomous acoustic monitor,
- Noise Hazard Level Indicators,
- Active noise control fans,
- Quiet (e.g. Prandtl) blades fans,
- Quiet prime mover fan design technology,
- Light-weight and anti-microbial passive acoustic materials development

Research Funded by NASA on this Topic:

Proposal Number: 10-1 O3.06-9114
Acoustic Monitoring for Spaceflight Vehicle Applications

References:
O3.06 Advanced Acoustic Monitoring Technologies

X12.04 Advanced Environment Monitoring and Control

Astrobee: Autonomous Acoustic Monitoring

FORM B - PROPOSAL SUMMARY

PROPOSAL NUMBER: 10-1 **O3.06-9114**
SUBTOPIC TITLE: Advanced Acoustic Monitoring Technologies
PROPOSAL TITLE: Acoustic Monitoring for Spaceflight Vehicle Applications

Research Funded by NASA on this Topic:

Proposal Number: 10-1 O3.06-9114
Acoustic Monitoring for Spaceflight Vehicle Applications

SMALL BUSINESS CONCERN (Firm Name, Mail Address, City/State/Zip, Phone)
ADVANCED MEDICAL ELECTRONICS CORP.
6901 East Fish Lake Road, Suite #190
Maple Grove, MN 55369 - 5457
(763) 463-4814

PRINCIPAL INVESTIGATOR/PROJECT MANAGER (Name, E-mail, Mail Address, City/State/Zip, Phone)
Gary Havey
ghavey@ame-corp.com
6901 E. Fish Lake Road, Ste #190
Maple Grove, MN 55369 - 5457
(763) 463-4814 Extension :104

Estimated Technology Readiness Level (TRL) at beginning and end of contract:
Begin: 3
End: 6

TECHNICAL ABSTRACT (Limit 2000 characters, approximately 200 words)
This SBIR will develop and demonstrate acoustic sensor technology enabling real-time, remotely performed measuring and monitoring of sound pressure levels and noise exposure levels in long-duration space vehicles. The acoustic sensor technology developed will enable a network of continuously monitored, real-time acoustic sensors providing sound pressure level information as a function of frequency and/or time at multiple locations for the current International Space Station (ISS) and future long duration spaceflight missions. The phase I will show the feasibility for the phase II to develop the software and hardware of an acoustic monitor to a TRL 6 level. In phase II a demonstration unit and it software package will be delivered to NASA for their testing. A phase II demonstration will be done in JSC Acoustics and Noise Control Lab (ANCL) so that testing can be performed in the ISS Acoustic Mockup.

POTENTIAL NASA COMMERCIAL APPLICATIONS (Limit 1500 characters, approximately 150 words)
Wirelessly network acoustic monitoring technology from this SBIR is highly desired for use by NASA on ISS and for future long duration space missions for the long-term. To reduce crew work while improving monitoring NASA needs a miniature, lightweight, network of acoustic monitors that can process data at the sensor and transmit their data wirelessly. Low power consumption is very important to achieve long operating life with minimal crew maintenance.

A. Sensors

In its baseline configuration, i.e. without any additional payloads in its payload bays, Astrobee uses a suite of six commercial off-the-shelf (COTS) external sensors (Fig. 2). The forward face includes the NavCam, which is a fixed-focus color camera with a wide field of view. Images from the NavCam inform the onboard visual navigation system and stream to the Control Station at 1 Hz to provide situation awareness to Astrobee's operator. Astrobee's forward face also includes the HazCam, which is a depth sensor that detects obstacles with LIDAR; and the SciCam, an auto-focus color camera that downlinks live HD video.

Astrobee's aft face houses the DockCam, a color camera nearly identical to the NavCam. The DockCam tracks fiducials on the Docking Station during autonomous docking maneuvers. The PerchCam is also on the aft face. The PerchCam is identical to the HazCam and it turns on to detect ISS handrails when Astrobee perches autonomously.

Finally, as part of Astrobee's strategy for minimizing collision risk, the top-facing SpeedCam sensor package provides an independent over-speed cutoff function, estimating velocity using its own optical flow, infrared ranging, and IMU sensors.

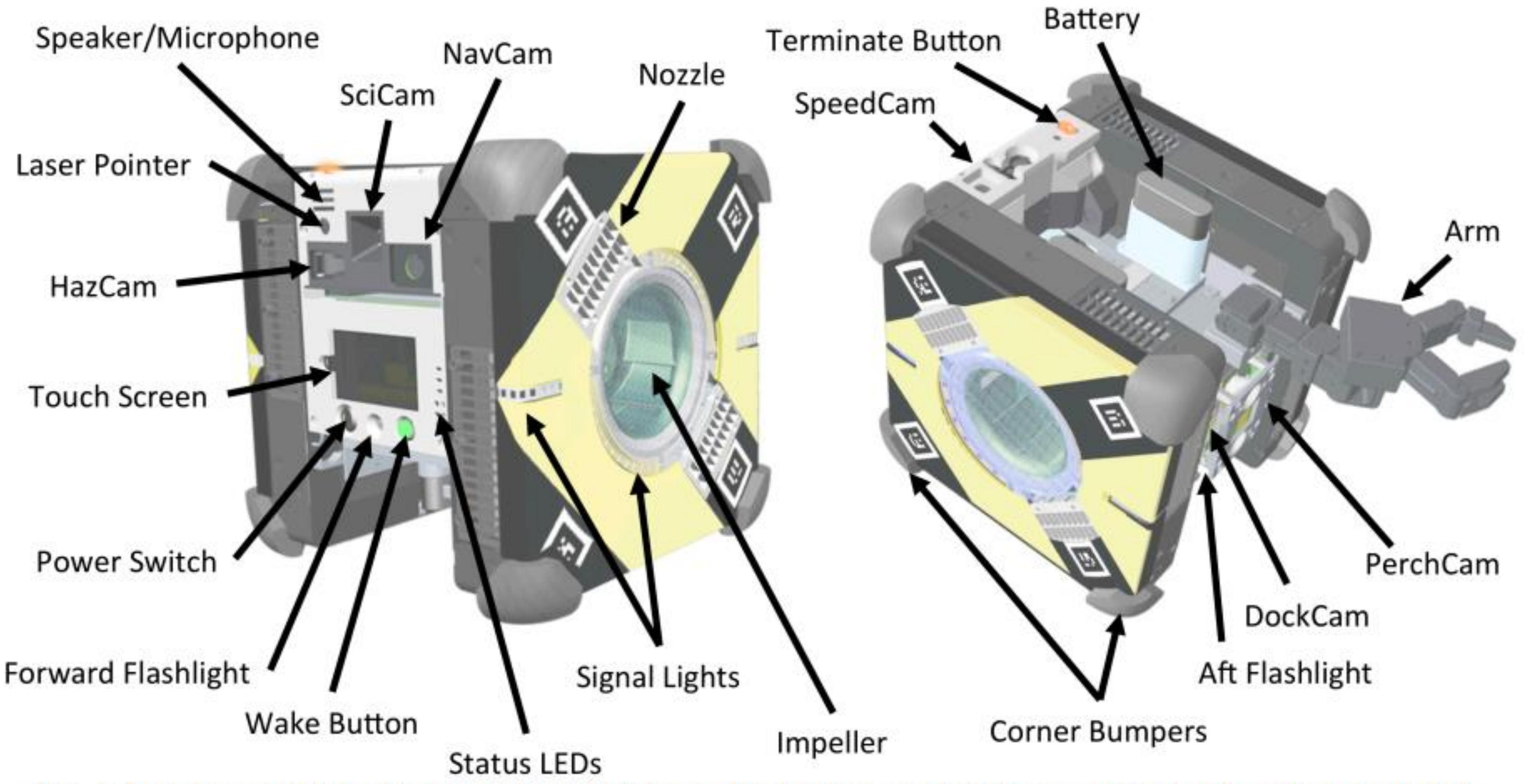


Fig. 2 Astrobee robot. Left: Forward and left faces. Right: Top and left faces, with Perching Arm deployed.

References:

[Astrobee: Autonomous Acoustic Monitoring]

HOW TO IDENTIFY TOPICS

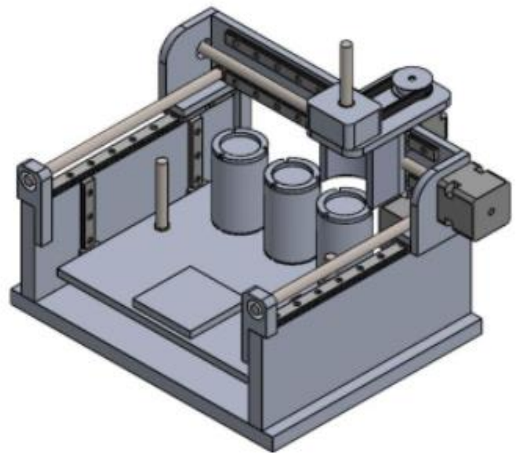
THE FOLLOWING ARE PAST NASA MINDS PROJECTS INTENDED AS REPRESENTATIVE EXAMPLES.

