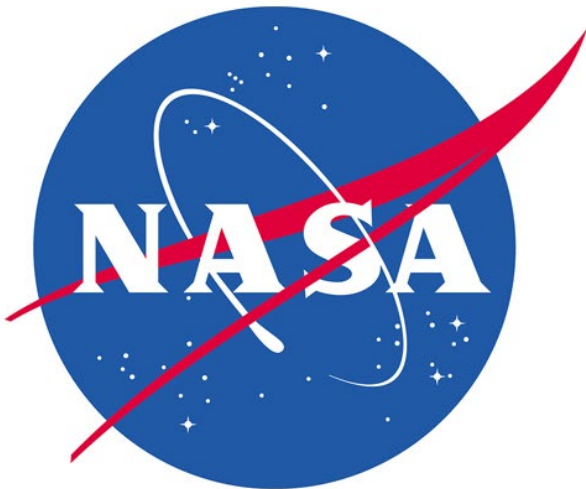


Deep Space Mars Transit Habitat Layout and Development
Studies

OKLAHOMA STATE UNIVERSITY X-HAB

Wednesday, May 10th, 2017

Final Presentation





OSU X-HAB Spring 2017





Semester Objectives



- ✓ Revise and finalize design concepts from fall semester participants.
- ✓ Construct and/or improve analogs with “Command & Control” theme.
- ✓ Explore outreach opportunities that X-HAB can offer to inspire the next generation.



Presentation Overview



Team Luna | Team Phobos | Team Ares | Team Icarus

- *Museum*
- Outreach
- Scheduling
- Coordinator

- Mission
- *MPLM:*
Stafford
Deep Space
Habitat
- Transit
Vehicle

- *ReHAB*
- Surface
Habitat

- *Mission*
Control
- Computer
Components
- Electrical
Design



Introduction



Team management and educational outreach exhibit.

Team Luna

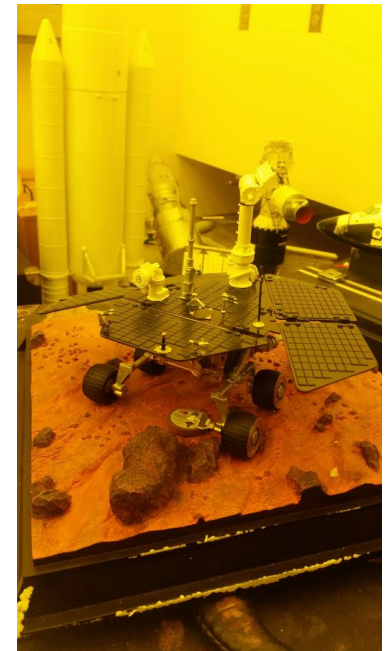
Shayna Borgfeld
Architecture, Senior

Anna Jackson
MAE, Senior

Models

We had more than 30 scale models just sitting in their storage boxes at our research facility... what could we do with them?

- Put them on display
- Create a museum
- Provide outreach for NASA and our program





Inventory

- Alouette (satellite) @ ¼" scale
- X-33 (Air Transport) @ 1:50 scale
- Saturn 1 (Rocket) VERY TALL
- Tethered Satellite (Space Telescope)
- Shuttle (Space Orbiter/Shuttle) @ 1:50 scale
- Viking (Rover & Orbiter—Mars Lander) scale not noted yet
- Command & Lunar Module (Saturn 5 Mission) Apollo-Soyaz
- Hubble (Space Telescope/Satellite)
- ISS
- Telescope
- Telescope @ 1:25 scale
- Sky Lab @ 1:48 Scale
- Hubble .. again .. (Telescope)
- Rocks from Apollo Mission
- Saturn 1B, Saturn 5 (Lunar Mission Rockets) @ 1:96 scale ~3ft tall (we have 2 of these)
- Space Food
- 777 @ 1:100 scale (airplane)
- x-30 @ 1:36 scale
- x-43A @ 1:36 scale
- Shuttle Solid Boosters @ 1:50 scale (brand new! And we have 2 of these)
- Rover
- Fuel Stack Shuttle for "Discovery" @ 1:10 scale (very nice, brand new!)
- Shuttle "Columbia" @ 1:100 scale
- Mariner @ 1/8" scale
- M.E.R. "Spirit" [Mars Exploration Rover]
- AND MORE ON THE WAY!



Hastings Cases





Construction

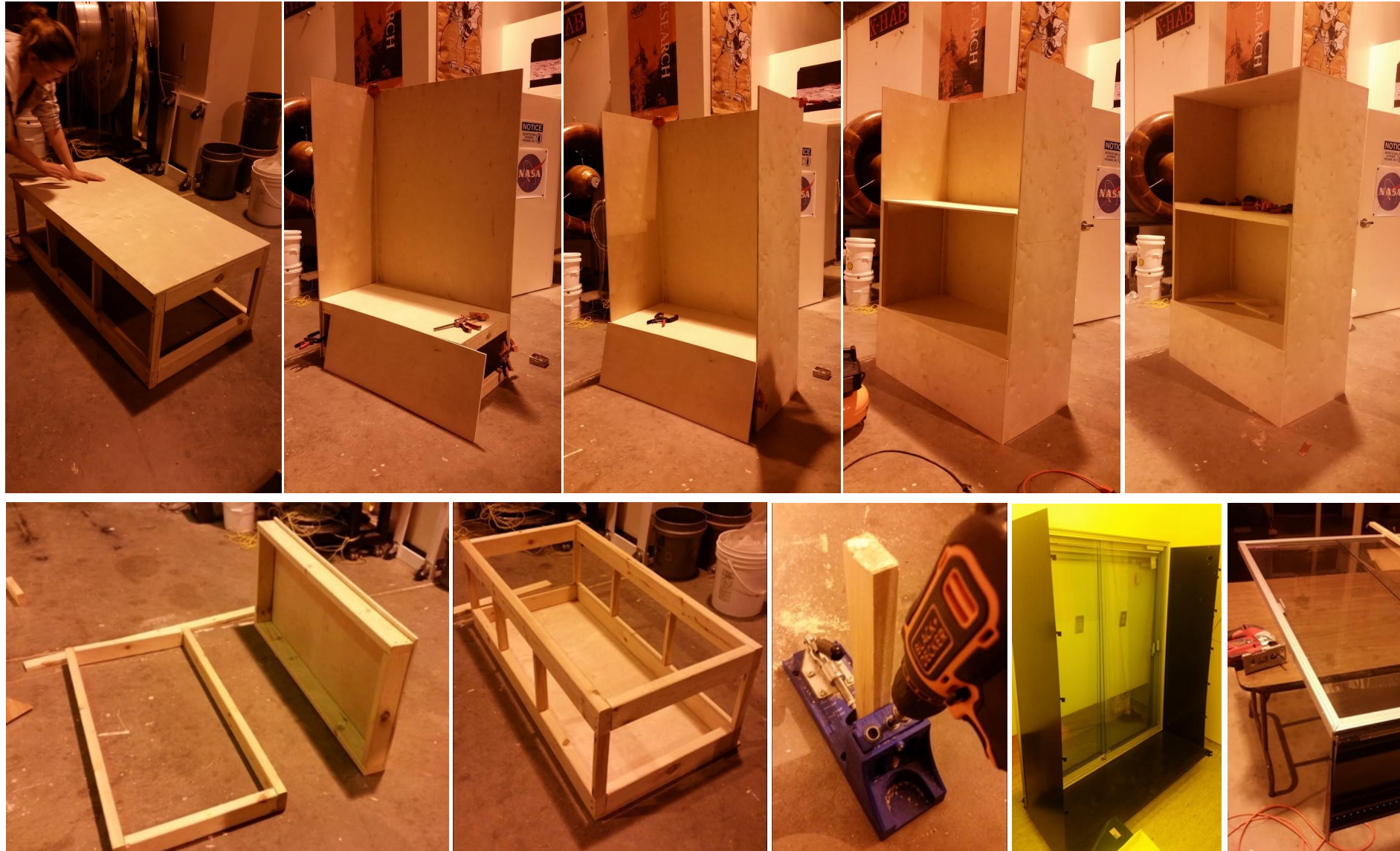


More cost effective, easier to assemble, common products...

