Lunar Dust Baffles
Semi-Finalist List
for
NASA HUNCH
Design and Prototyping 2021

Congratulations for being chosen as a Semi-Finalist for NASA HUNCH Design and Prototype 2021. Your design was chosen as a semi-finalist because you have a prototype that shows some or all of your idea, interesting/original ideas in your design, you did some valuable testing, and/or had some CAD designs that conveyed significant contributions. Despite the difficulties and not as many schools participating this year, I believe that HUNCH has received as good of quality of projects as ever. You should be very proud of your prototypes and ideas especially because of the difficulties surrounding this school year. Some schools have been out of class all year and others have been in class all year but students were being pulled out of class for weeks at a time. Some students were only able to work and build from home. One school was only able to work together on their project for 3 weeks before their CDR. Everyone should be commended on your resilience to finish your project and the great ideas and work you have put together in front of your own eyes. Prototyping and testing are the first steps in any engineering project and all of you have learned the value of it.

It is from the Semi-Finalist list that we will narrow down our choice for Finalists. We at HUNCH are very proud of how difficult you as students and teams have made it to choose which designs should go forward. **Congratulations!!!**

This list may be updated in the next day or two if we find we are missing a few team's brochures.

We expect to have the list for the Final Design Review in the next day or so as well.

NASA Hunch: Lunar Baffles

February 10th, 2021

Product Overview

In outer space, there are many factors that make space-travel dangerous. From extreme temperature fluctuations to space debris, many things can cause trouble for astronauts. One of the most pervasive issues that NASA faces is radiation. Radiation is far more lethal on the Moon than on Earth due to the lack of an atmosphere or magnetic field. Because of this, radiation will prove to be debilitating for the crews that are working/living in their habitats.

Solution

In our group, we aim to help NASA with our solution to the problem of radiation. Since the habitats are inflatable, we took inspiration from the Bigelow and thought of an idea of covering the habitat. In the image, you can see our prototype that demonstrates how the entire system will work. It only consists of two parts, which are the tarp and the foam layers(not including the stakes in the ground or the brads connecting the tarp and the tarp).

Before you inflate the habitat, you place the tarp on top of the deflated habitat. This tarp will have brad-like ends sticking throughout the tarp. After the tarp is secured into the ground, the foam sheet is expanded and placed on top of the tarp. The brads are folded

out onto each hole, making it the ideal attachment method instead of something more arduous like tape. Once everything is connected, the habitat can expand. As the habitat expands, the tarp and foam will stretch out with it. Once done, the baffles are ready to collect soil.

Advantages

Our product can give NASA certain advantages that other products can't. Some of the strengths of our product are the light-weight materials, which will help during transports and setting up the system. Another strength is that the product is very simple. This means it will be easier to build, design, and test. This means that no complicated or innovative technology will be required. Something else to know is the flexibility of the product. Our group has thought in the past of using multiple layers to collect soil to reach the 5-foot height required. This is why the prototype has a line on the side, demonstrating the size of a layer of foam. If we needed to implement this technology or we found out it wasn't necessary, then we can simply change the size or type of foam we use. The main brand we planned on using was open-celled polyurethane foam, which is already used on NASA spaceships.