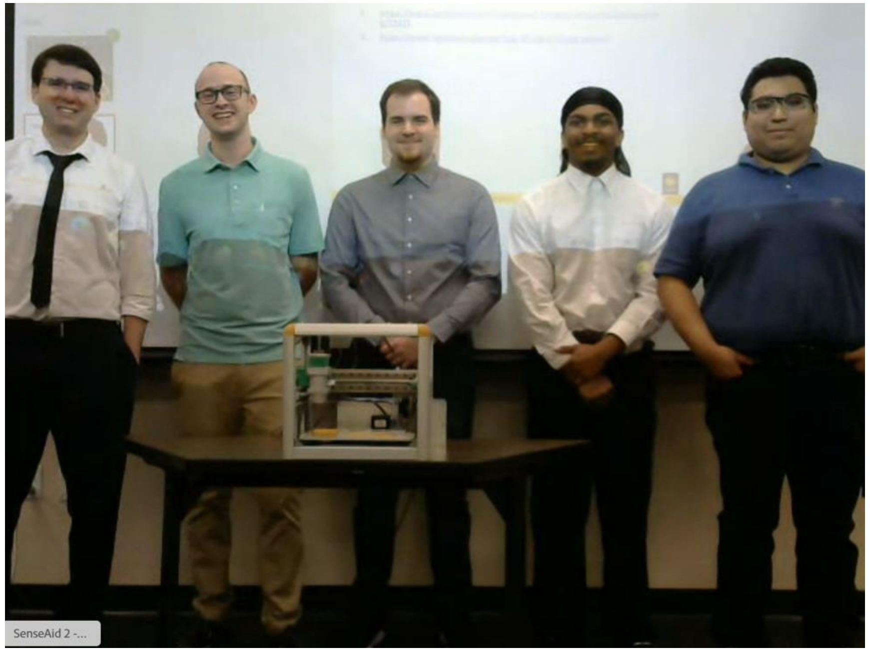
Your team should identify and pursue a project that most inspires them, and for which they may have basic capabilities.

EXAMPLES OF PAST NASA MINDS PROJECTS

2021 https://nasaminds.org/2021-nasa-minds-teams/
2022 https://nasaminds.org/2022-nasa-minds-teams/

University of Central Florida





3D Printing of Engineered Materials in Microgravity

3D Printing of Engineering Materials in Microgravity

Alexander R. Cabezas, Jonathan A. Chambers, Michael Daleo, Tatianna R. Gary, Robert J. Llewellyn,
Dylan S. Lyon, Kevin T. Owens, Norrel C. Thomas, Robert J. Trautwein

Team SenseAid

Advisor: Dr. Kurt Stresau, Co-Advisor: Perla Latorre Suarez

University of Central Florida

Abstract

Team SenseAid worked closely with UCF's Raghavan Research Group (PI: Dr. Seetha Raghavan) and Co-Advisor Perla Latorre Suarez to prototype a 3D printer capable of gravity and microgravity printing across the widest possible range of engineered materials. The printed ink is a composite of photoset resin and a volume fraction of additives containing the desired engineered properties of the print. Innovations in the Direct Ink Write (DIW) print method make the printer capable of space operation. Consideration was given to forward compatibility for parabolic flight testing and ultimately in-orbit operation on the ISS EXPRESS Racks.

Motivation

- NASA Artemis missions require parts to be manufactured throughout long manned missions
- 3D printing can fulfill this role if operable in microgravity
- Current space 3D printers can only print with traditional inks
- Printed parts in space may need to be vacuum, thermal, radiation resistant

Problem Statement

Team SenseAid shall design a 3D printer for engineered materials under microgravity conditions.

Objectives

- Shall function under both microgravity and gravity conditions.
- Shall print a wide variety of current and future engineered materials.
- Shall maintain forward compatibility towards practical tests and implementation.
- Shall have high precision.
- Shall be readily modular, with replaceable parts and sturdy construction.

Data

Property	Requirement Target (Interval)	Actual Value	Property	Requirement Target (Interval)	Actual Value
Frame Width X	.5m (0m – 1.05m)	0.3m	Print Width X	55mm (40mm –)	90mm
Frame Depth Y	.5m (0m – 0.83m)	0.3m	Print Depth Y	55mm (40mm –)	55mm
Frame Height Z	.5m (0m – 2.0m)	0.275m	Print Height Z	15mm (10mm –)	40mm

Trade Table

Team SenseAid had the task of narrowing down printer methods. The team compiled 9 different printing methods in the exploratory research stage. These were sieved based on the team's systems requirements and interview with a current microgravity printer expert. Ultimately the decision came down to a formal trade study, where weighted categorical ratings provide an overall score. Direct Ink Write was chosen over Stereolithography. More trade studies were conducted for the three softwares required for 3D printing. The critical construction materials and geometry decisions were also resolved through more formal trade studies, resulting in the finalized CAD model shown.

Prototype

Figure 1. Semi-Iso View

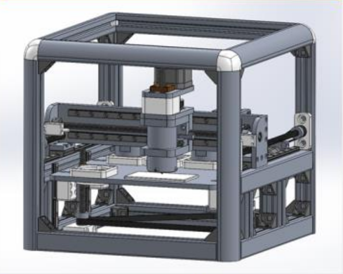


Figure 2. Top View

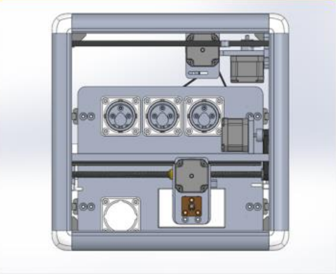
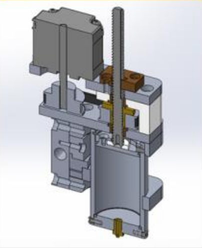


Figure 3. Head Cross View



The team's original intent to design a printer realized when Direct-Ink Write (DIW) was selected as the print method. The simplest overview of a DIW printer is that it moves a point nozzle across stacked layers of lines, extruding a continuous stream of resin that cures (hardens) into a finished print. This desired operation decomposes into the six primary subsystems shown in Figure 5.

Secondary subsystems were not immediately obvious and were the focus of much of the preliminary design review stage. One instance is that the frame had to trace in 3D; There are three dominant designs in practice: Cartesian (X/Y/Z axes), Delta, and Polar. A Cartesian design was chosen for its simple construction and periodic slicing (Reduces anisotropy). Critical design review led to the 3 axes being split in a 2/1 configuration for a more accurate calibration, a desirable feature for withstanding launch loading. This is visible in Figures 1 and 2 as having one pulley belt beneath the bed and two above.

Another innovative secondary subsystem was the grasping mechanism. CAD sketching revealed a lack of space for additional servos in the head (See Figure 3). Instead, the ability to contact the head to the frame enabled the printer to lock / unlock the canister with one additional piece dubbed the grasping lock. Figure 4 emphasizes the grasping lock and shows its place in the back of the head.

During the preliminary design reviews, it was determined that ink switches ought to be automated, particularly in the case of multi-ink prints where the switches could become frequent and tedious. This prototype opts to use a canister (Grey cylinders in Figures 1-4) for each ink, up to 3 inks before manual input. Using designated canisters per ink also negated the need to change nozzle diameter, an ink-specific constraint. The canisters are each stored in shallow holes in the bed where the nozzle lies flush with the surface. This creates a secondary seal in case of a broken piston seal. Despite each canister having its own piston and O-ring, there is only one extruding servo that pushes directly center on each piston to force ink out. This feature was cost-efficient and avoided potential spills in removing and pressure sealing remaining ink.

Figure 4. Head Exploded

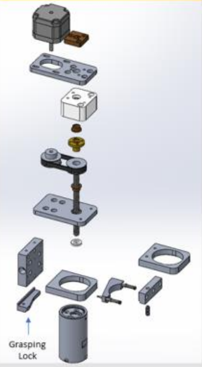
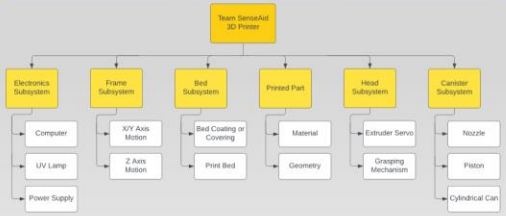


Figure 5. Systems Hierarchy



Design Process

Team SenseAid adhered to the three major review stages typical of large system design.

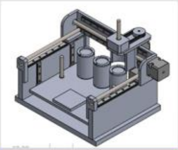
A. Systems Requirements Review

The team began by holding weekly meetings with Co-Advisor Perla Latorre Suarez and her research advisor Dr. Seetha Raghavan of the Raghavan Research Group (RRG). Together, the team compiled a customer shortlist of the RRG (Including Perla), NASA MINDS' judges, and the engineers at Redwire, Inc., a space company. Team SenseAid compiled a question list for both the RRG and Dr. Kevin DiMarzio of Redwire and conducted two separate interviews. Important takeaways were that the RRG wanted a ground-functional printer that had future upgradability for parabolic tests, and Redwire wanted to see an innovative printing method prototyped.