- Utilize glass fronts from Hastings cases.
- Construct housing of wood for most cost-effective solution.
- Custom shelving for each model.
- On casters for maneuverability...



Construction



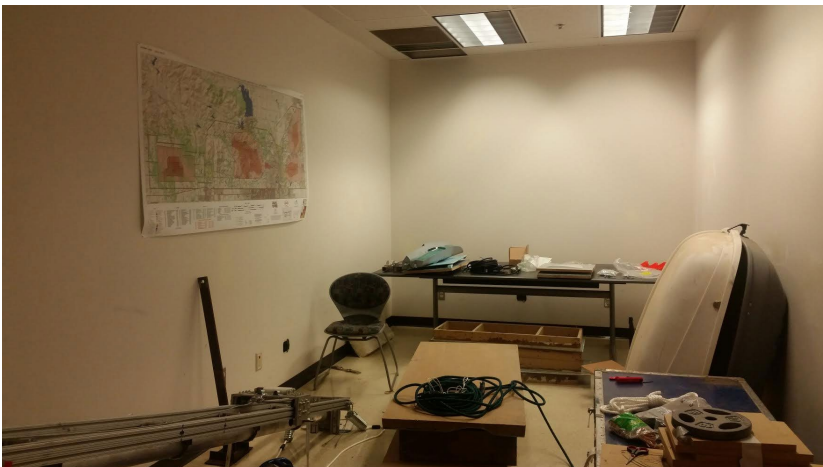


Construction





Museum Room





Museum Room



https://www.youtube.com/watch?v=g0pzwls_YHc&feature=youtu.be



Introduction

Upgrade and outfit MPLM to act as transit vehicle for mission.

Team Phobos

Nick Lucido
MAE, Senior

Real KC
MAE, Senior

Kris O'Hara
MAE, Senior

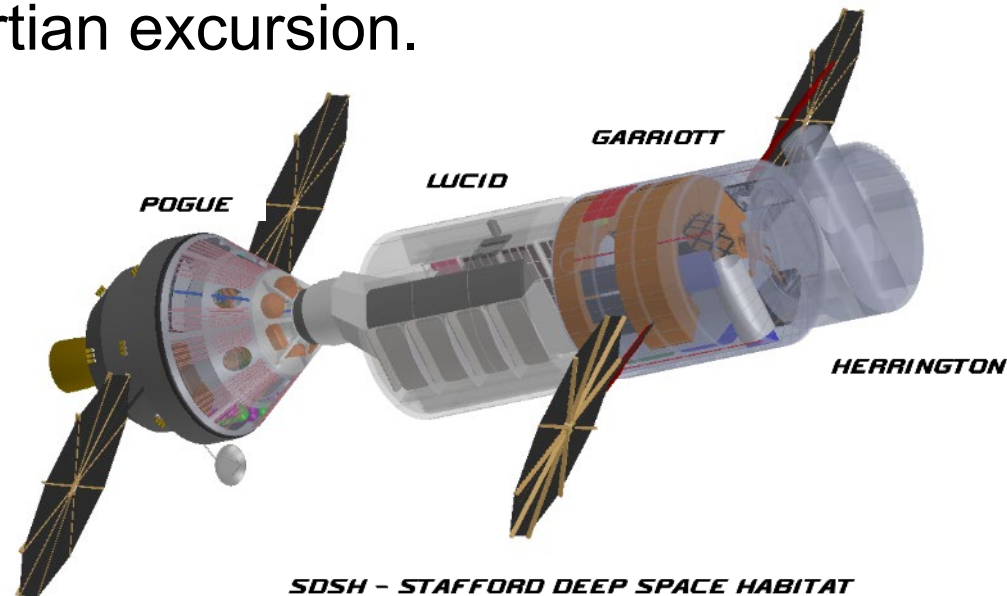
Charles Daniel
MAE, Senior



Overall Mission Objective



- Currently, we have two habitats in the lab:
 - ReHAB
 - Vertically oriented, two story
 - MPLM
 - Horizontally oriented
- By the end of the semester, we will be able to simulate a 21 day Martian excursion.



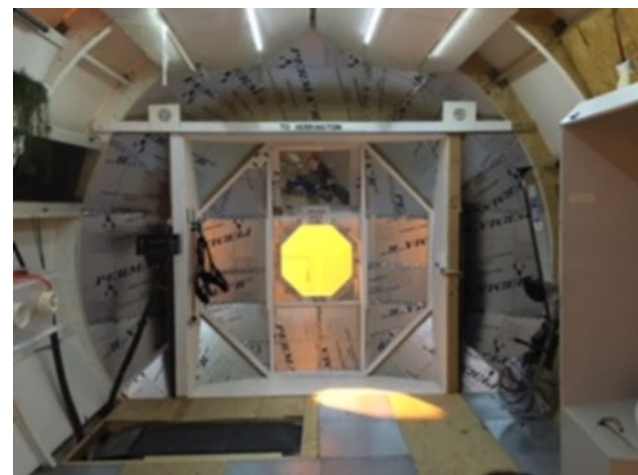
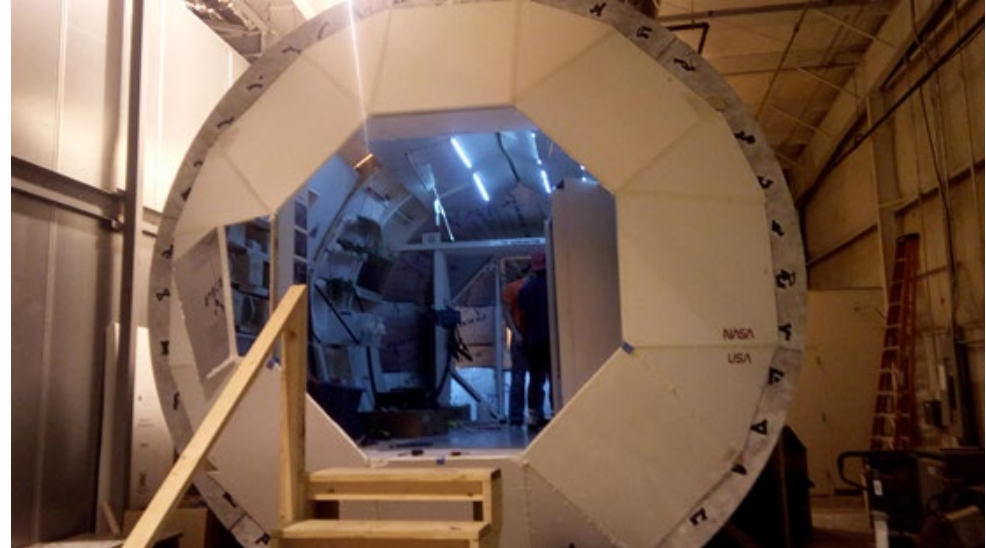


Projects

- Overall Mission Objective
- ConOps
- Schedule
- Design Systems
 - Door
 - Table
 - Electronics
 - A/C System
 - Lighting
 - Storage
 - Power Source
- Overall Cost