Contacts

Leader- Braden Johnson

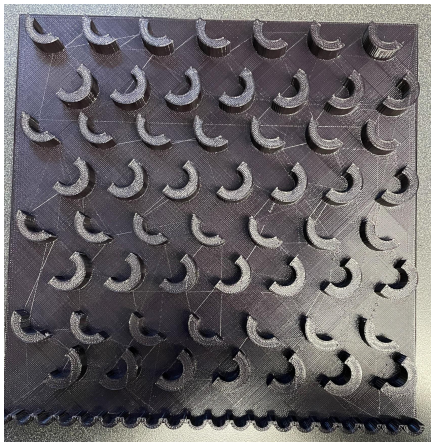
Trey Golden

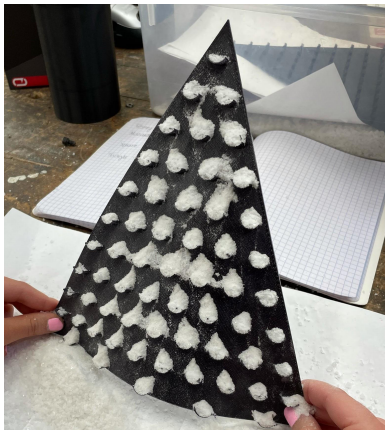
Jaxon Lloyd

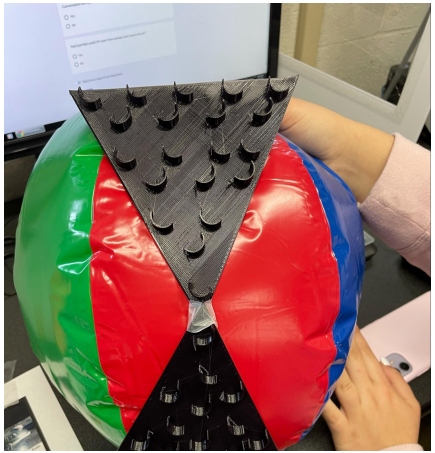
Dusty Waffles
(Lunar Soil Baffles/Waffles for Habitats)

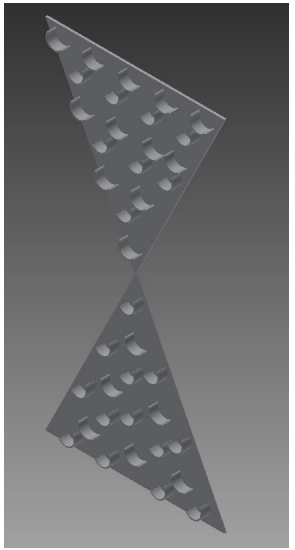
Kettering Fairmont High School
Brett Jenkins
By: Madison Reents and Savannah Gross

We have created a “Plinko Board”-like system that has angled pockets that hold and guide the lunar soil to cover the habitat evenly.









Critical Design Review

Project Title: **Lunar Dust Retention**
School Name: **Space Coast Jr/Sr High School**
Teacher: **Mr. Reyes**
Team Member Names: **Taramina Gibson** and **Patrick Marcello**

The project is within the requirements and constraints given to us. We solved the issue of radiation by allowing regalith to be caught in the baffle. The Model has been done 1:12 to what we assume the size of the habitat is. We do have a model and (Currently there is no 3D rendering). The model is intended to function identical to how it would on the lunar surface. The model is aimed towards the baffle and its structure. At the moment the 2nd prototype does not function, but the 1st one is complete and works as intended. Our baffle design has not been tested as of Friday, but is expected to hold all the soil up to the height of the walls. Although we could not attempt to replicate the baffle itself. With the research and concepts provided to us by the project description, we have a good idea that it will work accordingly. The model is very simple in design and could be easily replicated with an understanding of how to make circles with paper. Since the baffle ‘inflates’ with the habitat, gravity has relatively no effect on whether it works or not. Although the model does use COTS items, the final product will not use COTS.

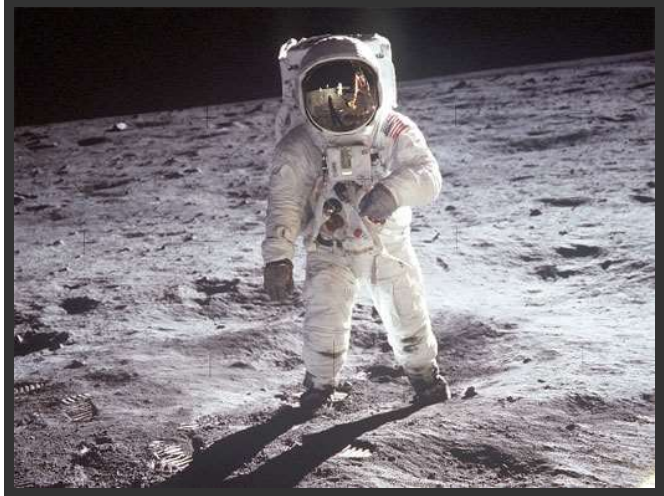
LUNAR DUST BAFFLES

PROBLEM STATEMENT:

NASA is creating lunar habitats to facilitate living on the moon for extended periods of time. To do this, NASA needs to protect the astronauts from radiation and meteorites. NASA determined that 5 feet of lunar soil coving all sides would provide sufficient protection. Our task is to design a baffle system attached to the habitats that will allow the 5 feet of dust to adhere to the habitat.

