2022 Design and Prototype Semi-Finalists

Lunar Supply Pod Airlock

Students: Thomas Creedonc, Joesph Norman
Teacher: Robin Merritt
School: Clear Creek, Texas

Students: Ty Tayler, Lula Samsur, Cexxxxxxx
Teacher: Joel Bertelson
School: Chatfield, Colorado

Students: Garrett Davis, Collin Green
Teacher: Ashley Pederson
School: Lakewood, Colorado

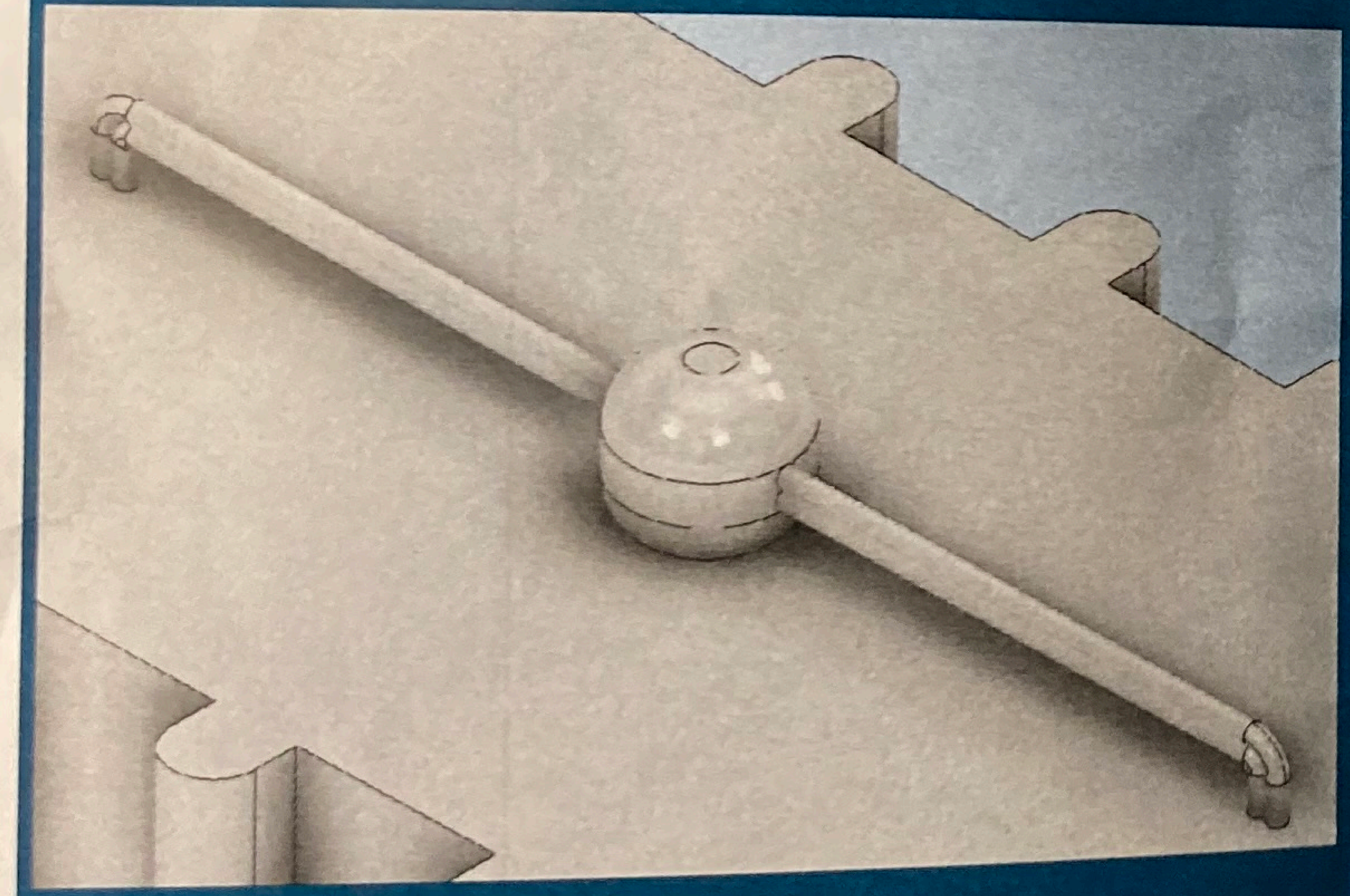
Students: Andrew McCarthy, Nthan Zhou
Teacher: Brett Jenkins
School: Kettering Fairmont, Ohio

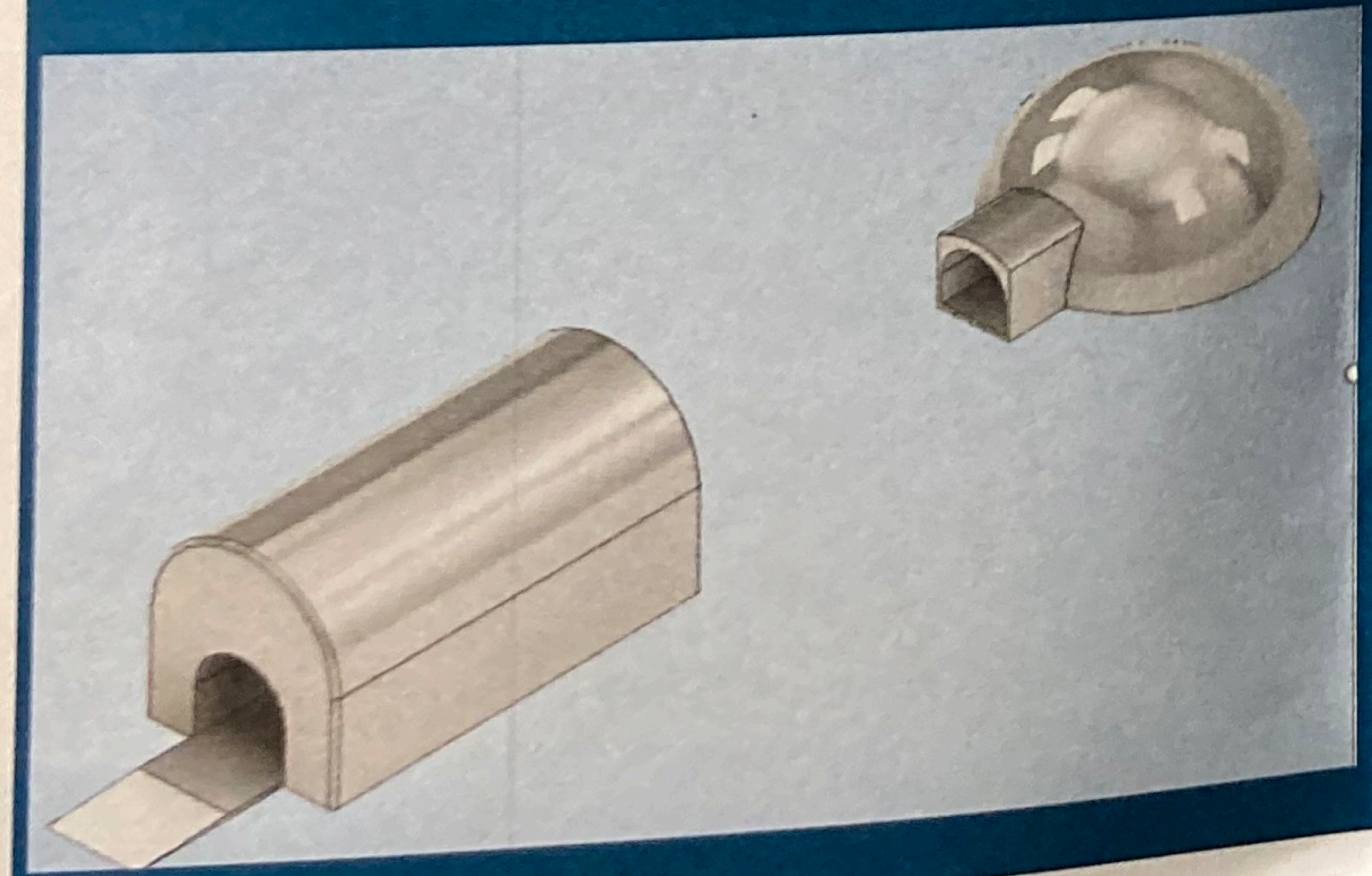
Students: Mattie Sticker, Djaline Xiong, Kyle Pham
Teacher: Michael Cuaron
School: Sanger, California

