2022 Design and Prototype Finalists

Lunar Supply Pod Airlock

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School: Jesuit College Prep, Texas

Students: Derry Lin, Trevor Gidney
Teacher: Robin Merritt
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Students: Savannah Snyder, Channing Lee
Teacher: Michael Hayes
School: Theo, Texas

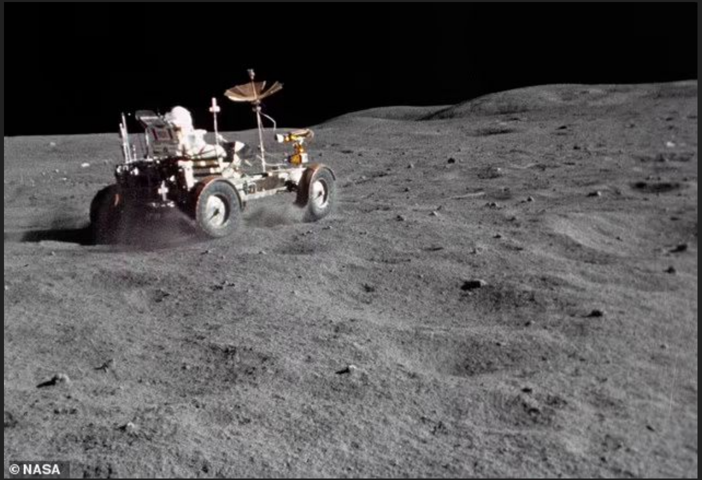
Students: Brenda Dodson
Teacher: Nate Olsen
School: Warren Tech Central, Colorado

Students: Nathan Blanchard, Marcus Cedillo, Cyrus Dickman
Teacher: Ashley Pederson
School: Lakewood, Colorado

Students: Benjamin Michalak-Brown, Samantha Steindel
Teacher: Sandra George
School: Frontier Central,

Lunar Supply Pod Airlock

Jake Pollock
Weston Smith
Thomas Karlsing
Luke Brackbill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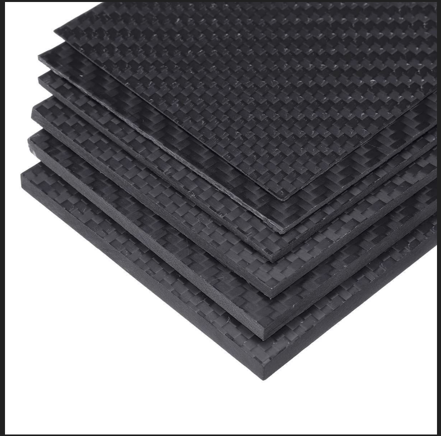

Seeing how the supply pod will fit

test fitting the inner layer of our fabric

LUNAR SUPPLY POD AIRLOCK
Prototype v2
Assembly

Problem Statement

Future astronauts who will be living in habitats on the lunar surface are struggling to find a way to transfer supplies from the supply pods into the habitats. Leading innovators such as NASA, believe that during this process space suits and lunar dust may present a substantial problem while unloading the supplies from the pods. The space suits cause difficulties when obtaining the supplies because of their size, preventing them from reaching the items within. Lunar dust, which are sharp and small, can pollute the internal environment of the habitats and create a hazard towards the astronauts' health. Preventing these factors is crucial because of the implications the supply pod airlock has in the future of space exploration.

Design Method

This design of the lunar supply pod airlock heavily incorporated the concept of ease of construction and accessibility. The design ensures that construction will be simplistic and easy for astronauts to construct on the moon and to use once assembled.