Interview notes were compiled into a list of explicit and implicit customer wants. Co-Advisor Perla and Dr. Raghavan weighted these by customer importance, providing a direct priority list to the team. Team SenseAid used these to create a matrix dubbed the "House of Quality", which given the key requirement's values could generate an estimate of customer satisfaction. The House of Quality led to an enumerated list of quantifiable targets to reach with the design, which was critiqued, edited, and approved by the concerned parties.

B. Preliminary Design Review

Throughout the systems requirements stage, the individual team members performed research on separate aspects of this field. Variations of 3D printer components were all studied, along with 9 total printing methods. Operating 3D printers on the ISS, including Redwire's own Additive Manufacturing Facility, were studied down to the patent level for design recommendations and implementation details. After several brainstorming sessions and research meetings with Co-Advisor Perla, the printer methods were reduced to 2. The first of many trade studies was used to determine Direct Ink Write as most capable. A preliminary design was sketched in SolidWorks in accordance with earlier system requirements.



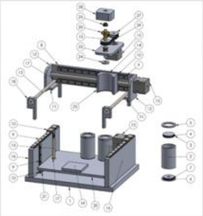


Figure 6. Preliminary Printer (Iso, Exploded)

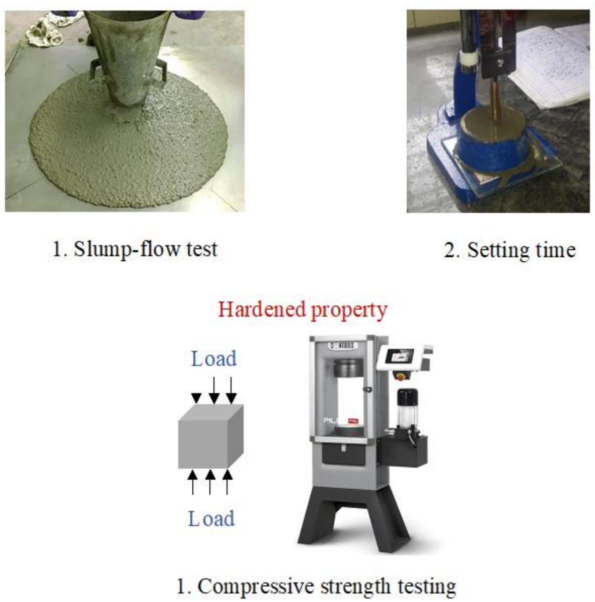
C. Critical Design Review

This review stage focuses on refining subsystems to ensure they interact without failure. Each subsystem was further developed to add additional functionality like automated ink switches. Weekly meetings continued to further the model, with critiques updating the model in real time. This stage left the team with an actionable model to begin assembly. Parts were purchased and machined in several stages, so that unforeseen design changes would not requisite re-specing purchased parts.

Results and Conclusion

Team SenseAid has prototyped and plans to begin testing the printer on an initial assortment of composite resins. Throughout the various review stages, the printer transformed from a vague set of wants into quantifiable system requirements, and finally into a CAD model that met the majority of requirements to target. The team worked arduously after reviews to manufacture a very complex SolidWorks model with machined precision. Future recommendations include modifying the frame to make it externally attachable for test parabolic flights, and adding bed heat and ventilation systems to make more photoset resins viable.

Texas State University



Geopolymer for Future Lunar 3D Construction

Geopolymer for Future Lunar 3D Construction

Students
Damini Gopal (Civil Engineering Junior); Rodolfo Castillo Hernandez (Civil Engineering Junior)
Faculty Advisors
Xijun Shi (Assistant Professor, Civil Engineering), Anthony Torres (Associate Professor, Engineering Technology)
Postdoc/Graduate Student Mentors
Solomon Debbarma (Postdoc, Civil Engineering); Mehrab Nodehi (Graduate Student, Civil Engineering)

We are the Bobcat CaerusCrete!
Caerus is the Greek god of opportunity. Indeed, the living building material offers tremendous opportunities for future massive lunar and Martian construction.

Background

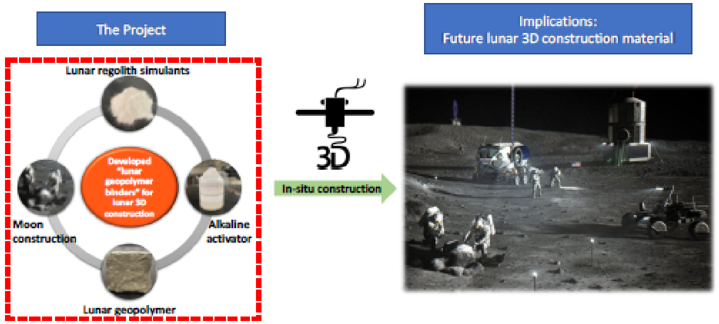
It is not realistic to produce conventional portland cement concrete on the Moon

- Limestone, one of the raw materials to produce portland cement, is not available on these planets
- The availability of liquid water for large construction is still unknown on these planets
- Cost of transporting concrete to the Moon is prohibitive (e.g., $1.2M/kg)

Geopolymer is a promising building material for lunar construction

- Geopolymer is a new type of inorganic, highly polymeric material, which is synthesized by the alkali activation of materials rich in silica (Si) and aluminum (Al)
- It has several advantages over conventional portland cement concrete, such as high mechanical strength, high resistance to temperature and radiation, and improved durability
- Lunar regolith is rich is silica and aluminum, so it is possible to produce lunar geopolymer that can support future construction on the Moon

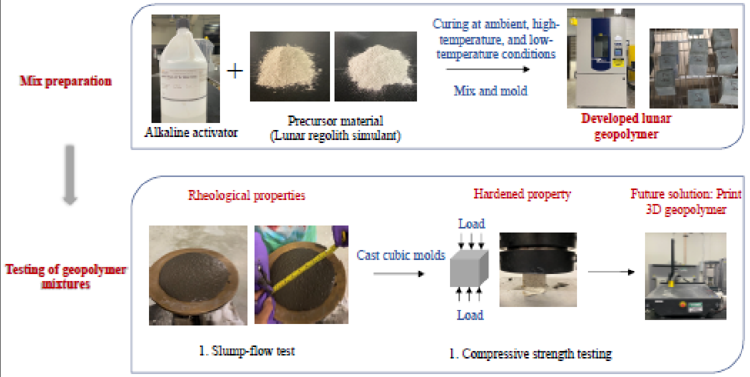
We seek to synthesize geopolymer for future lunar 3D construction



We are proposing to develop a portland cement-free concrete (i.e., geopolymer) that can support lunar construction. Our project facilitats the development of NASA's advanced exploration systems (AES). In particular, the material that we develop and test will potentially play a significant role in supporting building up habitation systems to enable crews to live and work safely on the Moon. Our efforts also fall under the foundational system domain area. By using lunar regolith simulants to synthesize geopolymer, we are fostering in-site resource utilization, in-space manufacturing, and additive construction. Our work also aligns well with the direction of Kenney Space Center Swamp works. In the Swamp Works laboratories, researchers are looking at how to utilize regolith for additive construction. The method we will present can be a potential solution to additive construction using in-situ resources on the Moon.

Work Plan

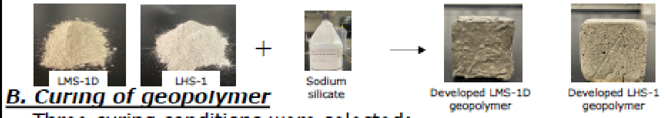
We used lunar regolith simulants to synthesize geopolymers for future lunar 3D construction



Formulation of Lunar Geopolymer Binder

A. In-situ resources

- *Two types of lunar regolith simulants i.e., Lunar Mare Simulant (LMS-1D) and Lunar Highlands Simulant (LHS-1) were used in this work*
- *Sodium silicate was used as the alkaline activator. The alkaline activator used contains 40% sodium silicate and 60% water*



B. Curing of geopolymer

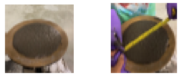
- Three curing conditions were selected:

- Ambient condition curing (20 ℃ and 50% relative humidity till 72 h and 168 h)
- High-temperature curing (93 ℃ and 0% relative humidity till 72 h)
- High-temperature curing (93 ℃ and 0% relative humidity till 72 h and -30 ℃ for another 96 h)

Developed lunar geopolymer binder testing

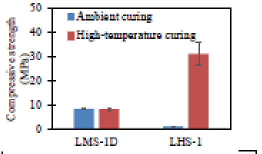
A. Flow of developed lunar geopolymer binders

- Developed LHS-1-based geopolymer binder has good flowability (flow of 100%) but poor buildability
- LMS-1D has poor flowability (flow of 92%) but good buildability