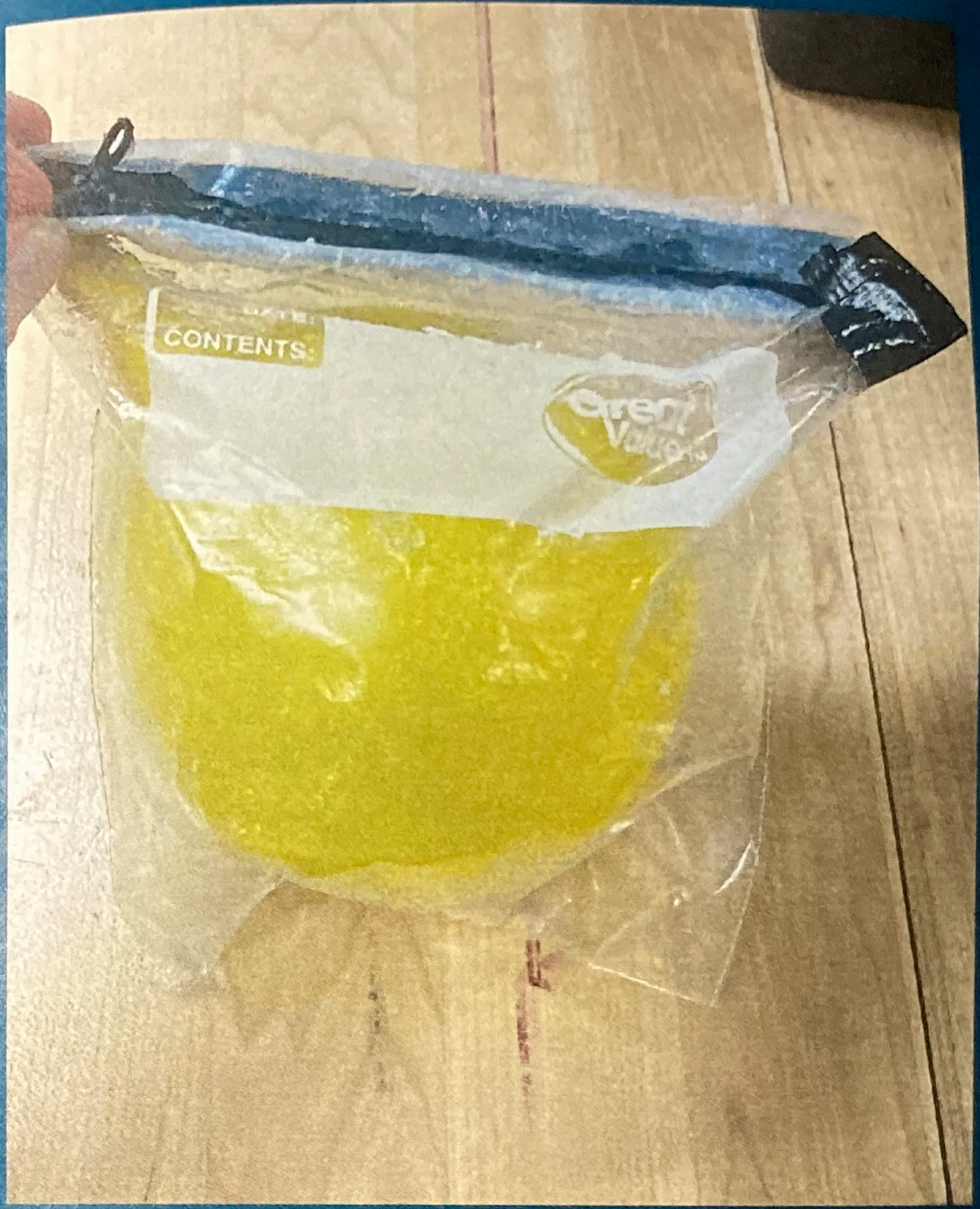
Students: MaKenzie Elliott, Brooks Schwab, Isaac Diggs
Teacher: Christopher Garris and Christy Bennett
School: Warhill, VA


FOOD LAB
MARKET & EATERY
Problem Statement
A lunar airlock is a sealed enclosure that allows astronauts to bring supply pods into a closed area to take out supplies. The airlock also keeps out lunar dust and space particles from getting into the supply pod and lunar habitat. The airlock serves as garage allowing the astronaut to take out what is needed before entering the habitat. The airlock will need to be fully sealed and easy access into and out of as astronauts will be using it frequently. It also needs to be durable and easy to build, transport, set up, and disassemble when needed on space or back on earth.
Design Feature
Transport
Airlock
Prototype 1
Prototype 2

The starting point for the project is to design a garage to be able to house the airlock and store the equipment needed like the supply pod and supply pod mover. There needed to be an oxygen and nitrogen tank to pressurize the airlock to allow astronauts to go in and out. The second photo shows the garage and the habitat constructed.