NASA HUNCH

Contact Information

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LUNAR SUPPLY POD AIRLOCK

NASA HUNCH

BY

DERRY LIN AND TREVOR GIDNEY

CLEAR CREEK HS

CLEAR CREEK ISD

INSTRUCTOR

MR. ROBIN MERRIT

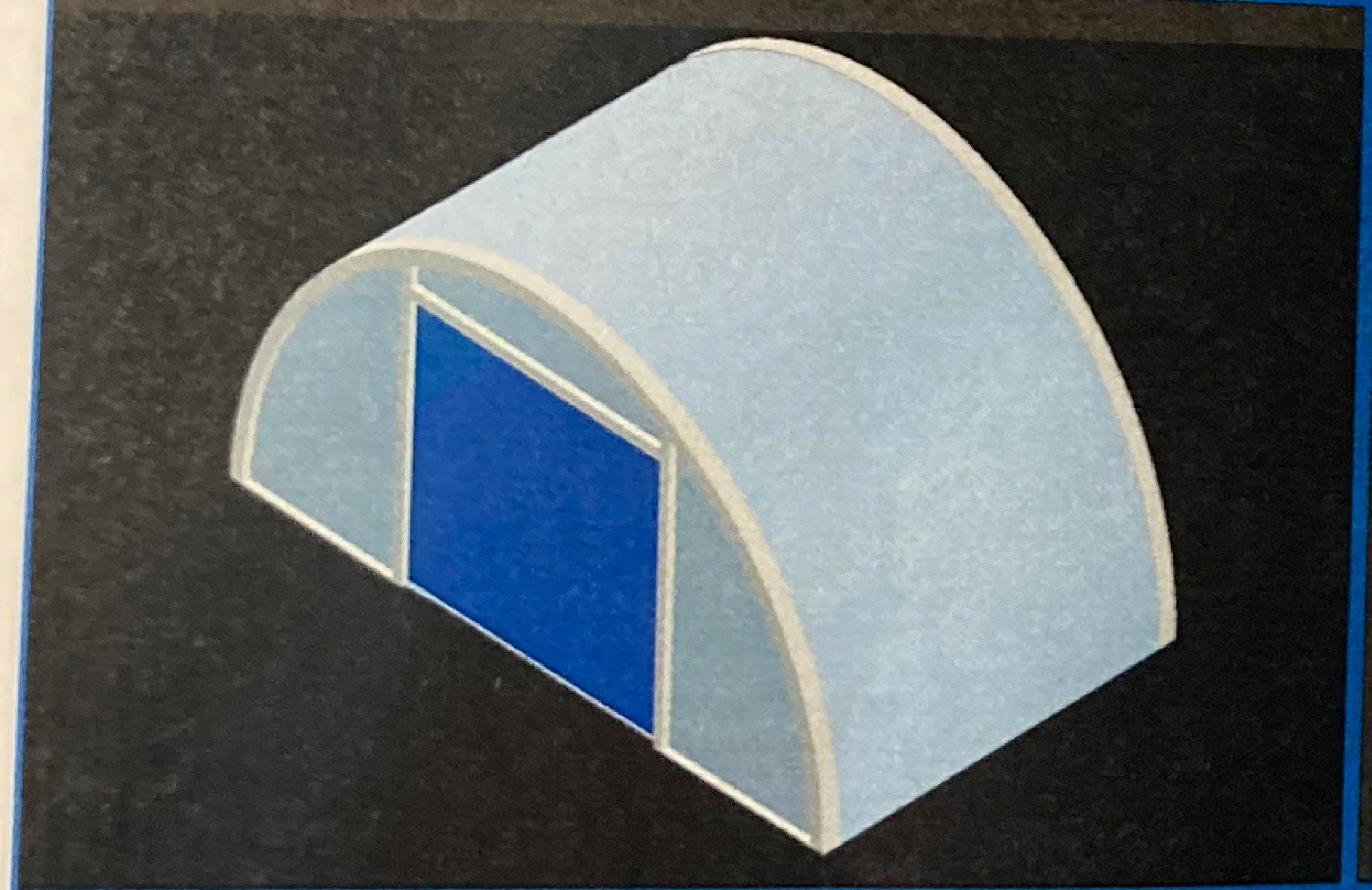
Demo Videos and Photos

CAD Models

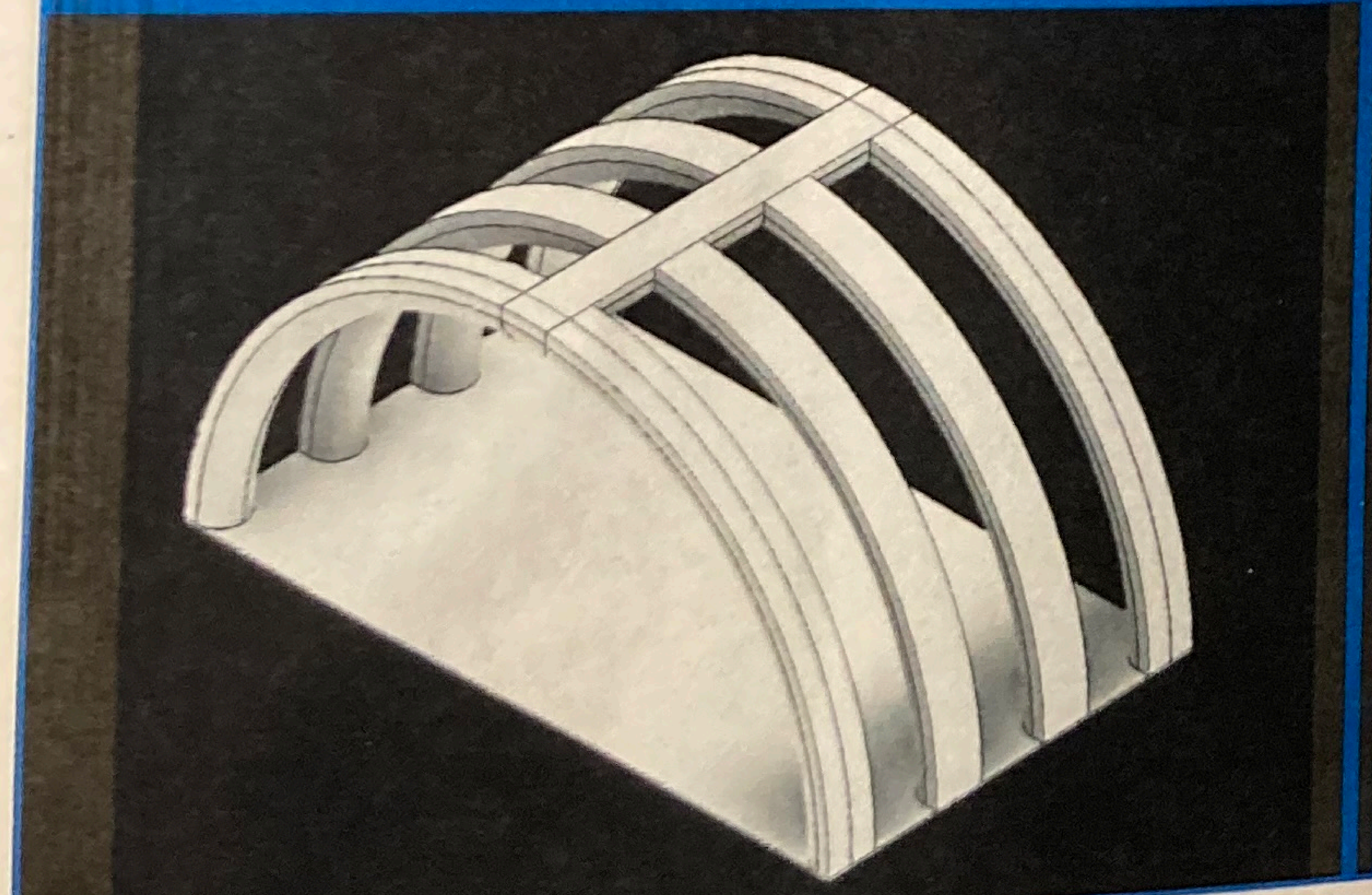
Assembled prototype BOM

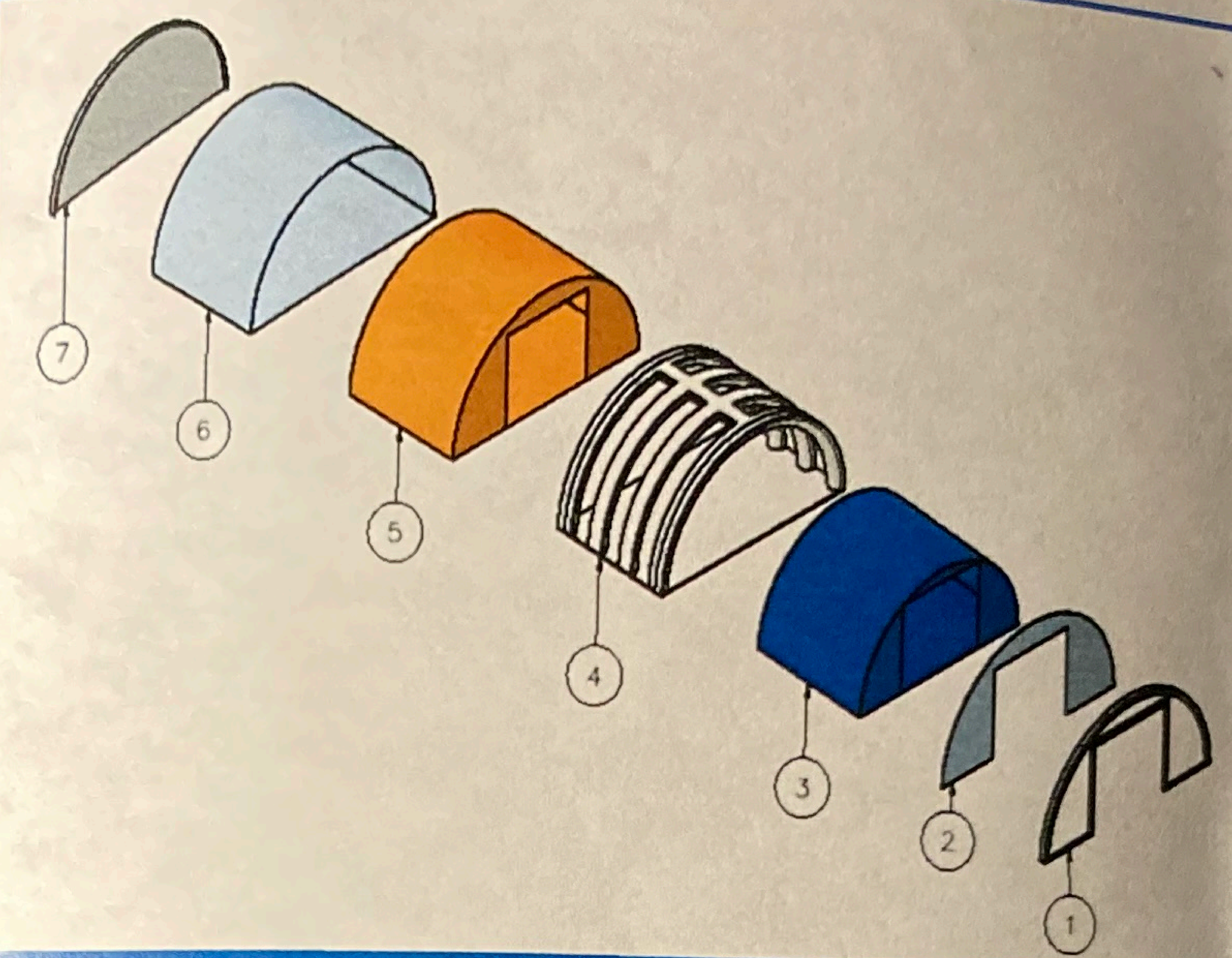
1- Metal frame for airtight door
2- Front beta cloth
3- Interior pressure bladder
4- Insulation filled rib cage
5- Insulation material
6- Exterior beta cloth
7- Back metal wall, modifiable to suit airlock

Assembled CAD Model



Interior Ribcage

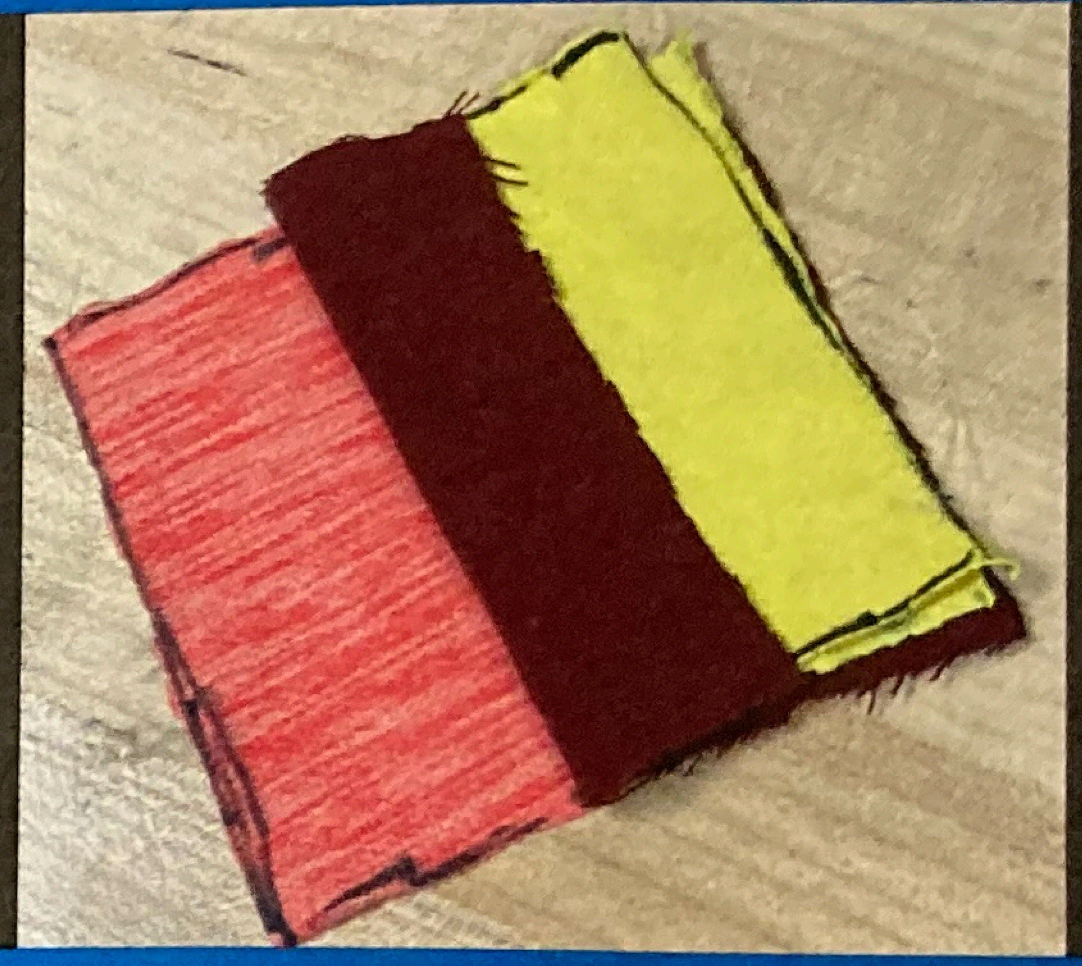




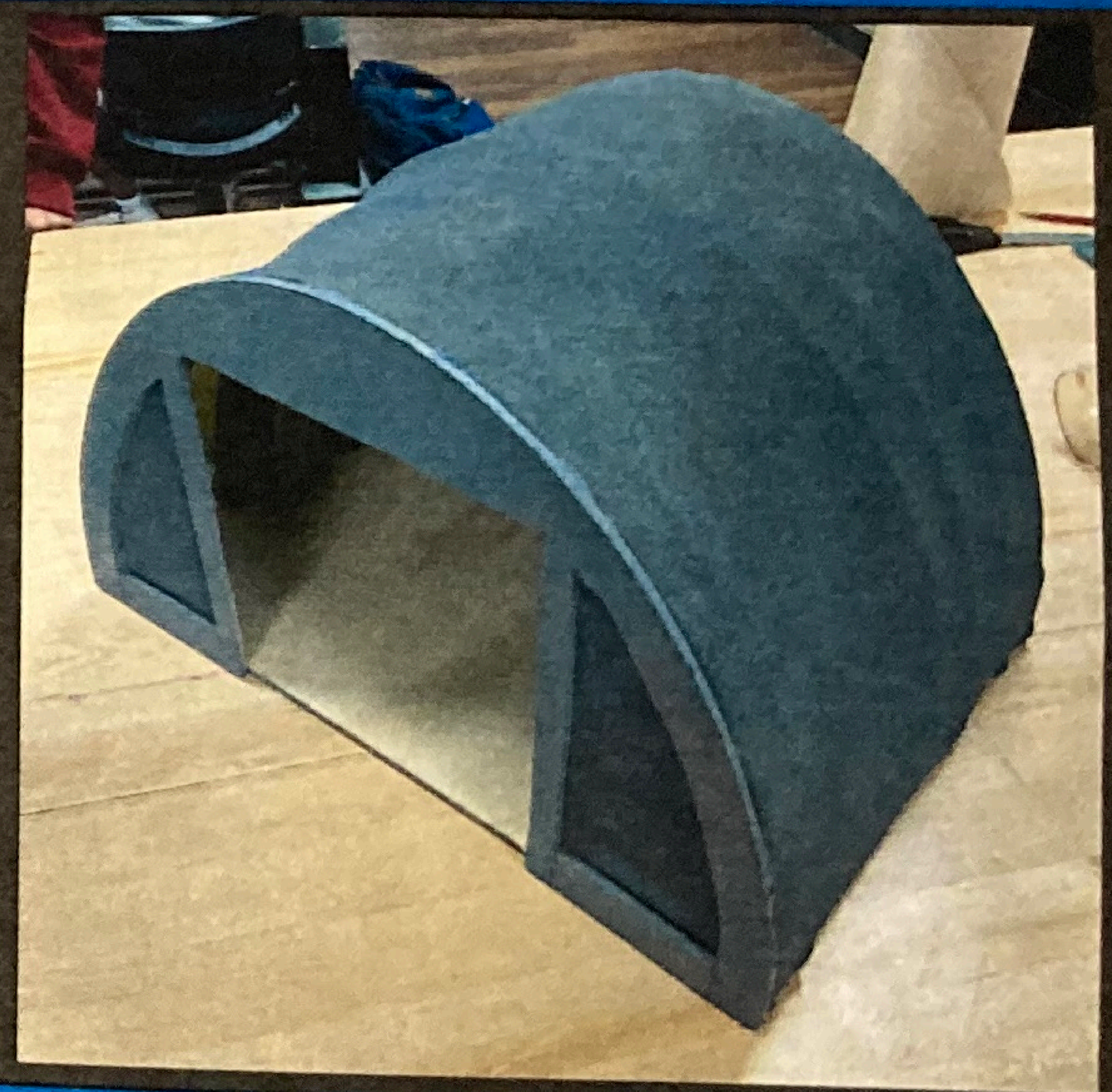
Ease of Construction

To make the lunar supply pod airlock assembly efficient when being constructed on the moon, the majority of its components can be manufactured and preassembled on Earth. This begins with the soft components (pressure bladder, insulation, beta cloth, rib cage) being created and attached together in the proper order. This along with the frames will be sent to the moon. Upon arrival it will be transported to the location of assembly. The deflated structure will need to be entered and predetermined injection sites will need to be located on the interior of the rib cage to then be filled with a two-part insulation foam. This will cause the entire structure the mold into the proper shape raising every soft component to the proper spot with less effort than otherwise would have taken. The structure will then be aligned with the framework to be attached through the use of nails or bolts through the framework into the now rigid rib cage, to be completed.