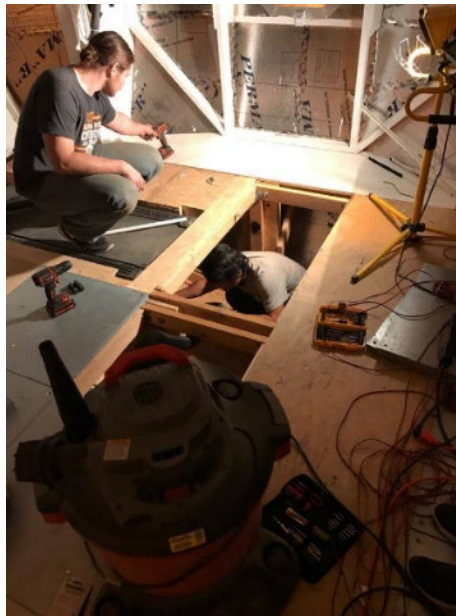


MPLM Clean-Up





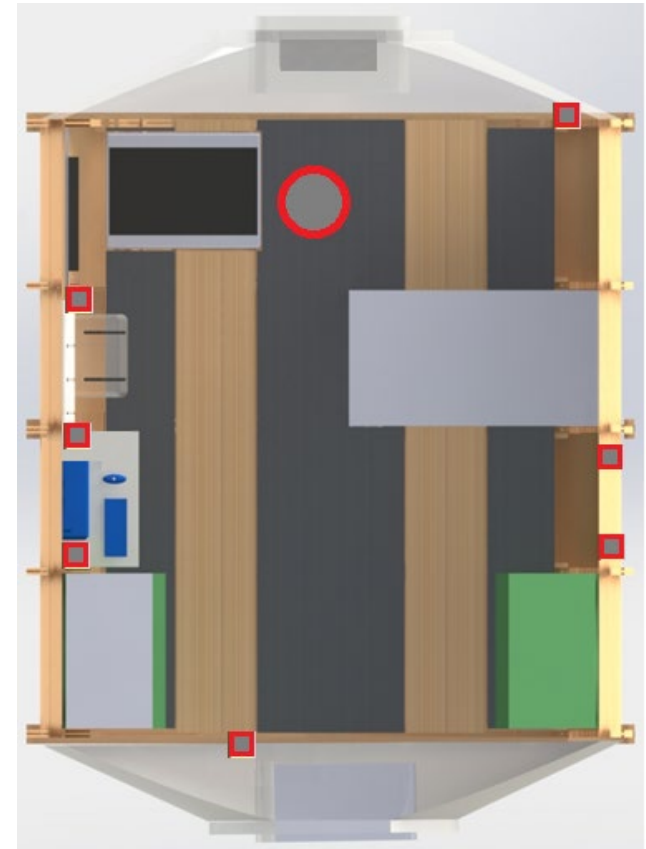
MPLM Clean-Up





Powering the Hab

- 100 Amp, 8 Breaker Panel
 - Space to expand in future
 - Mounted in subfloor
 - Easy access from inside



Electrical

- Adding Power and Outlets in MPLM

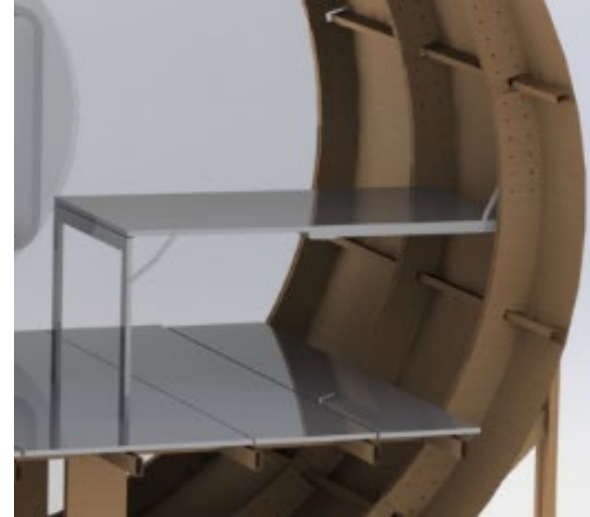




Collapsible Work Table



- Table as of KSC trip





Collapsible Work Table



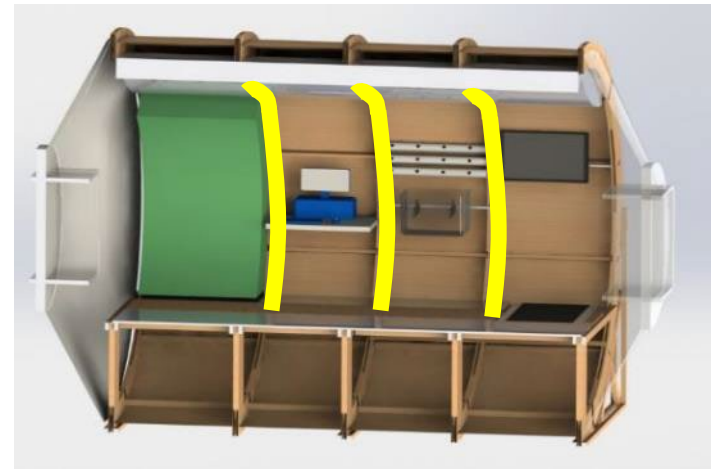


Lighting System

- Former lighting inadequate, in poor condition
- Can change color temperature to replicate earth day.
- Radial lighting provides complete lighted areas with minimal shadows.



Former Lighting in MPLM



New Lighting Design



Lighting System





Treadmill Before

- Treadmill surface always exposed
- Uneven heights
- Weakly supported floorboards





Treadmill After

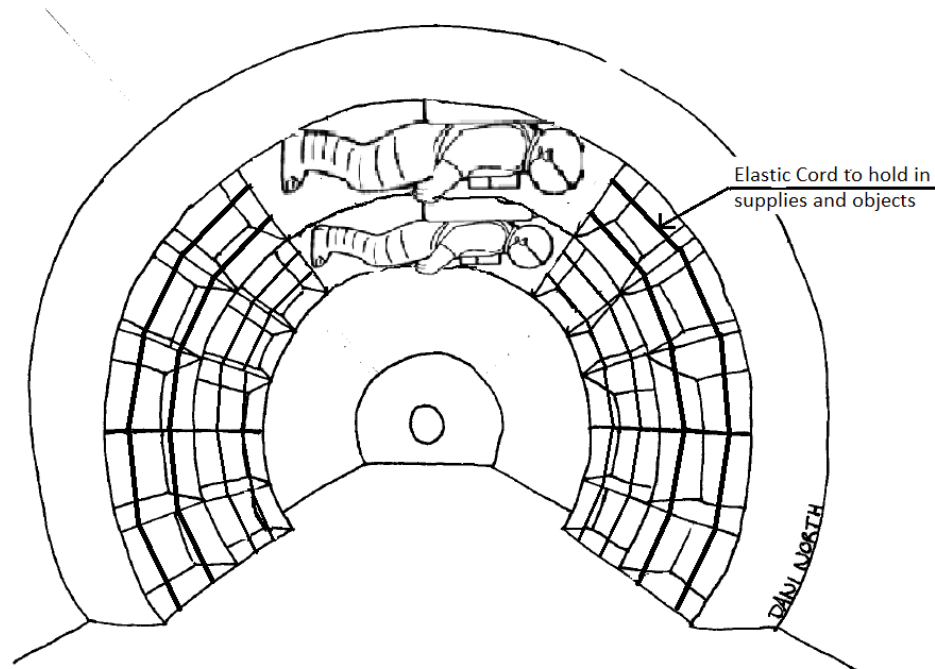
- Added:
 - New joist
 - 3 permanent $\frac{3}{4}$ " plywood sheets
 - Trapdoor
- Space is now useable for activities other than exercise
- Safer





Radial Storage

- Simulate the space environment within analog
 - Extend the current shelving overhead
- Use straps to keep supplies in place
- Incorporate storage for space suits