JUSTIFICATION:

Our solution is to create an outer baffle layer made of Kevlar and filled with expanding foam to support the lunar dust to protect the inflated interior. Expanding foam becomes rigid and dense once it fully expands, giving it the strength to support the lunar dust. The outer Kevlar layer will provide a barrier between the foam and the dust, protecting it from soil and dust launched by the Lunar Dust Blower.



Contact Information

Stephen Himel-Hansen

Easton Tucker

Joseph Norman

"IT'S THE DOME THAT'S FILLED WITH FOAM!"

LUNAR HABITAT BAFFLE SYSTEM

By

Stephen Himel-Hansen, Easton Tucker, Joseph Norman

For

Instructor Mr. Merritt

Architecture and Civil Engineering

Clear Creek High School

CCISD

NASA HUNCH

High school students United with NASA to Create Hardware

THE FOAM

Leveraging the properties of 2 part expanding foam, we can fill the dome quickly and efficiently with solid material to provide support for the lunar dust and protect the inner inflated dome from potential breaches.

On Earth, polyurethane foam expands to 30X its initial volume, allowing small amounts of liquid to fill the exterior shell. Using varying amounts of blowing agent, we can control the density of the foam to anywhere between 10psi and 100psi to create more rigidity or more flexibiliy as needed.

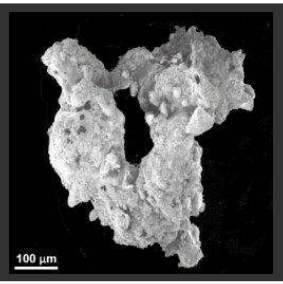
To create a representation of the rigidity of our baffles, we created a small section of tubing from canvas and filled it with a can of expanding foam. (See Below)

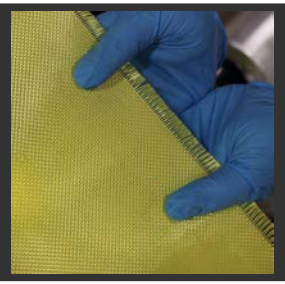
THE MODEL

To create our model, we decided to use upside down bowls to simulate a rigid exterior to place our baffles on. We utilized small, clear tubing to create rudimentary baffles and attached them to the hab using caulk.

To create a housing for our model, we used a large box and a piece of plywood. To replicate as closely as possible the shape and properties of lunar dust, we used premixed mortar powder.

To simulate the baffles as closely as possible, we created circular canvas tubes and filled them with expanding foam to demonstrate their ability to be utilized in this fashion.





THE DOME

Knowing that lunar dust is jagged and sharp, we decided that the inner habitat needed to be protected from projectiles.

We decided on Kevlar, for its great puncture resistance and its durability. With Kevlar covering the habitat, there would be low potential for punctures to occur.

Our baffle design is replicating the agricultural terrace system, with a slight modification – indented channels to hold dust. (See Below)