External Layers Model



Assembled Model



Interior Rib Cage Model


EXTERIOR
★ Fully inflatable, layered structure (similar to a tent) that can fold easily with lightweight, ultra-strong fabric (Dyneema) to fulfill shipping/storage restrictions
★ Redundant inflatable pillar or multi-chamber structure (like air tube tents) with inflatable "poles" to create the garage space
★ Dyneema Carbon Combination fabric for inside layer, is 2x lighter than carbon fiber, 15x stronger than steel, highly flexible
★ Dyneema Force Multiplier Technology outside over inflatable pillars which is used in bulletproof vests
★ Radiation shielding on top like a tarp that protects a tent from rain
★ Rigid airlock door with curved shape to secure the supply pod and keep the garage airtight
★ Air valves connected to the habitat to inflate from inside and seal to inflatable portion
EXTERIOR
DESIGN RESEARCH
To accommodate the safety requirements, weight and size limitations, an inflatable tent structure was the best solution as compared to fully rigid structure. Also, using a combination of lightweight Dyneema Fabrics protects the garage and keeps it lightweight with only a rigid airlock door and interior components.
★ Air tube tents are 50% lighter and fold up smaller than standard tents (Heimplanet, Coleman, Kampa and others)
★ They inflate once and seal, like a pool toy, instead of needing constant air like a inflatable tent (pictured below)
★ Rigid structures are too bulky and heavy to be shipped
★ Airflow is better in curved elbows (below)
Prefab "Kit" Metal
Inflatable Structure
Titanium ½ - Spheres
Inflatable Tent
Needs constant air
HEIMPLANET
2 chamber construction
Air Tube Tent
INTERIOR
★ Rigid airlock door is like a bank vault door or subm
to seal the garage
★ The floor will be divided into sections so that it can b
out while the 'garage' is deflated
★ Flooring is like a grate and curved to keep the supply p
secure
★ Underfloor heating/cooling system to regulate the temperature of the pod
★ Water recovery system in the flooring
★ Air jet blowers to fill the room with oxygen and blow the dus
off of the supply pod to make it safe for them to unload the supplies
★ Moondust vacuum collection and removal system like a woodworking shop with a sawdust collection system
★ Lighting and electrical systems & space for tools
INTERIOR
Lunar Supply Pod Airlock
Electronic Sensors and Mechanisms
• Air Pressure Sensor
• Humidity Sensor
• Temperature Sensor
LUNAR HABITAT (HOUSE)
With 5 ft of Soil for Radiation Reduction
RIGID AIRLOCK ('Porch')
With 5 ft of Soil for Radiation Reduction
Dyneema Carbon Fiber Combination (interior layer)
LUNAR GARAGE ('Garage')
AIRLOCK - and Loading RAMP
LUNAR SUPPLY POD AIRLOCK
Air flow valve keeps air sealed inside
Easy to deflate from inside the habitat

REQUIREMENTS:

- Create a safe, controlled environment for the crew to unload the pods without space suits
- The garage must be an airtight, temperature controlled and connect to the moon habitat

SAFETY CONSTRAINTS:

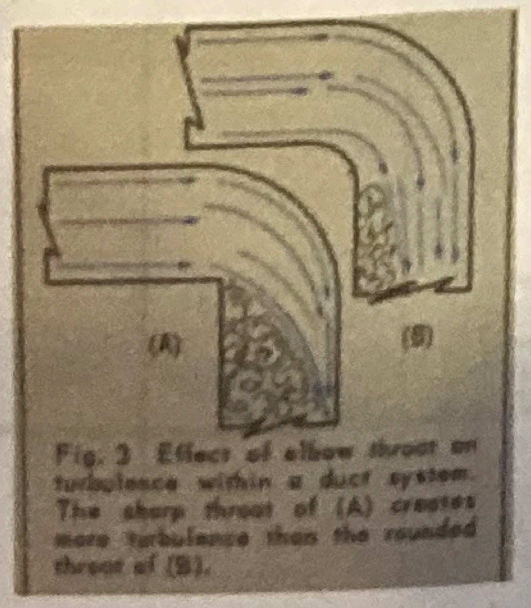
- Without moisture, the dust can build up static electricity
- Lunar dust can be very small and sharp like glass shards
- Garage must accommodate limited size and weight restrictions to be transported to the moon & stored
- The supply pod must be a certain size to accommodate the supplies & spherical or cylindrical so they can roll easily

DESIGN RESEARCH:

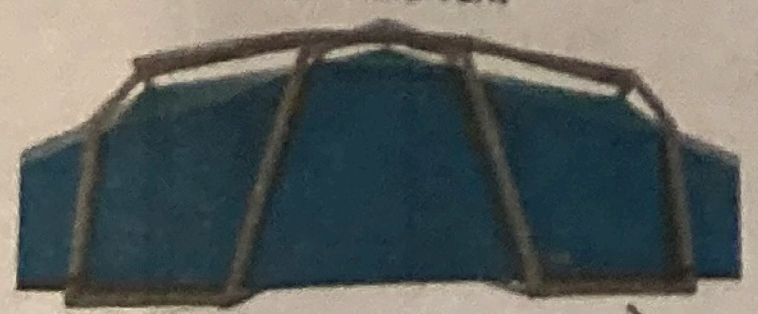
To accommodate the safety requirements, weight and size limitations, an inflatable tent structure was the best solution using a combination of lightweight Dyneema Fabrics with a rigid door and interior components

- Air tube tents are 50% lighter and fold up smaller than standard tents
- They inflate once and seal, like a pool toy, instead of needing constant air like a inflatable tent (pictured below)
- Rigid structures are too bulky and heavy to be shipped
- Airflow is better in curved elbows (below)

Inflatable Tent
Needs constant air



HEIMPLANET
2 chamber construction
Air Tube Tent



EXTERIOR:

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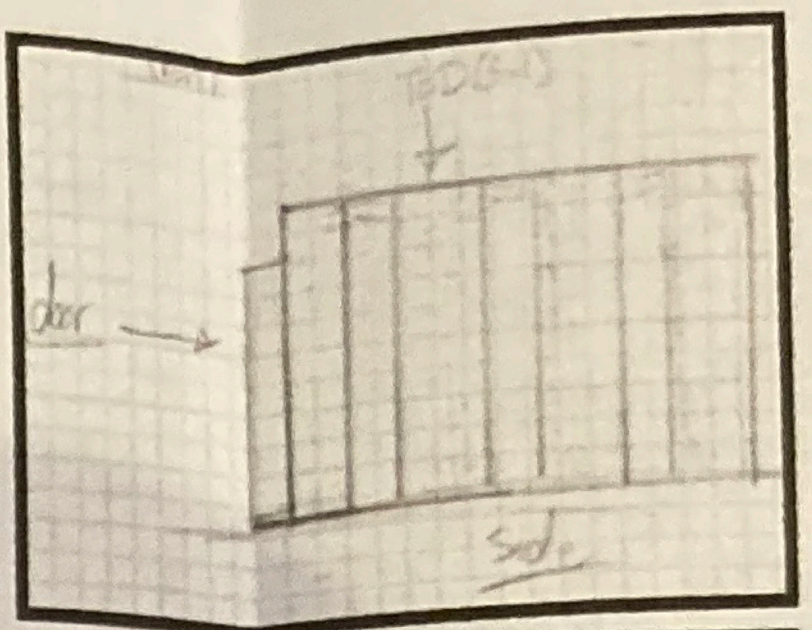
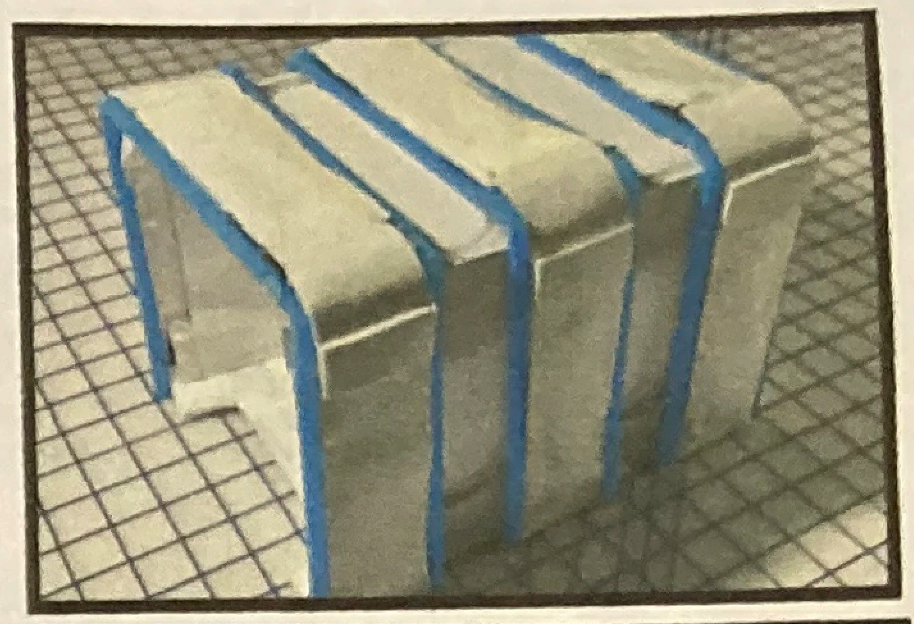
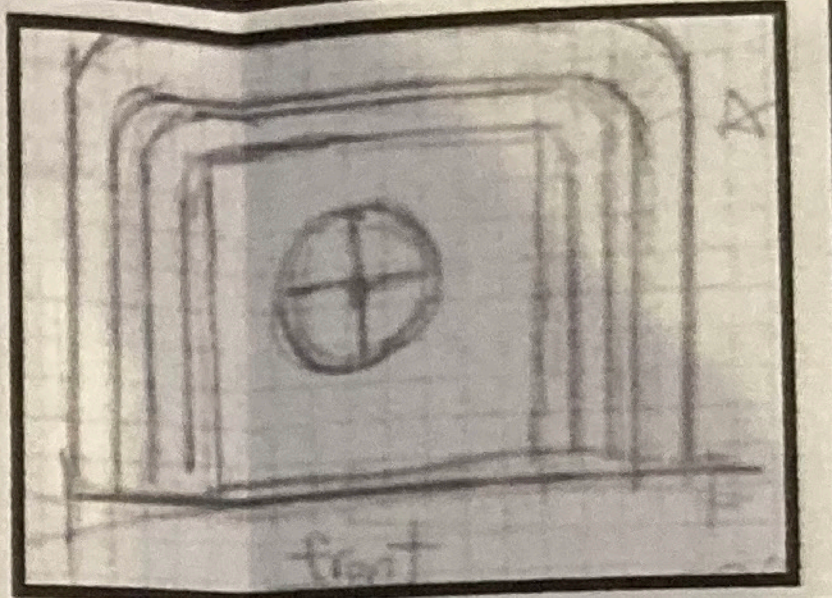
- Dyneema Force Multiplier Technology outside over inflatable pillars which is used in bulletproof vests
- Radiation shielding on top like a tarp that protects a tent from rain
- Rigid airlock door with curved shape to secure the supply pod and keep the garage airtight
- Air valves connected to the habitat to inflate from inside and seal to inflatable portion

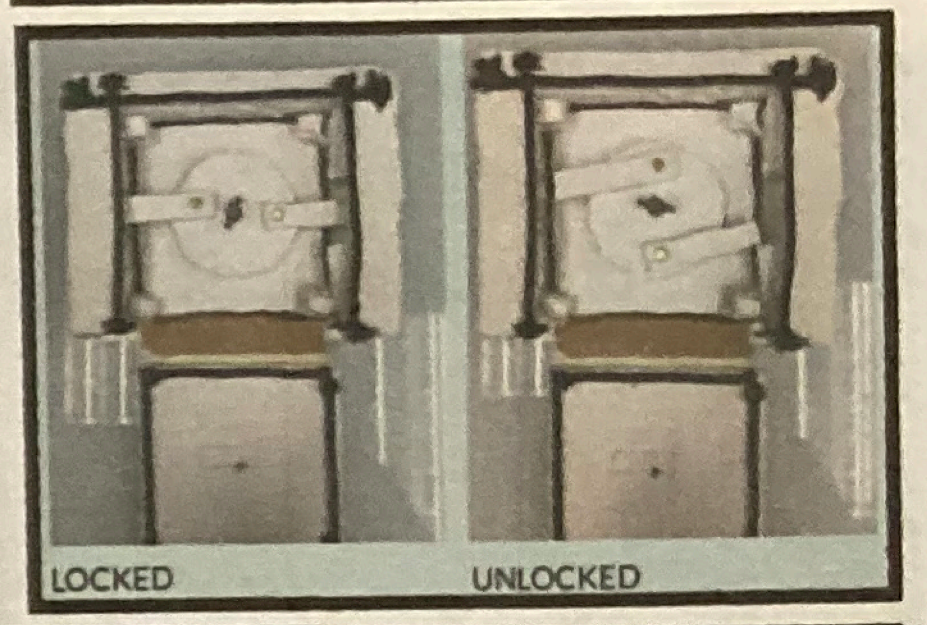
INTERIOR:

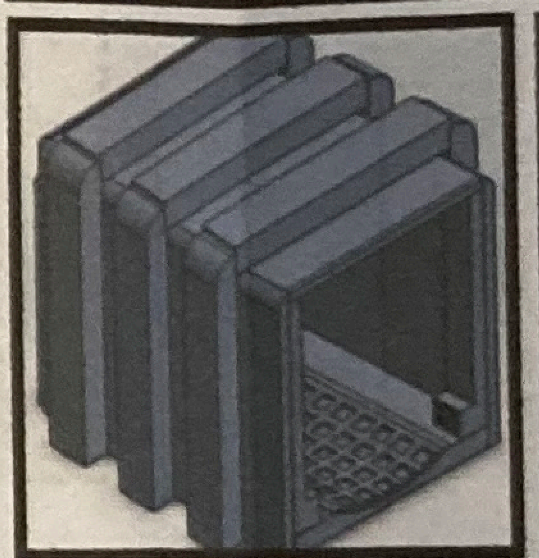
- Rigid airlock door is like a bank vault door or submarine door to seal the garage
- The floor will be divided into sections so that it can be taken out while the 'garage' is deflated
- Flooring is like a grate and curved to keep the supply pod secure
- Underfloor heating/cooling system to regulate the temperature of the pod
- Water recovery system in the flooring
- Air jet blowers to fill the room with oxygen and blow the dust off of the supply pod to make it safe for them to unload the supplies
- Moondust vacuum collection and removal system like a woodworking shop with a sawdust collection system
- Lighting and electrical systems & space for tools