Radial Storage



Radial Storage





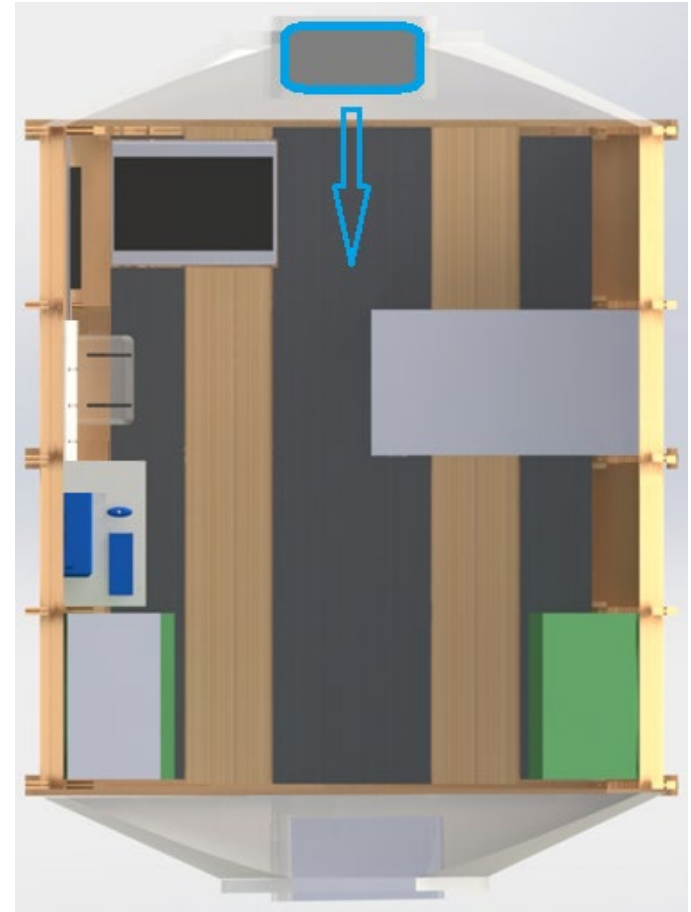
Radial Storage





Temperature Regulation

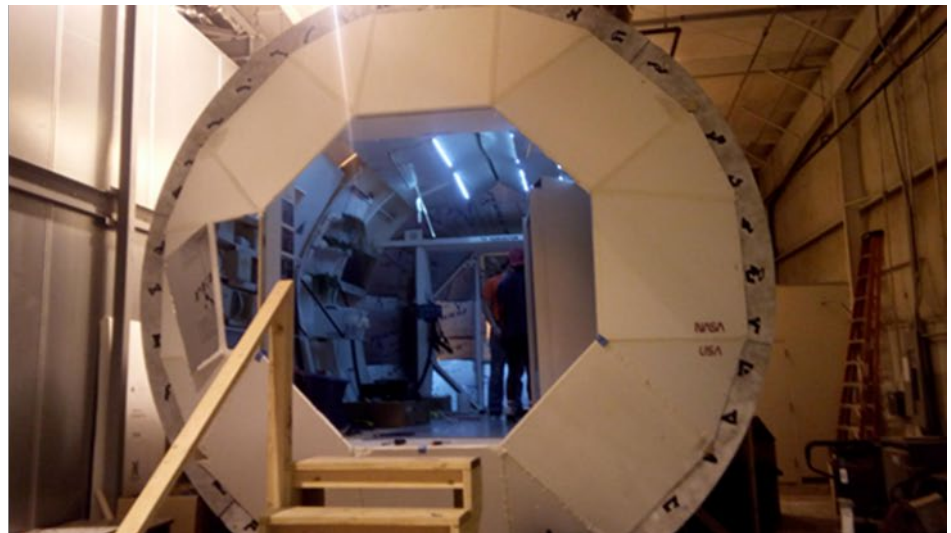
- Previously equipped with non-functional swamp cooler
- Salvaged AC window unit form OASIS
 - Mounted above treadmill





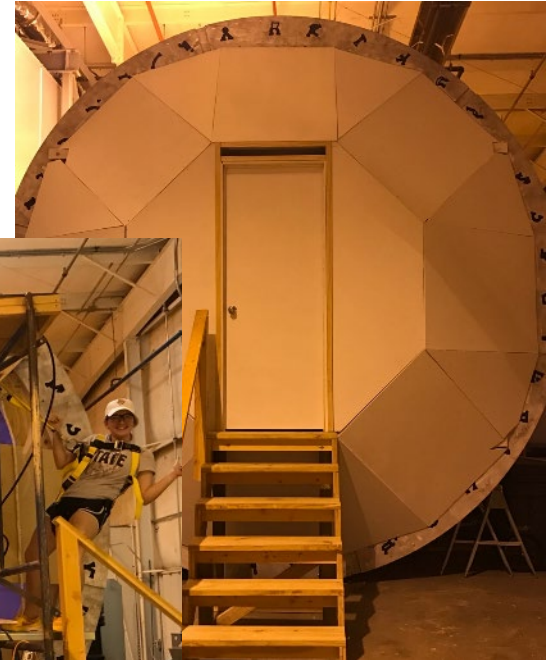
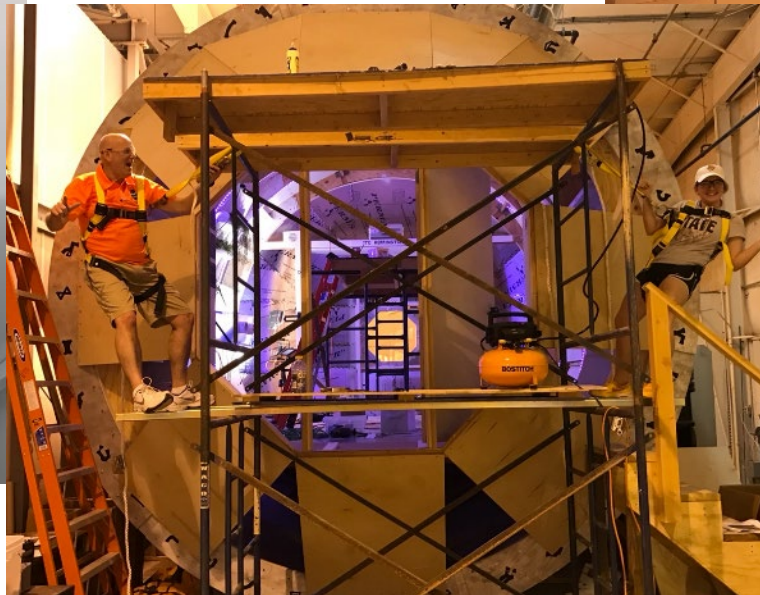
Pod Bay Door Before

- Foam board door
 - Couldn't keep AC or astronauts in
- Front hemi-sphere made of insulation foam
 - Flimsy



Pod Bay Door After

- It's all wood, amazing





A World of Pure Imagination



<https://www.youtube.com/watch?v=OYIYY7GLWQg&feature=youtu.be>



Introduction

Habitat optimization for long term surface missions

Team Ares

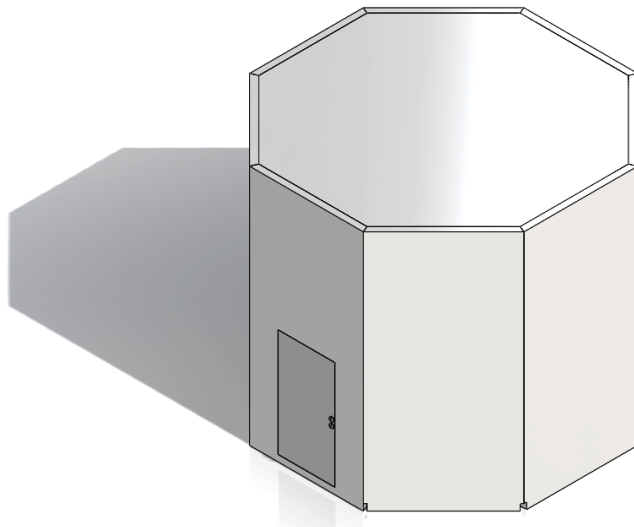
Matt Durkee
MAE, Senior

Claire Hudak
MAE, Senior

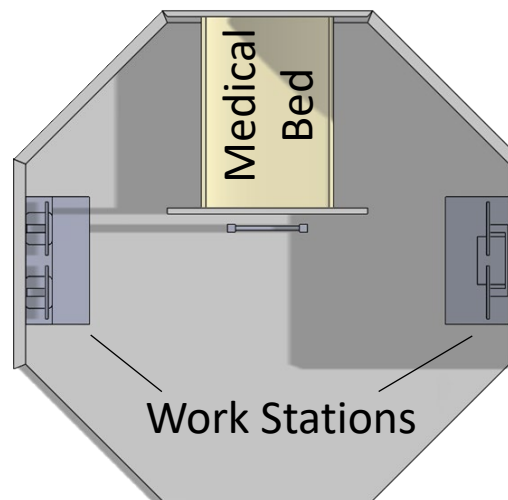


Habitat Overview

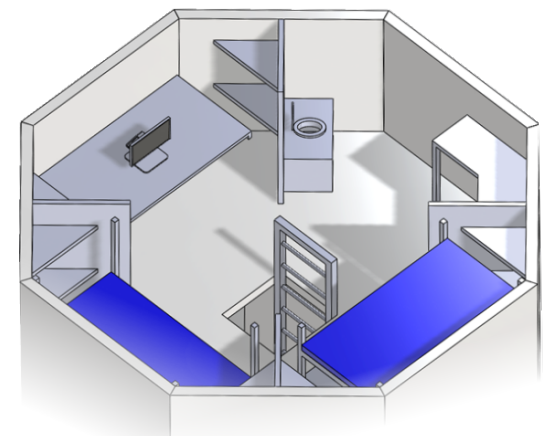
- ReHAB – Reconfigurable two-story Mars habitat
- 1st Floor – Work stations and hydraulic expanding bed
- 2nd Floor – 2 Beds, adjustable dropdown desk and bed setup, food preparation station, and restroom