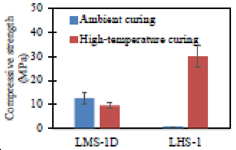


B. Compressive strength testing of developed lunar geopolymer specimens

- Compressive strength is the mostly widely used concrete material property. It can be easily obtained in the lab
- LHS-1-based lunar geopolymer developed highest compressive strength up to 31.12 Mpa when cured at high-temperature (93 ℃ and 0% relative humidity till 72 h) but has no effect at ambient curing conditions
- LMS-1D-based geopolymer exhibited consistent compressive strength irrespective of curing condition and curing times



Compressive strength of geopolymer binders after 72 h of ambient and high-temperature curing



Compressive strength of geopolymer binders after 168 h of ambient curing and 72 h of high-temperature curing and 96 h of low-temperature curing

Visual representation of fractured LHS-1 lunar geopolymer specimen showing highly porous structure

Visual representation of fractured LMS-1D lunar geopolymer specimen showing less porous structure compared to LHS-1-based geopolymer specimen

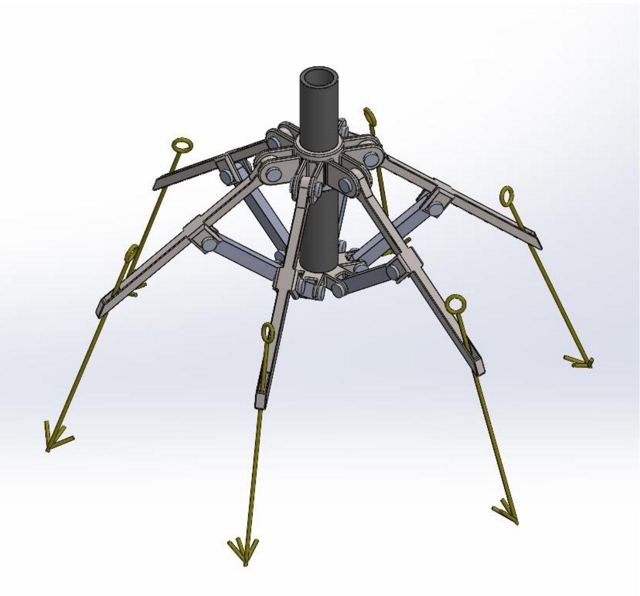
Ongoing Work

- Combine LMS-1D and LHS-1 regolith simulants to 3D print geopolymer

Acknowledgements

This research was supported by the NASA MINDS program. We thank the Concrete Laboratory at Texas State University for providing the facilities to conduct the experimental work

McLennan Community College



Fully Functional Lunar Ground Anchor

McLennan Community College Presents: The Pleiades Project
NASA MINDS - Artemis Project: Team Atlas

Ilyass Belaribia [Research and Design], Jonathan Bonilla [Media], Michael Deyo [Research and Design], Judith Marcos [Media], Edward Rodriguez [Research and Design], Solomon Stern [Team Lead], Ollie Wess [Auditing]

Problem Statement

Astronauts need a light, simple, and strong anchoring device for quick attachment and release action on a multitude of surfaces or structures.

Objectives

Our main objective was to create an anchoring device for the astronauts to be able to rappel into craters and hold or lower equipment. The following is required:

- Reliable and resistant wear
- Easily serviced on the lunar surface
- Quickly and readily reproducible parts
- Ability to withstand the unforgivable conditions of the moon
- Stay in locked position for an extended period without service

Research

Atlas investigated if there were any existing solutions as well as addressing environmental and terrain factors. Everything mentioned would have to be taken in mind for the prototype design. Moon dust would likely be our objective's biggest enemy. The problem of anchoring to celestial bodies is one that has been researched extensively by NASA, ESA, and other space agencies, but is not dissimilar to terrestrial anchoring problems, which have also seen attention.

Illustration of Philae. By ESA/ATG medialab

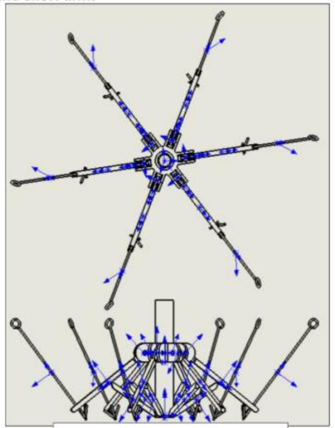
ESA's Rosetta Philae Lander
- Corkscrew anchors
- Angled harpoons
- Could not fasten to comet
- Failed mission

Stanford's Spiny-Bot, Sticky-Bot, and RiSE
- Uses micro-spines for textured surfaces
- Uses directional adhesives for smooth surfaces

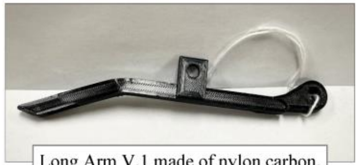
RiSE on Brick. By Mark Cutkosky · 28 Apr 2006

Design & Test

Early on we were able to settle on a base design for the anchor but after our first day of testing our design, we ran into our first issue. The arms of the anchor had difficulty performing to our expectations but after countless amount of redesigning the arms reached success. Following are first failed long arm and short arm:



An early conceptual design of Pleiades Anchor



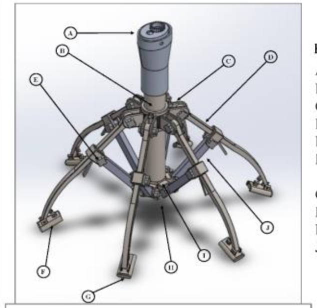
Long Arm V.1 made of nylon carbon. This arm snapped after 8 kg.

Short Arms V.1 made of PLA. Strapped vertically, this was able to hold at least 11 kg.

Following are two Trade Tables that contain our trade study data. The first compares three different 3D printing materials. The second compares multiple long and short arm designs that were tested in order to determine the best version according to our objectives.

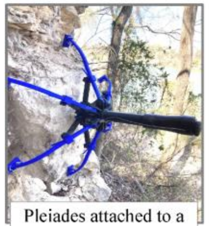
ID	Material	Shear	Tensile Strength	Susceptibility to Breaking in Natural Position	Shear against pins	Over-all Performance	Final Score:
1	PLA (Polylactic Acid)	6	5	6	5	6	5.6
2	NCF (Nylon Carbon Fiber)	2	8	7	2	5	4.8
3	PLA-CF (Polylactic Acid- Carbon Fiber)	8	9	7	7	8	7.8
	Ideal Score: 10						

ID	Part Name	Shear	Tensile Strength	Susceptibility to Breaking in Natural	Shear against Pins	Points of Failure	Final Score:
1	Long-Arm 0.1	6	5	6	4	5	5.2
2	Long-Arm 0.2	4	5	6	6	7	5.6
3	Long-Arm 0.3	8	7	7	6	9	7.4
4	Short-Arm 0.1	6	5	5	7	5	5.6
5	Short-Arm 0.2	9	7	7	8	6	7.4



Key:
A. Tensioner
B. Center Tube
C. Top Slide
D. Long Arm
E. Pin & Pin-Lock
F. Micro-spine Housing
G. Micro-spine Pad
H. Bottom Cap
I. Bottom Slide
J. Short Arm

Final Design Image of Pleiades Anchor



Pleiades attached to a vertical surface

Pleiades Anchor collects a rock

Looking Forward

The Pleiades anchor is a sturdy, reliable device that allows users to quickly grab objects and is easy to learn to operate. Future iterations and improvements upon this design might include:

- Improved modularity
- Usable with one hand
- Spring-loaded needles
- Variants for micro spines
- Authentic materials vs prototyping
- Redesigned tension mechanism to improve stability

Acknowledgments

We would like to thank the NASA MINDS program for providing this opportunity to our team. As well as a special thank you to our advisors, Dr. April K. Andreas and Prof. Larry Benton for giving us their time away from their families and by providing us the area, resources and guidance needed to take on this project.

Albany State University

Automatic Rover Detection of Craters

Automatic Rover Detection of Craters Using Sonar, Radar, and Lidar Triangulation Algorithms

Albany State University

Dr. Robert Owor/Amiralca Johnson, Sabrina Netters,Tavis Jackson, and Quyren Waldon

♦ Abstract

Throughout the years, various research has been conducted, theories have been discovered, and methods have been implemented that focuses on the detection of craters and navigation systems for space exploration. A crater is a "bowl-shaped depression produced by the impact or collisions of a meteorite, volcanic activity, or an explosion" (National Geographic Society 2012) and are located on planetary surfaces. They are the most abundant landform on the surface of planets and moons. Craters are vital features that are commonly used as research landmarks compared with other landforms, such as rocks, mountains, and cliffs.

♦ Introduction

The detection and identification of craters on a planetary surface are important for studying the surface and navigation. Landmark navigation utilizes crater information in a remotely sensed image for determining spacecraft orbits. Crater detection refers to discovering new and old craters in a given image. Determining crater identification means to catalog and map the craters to a particular reference crater. Unfortunately, there are no methods available to perform for detecting and identifying craters simultaneously. Therefore, in our research, we discovered that deep learning algorithms could be used for sufficient, accurate, and robust results.

♦ Questions

How do we reduce the damage of rovers during space exploration?