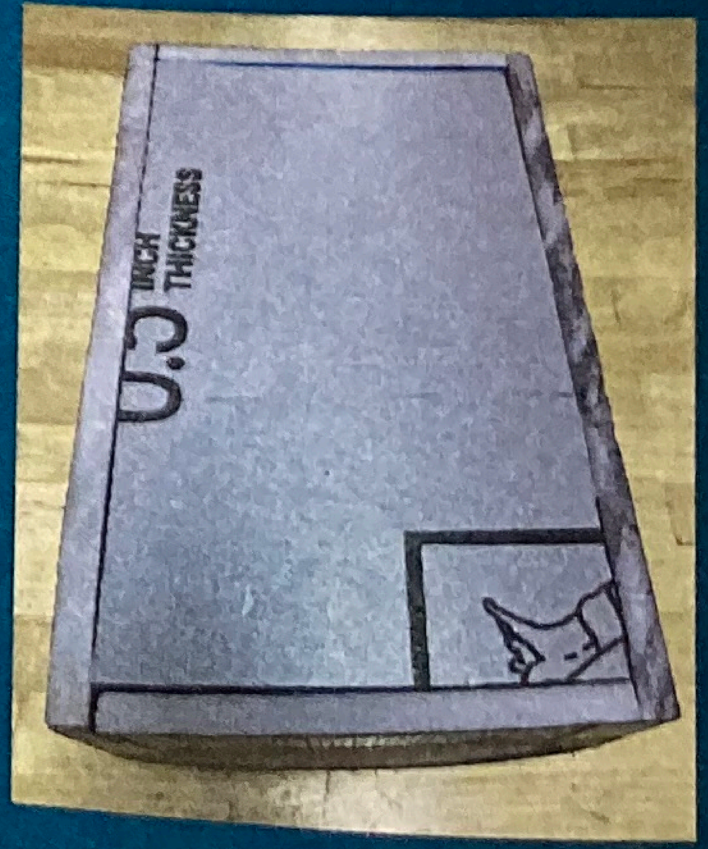






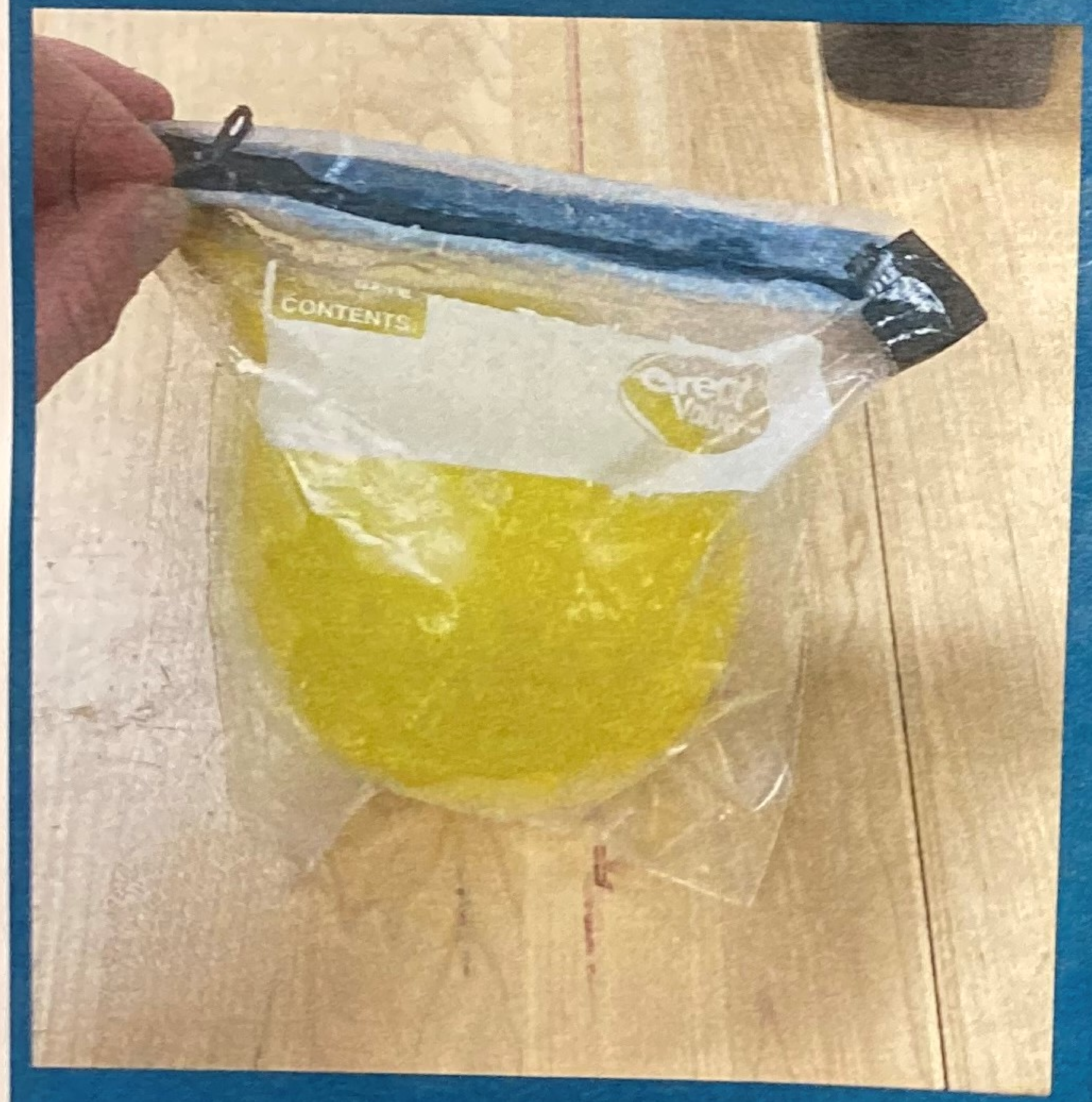
Scan this QR code to get the demo video

After the design was made on the computer, we started the 3d modules. The first picture represents half of a PVC pipe which is the whole garage. The garage is semi-rigid. The pink foam walls are used as the walls and the base of the garage. This allows for structural support and a sturdy floor. Lastly the rope represents ribs that are for support. These are made out of Kevlar and filled with expanding foam.



Second Prototype

To represent the airlock we created a second prototype. The zipper is watertight zipper that was glued onto a plastic bag with silicone sealant. The zipper can zip and unzip partial and is able to hold air. The balloon inside of the plastic bag represents this.



Problem Statement

A lunar airlock is a sealed enclosure that allows astronauts to bring supply pods into a closed area to take out supplies. The airlock also keeps out lunar dust and space particles from getting into the supply pod and lunar habitat. The airlock serves as a garage allowing the astronaut to take out what is needed before entering the habitat. The airlock will need to be fully sealed and easy access into and out of as astronauts will be using it frequently. It also needs to be durable and easy to build, transport, set up, and disassemble when needed on space or back on earth.