Exterior



1st Floor (Top View)

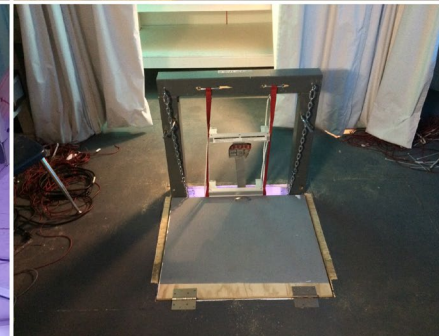
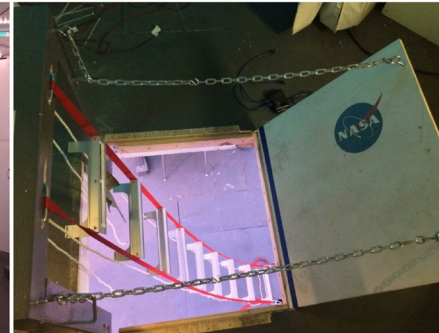


2nd Floor



Agenda

- Medical bed removal
- Retractable ladder
- Second floor hatch and safety measures
- Cost analysis and completed timeline
- Next steps





Medical Bed Removal

Previous design

- Bulky, hard to operate
- Came detached easily due to wall attachment threading

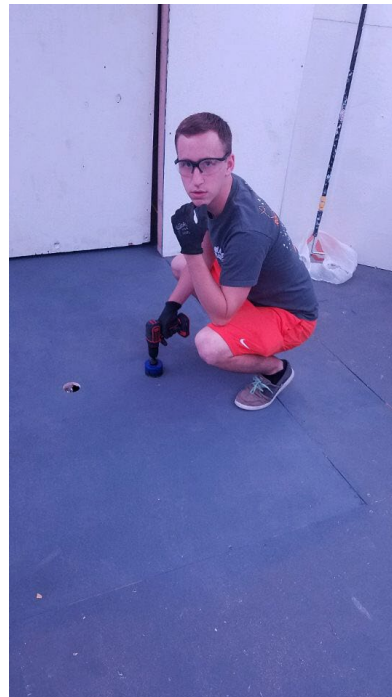
Future Potential

- Inflatable bed
- Lightweight operation
- Less moving parts





Medical Bed Removal





Medical Bed Removal



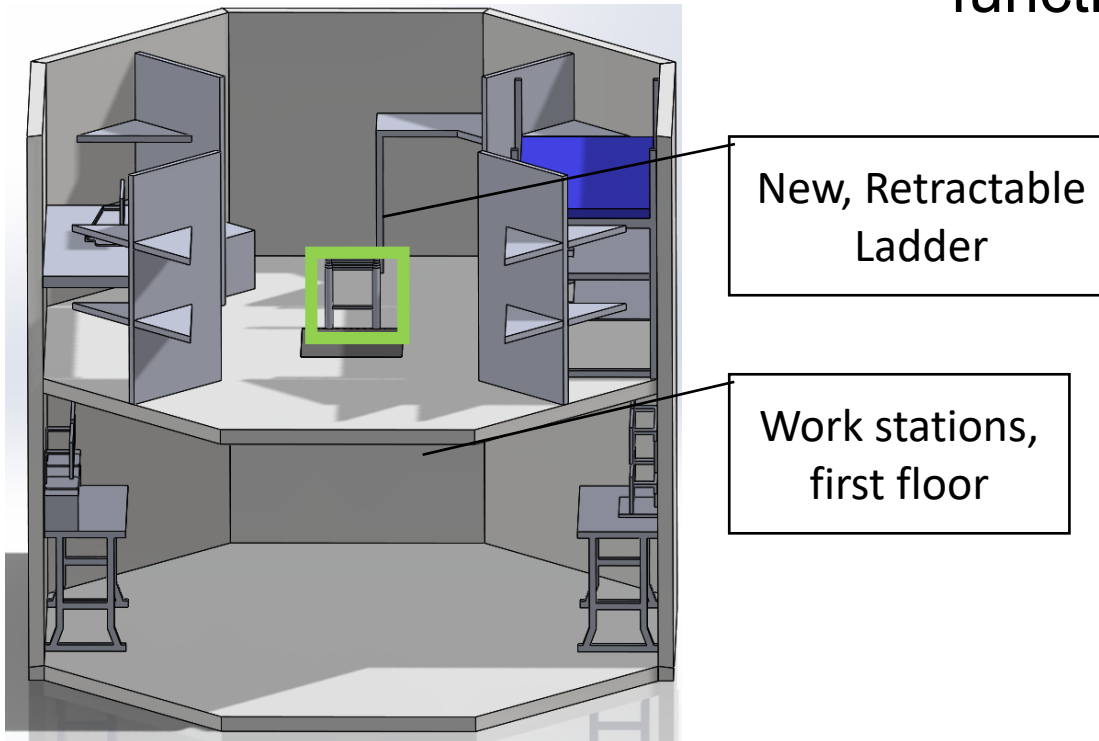
Retractable Ladder

Old ladder

- Inconvenient, stuck in place
- Open floor, falling hazard

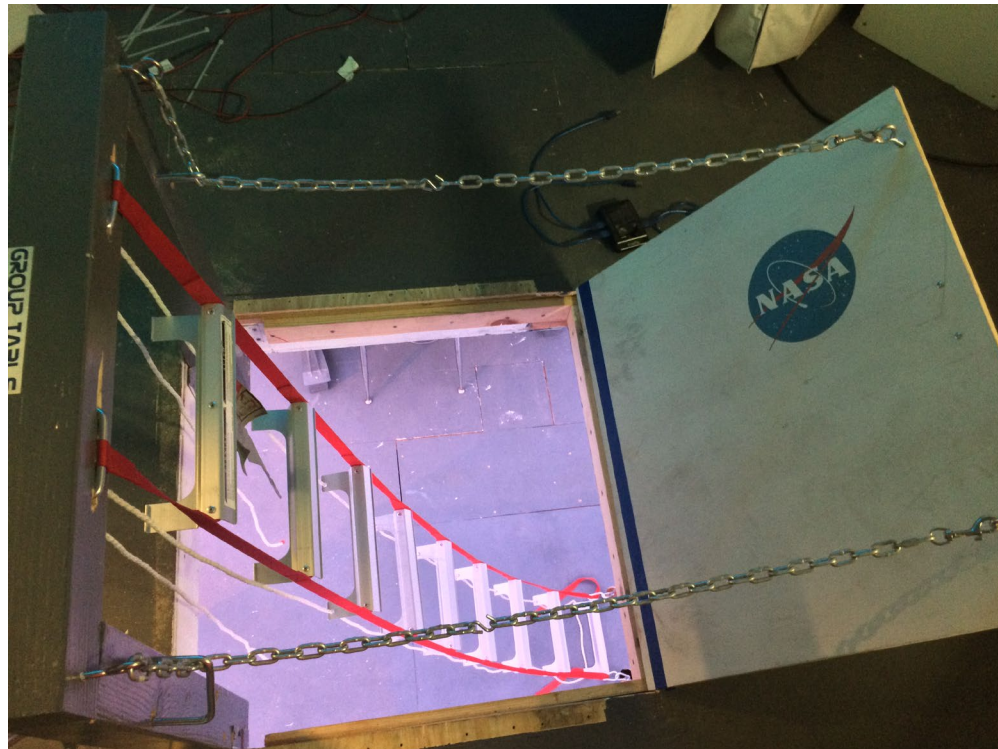
Rope Ladder

- Lightweight (lightens payload)
- Retractable (improves functionality)