♦ Hypothesis

We propose a solution based on a triangulation algorithm of Sonar, Radar, and Lidar data, which is emitted from the rover as it navigates the surface of the Moon and Mars.

♦ Results

The triangulation algorithm and deep learning image classification training programs test to identify if an image is a crater or not. If the image is a crater, the output result would be yes and no if the image is not a crater.

♦ Results

The criteria for determining if an image is a crater is height, diameter/radius, circumference, depth, and location (latitude and longitude).

Mars Craters

Moon Craters

Husarion Ros Robot detects Craters

♦ Discussion

This research study aims to present the development and implementation of deep learning algorithms for automatic detection and classification and cataloging of craters on both the Earth's Moon and the planet Mars. Crater detection and identification are widely used and are key technologies in deep space exploration.

♦ Conclusion

Inspired by the algorithms of triangulation and deep learning image classification, our team has developed an effective solution to provide efficiency in detecting craters on the Earth's Moon and the planet Mars, which have distinctive characteristics when analyzed and image intensity.

♦ References

Bue, Brian D, and Tomasz F Stepinski. Machine Detection of Martian Impact Craters From Digital Topography Data. Jan. 2007.

Kamarudin, Nur Diyana, et al. "Detection of Craters and Its Orientation on Lunar." IntechOpen, IntechOpen, 26 Sept. 2012, www.intechopen.com/books/matlab-a-fundamental-tool-for-scientific-computing-and-engineering-applications-volume-1/detection-of-craters-and-its-orientation-on-lunar.

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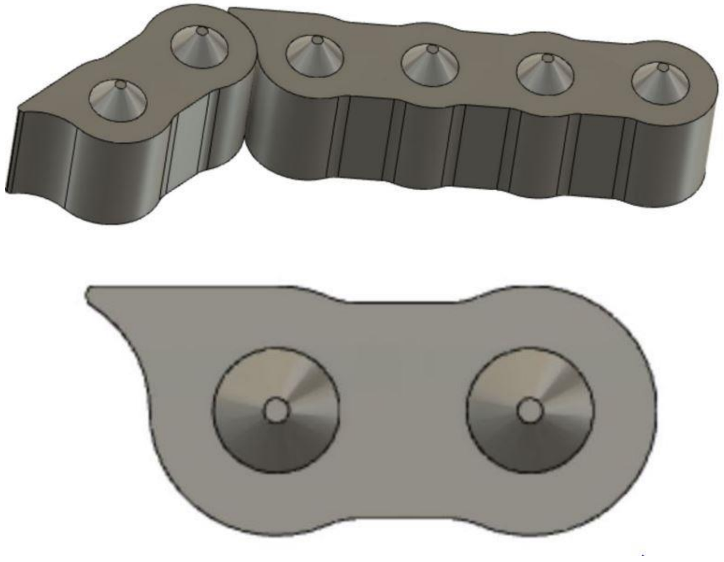
National Geographic Society. "Crater." National Geographic Society, 9 Oct. 2012, www.nationalgeographic.org/encyclopedia/crater.

Acknowledgements,
We would like to thank NASA Minds for enabling us to carry Out this research.

Bunker Hill Community College



In-Situ construction of building blocks

Blocks of Regolith for an Innovative Construction System

Bunker B.R.I.C.S. Team: Janine Rodriguez, Trang Nguyen, Iman F. Cherif, Sonia Zegdi, Aziza Rakba, Tim Butterworth

Bunker Hill Community College Honors Program, Boston Massachusetts

Artemis Mission Summary

NASA's Artemis lunar expedition program aims to land American astronauts, including the first woman and the next man, on the Moon by 2024. NASA will collaborate with commercial and international partners to establish sustainable missions by 2028. This program will contribute to new knowledge which will inform future missions to Mars.

As part of the NASA Innovative New Designs for Space (MINDS) Activity, undergraduate students are asked to design and build technologies needed for NASA's Artemis mission and the Human Exploration and Operations Mission Directorate.

The Bunker Hill Community College (BHCC) undergraduate team will investigate novel Blocks of Regolith for an Innovative Construction System (BRICS). BRICS will maximize the utilization of in-situ materials for construction. Modularity will allow for habitats, launchpads, and other structures.

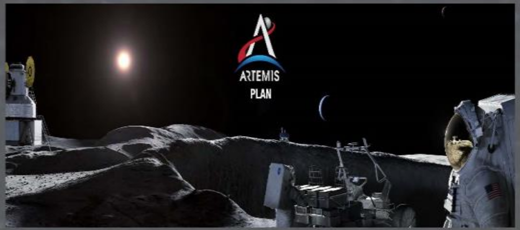


Image 1: NASA's Artemis Plan

Problem Statement and Challenges

Due to practical limitations on how much mass can be transported to the moon from Earth, NASA cannot simply launch an adequately sized habitat, let alone with enough material to thoroughly shield occupants from radiation and other lunar hazards. Therefore, sustained operations will necessitate in-situ construction of larger and more functional structures, leveraging lunar resources as building material. Some challenges include the harsh environment of the Moon,

Method

Our design philosophy was informed by the answers to three questions:

- What requirements have NASA identified for the minimum viable habitat for an extended lunar mission?
- What construction material geometries are needed to meet these requirements?
- What block design will most effectively allow for this geometry with minimal weight and resource consumption?

Project Design Process

1. Preliminary Prototype Review
2. Evaluation Matrix
3. Design Iteration
4. Experimental Design and Execution
5. Material Evaluation
6. Destructive Testing
7. Machine Design
8. Conceptual Design
9. Machine Proof of Concept
10. Block Design Finalization

Prototypes

Prototype # 1. A Heat Shrink Polymer Encasement

The lunar regolith was enclosed in a pre-designed plastic cube, and then wrapped the cube by two layers of PETG. A central feature of our design is the ability to use a lamination of heat shrink plastic to form the encasement of our bricks to apply tension around a quantity of regolith.

Image 2. Prototype # 1

Results

Prototype # 1. A Heat Shrink Polymer Encasement

Samples for the compression test. PLA containers with PETG layers with sand inside the cubes. This design was tested and could withstand a force of 7,100 Newtons without being deformed or broken.

Images 5. The brick with cube container and layers of PETG could withstand a force approximately 7,100 Newtons without being compressed

Prototype # 2. Sucrose Gelatin Concrete

This design made from sand and gelatin was tested. It was found to withstand a force of 7,100 Newtons without being deformed or broken.

Image 6 and 7. The sucrose gelatin concrete could withstand a force approximately 7,100 Newtons without being compressed.

Trade-off Table

Weight			
Points remaining:		0	0
Criteria	**Scale**	Prototype 1	Prototype 2
Block			

Conclusions

Both prototypes will only require a small amount of weight and cargo space to transport on the spaceship. They are easy to design and can withstand a range of force without being compressed.

After many experiments and tests, these prototypes satisfied the standards that first set – light weight, space-sufficient, time saving, and affordable price. These prototypes also demonstrated solid and unbreakable structures within a range of forces.

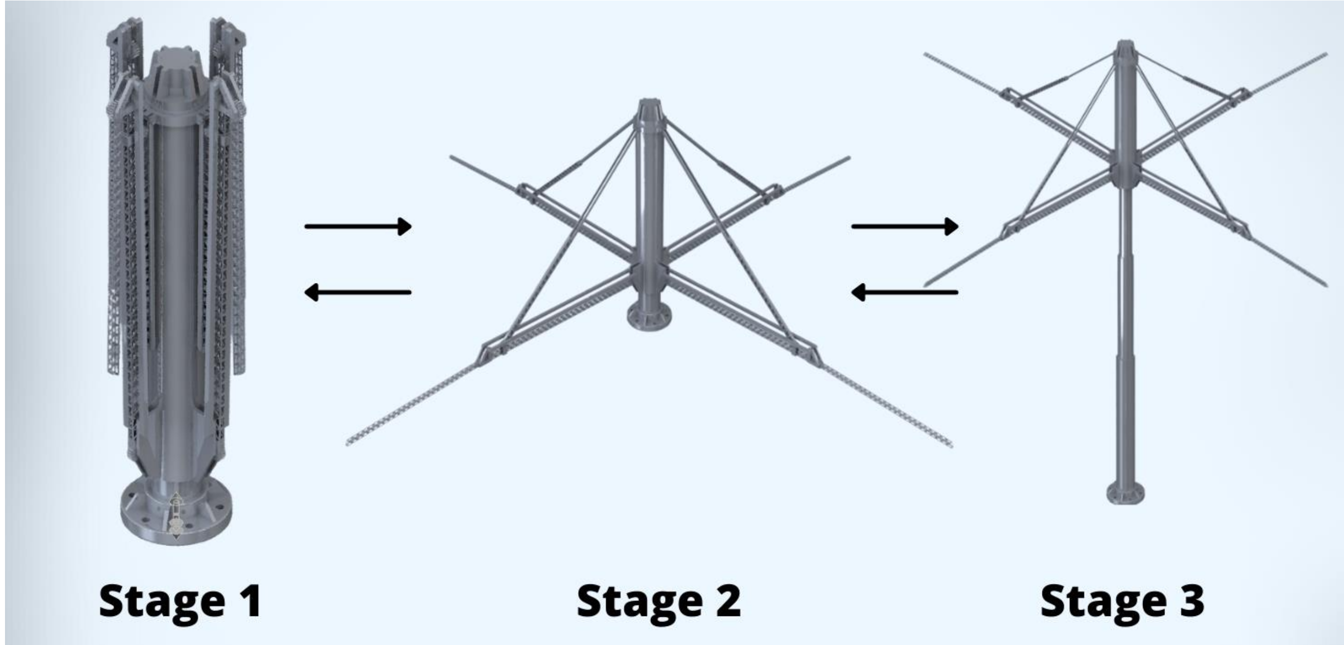
We designed a lightweight and durable encasement filled with lunar dust and a sucrose gelatin concrete. These composites were found to perform well in compression. The compression machine at Bunker Hill Community College cannot test compression which is over 7,100 Newtons. Both prototypes mentioned above withstood the maximum force that the machine could perform without being deformed or broken. There were 7 tests in total. The best 2 samples were selected as final prototypes (see images 8 and 9) based on the compression tests and durability.

