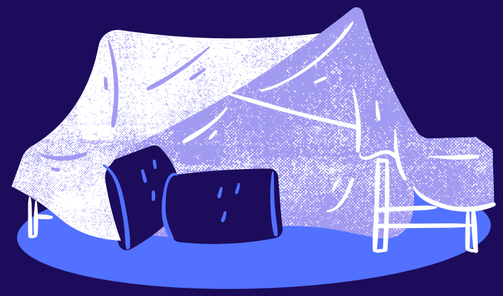
LUNAR GATEWAY

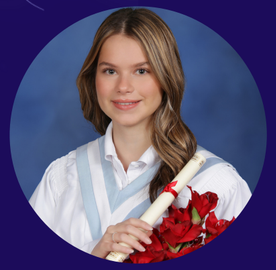
LIVING QUARTERS - HABITATION AND LOGISTICS OUTPOST (HALO)

DEVELOPING AN -INNOVATIVE MINDSET-



-MEET THE TEAM-

Loretto Abbey Team A



OLIVIA COMISSO

Mathematics and Statistics

SOFIA CUCCHI

Civil Engineering

JORDYN KNOCK

Chemical Engineering

JULIA HUGHES

Biomedical & Mechatronics Engineering

SAMANTHA SLACK-SANKOFF

Mechanical Engineering

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MAIN GOAL

LUNAR HABITATION

Create the most efficient, comfortable, and safe living space for the Astronauts travelling to the moon. Nurturing the ability to sustain a healthy mental and physical state in the lunar environment's unique living situation.

GENERAL GOALS

THE FUTURE OF SPACE

- [ ] Enable long-term human habitation in cislunar space.
- [ ] Provide a platform for lunar surface missions and future deep space exploration.
- [ ] Conduct scientific research and technology demonstrations in cislunar space.
- [ ] Foster international cooperation in space exploration.

GOALS

More specific goals.

STRUCTURAL

- [ ] Differentiating our design
- [ ] Efficient shape for environmental concerns
- [ ] Maximize interior space

MATERIALS

- [ ] Can survive the harsh environment
- [ ] Lightweight and easy to transport
- [ ] Durable
- [ ] Reflective (HALO)
- [ ] Easy to maintain

ASTRONAUT COMFORTABILITY

- [ ] Mental health
- [ ] Sleeping comfort
- [ ] Easy access to communication and washroom facilities

THE FACTORS

The following are major factors that needed to be considered with regards to the living quarters:

- SPACE ENVIRONMENT
  - Radiation,
  - Extreme temperatures.
- BUILDING LIMITS
  - Size limits and amount of space allocated to living quarters.
  - Cost.
- CREW SIZE AND DURATION OF MISSION
  - The crew size,
  - Duration of their stay.

OUR PROCESS

OUR PROCESS

01

STRUCTURE

Designating the right shape based on external and internal factors.

02

THE MATERIALS

Deciding the best materials to use.

03

THE INTERIOR

Maximizing space and comfort.

04

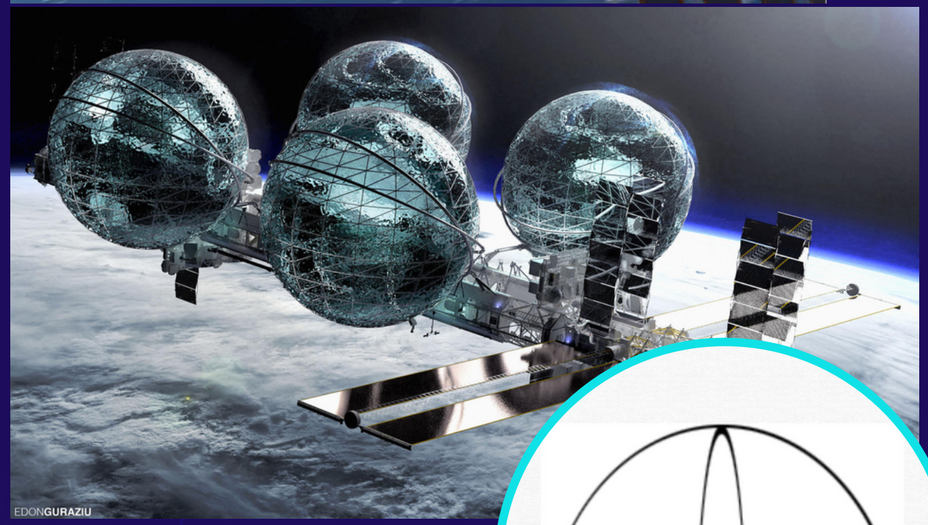
THE MODEL

Integrating our requirements and specifications into a final 3D model.

05

THE "REAL WORLD"

Budget, schedule plans, and maintenance.



STRUCTURE

STEP 1

Square-Based Dome is best for the following reasons:

- STRONG STRUCTURE
- Geometric sturdiness,
- Evenly distributes loads evenly across surface.

- LOW RESISTANCE
- Can withstand exterior forces and stresses.

- HIGH VOLUME LOW SURFACE AREA
- Greatest volumes for interior areas with the least of surface area.