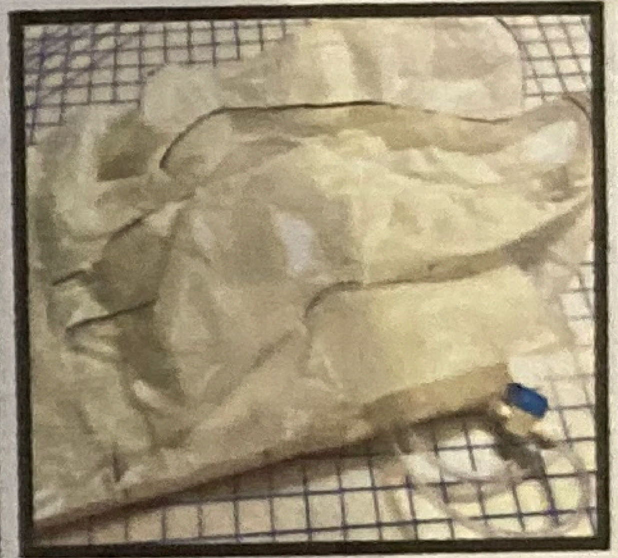


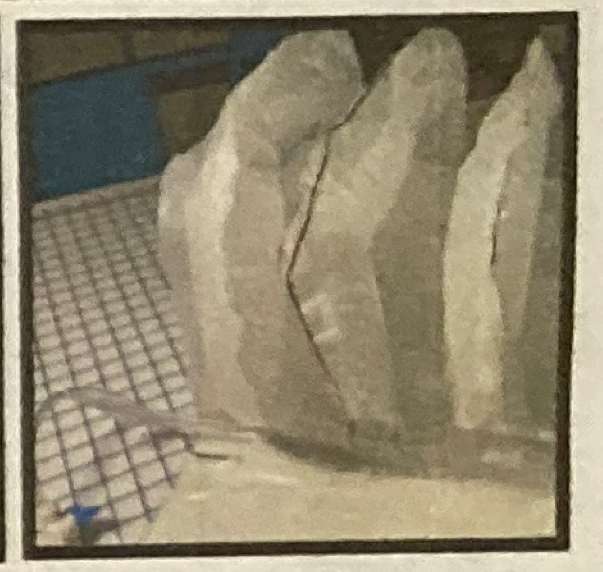


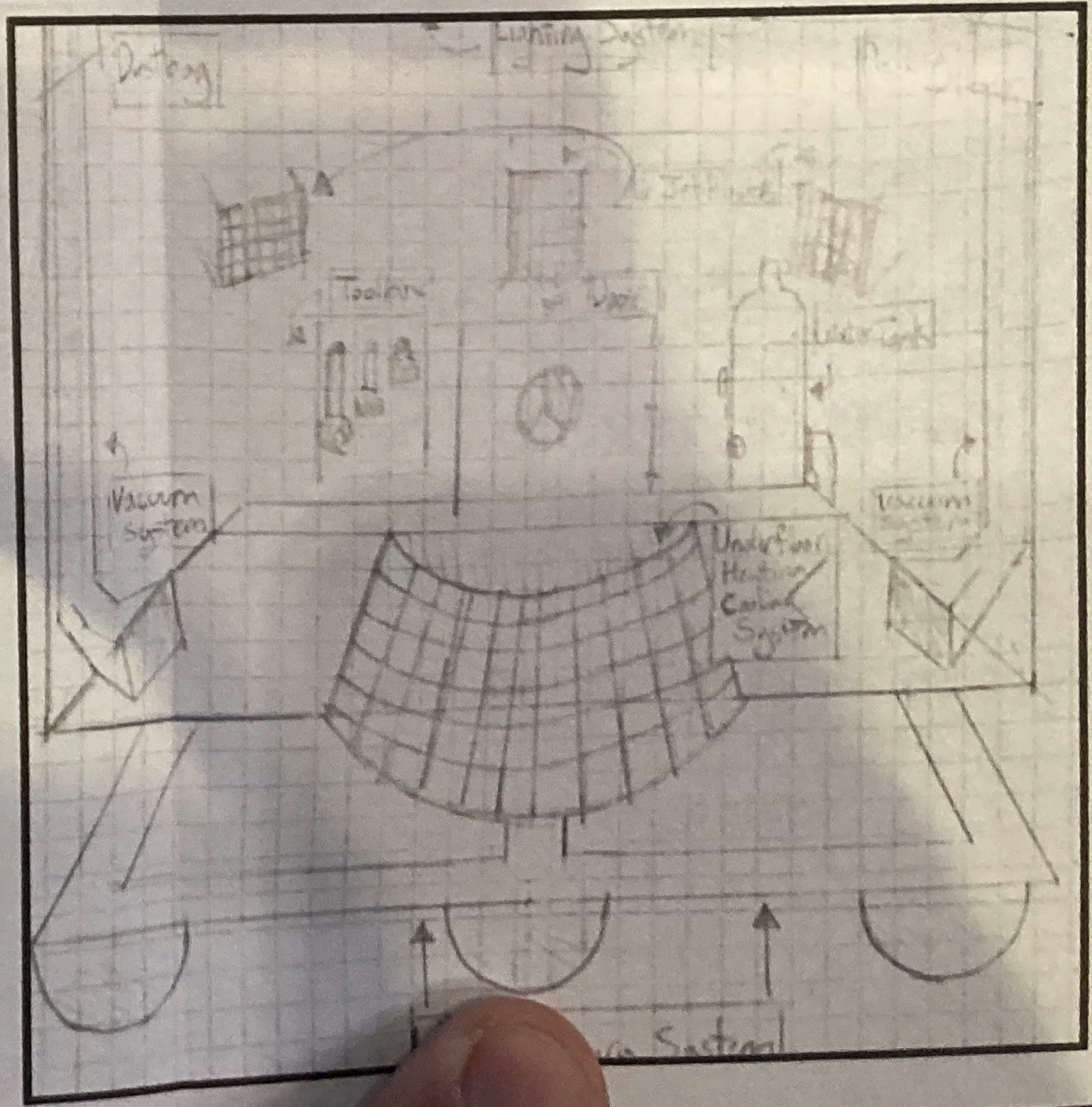










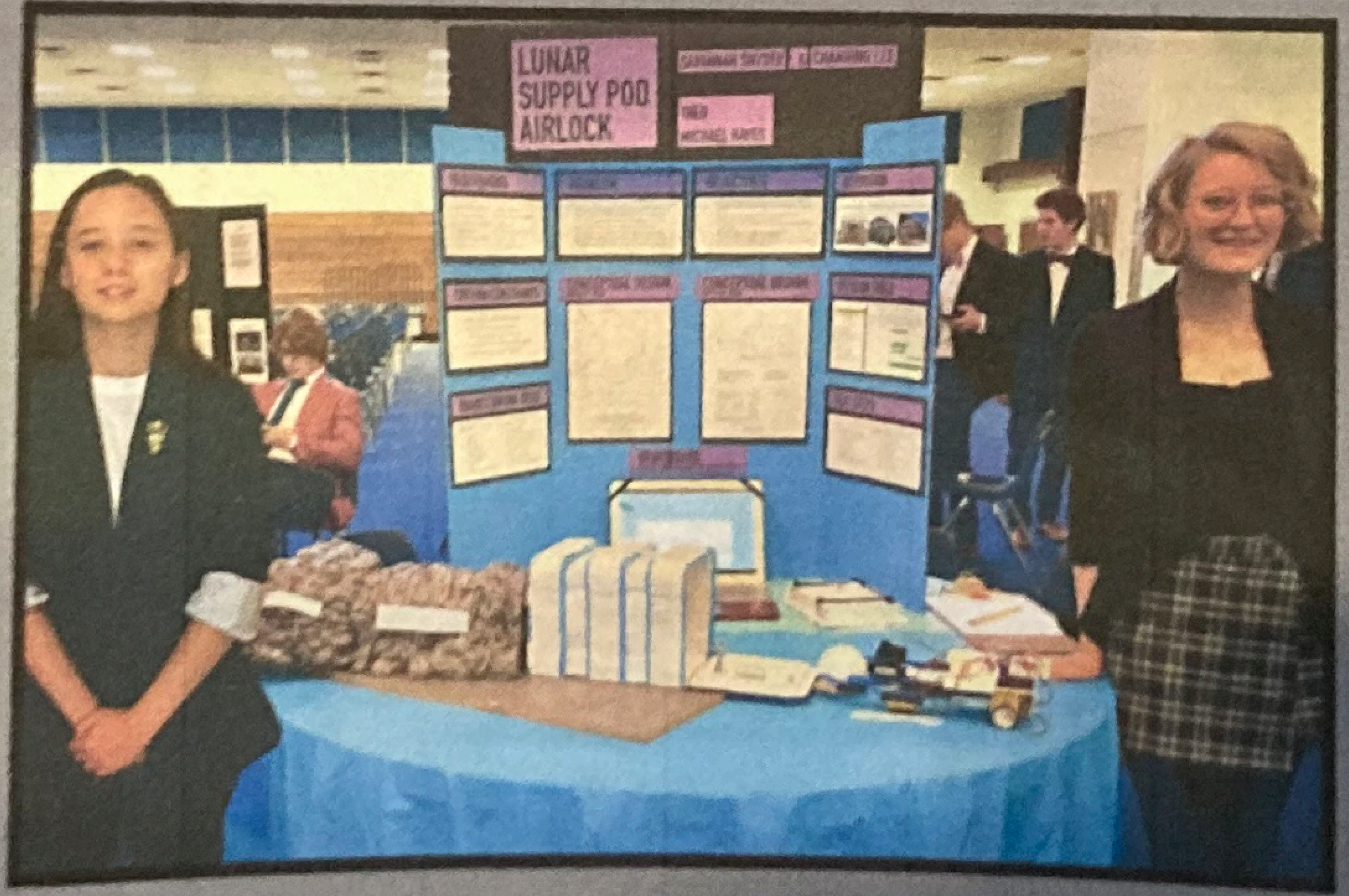


PROBLEM

NASA HUNCH needs a safe place where the crew can unload the lunar supply pods. If the crew unloads them outside in the vacuum of the lunar surface, the space suits are going to be too big and bulky to be able to crawl into and out of the supply pods in the dust would potentially get on the supplies. The supply pods needs to be brought into a controlled environment to make it easy for the crew to unload the supplies and bring them into the habitat where they can be used safely.