Life
is

NASA HUNCH
Critical Design Review

Project Title: **Lunar Soil Baffles/Waffles**

School Name: **Space Coast Jr/Sr High School**

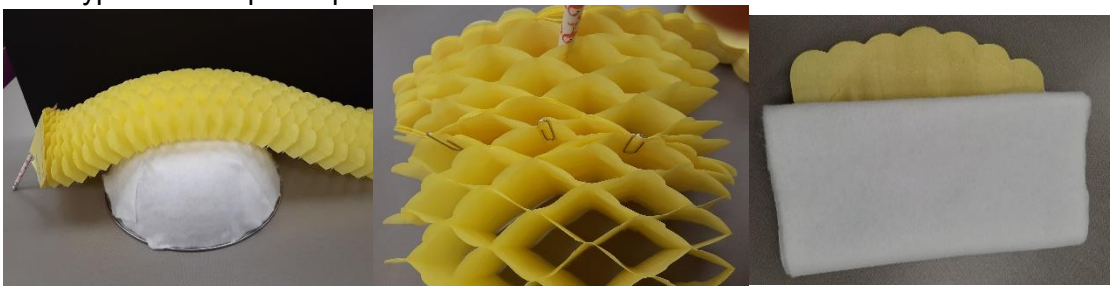
Teacher: **Mr. Luis Reyes**

Team Member Names: **Shayley Dauphinee, Alicia Merrell, Devon Merrell, Rachael Dey**

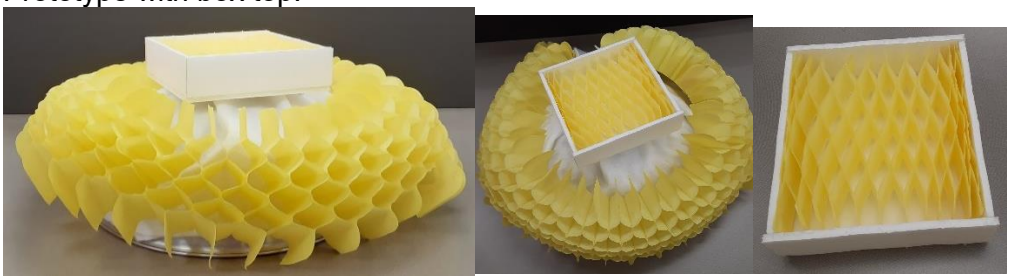
Description:

Our project/ idea has two different forms, the first involving split strips that drape over the whole habitat. Each strip will be divided into thirds so the creation can be folded up and easier to transport. The strips will have a honeycomb pattern of holes to gather the soil. Our design is connected to a tarp that will help provide a sheet of protection between the habitat and any possible sharp objects. The tarp will break in the same areas as the baffle strips and will be connected much like a quilt with zippers. The baffles will connect together with hook and eye clips. This strip type design would be used for habitats with a rounder structure. The second form of our design includes a box top. The box contains baffles the same as those used in the strips, just contained in a box. The purpose of this design is to fit habitat structures that have a flatter top. Because the strips are split into thirds the middle section can be removed so that the box can be connected in its place, the strips would then proceed to cover the rest of the habitat. In both designs the strips would extend to the ground and extend out a bit in order to help pin the structure (tarp included) in place. The baffles breaking apart into strips will make them be able to fold down smaller for transport. The width of the baffles will be about 5-6ft in order to provide the thick layer of dirt needed, and the height of the baffles can be adapted to any habitat to be as tall as needed. The materials utilized for our project will include; Kevlar for the baffles (which is flame retardant and abrasion resistant), and Nylon and Technora for the tarp (the same type of material as used in the mars rover parachute). The zipper type that we would look for would have large, aluminum teeth and lining it would be a fire retardant material (possibly more Kevlar).Our project will cover all parts of the habitat and be able to hold the required 5 feet of soil while also being lightweight and collapsing down into a small space for transport. With the testing of our prototype we used the box top that we had created. We used dirt and had simply thrown, (we threw it to possibly simulate a blower throwing dust over the top of it), over the box to see how well it would hold. When looking at how the dirt stayed in the box we could see that where it initially landed was where the dirt stayed within the baffles and the dirt built up quite nicely. With our prototype there was a small gap underneath the baffles that met with the box, so it was surprising to see that the dirt didn’t spread throughout the under layer of the box before building up within the baffle holes.