THE MATERIALS

STEP 2

·A Balance of Major Factors in Problem Solving·

Priorities
Impact Protection
Reflectivity
Manufacturing
Durability
Mass
Cost

EXAMPLE:

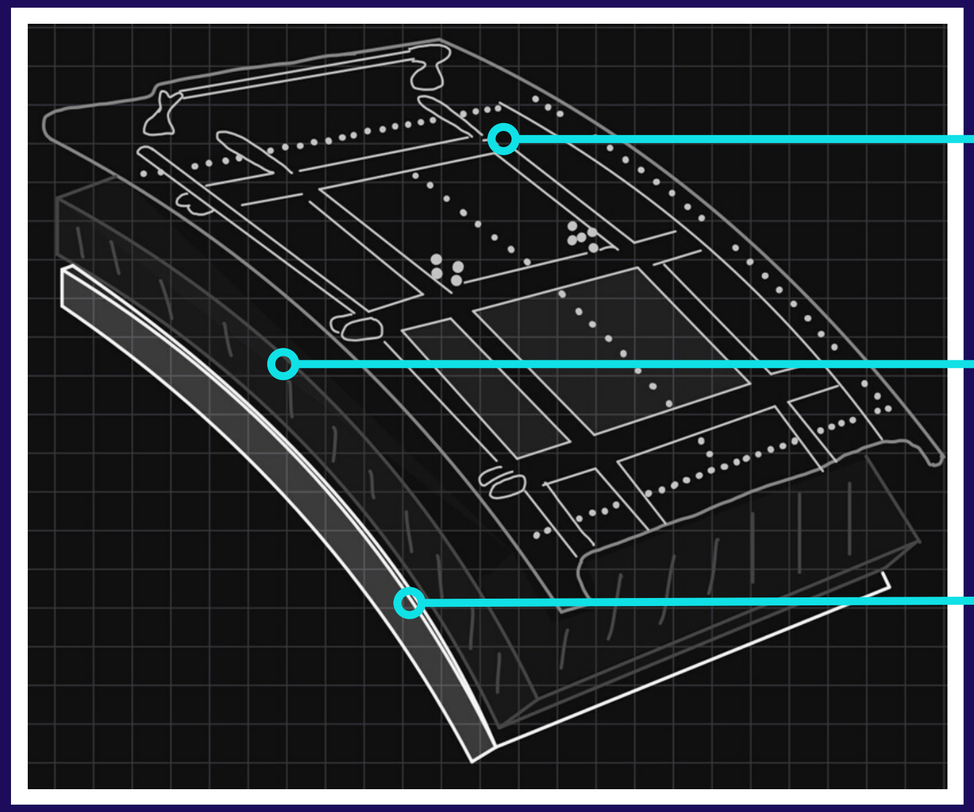
KEVLAR®

VS

ALUMINUM

-MATERIALS AT A GLANCE-

·OUTER STRUCTURAL ELEMENTS·



-WHIPPLE SHEILD-

I: ALUMINUM ALLOY 2219, 0.03M

impact resistance, manufacturability, cost-effective

II: BORON CARBIDE, 0.18M

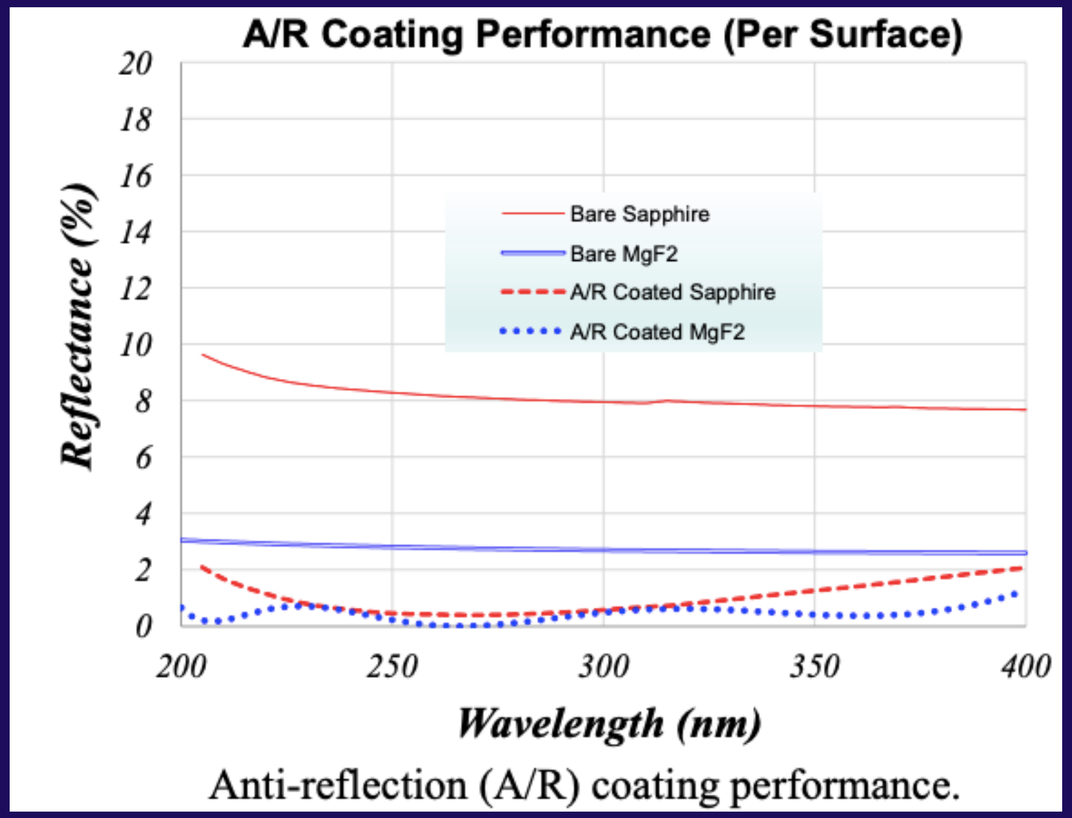
Excellent radiation shielding

III: ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE, 0.10M

High strength-to-weight ratio, excellent impact resistance, and low thermal conductivity

-MATERIALS AT A GLANCE-

·OUTER STRUCTURAL ELEMENTS·



Anti-reflection (A/R) coating performance.