Contact Information

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TRANSPORT AIRLOCK

By
Thomas Creedon and Joseph Norman
For
Mr. Merritt's
Engineering Design and Development

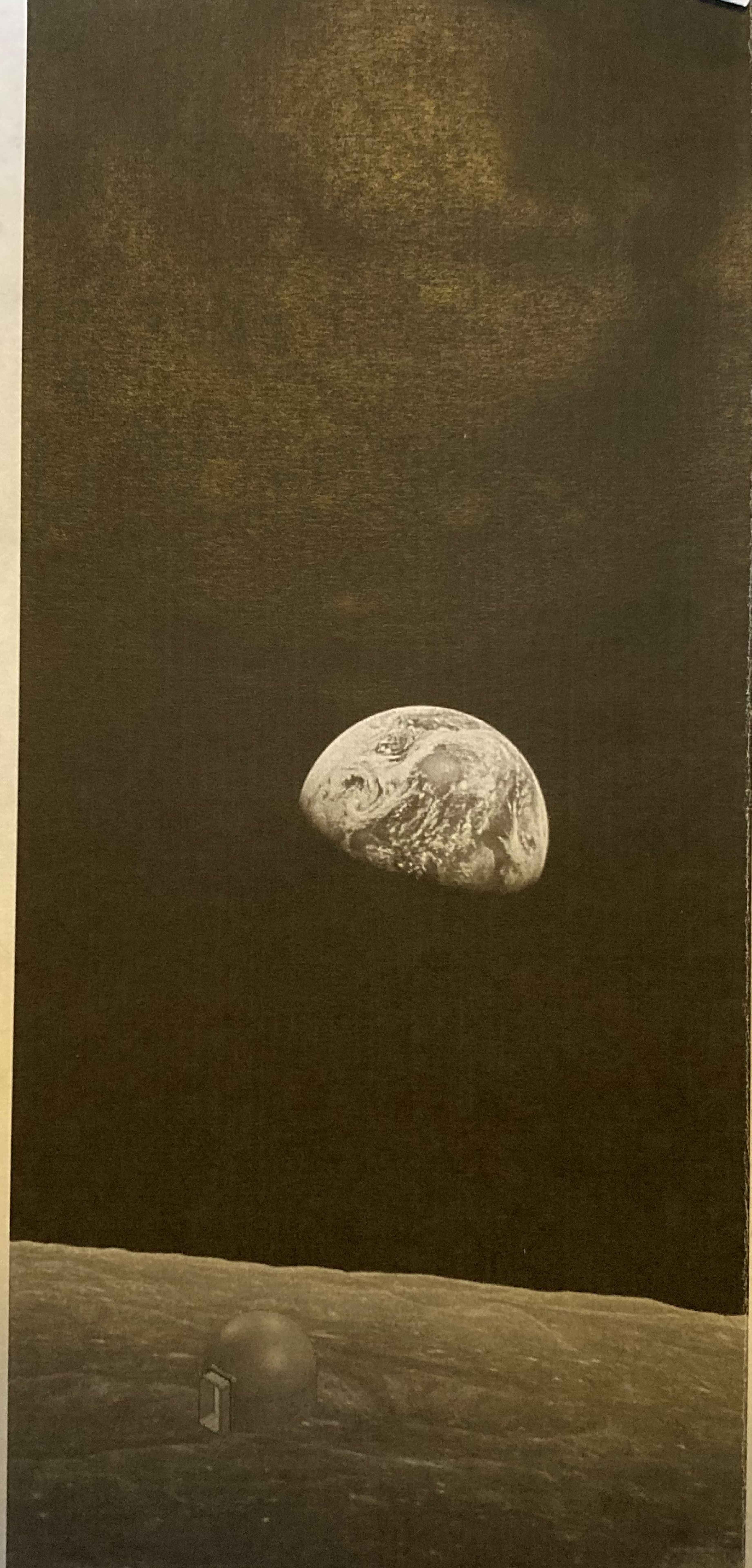

BLAST
Lunar Supply Pod
Airlock


Lunar Supply Pod Airlock
Lakewood High School
Ms. Pederson
Garrett Davis, Collin Green
Next Steps:
Our next steps are to improve our design by testing the materials themselves, and making small modifications based on results.
Testing:
Lunar Airlock
Lunar Airlock

Lunar Airlock

The lunar supply pod airlock creates a safe pressurized place for the lunar supple pod to be unloaded.

To inflate the lunar airlock, first, the airlock door and base attach to the Hab airlock. Then the air beams are inflated with nitrogen and the quarter panels are installed. Afterward, the supply pod is rolled in, and the airlock is closed and pressurized. And then the supply pod is unloaded.