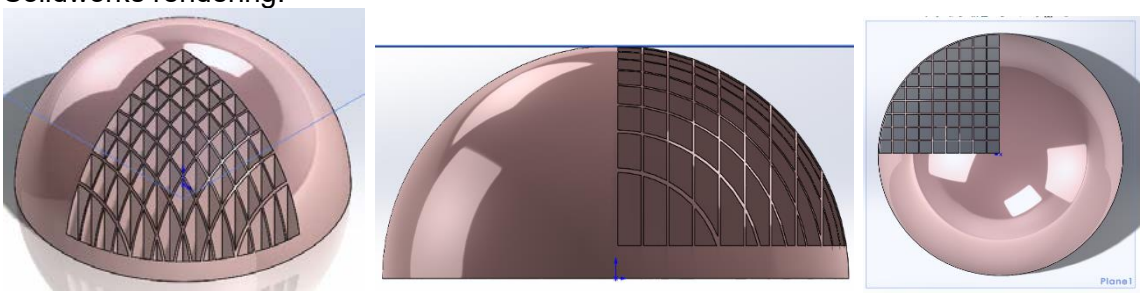
Prototype in third split strips:



Prototype with box top:



Solidworks rendering:



Testing our solution:

Background

We began by brainstorming different shapes that we could use to hold soil and pretty quickly settled on a diamond/square shape as it's fairly easy to build and can hold soil effectively. We developed a cardboard prototype that outlined the general shape that we wanted to go with. We then expanded that idea and added hinges to allow the baffles to collapse and expand for transportation and allowed them to bend to fit the dome shape of the habitat. This turned into a prototype with smaller panels connected to each other with larger, more flexible hinges.

1. Be able to adapt to the dome shape of the habitat.
2. Hold a depth of 5 feet of soil on top of the habitat.
3. Easy to transport to the moon.
4. As little work for astronauts to install.
5. Any installation should be simple and safe for astronauts.
6. Attaches to Inflatable habitat.
7. Folds out as habitat inflates.

Moon Waffles

Chatfield Senior High School
HUNCH Program

Colton Giles, Tim Falin, Ethan Campbell

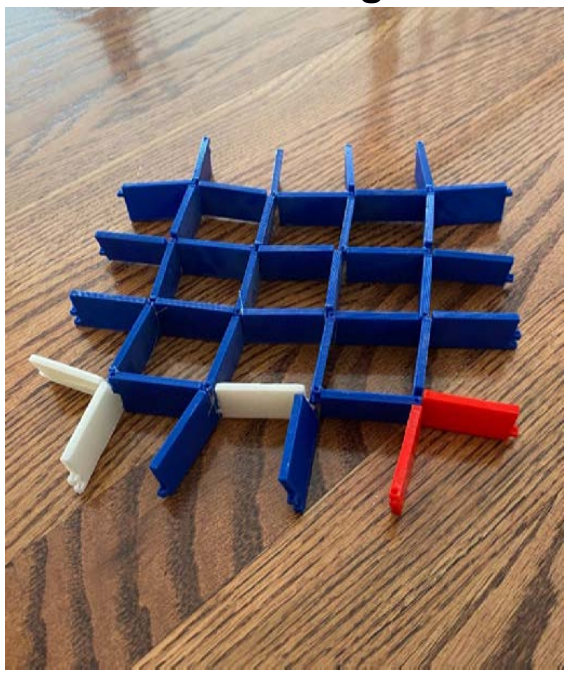
The first prototype was unsuccessful because it did not have enough flexibility to curve around a dome and stay curved.

This was our next idea, which was minorly successful because it proved that our pieces would attach together but made us realize that we needed to have more flexibility through a smaller pin.