Source: *National Aeronautics and Space Administration. 2016. "Optical evaluation of DMDs with UV-grade FS, sapphire, MgF2 windows and reflectance of bare devices." https://ntrs.nasa.gov/api/citations/20160010362/downloads/20160010362.pdf.*

-WINDOWS COMPOSITES, 0.08m -

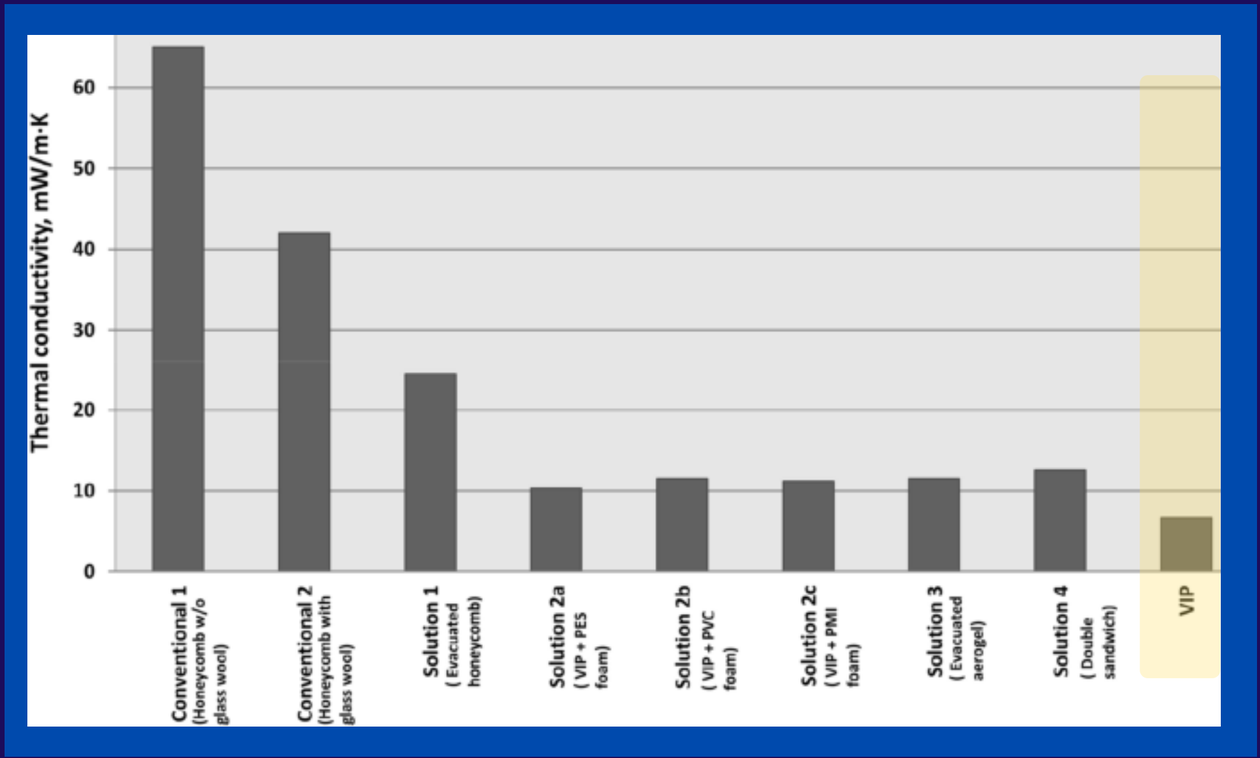
Manufactured through Optical bonding

1. UV-GRADE FUSED SILICA, BONDED
2. LITHIUM ALUMINUM SILICATE GLASS
3. MAGNESIUM FLUORIDE COATING

   Applied to the outer surface

-MATERIALS AT A GLANCE-

·INNER STRUCTURAL ELEMENTS·



-Thermal Insulation, 0.04m -

Vacuum Insulation Panels (VIP)

CORE MATERIAL: FUMED SILICA, GLASS FIBRES

- ENCLOSED IN A GAS-TIGHT ENVELOPE AND EVACUATED TO CREATE A VACUUM.

Benefits:

1. *Very low thermal conductivity*
2. *Thin*
3. *Lightweight*

FURNITURE MATERIALS

The weight of the material, the location of assembly, durability and sustainability all had to be taken into account when choosing a furniture material.

Bamboo

- Lightweight material,
- Deteriorate if not well kept.

Bungee Cord

- To secure to walls.