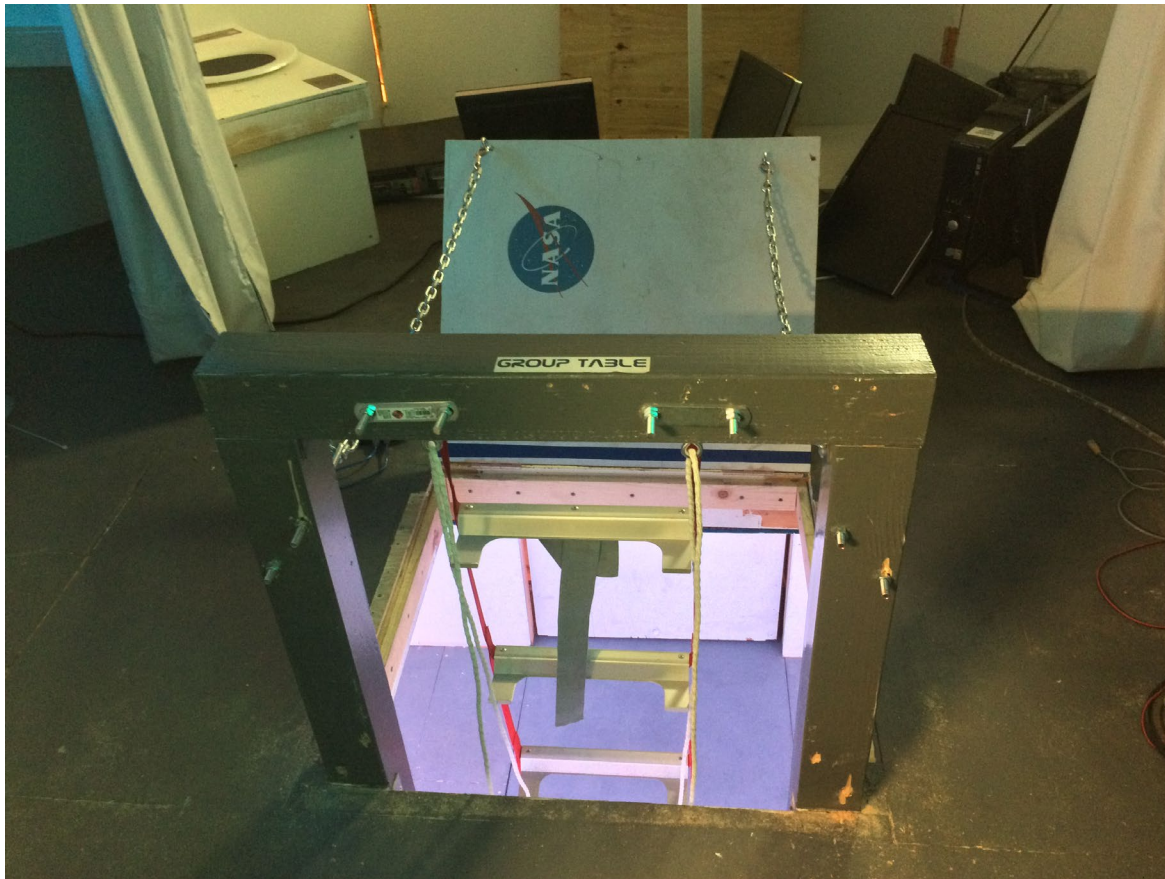
Retractable Ladder

- Fire escape ladder appropriated for our purposes
- Aluminum rungs for foot support
- Lightweight side support made of rope
- Bottom attached via floor eyelets and carabiners



Retractable Ladder

- Top attached through posts on 2nd floor





Retractable Ladder

Pulley-Like System

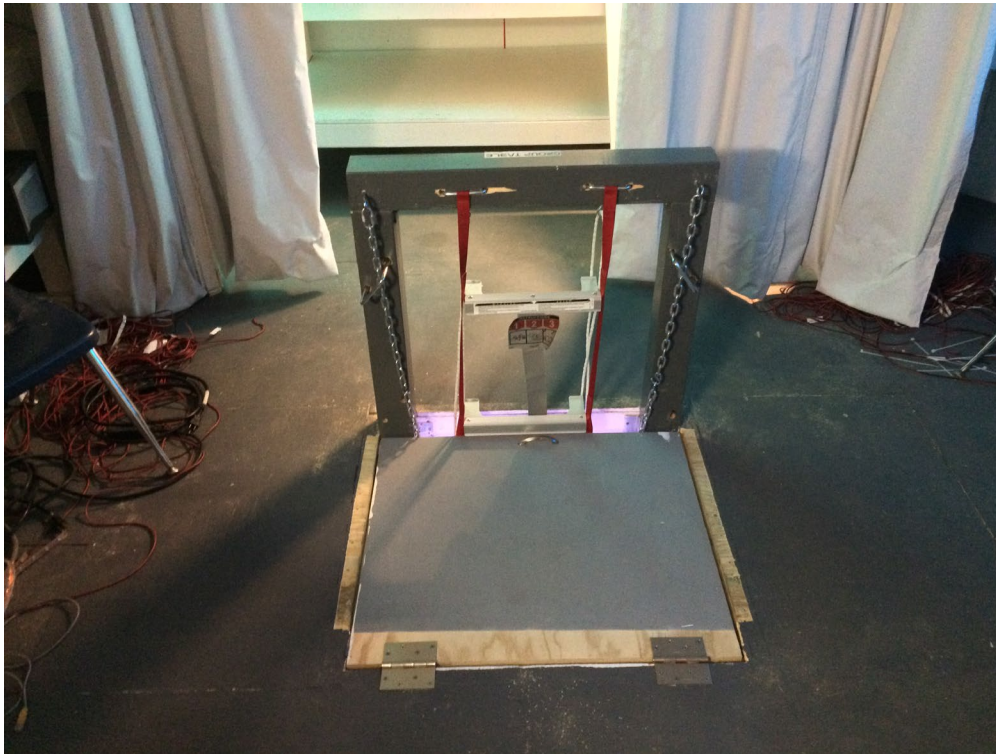
- Holes in the back tabs of ladder rungs pull them up
- Ladder is out of the way when not in use
- Downstairs is more spacious
- Future potential for automation





Hatch

- Wooden block support
- Even with ground, no tripping
- Not a falling hazard anymore
- Upstairs is more spacious when need be (i.e. at night)





Video



<https://www.youtube.com/watch?v=ANmnzEv7bKg&feature=youtu.be>



Cost and Timeline

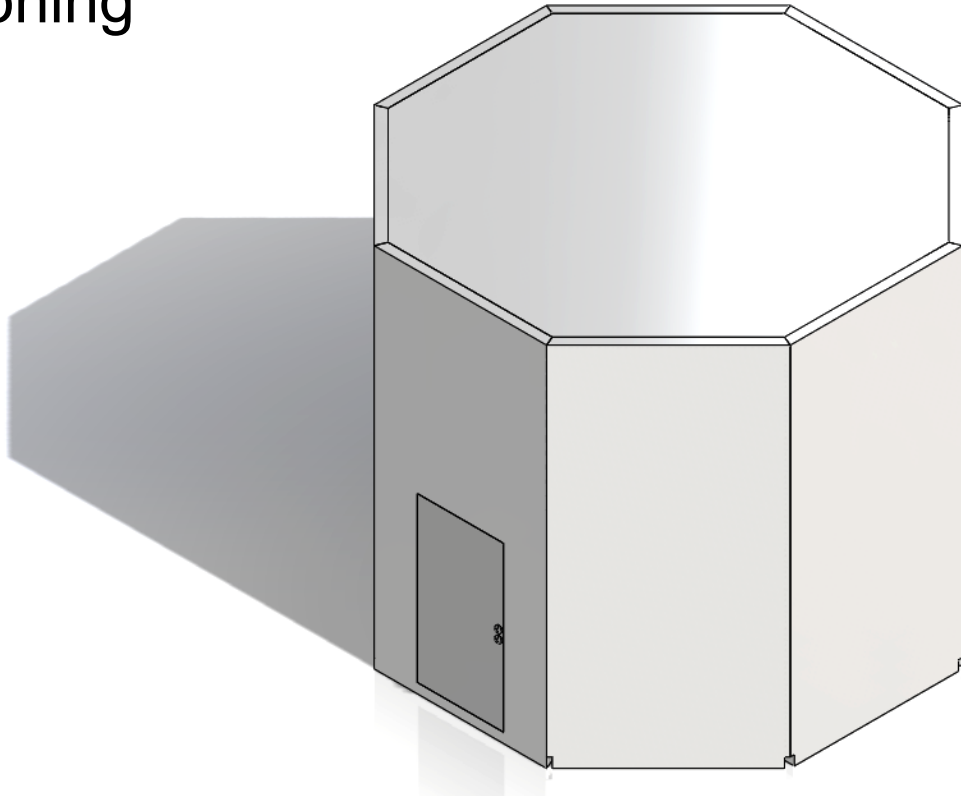
System	Component	Quantity	Cost	Description
Ladder	Rope Ladder	1	\$0	Fire escape ladder reused from previous years
	U-Bolt	2	\$10	Attachments for ladder
	Rope	1	\$4	Rope used for pulley system
	Boat Cleats/Handles	8	\$10	Rope storage and hatch/wall handles
	Carabiners	4	\$20	Support 200lbs each
Total			\$44	