Creating building blocks from lunar regolith is a promising method for utilizing in-situ resources without being fully dependent on supplies delivered from Earth.

Image 8 and 9. The best 2 samples were selected as final prototypes for Prototype # 1 and # 2, respectively.

Acknowledgments

Lone Star College - CyFair



Dust-Resistant Retractable Solar Array

Cy Fair Interstellar Deploying Actualizers

Adnan Khozema, Christian Jones, Haeseul Kim, Huy Vu, Khang Nguyen, Edson Ramirez
2020-2021 NASA MINDS
Lone Star College – CyFair, Engineering Department, Houston

Problem Statement

The purpose of the Lunar Surface Array Structure (LSAS) is to act as an expandable and retractable mechanism for the efficient deployment of solar arrays that will power NASA's lunar base, which will easily attach at least two of three different surfaces such as the Lunar Surface, Rover body, and ISS. System height reaches 14 meters, and the solar array is open at an angle of 223° SW. It makes it easier for NASA to move its system to a new location without disassembly requirement by having expandable and retractable mechanisms.

Background

NASA would like to have a reliable energy esource on the South Pole of the Moon to advance technology for future space exploration. Our proposed design aims to maximize the ease of deployment, elevation reach, retractability and portability, and weight reduction of Lunar Surface Array Structure for lunar base camp operation. This proposed design will provide the effective means to deploy Lunar Surface Array Structure (LSAS), which will provide Artemis Base Camp with constant and sufficient solar energy for sustainable operation and habitation on the Moon surface.

International Space Station | Lunar Base | Insight Lander Rover

Design Objectives

1. Device shall be able to open the booms when it moves in a linear pattern. The device shall include a corkscrew mechanism for gear operation.
Design Solution: The device uses the corkscrew mechanism of a wine opener which converts the pole's systems linear motion into circular motions of the booms.

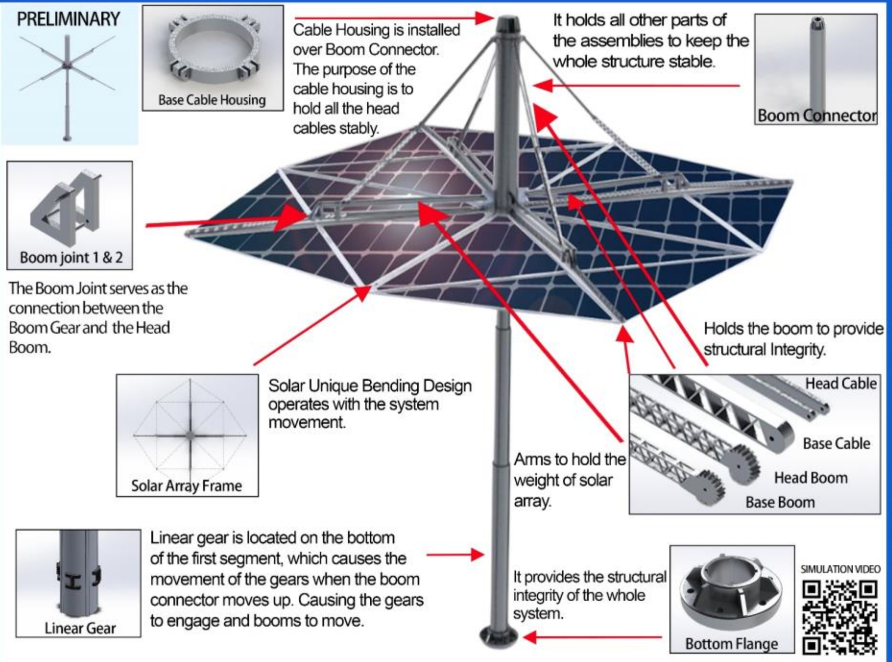
2. Design should be installed on various surfaces.
Design Solution: The device shall be removable at the bottom flange.

3. The device shall cause no damage to the Solar Array while in Operation.
Design Solution: The Solar array is mounted on the booms; therefore, there is less chance for the solar array to get damaged.

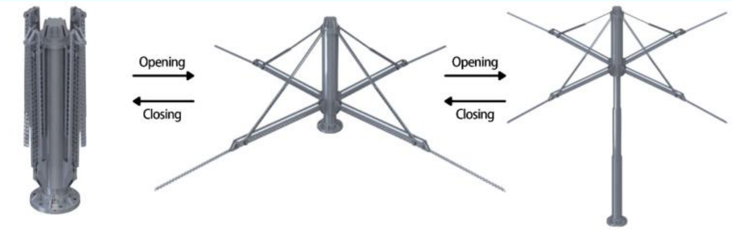
Design Process Methodology

Define the Problem → Background Research → Specify Requirements → Brainstorm, Evaluate, and Choose Solution → Develop and Prototype Solution → Test Solution → Communicate Results

Final CAD Model

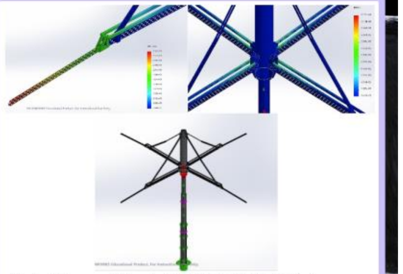


Prototype Operation



Retracted System | Intermediate State | Fully Expanded System

FEA Analysis



Finite Element Analysis (SOLIDWORKS®) shows:

- 1KN force is the weight of the solar array under moons gravity.
- The stress displacement is indicated by the color scheme, the redder the color the more displace ment that area has due to the 1KN force.

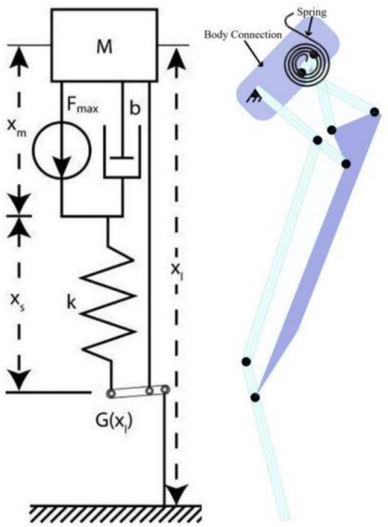
Conclusion/Future Work

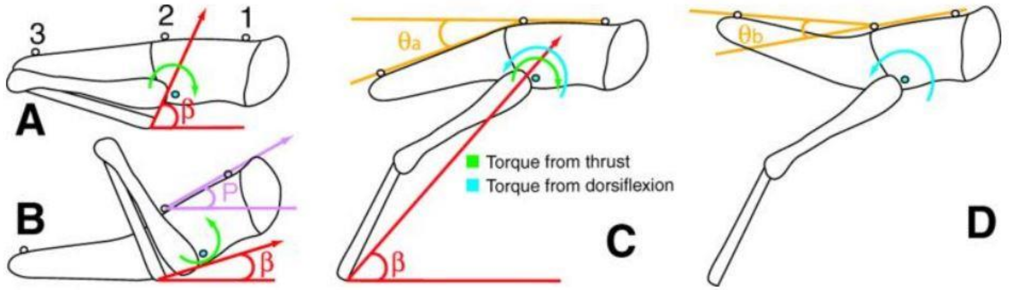
- Team CIDA successfully designed and prototyped mechanical Solar Array structure that meets NASA goals to have an array structure that can reach the height of more than 10 meters and operate at an incline angle of 15 degrees to capture continuous sunlight at the lunar south pole.
- System retractability is to provide reliability and minimum packing volume.
- It can use to all three surfaces Lunar Surface, Rover body, and ISS with desired reliability, flexibility, and ease of use.
- Our goal in future research would be to lessen the weight of the structure by using different materials that provide better stability, and strength.

Acknowledgements

Team CIDA thanks advisor Professor Yiheng Wang for directing the team. Team CIDA thanks NASA MINDS for this opportunity to learn practical applications and influence the importance of the Artemis mission.