OUR TEAM

SAVANNAH SNYDER & CHANNING LEE



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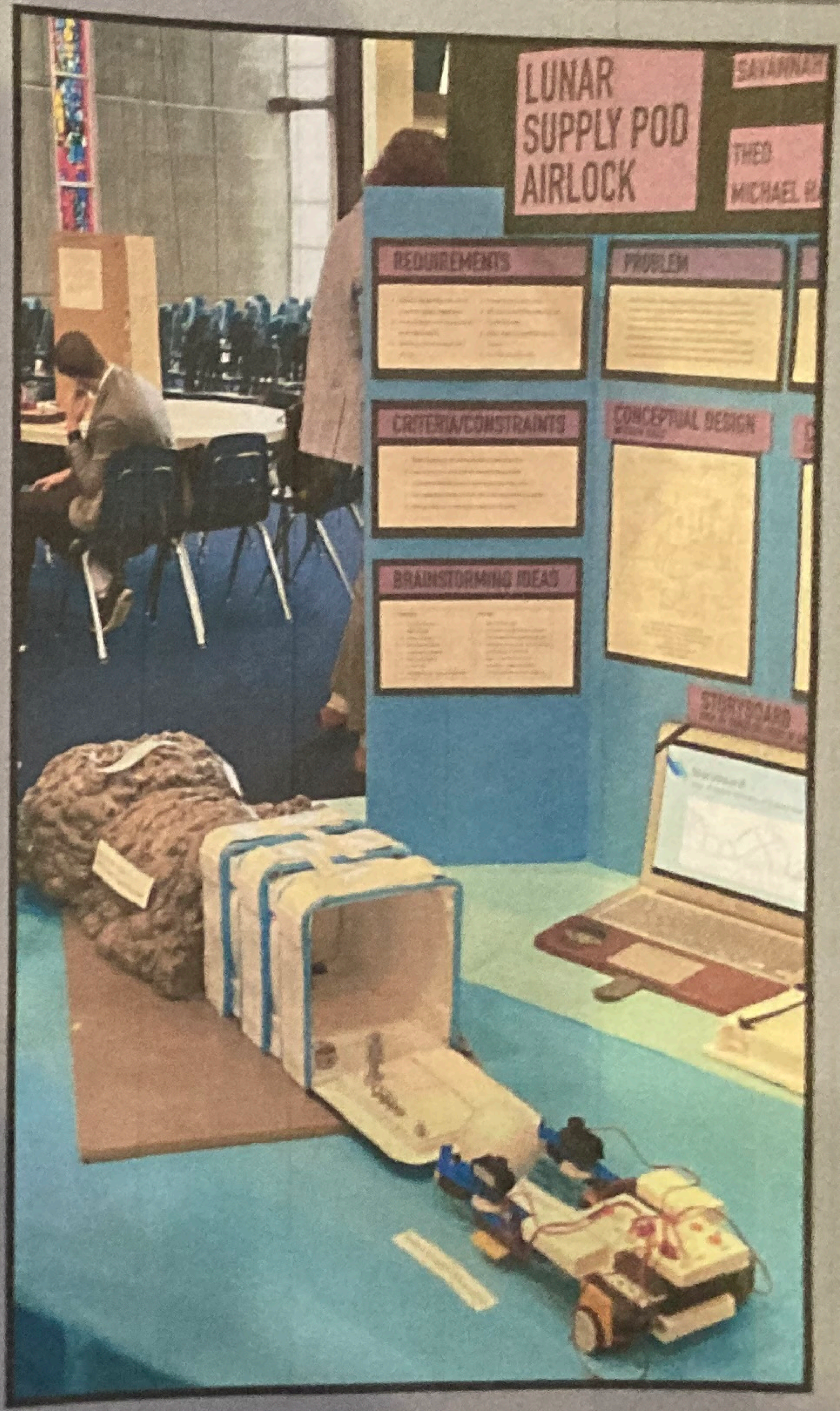
School: THEO
Teacher: Michael Hayes

LUNAR SUPPLY POD AIRLOCK



SAVANNAH SNYDER & CHANNING LEE

School: THEO
Teacher: Michael Hayes


Lunar Supply Pod Airlock
Warren Tech Central
Mr.Olsen
Brenda Dodson
Invisible zippers
3 layers of zippers (Will roll up like blinds)
Rolling cart to transport the supply pod inside
Prototypes
non-rigid, inflatable and blows up like a bouncy castle.
PVC fabric- UV resistant/airtight
My Airlock will have floor panels for easy transportation/setup.
Aluminum Alloy AA6061
NCH

Lunar Air Lock

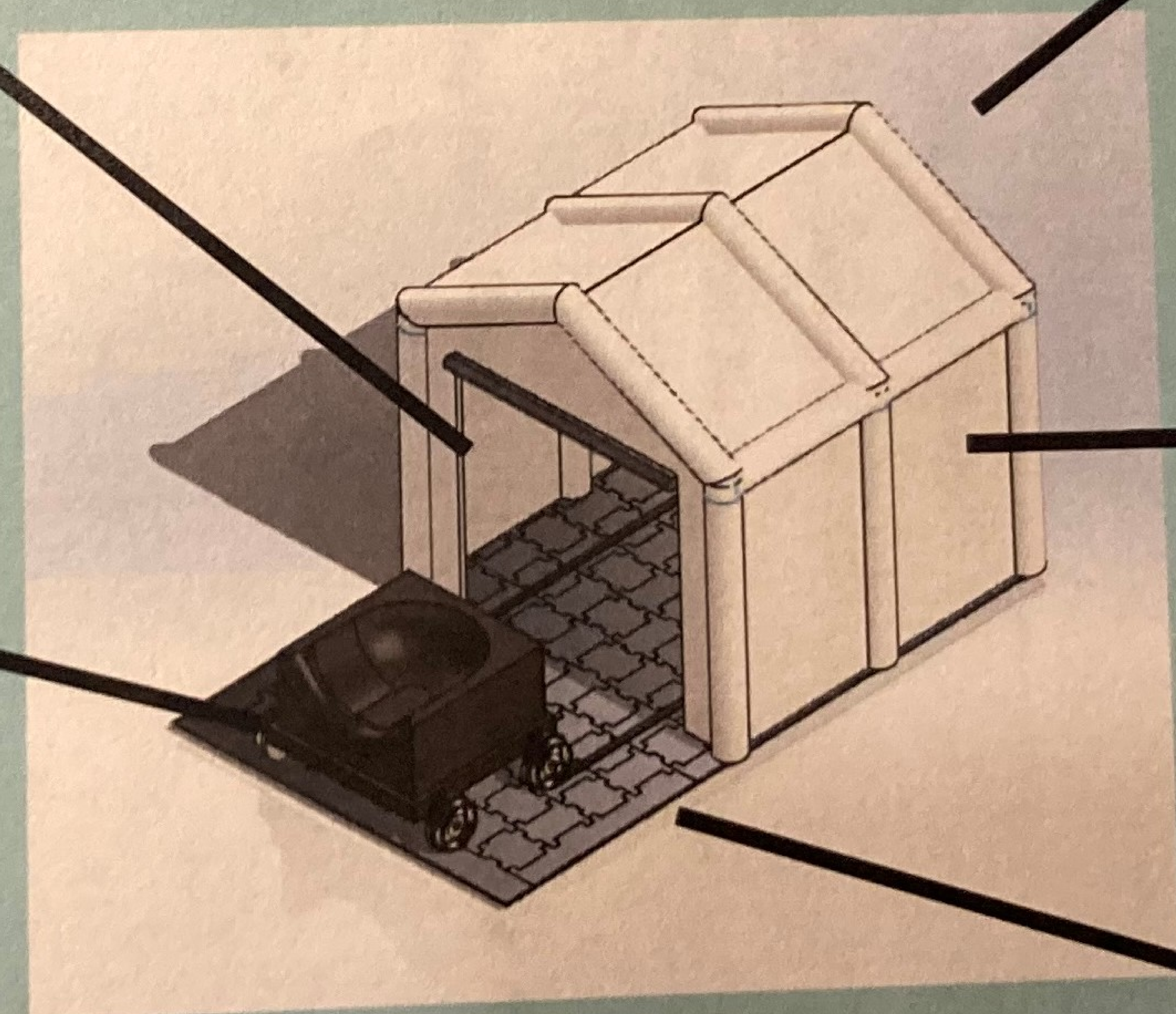
Warren Tech
Mr.Olsen
Brenda Dodson

Problem: How will the supply pod be brought inside? Will this bring in a lot of lunar dust?

Problem: How will the structure be transported and set up on the moon?

Front opening will be comprised of 3 layers of 'hidden' zippers to keep in the air while remaining non-rigid. The 'hidden' aspect will prevent dust from jamming the zippers. The flaps will roll up like window blinds.

Rolling cart will help transport the supply pod inside and will prevent some lunar dust from making its way inside.

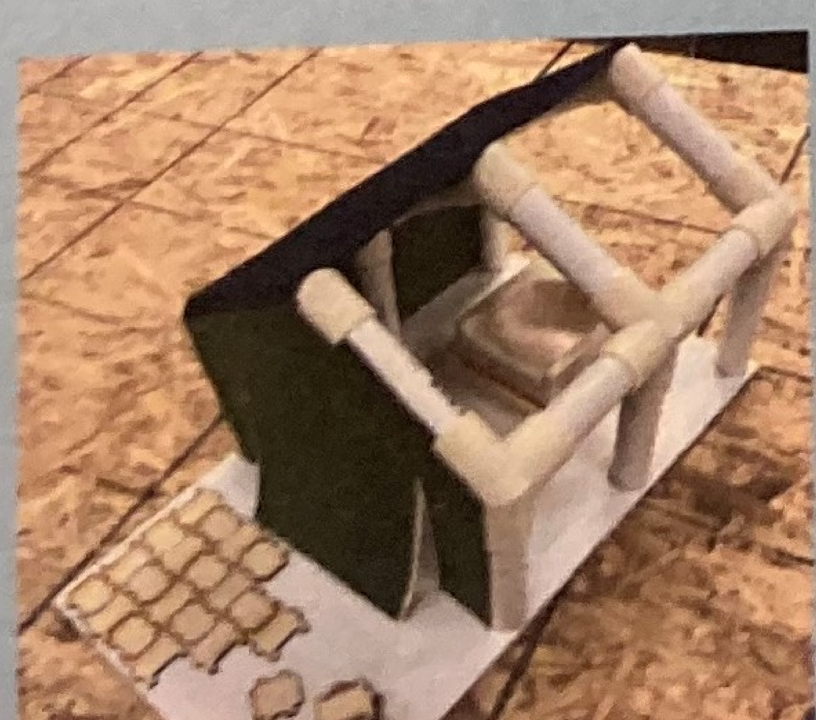


My Airlock is a non-rigid, inflatable and blows up like a bouncy castle. It will be light so transportation and set up will be simple.

Side panels will be made of UV resistant PVC fabric, this will protect against wear (it won't rip in transport or other cases) and will remain air tight.

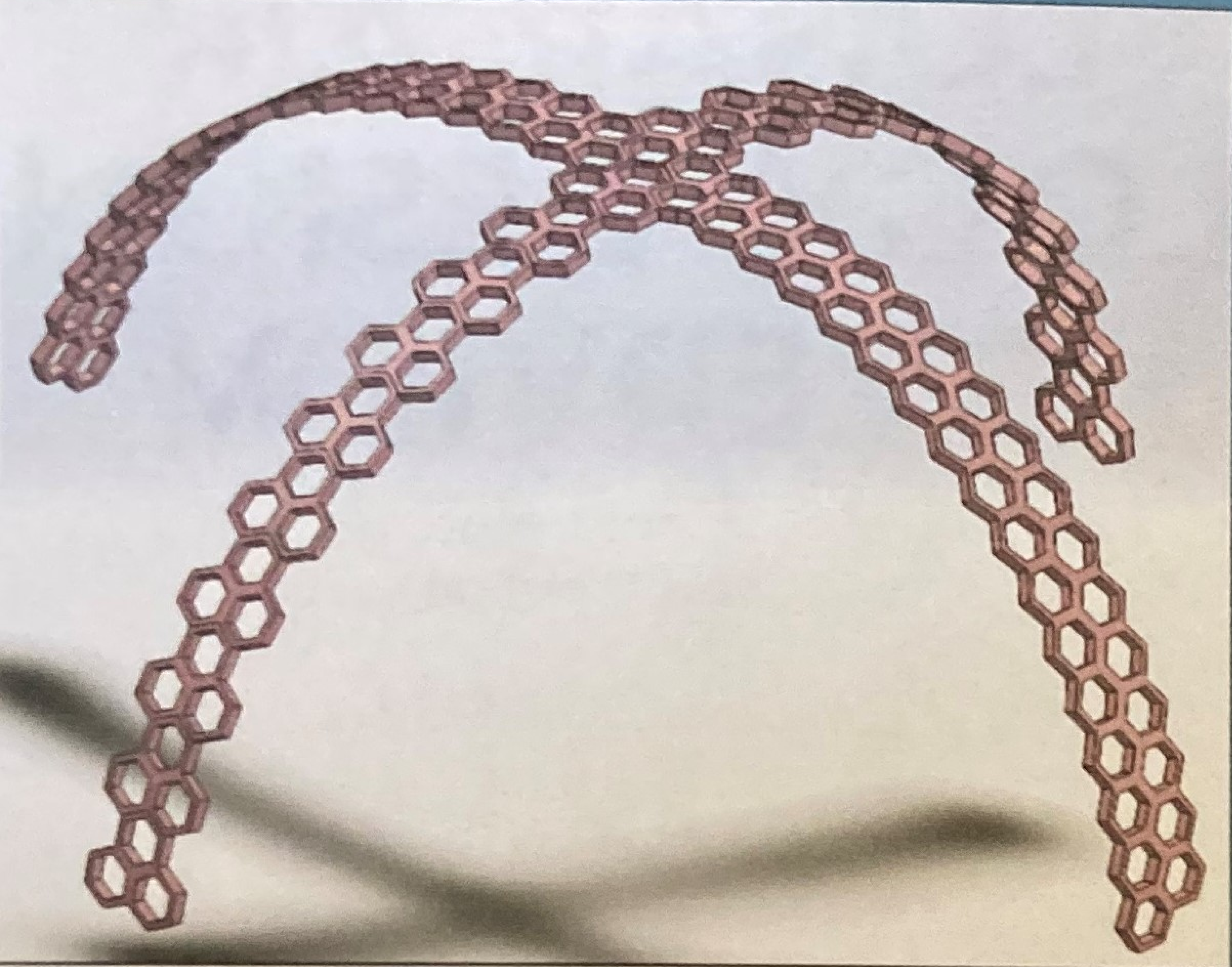
Inside floor will be made of panels which will allow for easier transportation and setup. They will be made of Aluminum Alloy AA6061.