The Project

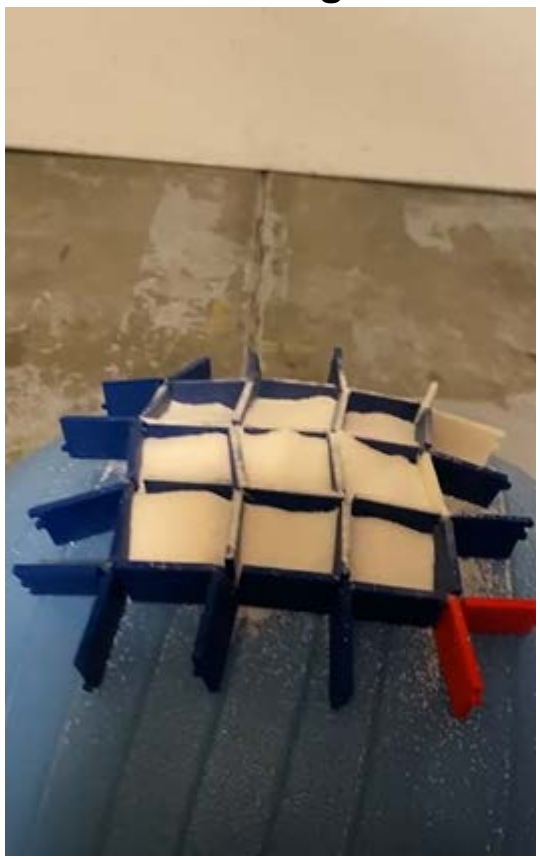
Astronauts need a way to protect themselves from radiation while in their enclosures, and lunar soil is a cheap and easy way to accomplish that. We need to design some way to hold lunar soil on the sides of the lunar habitats to protect the inside from radiation.

Final Design



This is our final design. We achieved the design by searching for maximum flexibility while still keeping proper strength. This design succeeded in all of our decided criteria and held the sand well.

Testing



Lunar Soil Baffle

School:Tri-County Reg Voc Tech HS

Franklin, Massachusetts

Teacher: Ms Magas

Team Members: Tony, James, Tyler ,Brian, Max

Description

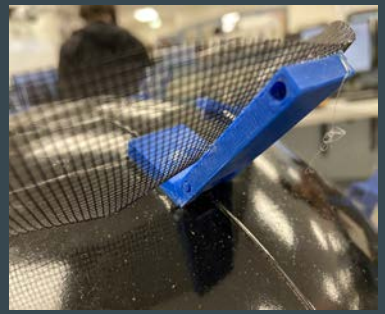
Our Lunar Baffle idea is designed to hold 5 feet of lunar soil on every square inch of the design. The ring idea is meant to use the soil as a shield to protect the astronauts from extreme temperatures and radiation.

Measurements

Meeting requirements and constraints.

Provides 2-3 inches of coverage that corresponds to 5 feet on a full-size scale.

- Our design is easily collapsible and takes up little room on the ship
- The hinges on the side fold-out once the habitat opens up and lock in place
- The rings have a lot of space so that you can fit many feet of soil



Waffle Baffle

Kevin Miller, Tommy Tracy, and Greg Kelley
Glenelg High School
Glenelg, Maryland
Mr. Gerstner

Waffle Baffle Brochure

April 2021

Final Habitat Design

- This design is similar to a pool dome. We chose to go with the arched roof because we believed this would lead us to use the least amount of parts, because we could be able to push the sawdust against the sides of the habitat.
- We plan for it to be brought in pieces and set up on the moon.
- Next Step: Making the habitat inflatable. We think the chicken wire frame can be an outline for the inflatable part.

Waffle Baffle Pieces

- We built them in a hexagon shape so they could easily fit in a grid like pattern.
- We eventually wrapped them in wire filtering cloth because it is a very strong material.
- Next Step: Develop a good grid like pattern to place on the habitat, develop a way that they can either stack or decompress.
- Also, make it into a sheet so they are already connected, and it is easy for the astronauts to put out.

All Coming Together

- In the first picture we wrapped in plastic wrap, but it is a good demonstration of how the pieces link together.

- In the next picture we placed gravel on our habitat, in case there were outlier pieces of lunar soil.
- In the second picture the habitat held 10.2 pounds of gravel.

Calculations

- The weight on the Moon is ⅙ of what an object would weigh on Earth.
- Lunar soil weighs 93.64 lb/ft³ on Earth.
- On the moon-15.6 lb/ft³
- Sawdust- 13.11lb/ft³
- We decided to use sawdust to test our designs because it's the closest to lunar soil in weight when it's on the moon.
- So, for 5 cubic feet of lunar soil it would be around 78 lb/ft³ on the moon.
- Structurally, we believe our build can hold this weight.

Notes

- We have a 1in to 1ft scale, so the 5 in of sawdust we put on the habit represents the 5 ft we need for protection on the moon.