New Mexico Institute of Mining & Technology & Southwestern Indian Polytechnic Institute





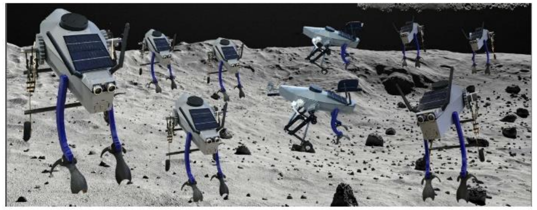
Swarm of Locust-Inspired Robots for Moon Exploration

Moon Hoppers: Swarming of Jumping Lunar Robot

Brenden Herkenhoff[1], Sara Lanctot[1], Trent Bjorkman[1], Nathaniel Serda[1], Tishai Yazzie[2], Veronica Martinez[2], Tiresius Johnson[2], Caresse Davis[2], Dr. Mostafa Hassanalian[1], Dr. Nader Vadiee[2]
Department Mechanical Engineering New Mexico Institute of Mining & Technology, Socorro, NM 87801[1]; Southwestern Indian Polytechnic Institute[2]

Introduction

As it stands, the two primary focuses of space exploration are the Moon and Mars, due to the attainable travel distances using current technology. Both provide a unique challenge in exploration and data collection; however, as the Moon has no atmosphere, the modern approach of aerial drone-based exploration is not an option. In the past, planetary exploration and data collection has been limited by the employed modes of transportation in related missions. The main implementation has relied on more traditional automobile-based rovers; however, this method is significantly limited by maneuverability. Unfortunately, rough terrain, obstacles, dust storms, and environmental conditions make it challenging for traditional land rovers to efficiently explore and cover large amounts of terrain. Applying these land rovers has opened many exploration and data collection opportunities, but the rate at which these have been carried out leaves more to be desired, especially due to a large number of unreachable areas.



A Novel Jumping Solution

The implementation of a novel bioinspired design focused on the jumping locomotion of locusts may be advantageous as such a design could reduce the limitations of exploration by vastly expanding the movement capabilities of rover systems on the Moon. In conjunction with this expanded range of movement, this design would be compact and lightweight allowing for the transportation of several units designed to operate in a swarming fashion. These swarm mechanics would allow for communication between members to more effectively perform missions over a large area, such as terrain mapping, or lava tube exploration.

Figure 2: CAD Model of the Lunar Locust

EXPERIMENTAL SECTION

The robot has successfully integrated the ultrasonic sensors, LiDAR, and thermal camera in a limited capacity, and will be improved upon as the robot progresses. At the moment these

Figure 3: Prototype 1, right-view

Design Components

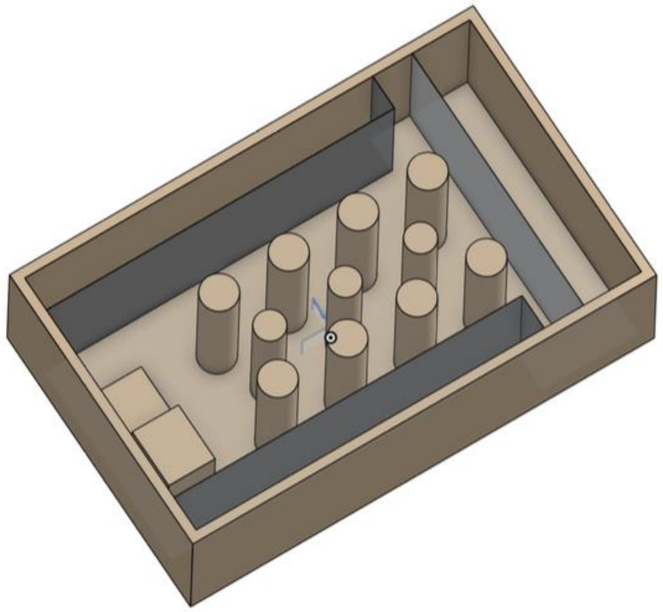
The swarm of the proposed bioinspired concept: (1) has significant merit and enables dispersed measurements at different cave and lava tube locations on Moon; (2) has the capability to obtain thermal information, temperature, radiation levels, and geothermal heat sources; (3) to obtain images of walls, ceiling structures, and floors in the caves and lava tubes; (4) obtain information and images of any water sources, and subterranean aquifers.

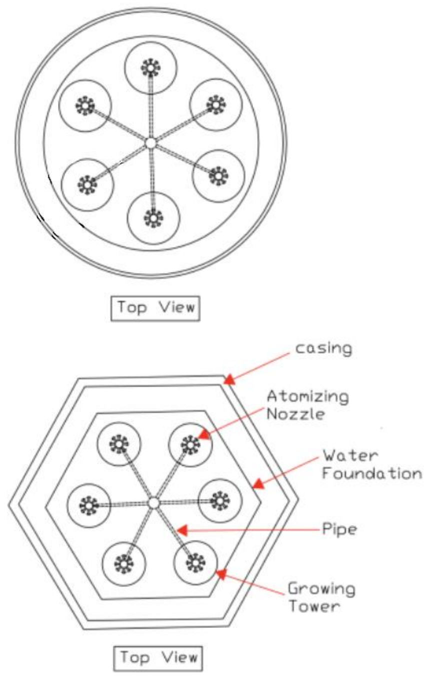
It would utilize two main jumping legs connected to a central body that will house necessary electronics and actuation mechanisms. This housing will also provide a platform for exterior solar panel mounting as a common energy harvesting technique. By employing the key jumping mechanisms of a locust, an effective transportation mode will be attained, allowing for increased efficiency and range of

Design Inspiration

Locusts were selected as the primary inspiration due to their noteworthy control when performing movements, providing high maneuverability, and their capability to effectively jump much higher and farther than their size. This capability would allow for the exploration of hard-to-reach areas such as elevated regions, steep slopes, and highly rocky obstructed terrain. The implementation of a swarm of the suggested robot will allow for continuous data collection with the ability to easily reach previously challenging areas with higher efficiency. The swarm aspect of this design will allow for a significant number of data points to be collected at a high rate while providing backup units in the event of a failure or malfunction, ensuring extended survival of the mission.

Montgomery College





Development of Lunar Greenhouse

Lunar Underground Greenhouse (MC Green Thumbs): Hydroponics Surpass Aeroponics in Short-Term Experiments

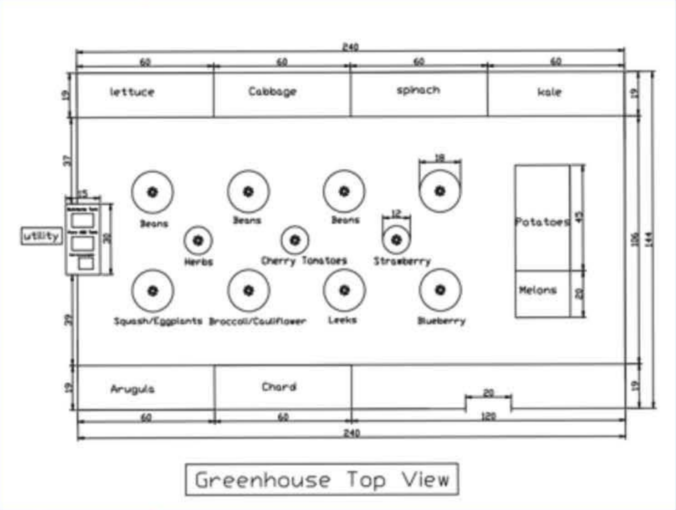
Members : P. Kabthiyal, N. Khan, A. Shahmor, A. Knox, C. Ogunsola, L. Sabatte, A. Tran, F. Yang
Research Mentor: Professor Jennifer Lee

Introduction

Overview | Lunar Underground Greenhouse

For the Artemis mission, this team focuses on the long-term effects of sustainable human exploration on extraterrestrial planets. The main component of any sustainable colony is food or the continual growth and harvest of plants.

Design | Lunar Underground Greenhouse Top View



Research Experience

Prototype | Soil, Hydroponic, and Aeroponic Systems

Figure.1 Soil System separated to lessen contamination and help maintenance

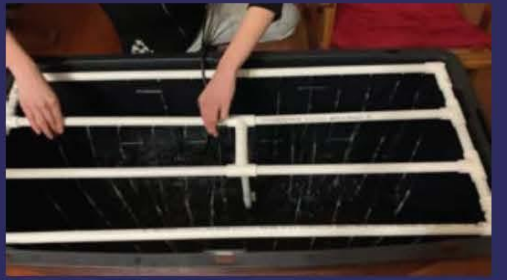


Figure.2 Assembled pipes in Aeroponic System with water pumping through

Figure.3 Hydroponic System with eight growing sites, including a thriving basil plant

Key Findings

Three individuals were needed to create the simplified aeroponic system, whereas one was able to create the simplified hydroponic system. The hydroponic system also used less water than the aeroponic system. Issues arose with material malfunctions and plant death.