Lunar Airlock

LAKEWOOD HIGHSCHOOL B3 ENG 2
GARRETT DAVIS, COLLIN GREEN

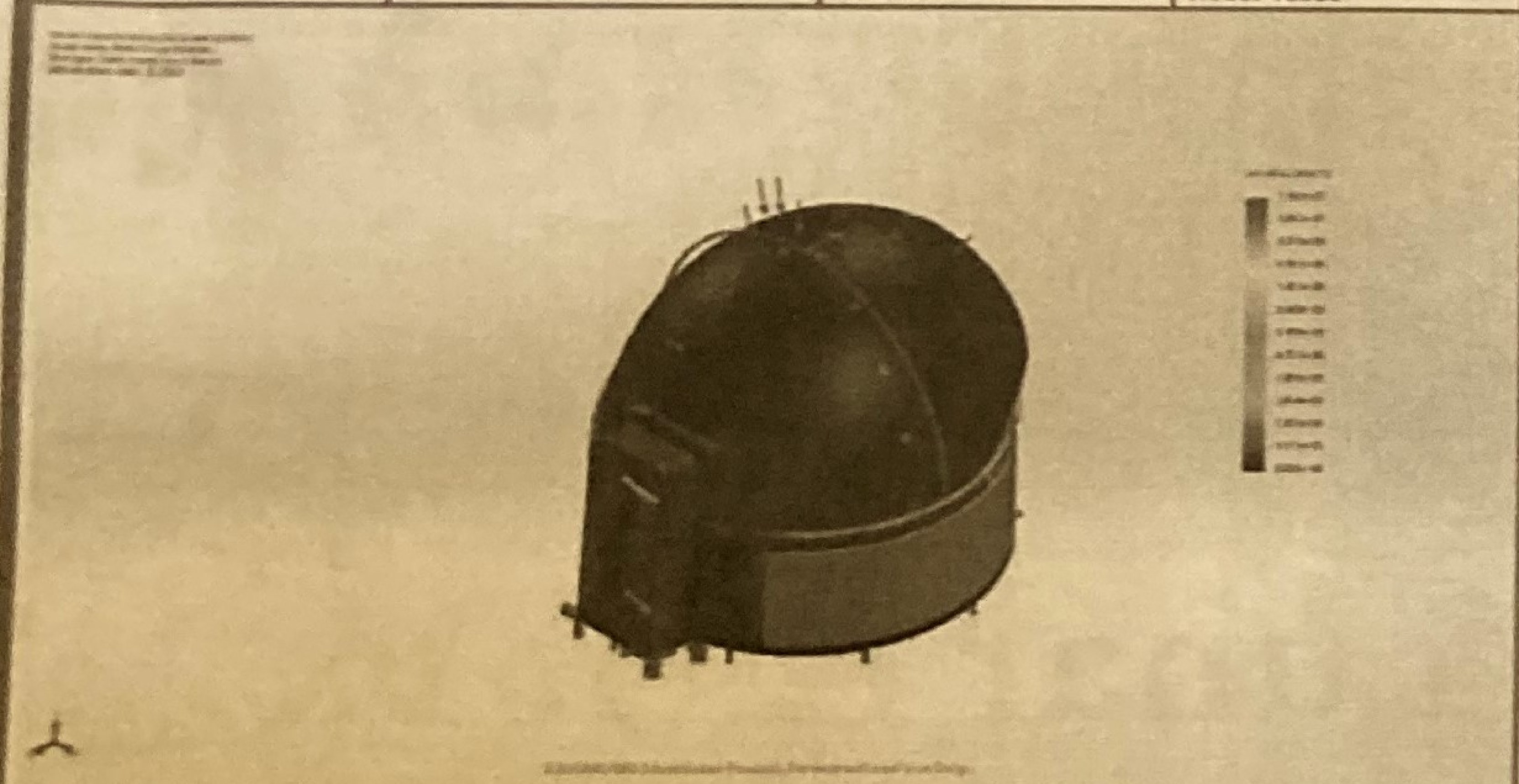
Testing

Assembly for quarter pannels-Static Study-Displacement-Displacement1

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	0.000e+00 Element: 1	2.629e-03 Element: 13126

Study Results

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.000e+00 N/m^2 Node: 1	1.142e+07 N/m^2 Node: 10883