[illegible]



Next Steps

- Add inflatable bed
- Automate pulley system
- Store excess rope more efficiently
- Re-route air conditioning





Introduction

Facilitate command and control between mission modules.

Team Icarus

Kaleb Cooper
CS, Junior

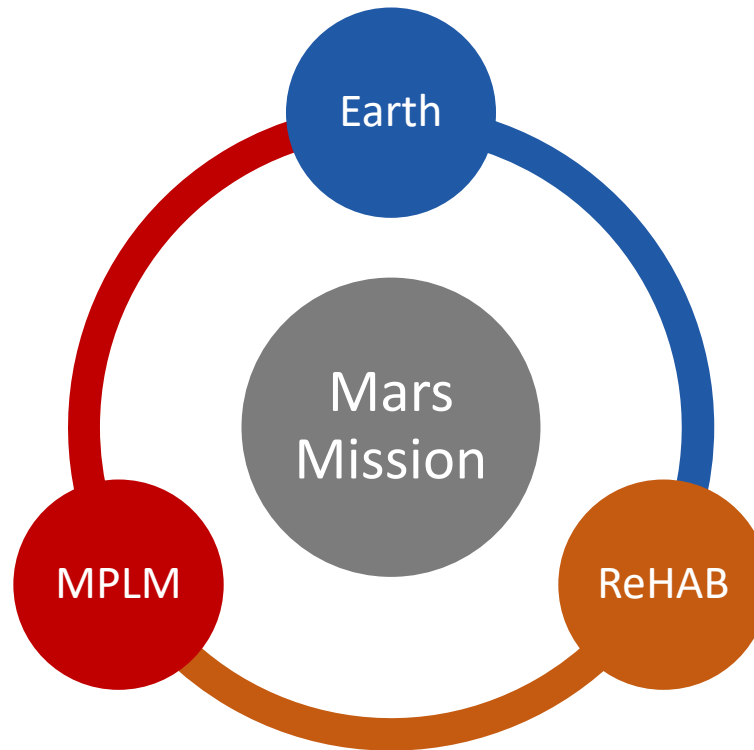
Michal Kegel
MAE, Junior

Cameron Jump
EE, Freshman

Zhong Thai
MAE, Junior



Mission and Objectives



- Direct lines of communication will be established between both habitats and Earth.
- MPLM will have the main mission control station, acting as a communication node between Earth and the ReHAB, and controlling the ReHAB



Mission and Objectives

■ Mission

- Monitor and Control the internal environments of the both the ReHAB and MPLM from either habitat or Earth

■ Objectives

- Receive data from DAQs from around the habitats
- Process data and send commands to control outputs
- Transmit audiovisual between stations
- Control above systems remotely
- Create portable touchscreen interface to control systems

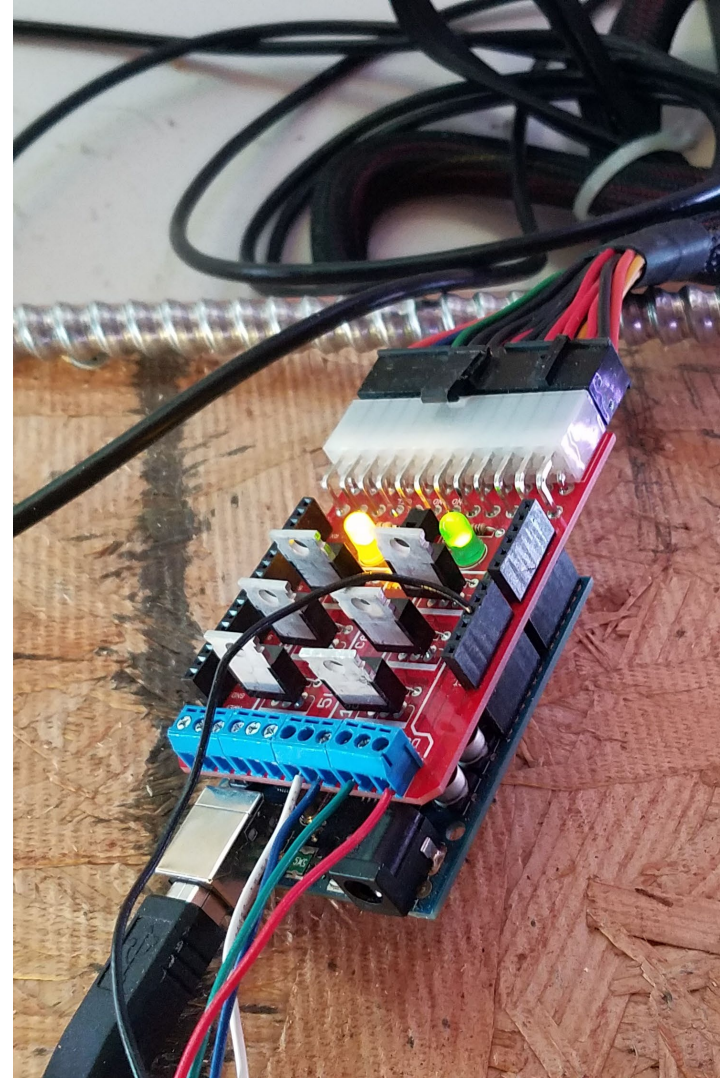
Control Station

- Two computer stations to command each habitat
- Big screen for overall data display
- Control Station inside each habitat for local control
- System duplicated on wireless tablets



Control System

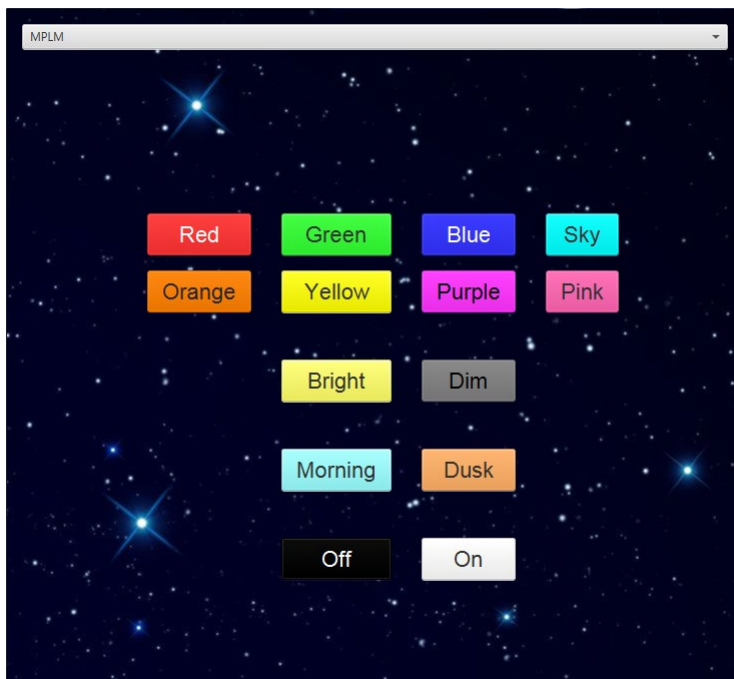
- Lights controlled by Arduino
- Commands sent through attached Raspberry Pi computers
- Temperature sensors and cameras connected to Raspberry Pi Zeros
- Code based on Java, C++, and Python