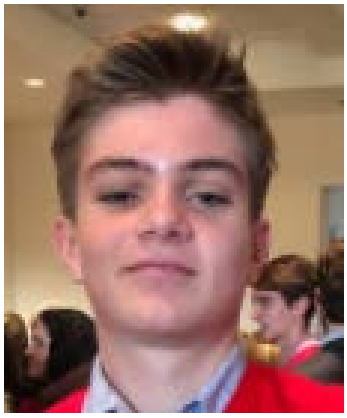
- We built the pieces to be around 5 in in height by 3 in width and 2 in length. So, on the moon it will be 5 ft tall.

Pros to Our Design

- There is more usable space in this type of habitat then one that is more circular.
- This also leads to less weight on the sides, more potential support, and less chance is caves in, then for example an ellipse habitat.
- The pieces will have a hard time breaking if they are linked together.
- The pieces can be eventually made in sheets so it is easy to put out.

Team Members

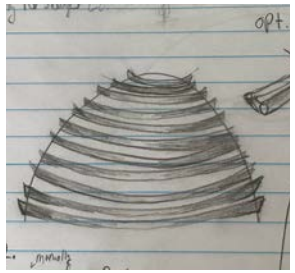
Kevin Miller- I want to become a Mechanical Engineer at an undecided college.



Greg Kelley- I will be attending HCC for at least one year to play hockey, one more year for my club team then I will be attending a four year school.

Tommy Tracy- I will take gap years then major in Engineering at a 4 year school College undecided.

Original Design Concept

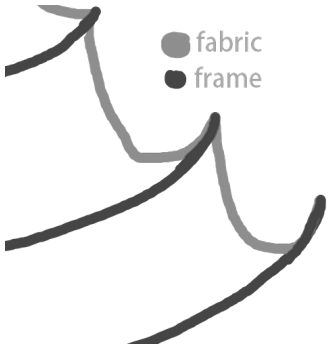


A ‘crinoline’ attached to habitat via a central support beam, with 3 supporting hooks for each “hoop” to lift them and attach them to the hoop above, allowing for a fabric which would be sewn around the frame to drape within the gaps in a manner that would allow it to cradle the lunar soil.

Selling Points

- No mechanical parts
  - Easy to repair if damaged
- Simple design
  - Easy to expand upon and adjust as necessary
  - Easily manufactured
- Collapsible
  - Easy to store and transport

Prototype



Lunar Habitat Baffle System

Saint John Valley Technology Center

located in Frenchville, Maine

Serving students from Fort Kent Community High School, Wisdom High School, and Madawaska High School

Team

Ashley Gendreau

Instructed by Mitchell Daigle

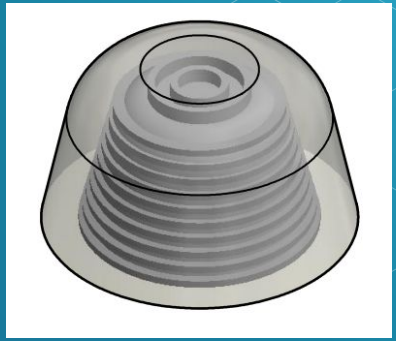
Waffle/Baffle Lunar Soil S.A.M.

Instructor: Carmen Garvis

Visit our website for more information
Website

School: Sanger High School

SCAN ME!



This structure has a large dome that goes over the actual shelter that will protect the astronauts from soil. There are also divots that go all around that will hold the soil as it stacks. There is a clear plastic lining all around.

Bag

Strings and supports

supports

Funnel

Thinking Map

Waffle baffles → **Geo -textiles**

Spiral → **Rings only** → **Bags/ Rings**

Emails:
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NHI.04VU@GMAIL.COM

We thank Eduardo Soto for his ideas

Cypress Springs High School

Industrial Technology

Engineering design ll

Cypress Fairbanks ISD

Cypress, Texas

NASA HUNCH PROGRAM

Lunar Soil Baffle

Team members:
Nhi Vu
Whitney Reinkoester

Instructor:
Steven Marcus

HUNCH Advisor/ Mentor:
Glen Johnson

OBJECTIVES:

Create a baffle to hold 5 feet of lunar soil atop lunar domes

MATERIALS:

Kevlar or nomex (bag)

Nylon rope (rope)

Aluminium (supports)

CONSTRAINTS:

- Hold 5ft of soil
- Easy to assemble/ transport
- Light weight

TECHNIQUES:

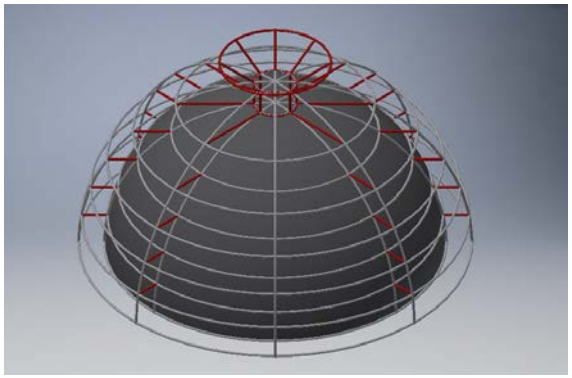
We looked alot into bags and spirals and how to modify them for the moon to hold soil

CHALLENGES:

We need to keep the design as simple as possible and make set up quick and easy for the astronauts

Description/general information:
One of the biggest challenges facing astronauts when going on long term lunar missions are micro-meteorites and radiation. By using lunar soil, the astronauts can cover the whole habitat a minimum of 5ft and protect themselves from both the micro-meteorites and radiation.

Solution: We are using a bag-baffle system to protect the habitat. We have multiple rings that will be about 5 ft away from the habitat and will be held in place by supports and rope. There will be a bag on the outside of the rings/ supports that will be made of a stiff, not too flexible material. There will be a funnel on top of the habitat that will allow the soil to be distributed in to all the baffles evenly. Once the astronauts are done filling the baffles, they will remove the funnel and leave the top exposed.



Scaled 1:45

WAFFLE BAFFLE

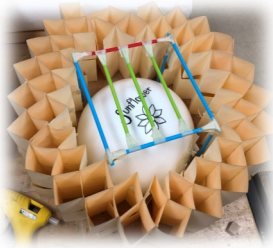
Newest Model:“The Sunflower”

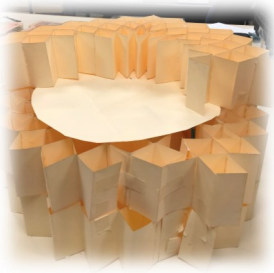
The “Sunflower” is our newest model. It is an oak tag baffle with equal heights (4inx2in)

Our accordion fold and compression. As you see it unhinges and wraps around the structure as it inflates, then

THREE TIER CONSTRUCTION

The structure is the stabilization for the third tier that will be placed on top of the flat layer you see below it. This allows us to safely fill the top layers of the baffle without worrying about puncture or pressure from a load.





We filled the baffle sand to modewith l the soil then placed a tape dispenser on top to replicate the possibility of a load (like a rover) being placed on top. (r)

MATERIALS

3 Layer System

- **Sodium Polyacrylate filled between 2 layers of Polyester**
- **Making it this way, so our baffle can be repurposed and provide extra radiation protection**

POLYESTER

- **Hydrophobic & quick drying**
- **Contains benzene ring to absorbs UV light**
- **Darker color offer more protection than lighter**

SODIUM POLYACRYLATE

- **Can be used to keep moisture away**
- **Since it can absorb liquids, it can prevent rashes**
- **Aid in the absorption of liq-**

OUR TEAM

Dan Krauss

Sydney Mandel

Ava Paulson

Lunar Soil Baffles/Waffles For Habitats

School: Ranger High-Tech Academy

Teacher:Coach DeSciscio

List of all students: Colin Czech, Natalie Prijaya, Kyler Swanson

Description: We've created the number one baffle system designed to secure 5ft of lunar soil on top of the first human habitats. Our design takes aspects of all our original designs and combines them together. The bottom portion of the the human habitat will feature a ring like system designed to catch lunar soil that falls from the top of the habitat. At the top of the habitat is a combination of a netting and intricate baffle system.