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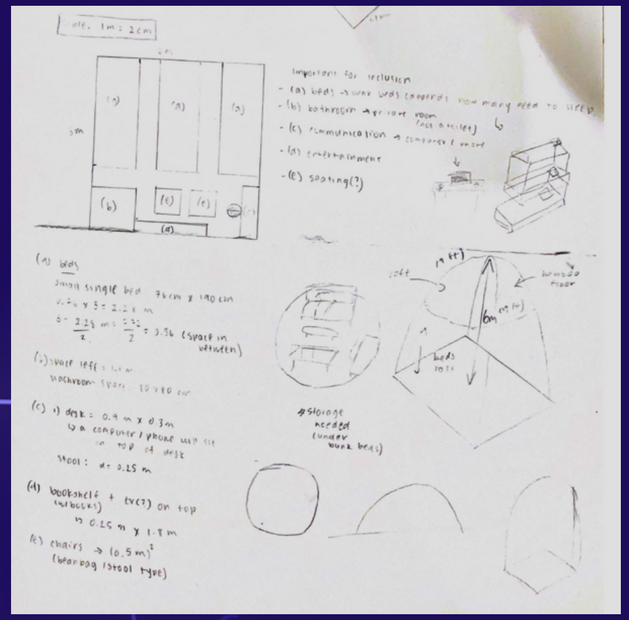
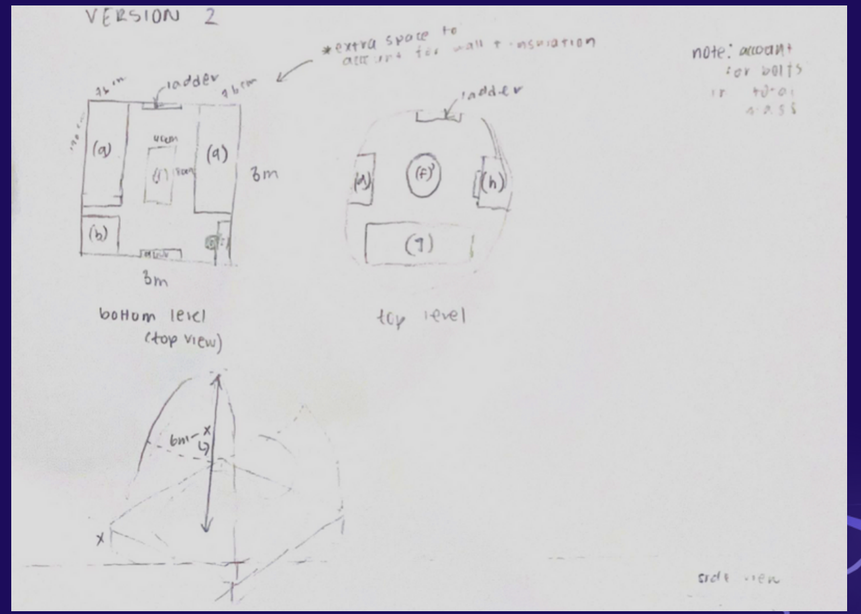
THE INTERIOR

STEP 3

First drafts of some drawing and calculating for the interior.

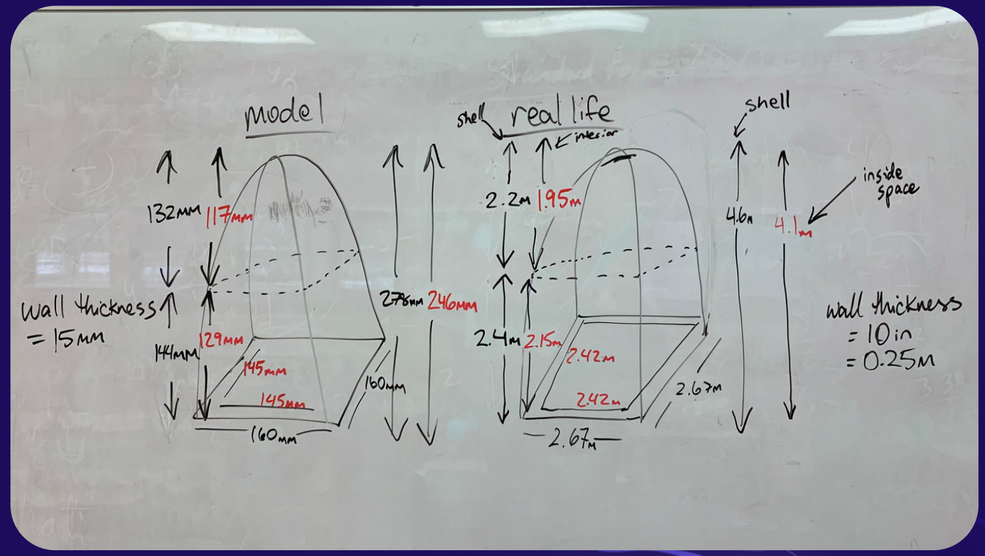




THE SPACING

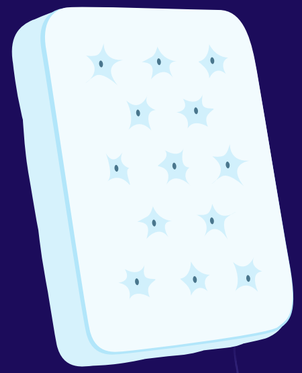
STEP 3

- Making sure everything was to scale,
- Subtracting the space taken by the docking systems,
- Deciding on wall thickness, and subtracting that from the overall space,
- Figuring out the ideal shape,
- Maximizing the interior space.



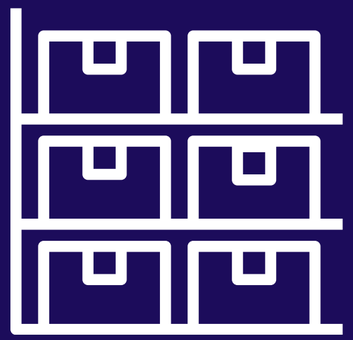
WHAT DID WE WANT TO INCLUDE INSIDE THE MODULE?