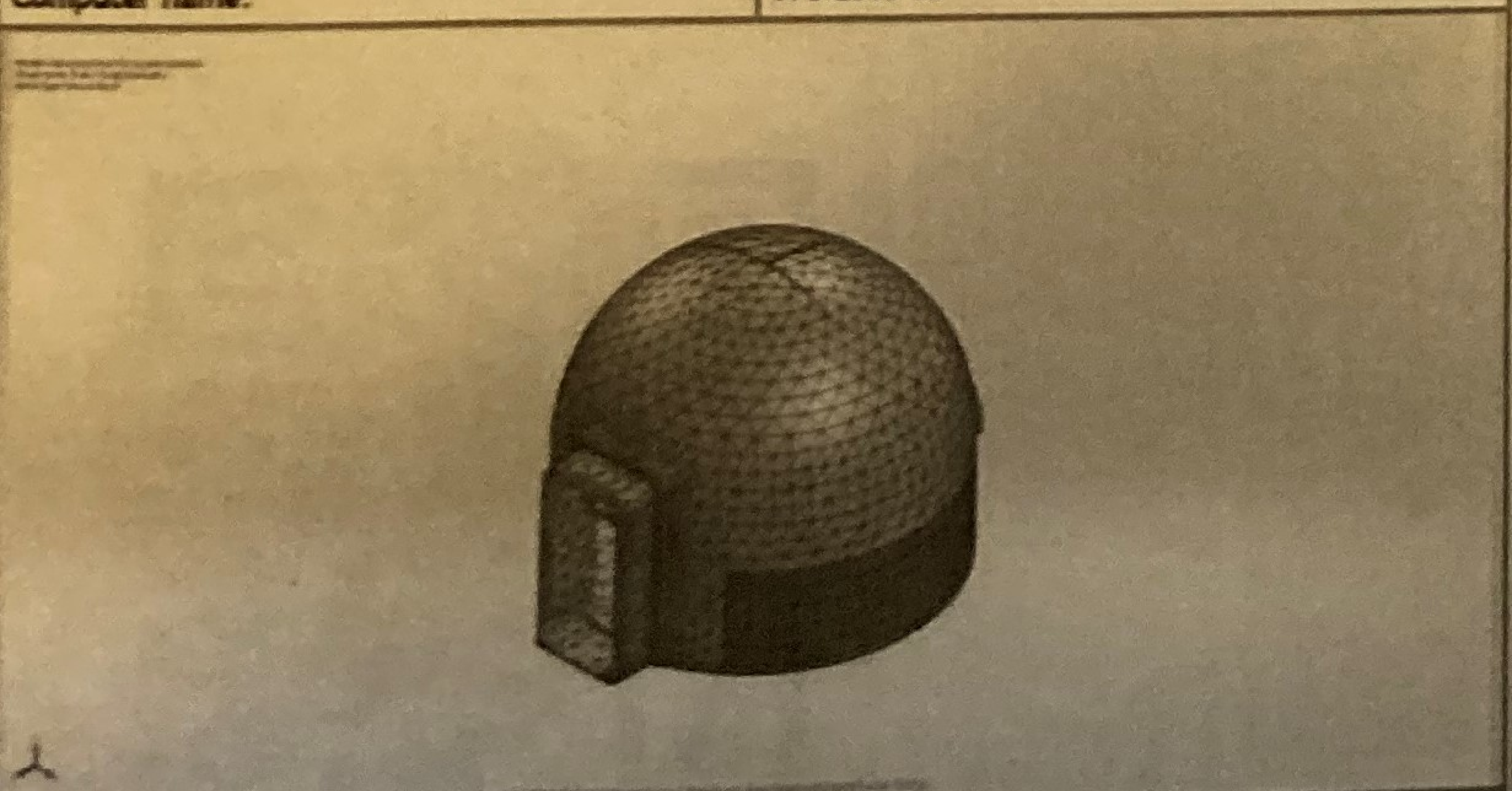


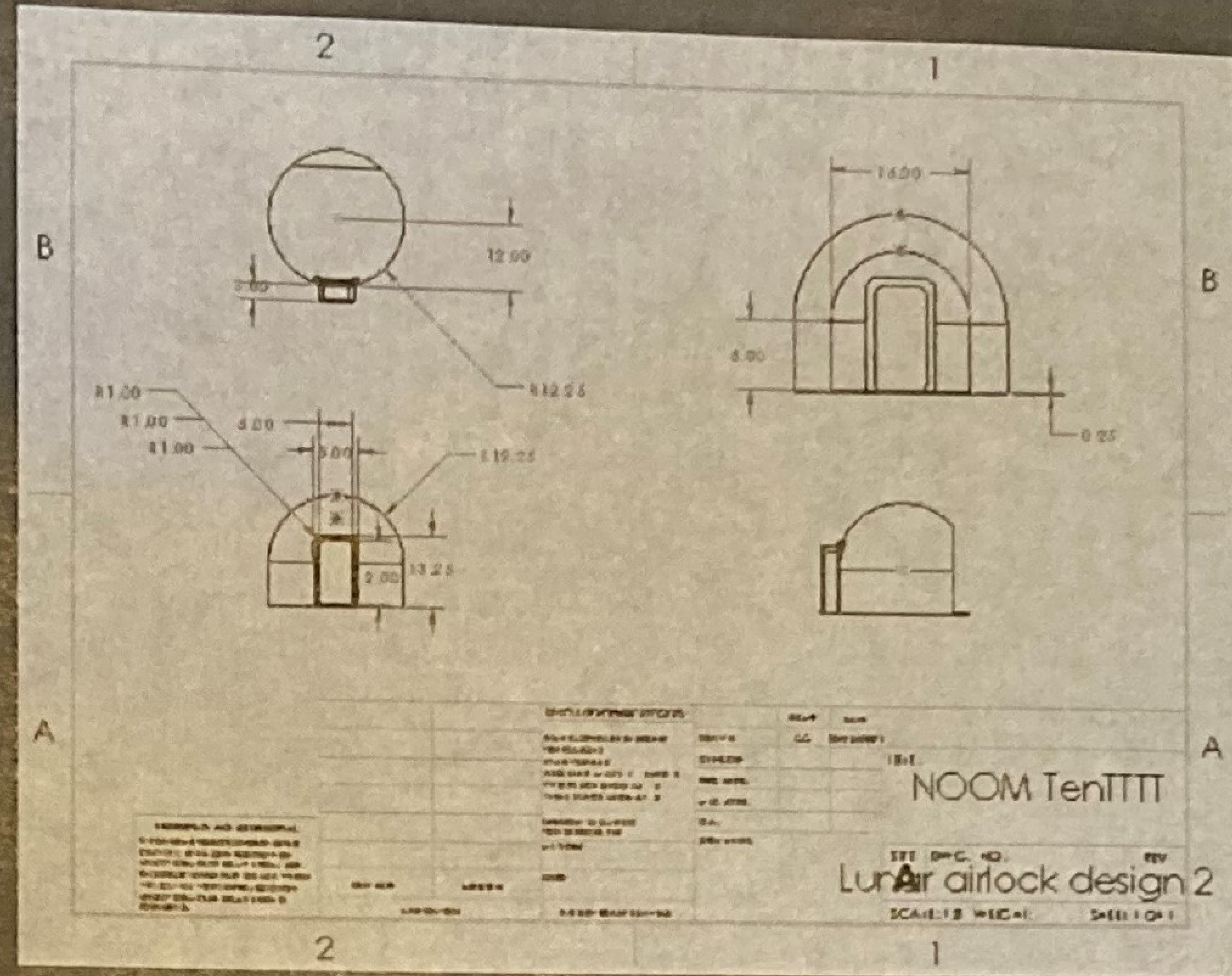
Assembly for quarter pannels-Static Study-Stress-Stress1

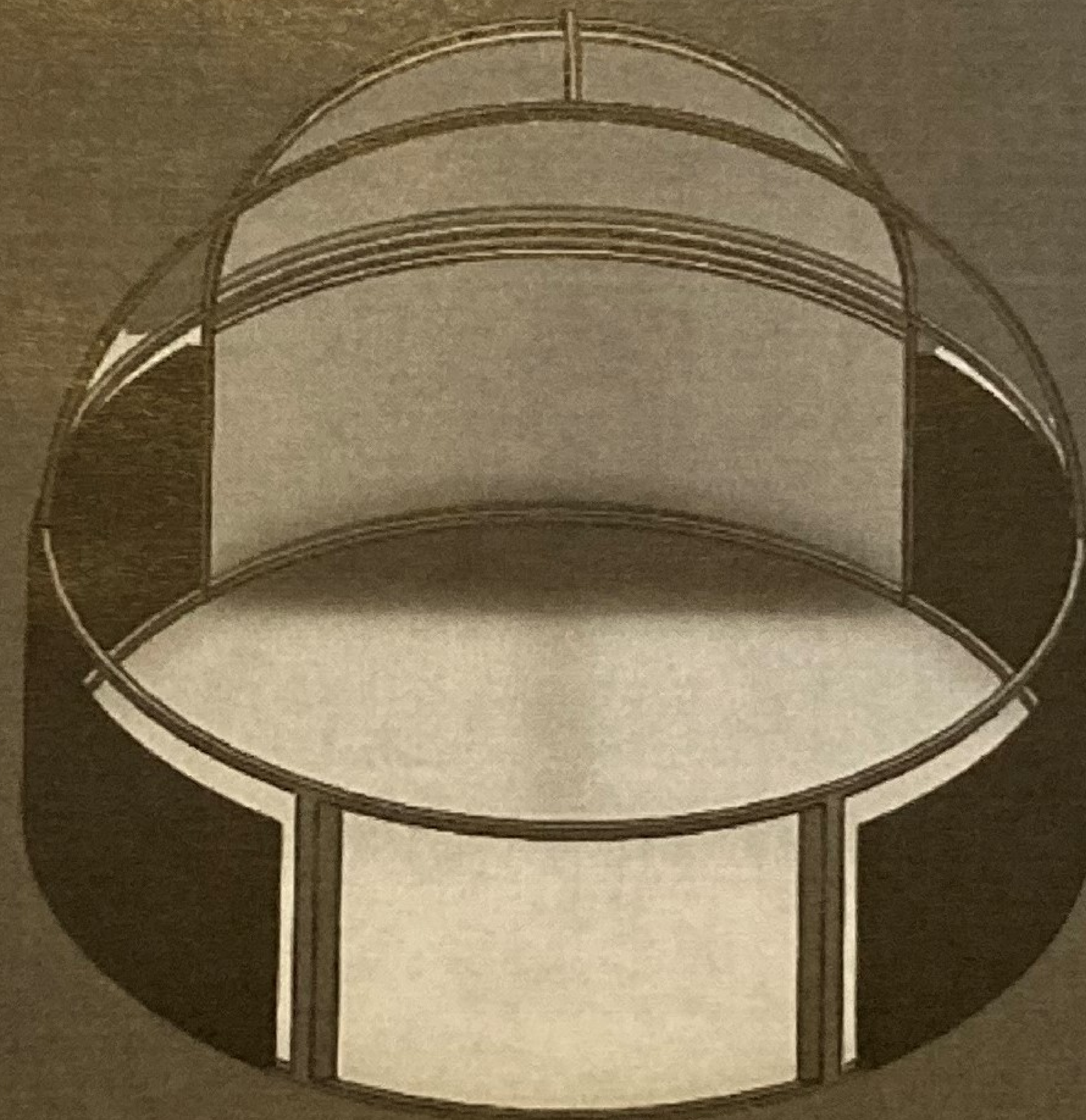
Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.000e+00 mm Node: 1	1.047e+00 mm Node: 7356