Montgomery College

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

APPLY

https://nasaminds.org/application

DEADLINE OCTOBER 18, 2022

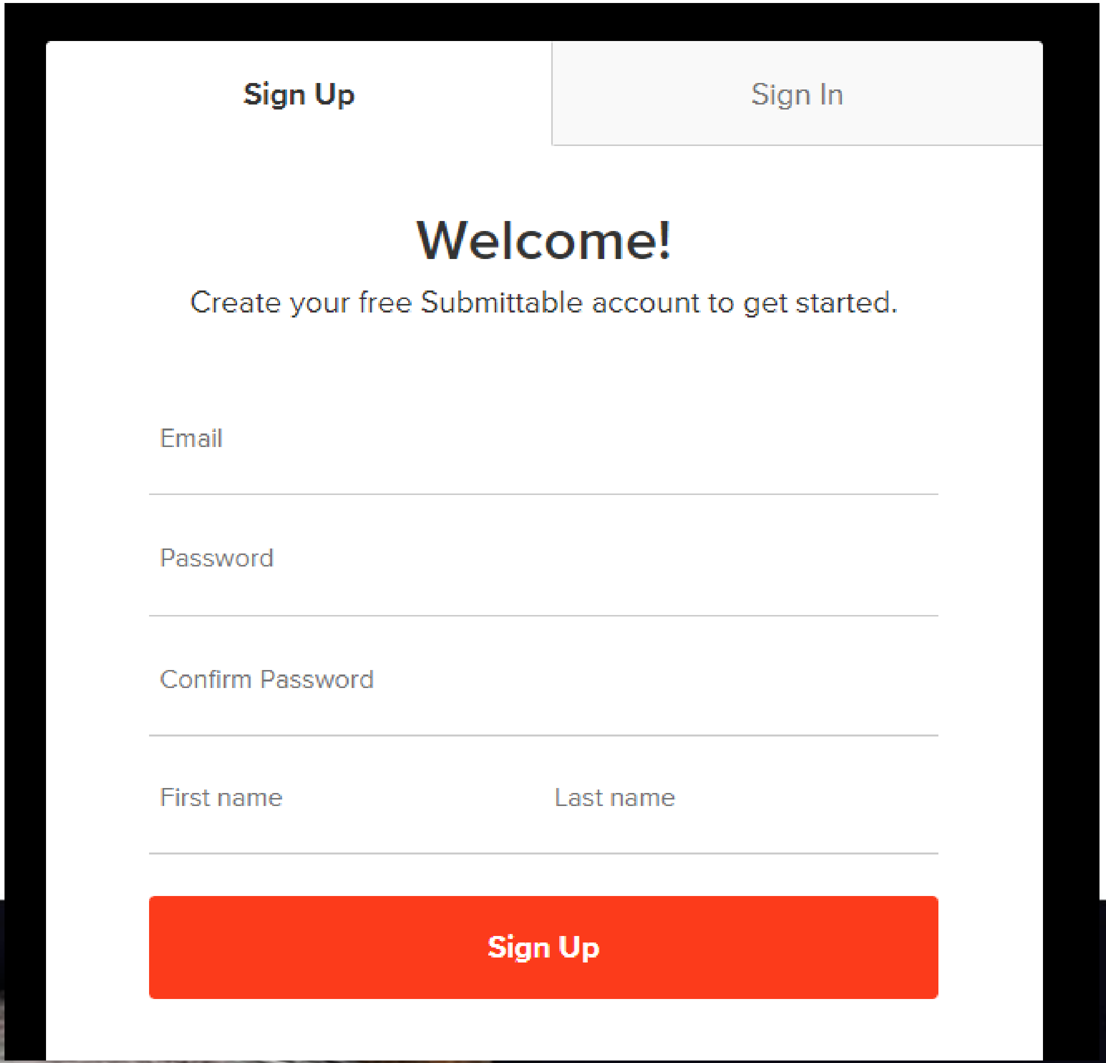
WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

YOU MUST FIRST CREATE A "SUBMITTABLE" ACCOUNT

It is found on the application page and only requires name, email, password. Once completed the application will appear.

Please keep in mind that this will be your official team account. You will get notices to this email, and you will use this account to upload deliverables.

Consider making a shared account by creating a general email account such as a gmail, so you can share the email and credentials within the team.



WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

Official School Name *

Please carefully enter your official school name. The manner in which you enter it (example: "Florida A&M" vs. "Florida A&M University" vs. "Florida Agricultural and Mechanical University") will be how we will reference your school on websites, programs, certificates, etc.

School's Street Address *

School's City *

School's State / US Territory *

Select...

School's Zip Code *

Team Nick Name *

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

Student Team Lead Name *

First Name

Last Name

Student Team Lead Email *

email@example.com

Student Lead Phone number

If you don't have a team lead you can enter TBD and use your/faculty email.

This can be edited later.

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

My school is Minority Serving Institution because it is classified as a:

- [ ] Asian American and Native American Pacific Islander (AANAPSI)
- [ ] Alaska Native and Native Hawaiian (ANNH)
- [ ] Historical Black Colleges and Universities (HBCU)
- [ ] Hispanic Serving Institution (HSI)
- [ ] Native American Serving Non-Tribal Institution (NASNTI)
- [ ] Predominately Black Institution (PBI)
- [ ] Tribal College or University (TCU)

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

Signed Letter from Faculty Advisor *

Choose File

Upload a file. No files have been attached yet.

Acceptable file types: .doc, .docx, .pdf, .gif, .jpg, .jpeg, .png, .svg, .tif, .tiff

Please upload a SIGNED letter from the faculty member, on university letterhead, indicating that your team has the support from its university/college to participate, and that he/she has agreed to serve as the Faculty Advisor for the duration of the project. The faculty member will receive a $1,000 stipend upon successful completion of the project.

The faculty advisor shall submit a letter must include the following:

a. A statement that the college/university is aware of and in support of the team's participation in this project.
b. A statement that they have agreed to serve as the team's Faculty Advisor for the duration of the project.
c. A statement that they will track and manage the $1,500 team stipend funds if the team is selected.
d. The letter must be on the school's letterhead.
e. The letter must be signed by the faculty advisor.

MAKE SURE YOUR LETTER HAS THE STATEMENTS LISTED IN ITEMS A THRU E.

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

Do you have an official collaboration with another school that is competing? *

- ◯ Yes
- ◯ No

THIS IS OPTIONAL. NOTE: IF A COLLABORATING SCHOOL MUST BE A HIGHER EDUCATION INSTITUTION THAT IS AN MSI.

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

Title of your team's Proposed Project (15 words max) *

1 /

Description of what you plan to design and build (In 500 to 1,000 words max). Please include what technological gap or problem this project seeks to address. *

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

Is your project based on one of the Spec Sheets found in NASAMINDS.org/spec-sheets/ or your own research? *

- (selected) Yes, I found it in NASAMINDS.org
- No, I did my own research

Note: There is no competitive advantage to using the spec sheet versus your own concept

NOTE: THERE IS NO COMPETITIVE ADVANTAGE TO EITHER OPTION

Please indicate which Spec Sheet you are using *

Select...

1) Sound Monitoring and Control for NASA's Spacecrafts
2) Cleaning Clothes in Space
3) Compact Commode in Space
4) Dust Mitigation Technologies
5) Exercise Vibration Isolation
6) Food Resources
7) In Space Welding
8) Inventory Tracking

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

Title of your team's Proposed Project (15 words max) *

1 /

Description of what you plan to design and build (In 500 to 1,000 words max). Please include what technological gap or problem this project seeks to address. *

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

Executive Summary that we can share PUBLICLY if your project is accepted (100 words max)

Technology terms corresponding with your project (10 words max) *

WHAT DO I NEED TO SUBMIT IN MY APPLICATION?

How does this project support the NASA's Artemis Mission (In 25 to 100 words max). *

I HAVE read Rules and Rubrics and agree to abide by them. (see link to rules below) *

By checking this box you agree to that you have read the rules and rubrics, and agree to abide by them. The Rules and Rubrics can be found HERE.

Save Draft

Apply Today

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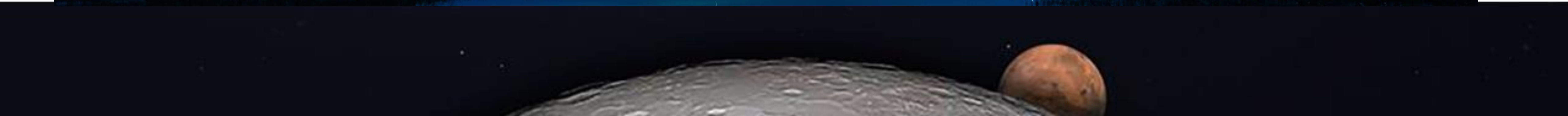
APPLICATION DEADLINE 10/18/22

https://nasaminds.org/application

TAKE ACTION!

Programs like NASA MINDs can change the trajectory of a student's life!

…. we know this to be true because we have seen it repeatedly.



HOW CAN WE HELP YOU?