AND HOW WOULD THEY SURVIVE THE ZERO GRAVITY ENVIRONMENT?

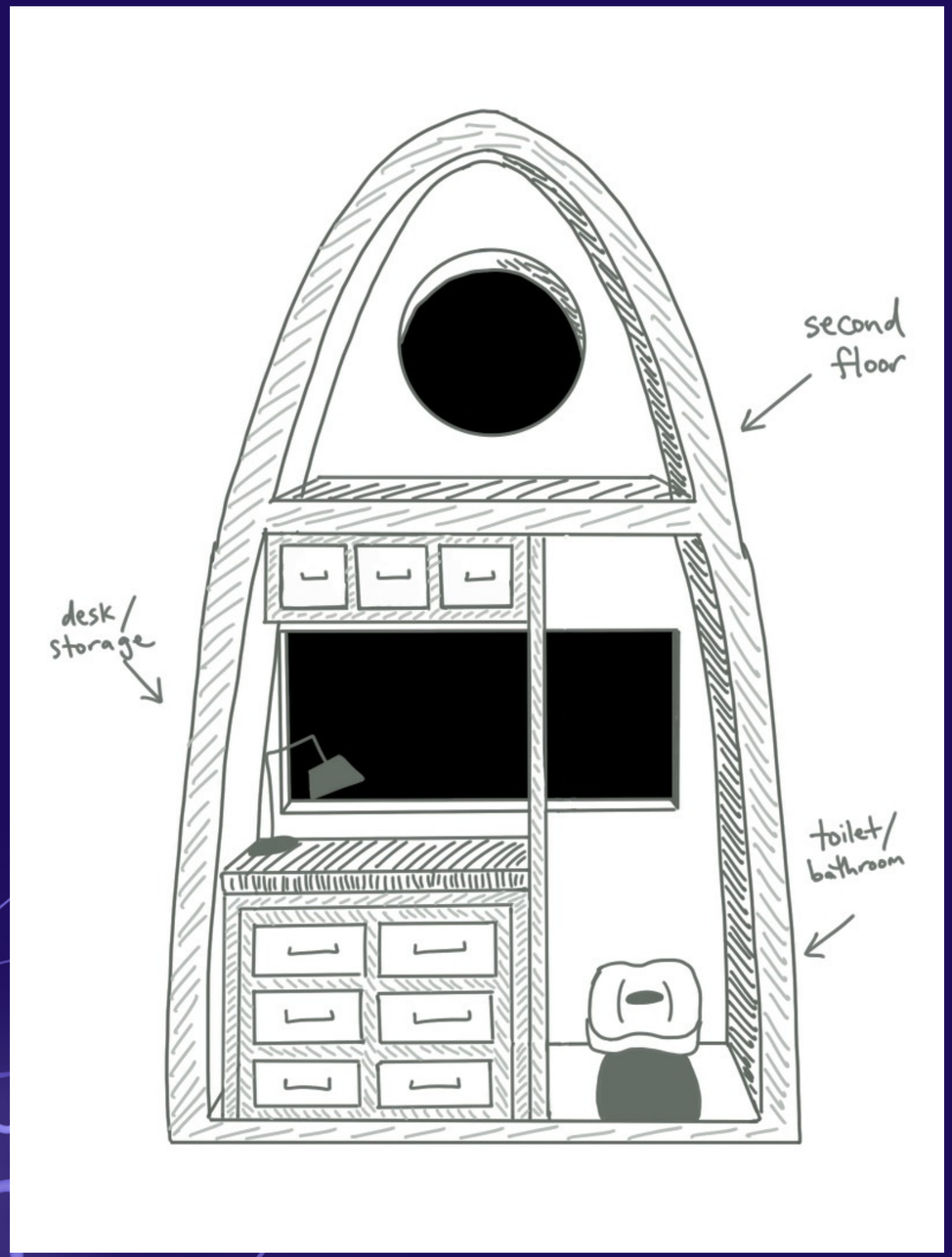


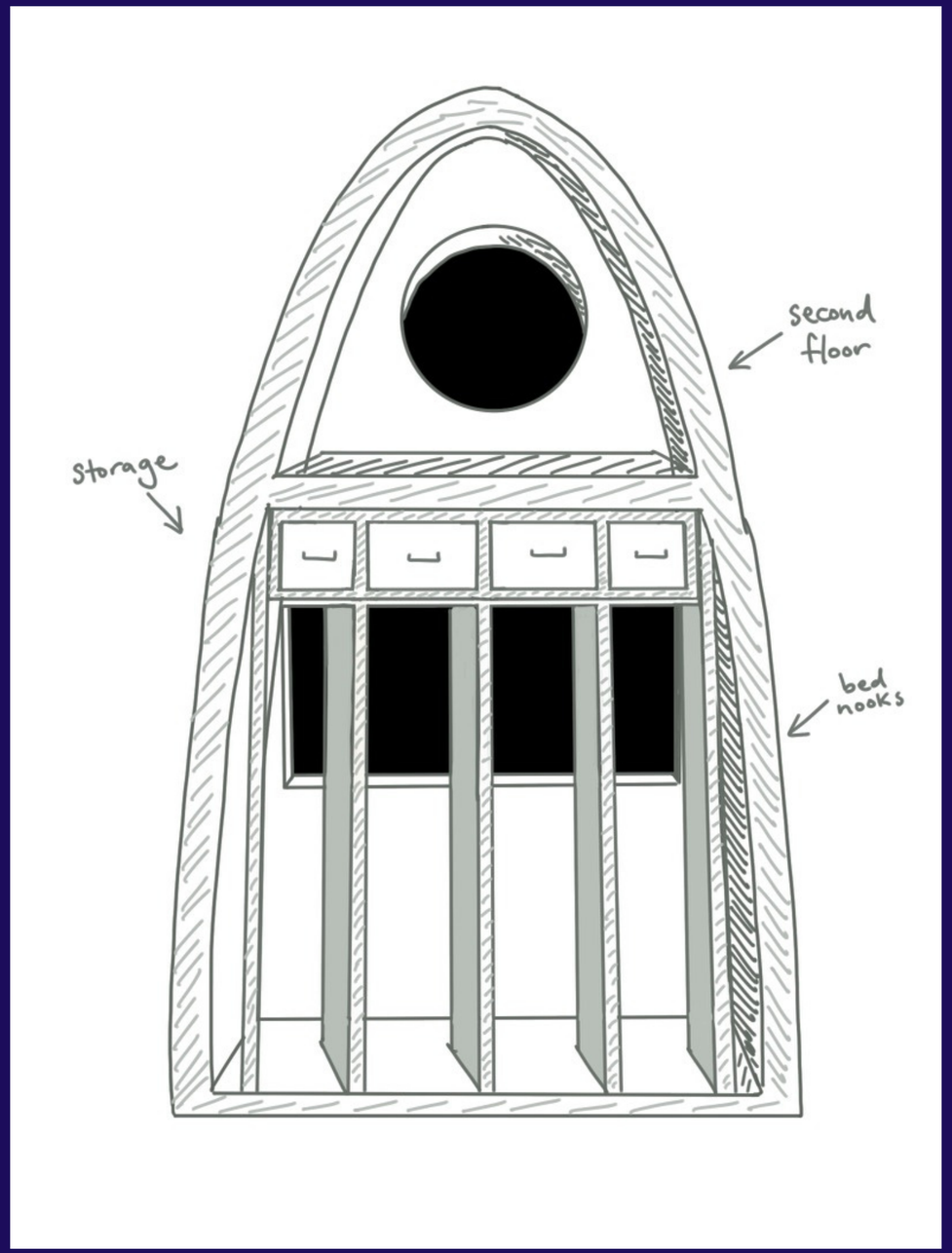
Beds are standing up as the zero-gravity environment allows for it