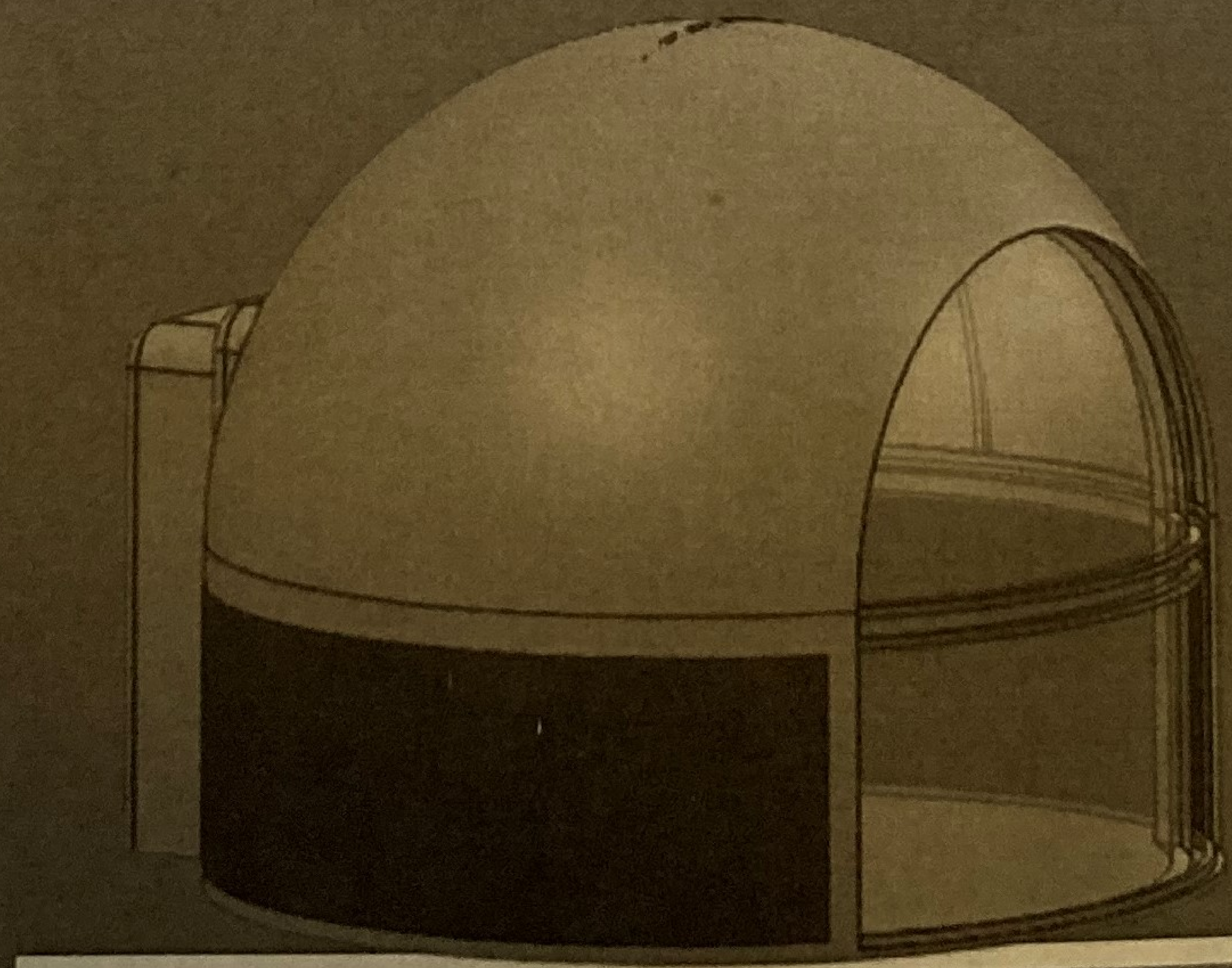
Mesh information - Details

Total Nodes	27420
Total Elements	13591
Time to complete mesh(hh;mm;ss):	00:00:03
Computer name:	770-E113-19









Materials

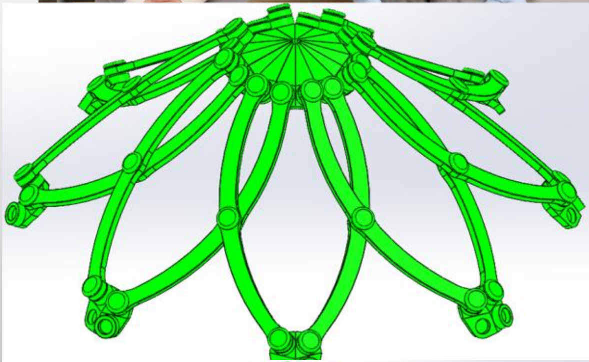
- M47022 PA PU 2C
  - Airtight coated and laminate
    fabric. High tenacity polyami
    fabric PU-coated + gas-tight
    film – helium-proof and HF-
    weldable
    - 380 g/m2
- Beta cloth
  - Used as an outermost
    insulating layer on many
    space commodities (EVA sui
    space station, shuttle, etc
- Nomex
  - Excellent thermal, chemica
    and radiation resistance fo
    polymer material.

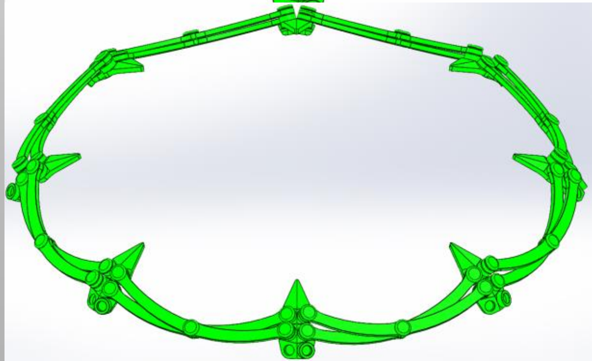
Can withstand temperatures up
370o Celcius

Hoberman Bros.
(Lunar Supply Pod Airlock)

Kettering Fairmont High School
Brett Jenkins
Made by Andrew McCarthy and Nathan Zhou

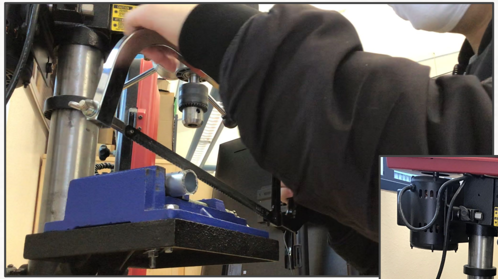
We have designed a lunar base airlock to transport supply pods based on the Hoberman Dome.