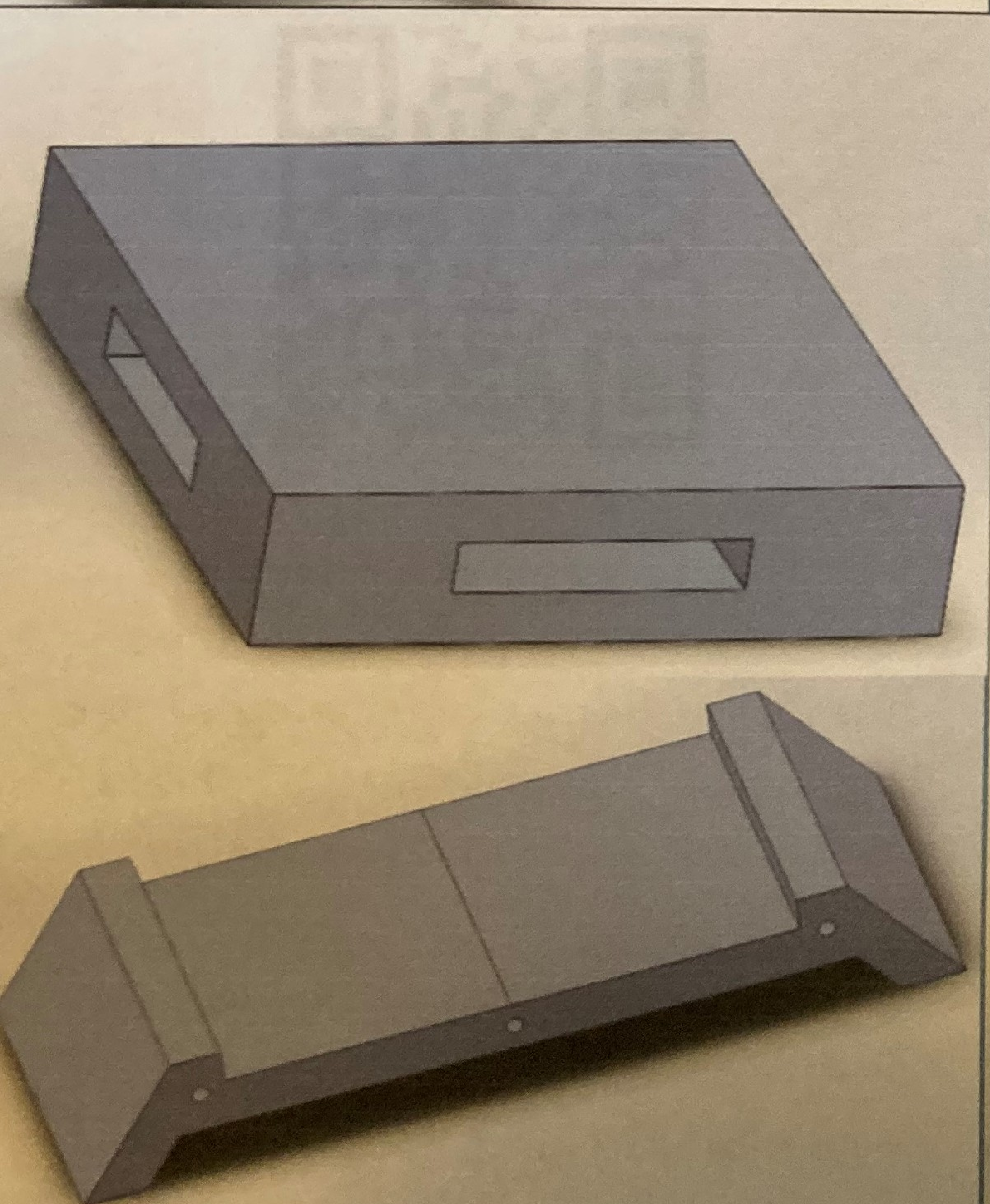
Final Prototype:




Lunar Air Lock Project
Nathan Blanchard, Marcus Cedillo, and Cyrus Dickman
Lakewood High School
Ashley Pederson
Solution Statement:
Our team has provided a lunar habitat structure consisting of two principal, flexible MMOD shield layers, four rigid, aluminum structures to provide integrity, and a modular foundation; in order to create an easily transportable and assemblable lunar lodge structure that can be used to unload supplies from lunar supply pods.
Aluminized Beta Cloth
PTFE (Teflon™) infused silica fabric
Used As
MLI blanket
Thermal insulation
MMOD Shield layer
3M Nextel 312: $522.36/lb
Nextel is a ceramic fiber that is fireproof and withstands meteoroids. Ceramic fibers like it Are super strong and very heat resistant.
Used As
Interior structure
Used in heat shields
NASA 398 Aluminum-Silicon Alloy: $0.90/lb
A strong, thermal expansion resistant, lightweight alloy of aluminum and silicon.
Used As
Inner honeycomb struts
Hempcrete: $14.35/ft³
A strong, lightweight, low-carbon concrete that is comprised of hemp hurd, a binder (possibly lime), and water.
Used As
Regolith shield and foundation structure