A bathroom

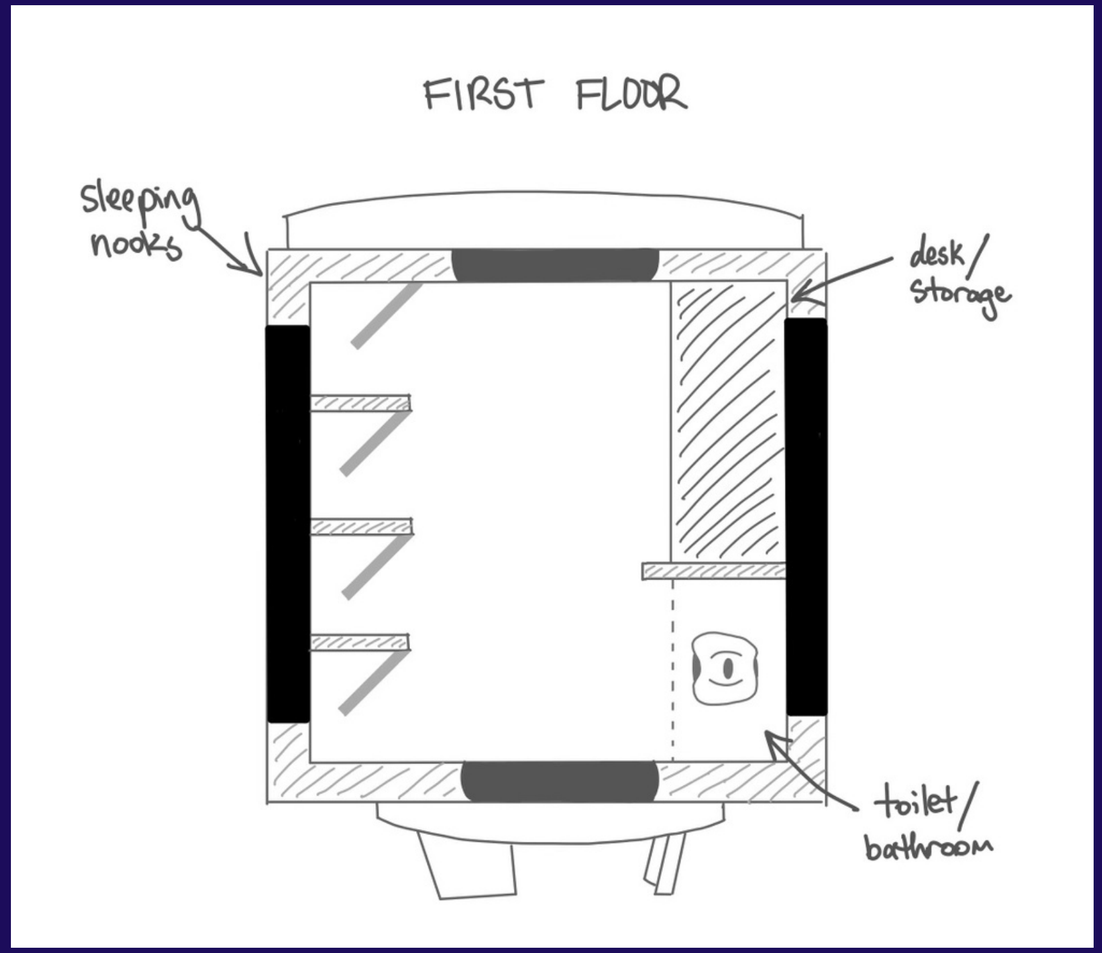


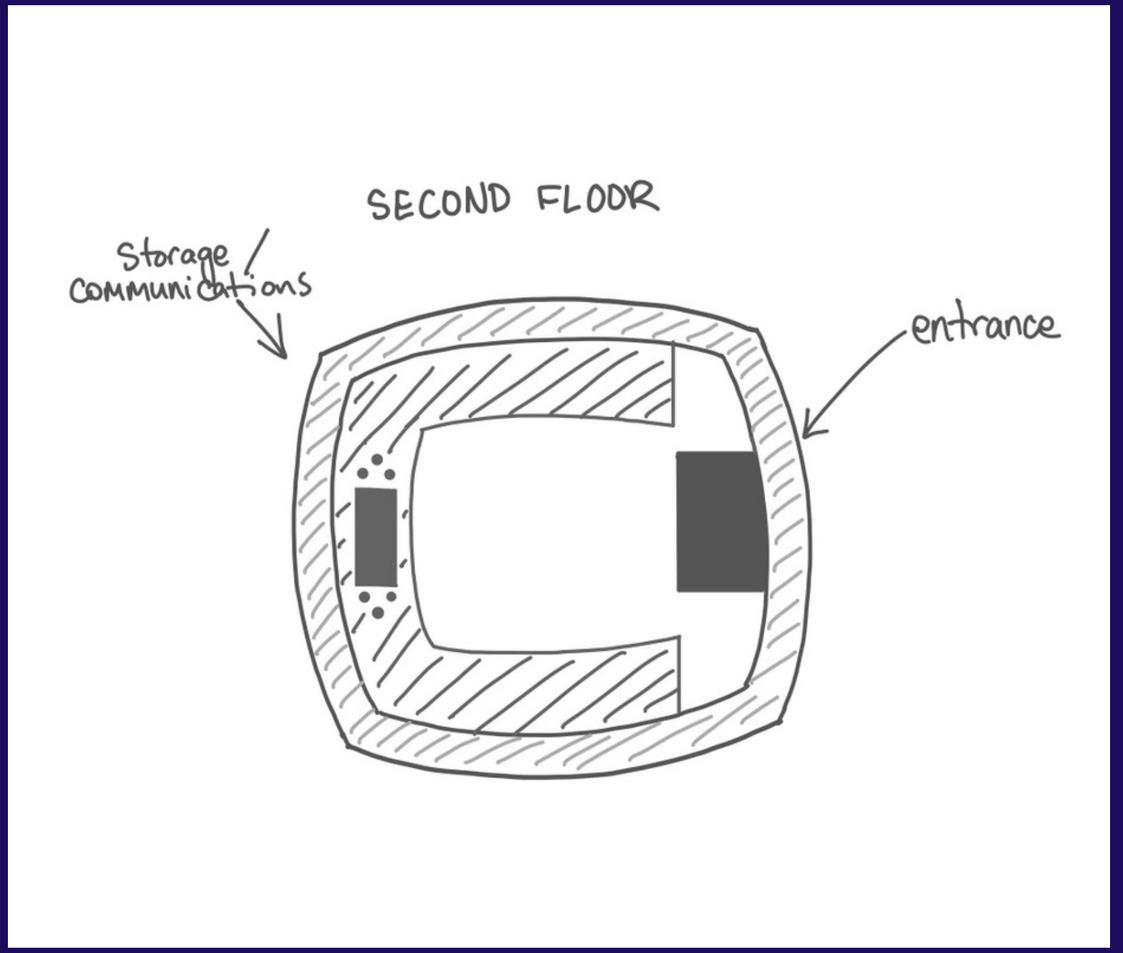
Extra storage space in the loft


second floor
desk/ storage
toilet/ bathroom


second floor
storage
bed nooks

BIRDS EYE VIEW

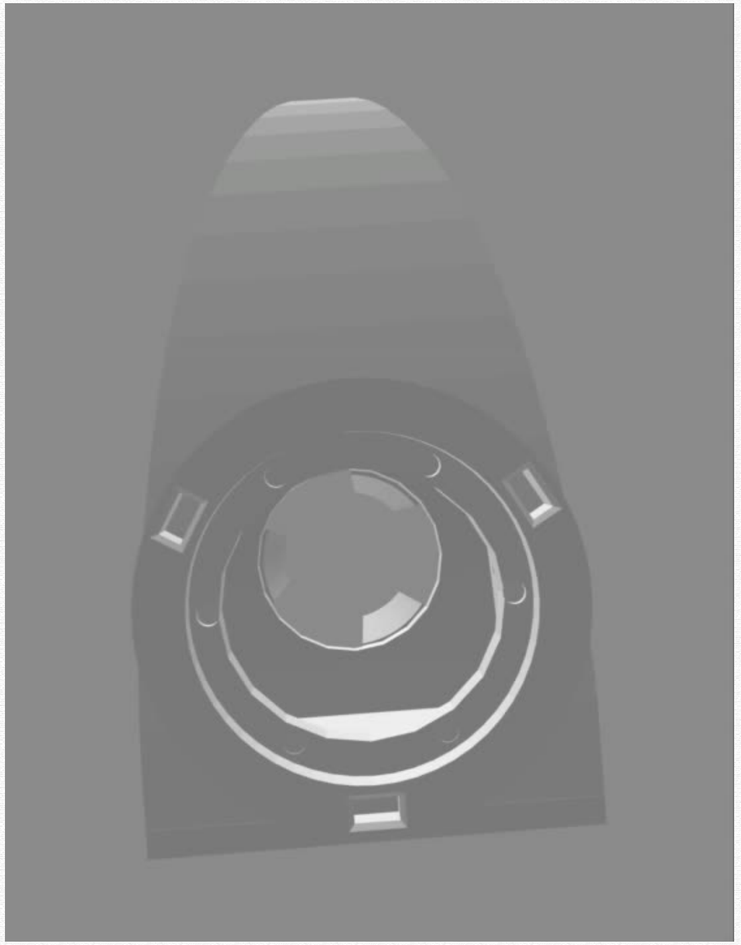




THE FINAL MODEL: HALO

STEP 4

- Combines the purpose of our role on the lunar gateway, along with conforming to the design challenges.
- Ensuring all components work together efficiently- specifically scaling and layout/space.
- Provides an efficient habitat for astronauts to perform scientific research, while also allowing for a comfortable space to eat and rest.



PROJECTED BUDGET ESTIMATION

STEP 5

Based on Past Similar projects

- Cost of flying out supplies ($5-10 mil)
- Materials ($100 million)
- Salaries ($200 million) - 2000 workers
- Building a facility for creation ($8 million)
- Other costs - $500 million
- A total of roughly 800 million to create

The NASA HALO was given a firm, fixed-price contract valued at $935 million USD, or roughly 1.3 Billion CAD.

Scheduling

BUILDING TIMELINE

Spring 2023

Finalization of HALO design and approval.

Spring 2023

Building process of HALO begins.

Spring 2024

Building process of HALO ends.

Summer 2024

HALO attaches to the Power and Propulsion Element.

Winter 2024

First part of the Lunar Gateway launches.

Winter 2024

First part of the Lunar Gateway enters the moon's orbit.

MAINTENANCE