Lunar Supply Airlock

MDKSpace.Inc



Visit our website for more information, testing videos, and detailed descriptions: MDKSpace.Inc

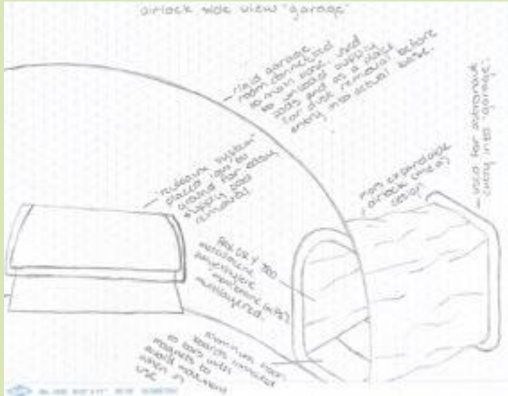
School: Sanger High School

Teacher: Mr. Cuaron

Students: Mattie Stricker, Dejaline Xiong, Kyle Pham

Description: This lunar supply airlock is great and compatible with lunar habitats. It holds supply pods, is easy to set up with inflatable parts, and is lightweight. The airlock is completely sealed to hold human air pressures.

Lunar Base Supply Pod and Airlock System



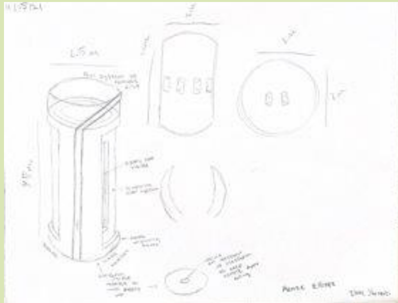
Students: MaKenzie Elliott, Brooks Schwab, and Isaac Diggs

Teachers: Christopher Garris and Christy Bennett

School: Warhill High, Williamsburg VA

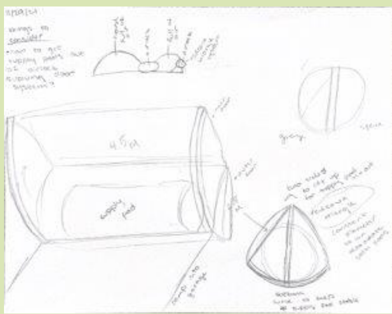
Initial Design Planning

Cylindrical Supply Pod Entry Design



This original idea was based on a revolving door concept. It would stand upright and sit on the surface so supply pods could be aligned vertically for insertion. The inner cylinder that has a singular opening would spin to align with the inner or outer cut out in the outer cylinder to allow for the supply pods to enter or exit.

Reuleaux Triangle System (RTS)



This design would sit horizontally a few feet off the surface, built into the wall of the habitat. The outer door would open down and the inner door up to allow for easy insertion of the supply pods. The reuleaux triangle shape accommodates both supply pod shapes with as little wasted volume as possible.

Research References

Shape-Memory Alloy Hinges

Adams, Douglas S., and Mehran Mobrem. "Lenticular Jointed Antenna Deployment Anomaly and Resolution Onboard the Mars Express Spacecraft." *Journal of Spacecraft and Rockets*, vol. 46, no. 2, Mar. 2009, https://doi.org/10.2514/1.36891. Accessed 14 Mar. 2022.

Mallikarachchi, H., and S. Pellegrino. "Quasi-Static Folding and Deployment of Ultrathin Composite Tape-Spring Hinges." *Journal of Spacecraft and Rockets*, vol. 48, no. 1, Jan. 2011, https://doi.org/10.2514/1.47321. Accessed 14 Mar. 2022.

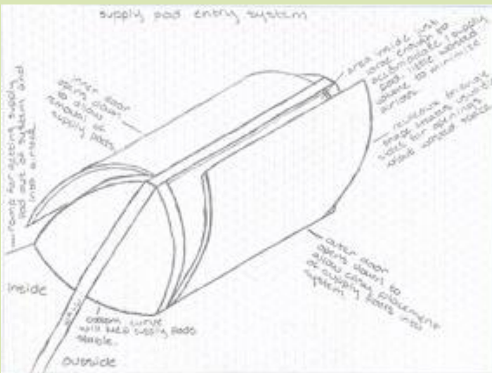
Mars Expandable Airlock

Marquis, Kyle, et al. "Development of an Expandable Airlock for a Martian Settlement." *69th International Astronautical Congress*, Oct. 2018, ubcmarscolony.files.wordpress.com/2018/10/development-of-an-expandable-airlock-for-a-martian-settlement.pdf. Accessed 14 Mar. 2022.

Deciding on Options

After listing pros and cons of both designs, we felt that the Reuleaux Triangle System would be more usable for our purpose. The main thing we were concerned about with the cylindrical design was the longevity of a revolving system.

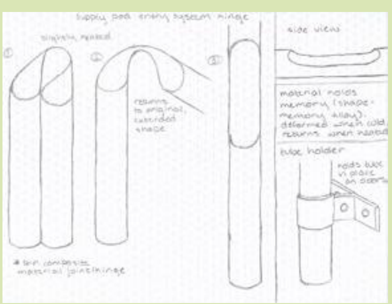
Reuleaux Triangle System Design



Research

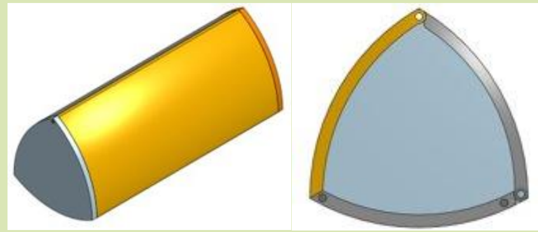
Hinges

The biggest question we had regarding the RTS was concerning the opening and closing technology for the doors. After some research we found shape-memory alloy designs that can be deformed when cold and return to their original shape when heated.



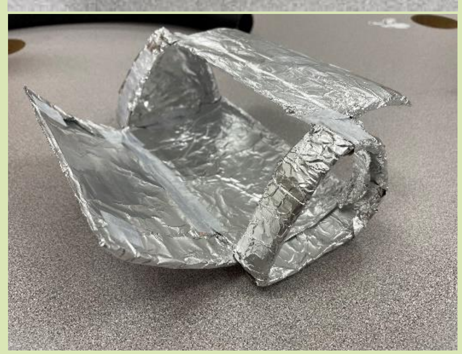
CAD Design

Once we had decided on the supply pod entry system (RTS) and done some research on hinge options we started doing some virtual sketches.



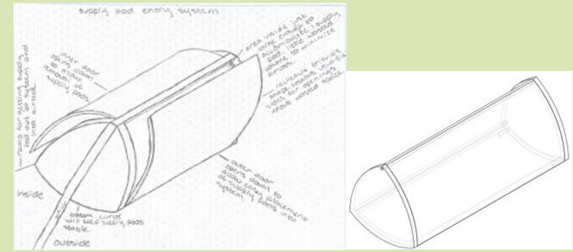
Prototypes

With virtual designs and draw up plans we set to make our first prototype of the RTS which we covered in tinfoil to represent our ideas of using aluminum-based materials



Final Plan

RTS Prototype and Plan



Shape-Memory Alloy Hinge

Mars Expandable Airlock (MEA) Design

For the astronaut entry system, we did some research and found existing plans for an expandable aluminum-based airlock, the Mars Expandable Airlock (MEA).