FINAL CAD DRAWINGS

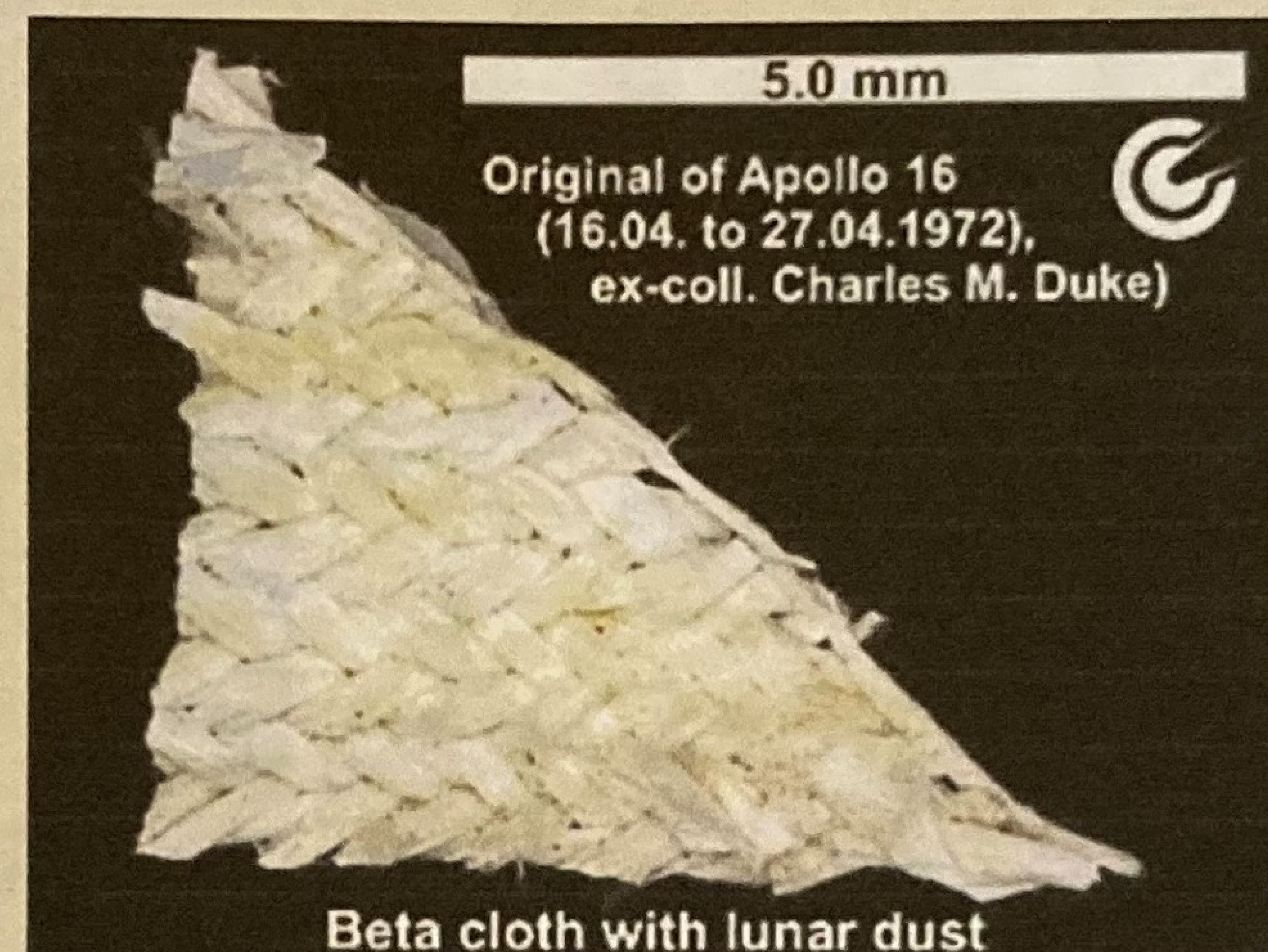




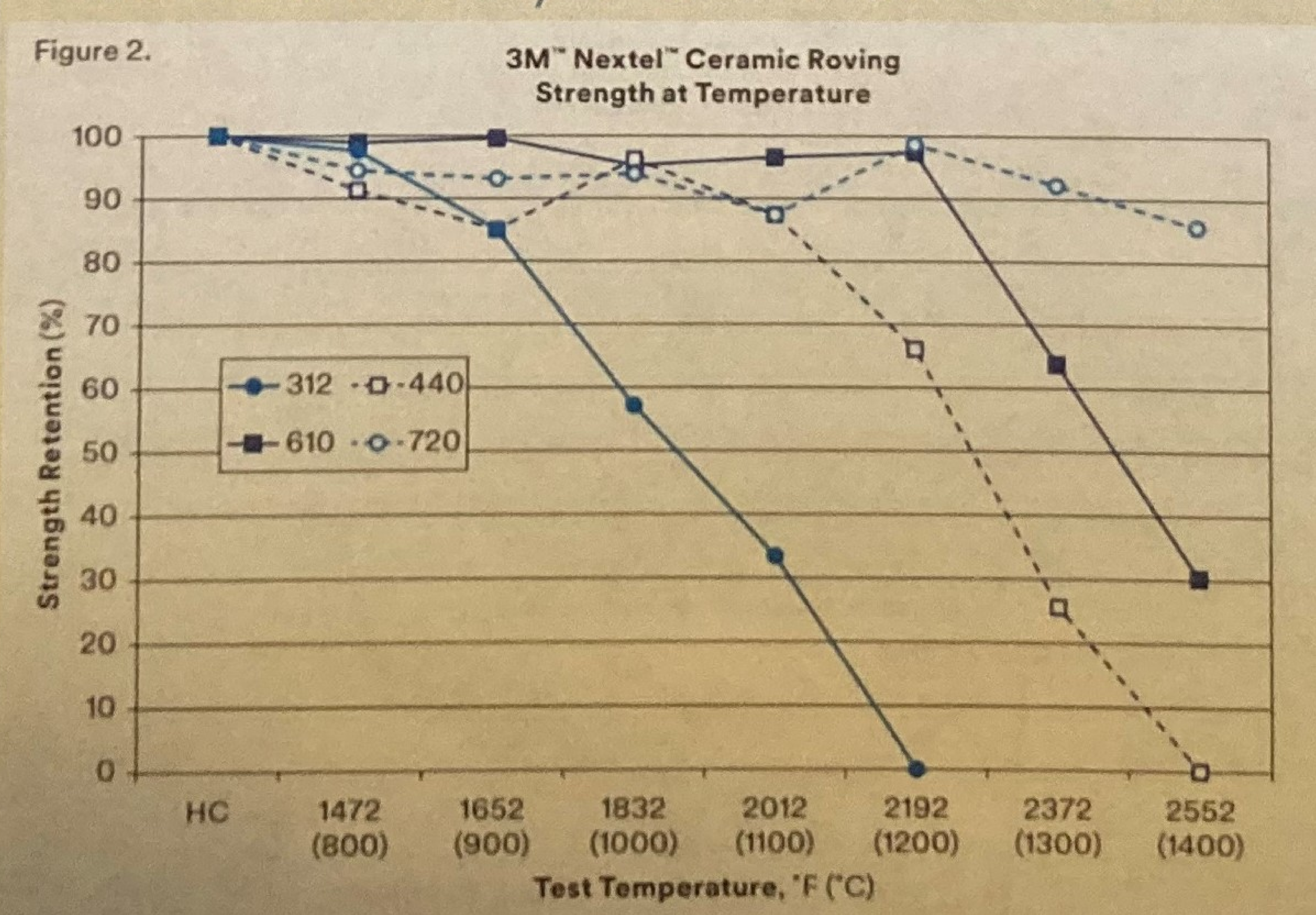
MATERIALS LIST

MMOD SHIELD

Aluminized Beta Cloth: PTFE (Teflon) infused silica fabric



3M Nextel 312/440 Ceramic Fabric



Estimated Cost: $522.36/lb

INNER RIGID STRUCTURES

NASA 398 Aluminum-Silicon Alloy

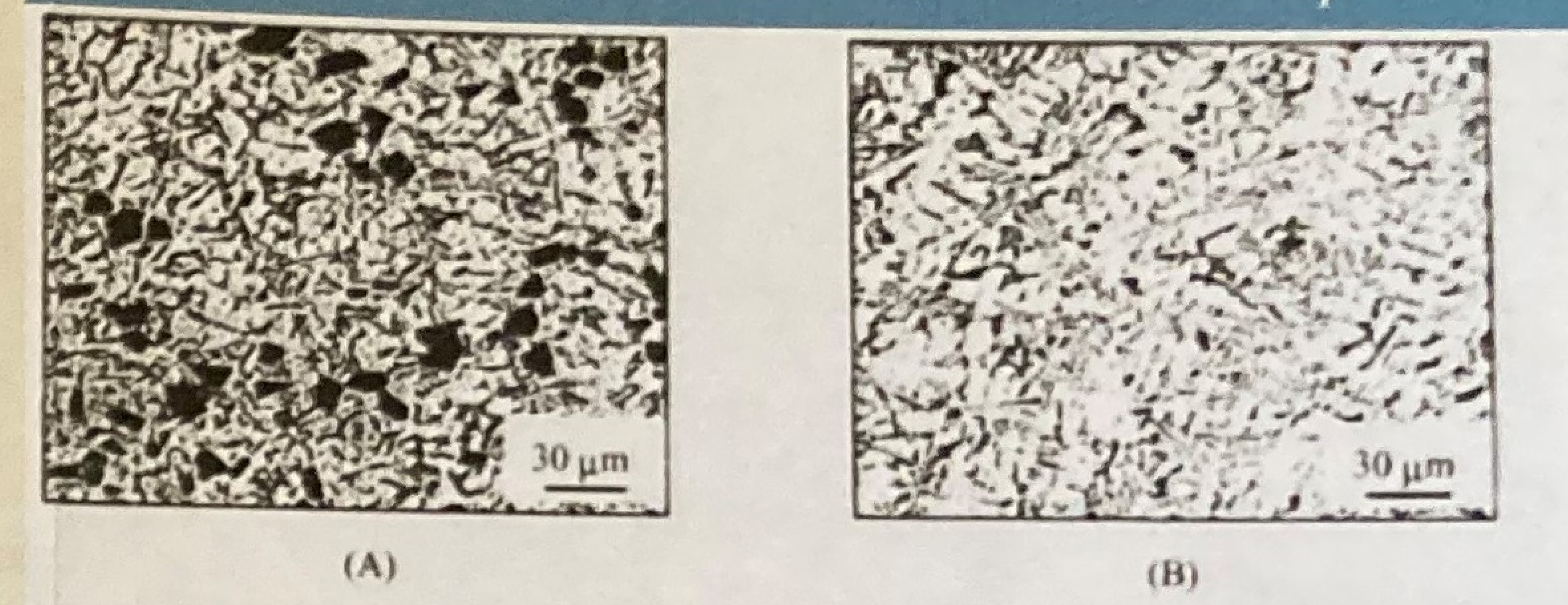


Figure 2: Microstructures of NASA alloys in hypereutectic (A) and eutectic (B).

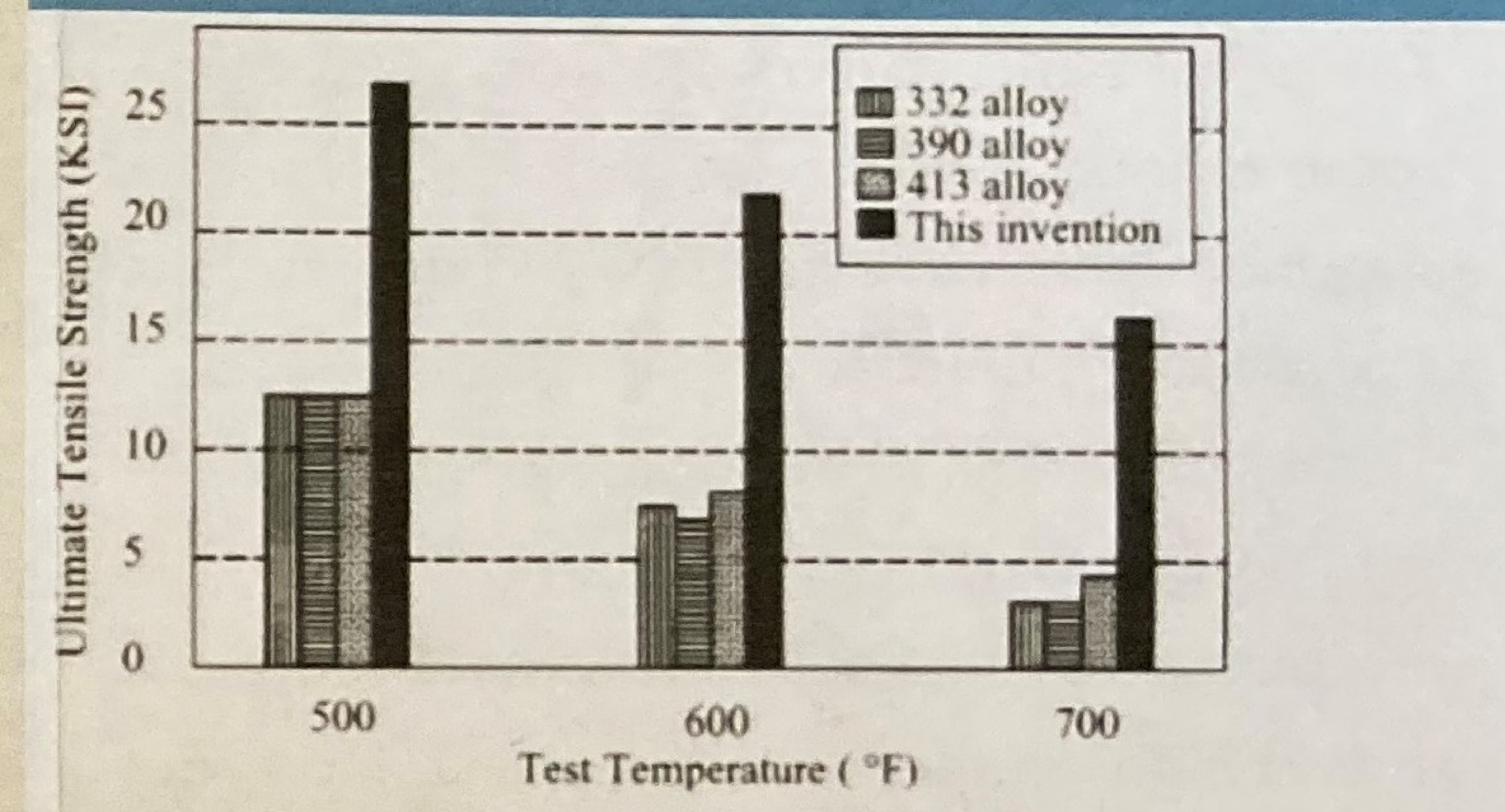
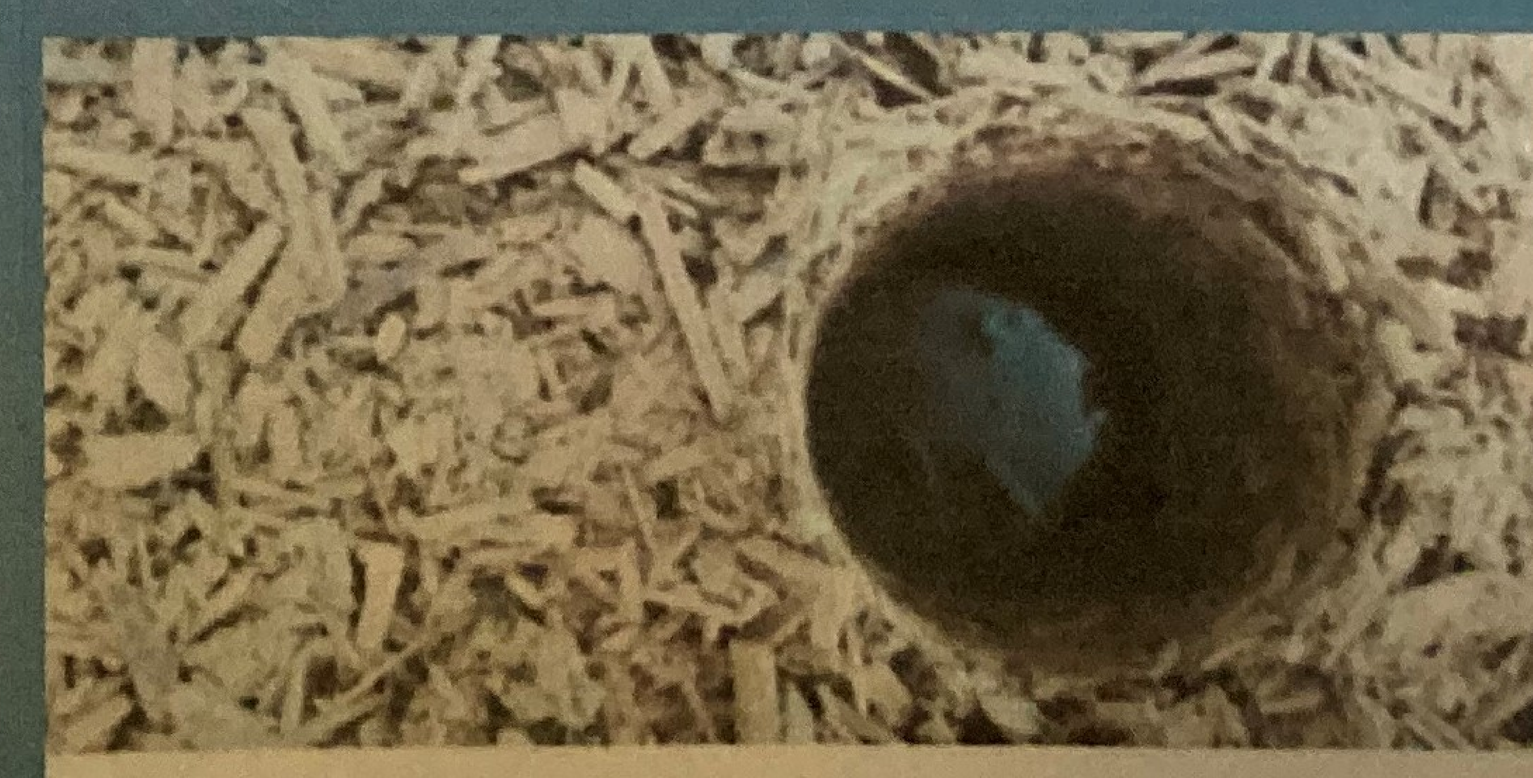


Figure 3: Comparison of tensile strengths at elevated temperatures for NASA alloys.