- Equipment checks,
- Bamboo and furniture checks,
- Cleaning and upkeep,
- Damage repair,
- System testings.

CONCLUSION

THROUGH WORKING AS A TEAM WE WERE ABLE TO...

- Achieve all of the goals we set
- Overcome the many factors taken into consideration
- Follow an organized and effective process
- Come up with a final model that satisfies the above

THANK YOU

REFERENCES

IMAGES

- https://melscience.com/US-en/articles/characteristics-aluminum-and-combustion-reaction-m/
- https://issuu.com/wemarkets/docs/ultra
- https://www.asc-csa.gc.ca/eng/astronauts/living-in-space/sleeping-in-space.asp
- NASA/GSFC/Arizona State University
- https://www.deviantart.com/edonguraziu/art/Bio-Space-Station-2-618773215
- http://mathcentral.uregina.ca/QQ/database/QQ.09.06/danielle1.html
- https://www.bungeeconsultants.com/cordsandequipment
- https://www.quora.com/Do-astronauts-sleep-in-space
- https://www.asc-csa.gc.ca/eng/astronauts/living-in-space/sleeping-in-space.asp
- https://www.google.com/search?q=toilets+in+space&rlz=1C5CHFA_enCA969CA969&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiKo5yysb79AhV8jIkEHWFdDcQQ_AUoAXoECAEQAw&biw=1420&bih=730&dpr=2&safe=active&ssui=on#imgrc=gahk12_m8XJ66M

REFERENCES

WEBSITES

- https://www.gardenista.com/posts/bamboo-pros-cons-everything-you-need-know/
- https://craftedbycitrus.com/blogs/news/the-strength-of-a-triangle
- https://www.futurity.org/nasa-astronaut-furniture-906032/