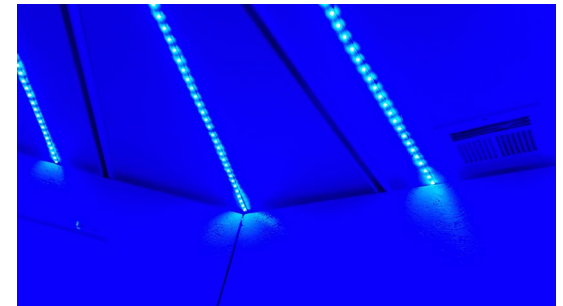
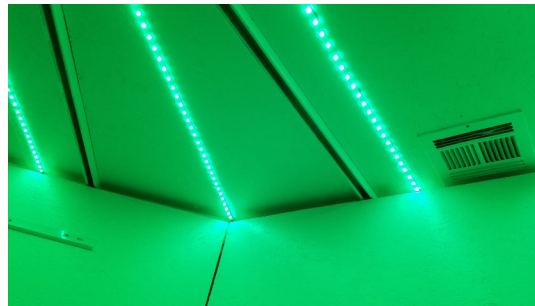
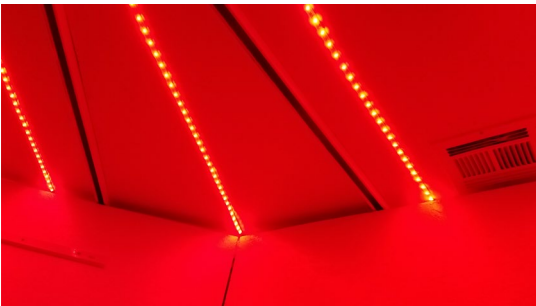
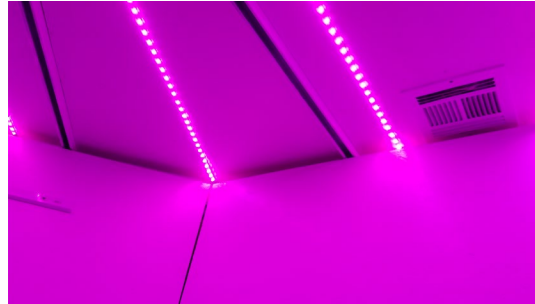
Interface

- Interfaces can switch between habitats
- Same interface on all control station and habitats
- Data shown is live from the habitat





Light Control

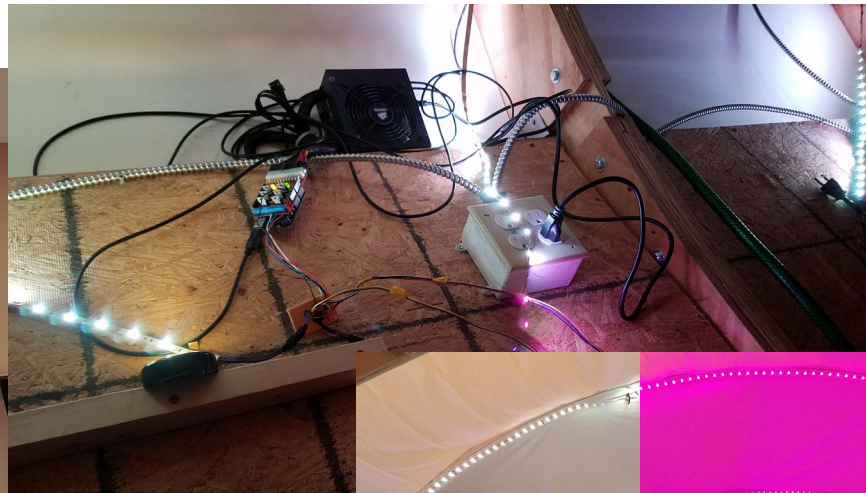


LEDs can cycle through a variety of colors to simulate different environments and conditions



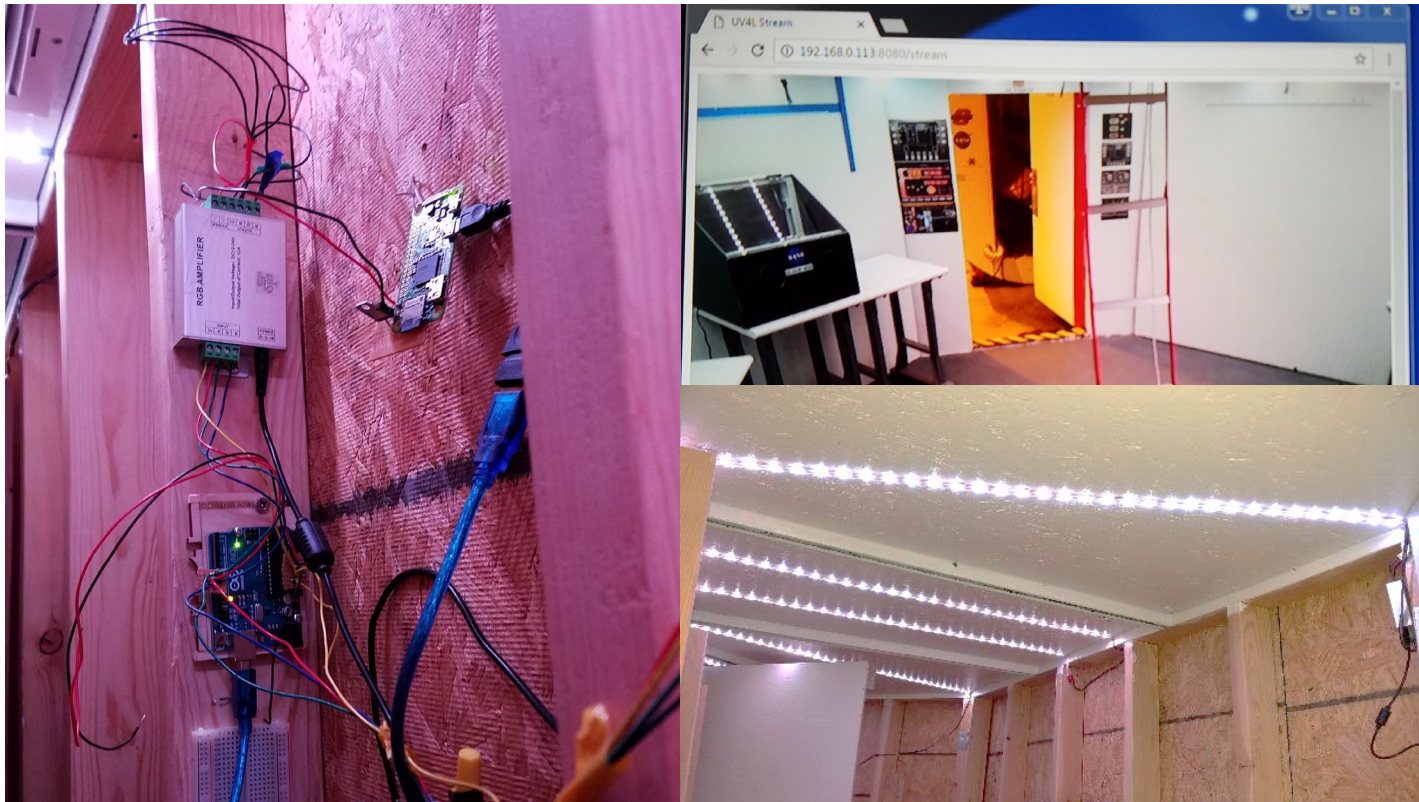
MPLM Station

- Control system accessible from hatch
- Computer can be stored by collapsing the keyboard



ReHAB Station

- Control system accessible from behind wall
- Video feed shows door and workstation
- Can be duplicated onto second floor





Video



<https://www.youtube.com/watch?v=tsxLAAnvKNI&feature=youtu.be>

Questions?





X-HAB 2017



THANK YOU