Estimated Cost: $0.90/lb

FOUNDATION STRUCTURE

Hempcrete and Lime Binder

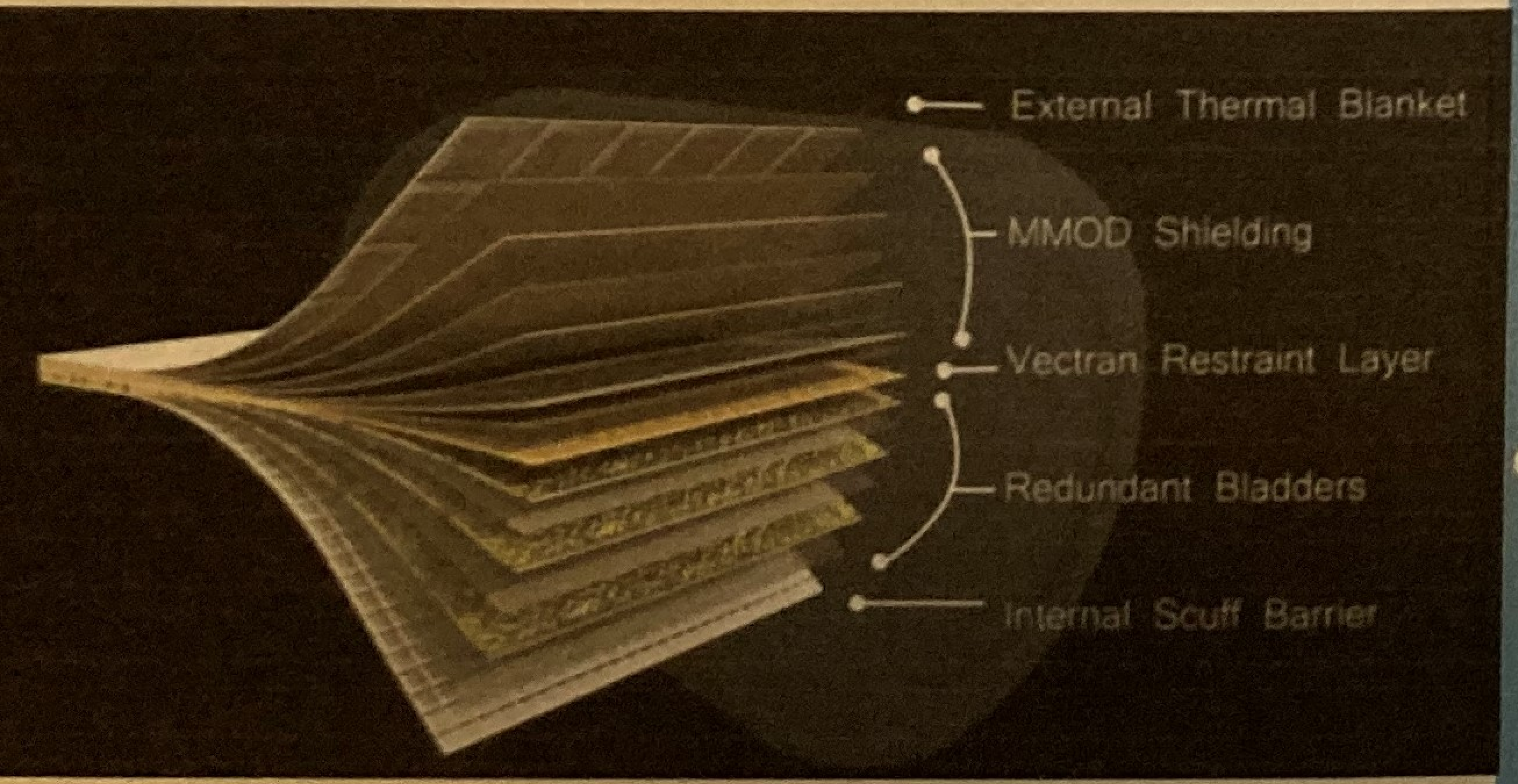


UTSOA Materials Lab

Estimated Cost: $14.35/ft^3

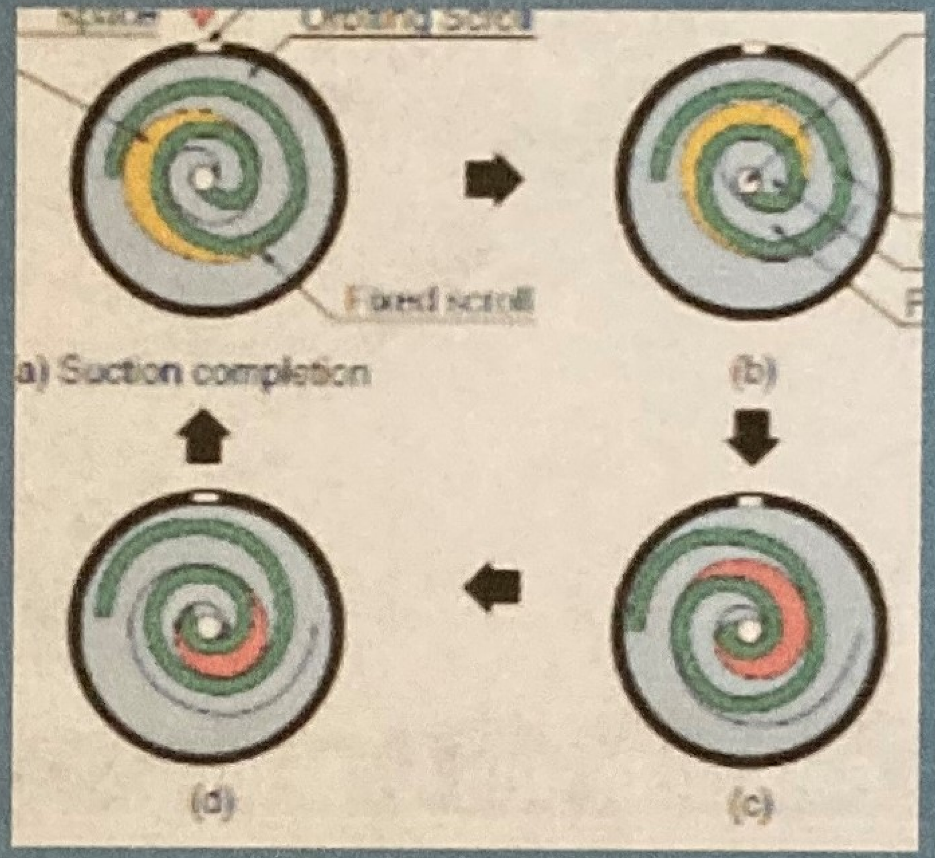
MMOD AND MULTI-LAYER SHIELD

Our dome design is a multi-layer MMOD Shield design, with an inner honeycomb structure comprised of light metal or carbon fiber struts. The MMOD Shield consists of a primary layer of aluminiumized beta cloth, an inner layer of Nextel, and some thin, dispersed layers of Kevlar for extra micrometeoroid protection. Some amount of Aerogel might also be used surrounding high energy drawing devices such as a vacuum pump as a thermal dissipator. All the materials in the dome design are lightweight, and both beta cloth and Nextel are also good thermal insulators. Beta cloth has a high atomic resistance, making it an ideal choice for the outermost layer of the design.



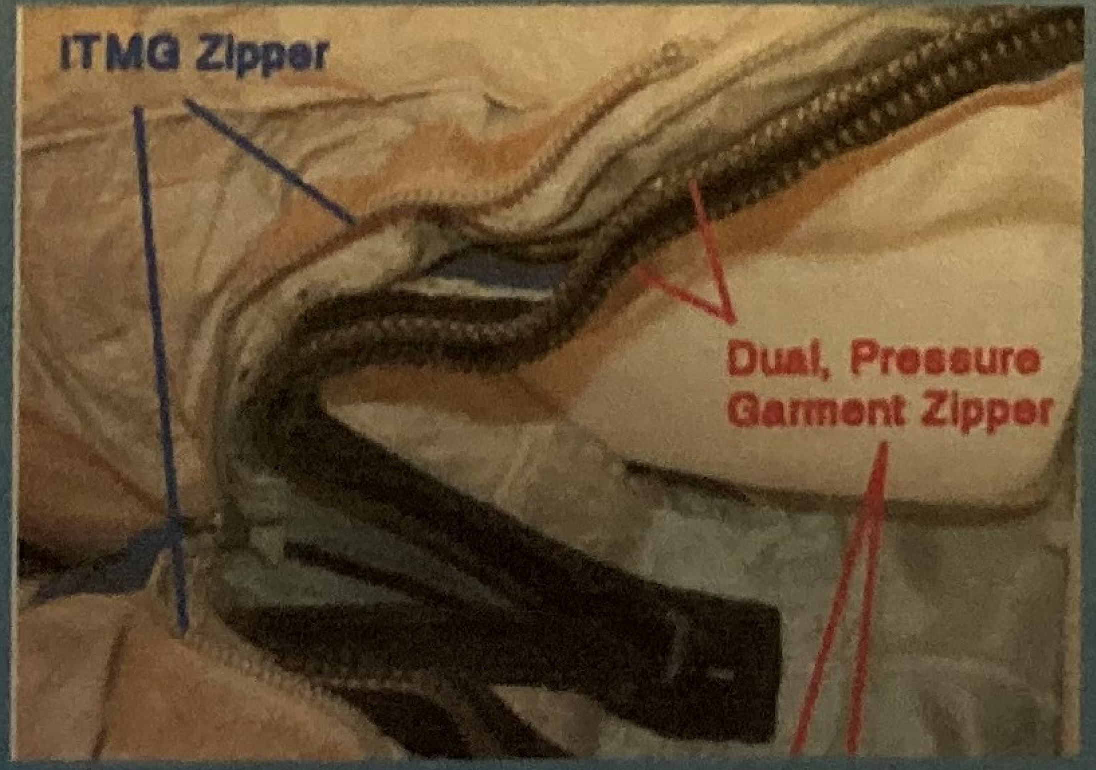
DRY SCROLL VACUUM PUMP

Our interior vacuum pump design is that of a dry scroll pump. We chose this design as opposed to other rotary designs such as centrifugal and peristaltic pumps as a dry scroll pump is better at removing gases, and does not involve oil or liquids of any kind. The purely mechanical movement of air without the use of oil or water allows for high pumping speeds, with low, moderate, or high ultimate pressure thresholds.



EXTERIOR ZIPPER DOOR

Our exterior door design is comprised of a multi-layer system similar to that seen on the Sheppard spacesuits, with a silicon or rubber layer in between to create a seal. The use of zippers allows for a flexible door design. In addition, with the multi-layer dome design, a vacuum pump (described below), can remove air between layers, further sealing the layers of the door to one another.



LUNAR AIR LOCK DESIGN OVERVIEW

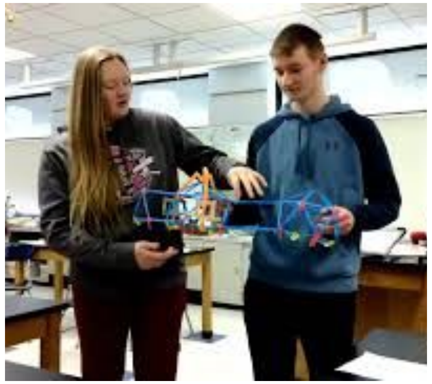
Nathaniel Blanchard, Marcus Cedillo, Cyrus Dickman

Lakewood High School

Instructor: Ashley Pederson

SOLUTION STATEMENT:

Our team has provided a lunar habitat structure consisting of two principal, flexible MMOD shield layers, four rigid, aluminum structures to provide integrity, and a modular foundation; in order to create an easily transportable and assemblable lunar lodge structure that can be used to unload supplies from lunar supply pods.



Lunar Supply pod Cleaning Domes
Lunar Supply Pod Airlock

Benjamin Michalak-Brown,
Samantha Steindel
Frontier Central School District
Teacher: Sandra George

We built a model of a geodesic dome structure that can clean a Supply Pod easily of all the space particles, harmful dust and debris. This will make the Supply Pod safe for astronauts to access the supplies and materials inside the pod.

Description:

- 4 x 9.87ft Kruschke Geodesic Dome - Flat Base
- Graphite Pipes with Aluminum Connectors
- Canvas/Vinyl covering
- Controlled from inside the habitat
- System that will pressurize the dome while fans blow the gas on the Supply Pod to clean it. (Oxygen)
- Filtration system with Electrostatic Scrubbers to clean air while system is cleaning.
- Elevated floor platform with grates - part of filtration system
- Conveyor Belt (3 stage transfer system)
    - Lunar surface → Cleaning Pod → Habitat unloading