- https://www.sciencedirect.com/science/article/pii/S1350448700001642
- https://adsabs.harvard.edu/full/2005ESASP.587..465M
- https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20060045944.pdf
- https://www.sciencedirect.com/science/article/pii/S0094576511003252
- https://ntrs.nasa.gov/citations/20160010362
- https://ntrs.nasa.gov/api/citations/20160010362/downloads/20160010362.pdf
- https://ntrs.nasa.gov/api/citations/20160010355/downloads/20160010355.pdf
- https://www.spiedigitallibrary.org/conference-proceedings-of-spie/10401/104011I/High-strength-optical-bonding-for-the-Next-Generation-Suborbital-Research/10.1117/12.2274277.short
- https://www.jstage.jst.go.jp/article/jvsj2/53/1/53_1_37/_pdf/-char/en
- https://www.nasa.gov/press-release/nasa-northrop-grumman-finalize-moon-outpost-living-quarters-contract
- National Aeronautics and Space Administration. 2016. "Optical evaluation of DMDs with UV-grade FS, sapphire, MgF2 windows and reflectance of bare devices." https://ntrs.nasa.gov/api/citations/20160010362/downloads/20160010362.pdf.
- Source: Seong Jin Chang, Youngtag Kim, Gyeong Seok Choi, Seunghwan Wi, Yujin Kang, Sumin Kim, Effective thermal performance analysis of vacuum insulation panel with metal-less film and infrared-dried core material, Energy and Buildings, Volume 233,2021,110684,ISSN 0378-7788, https://doi.org/10.1016/j.enbuild.2020.110684.(https://www.sciencedirect.com/science/article/pii/S0378778820334708)