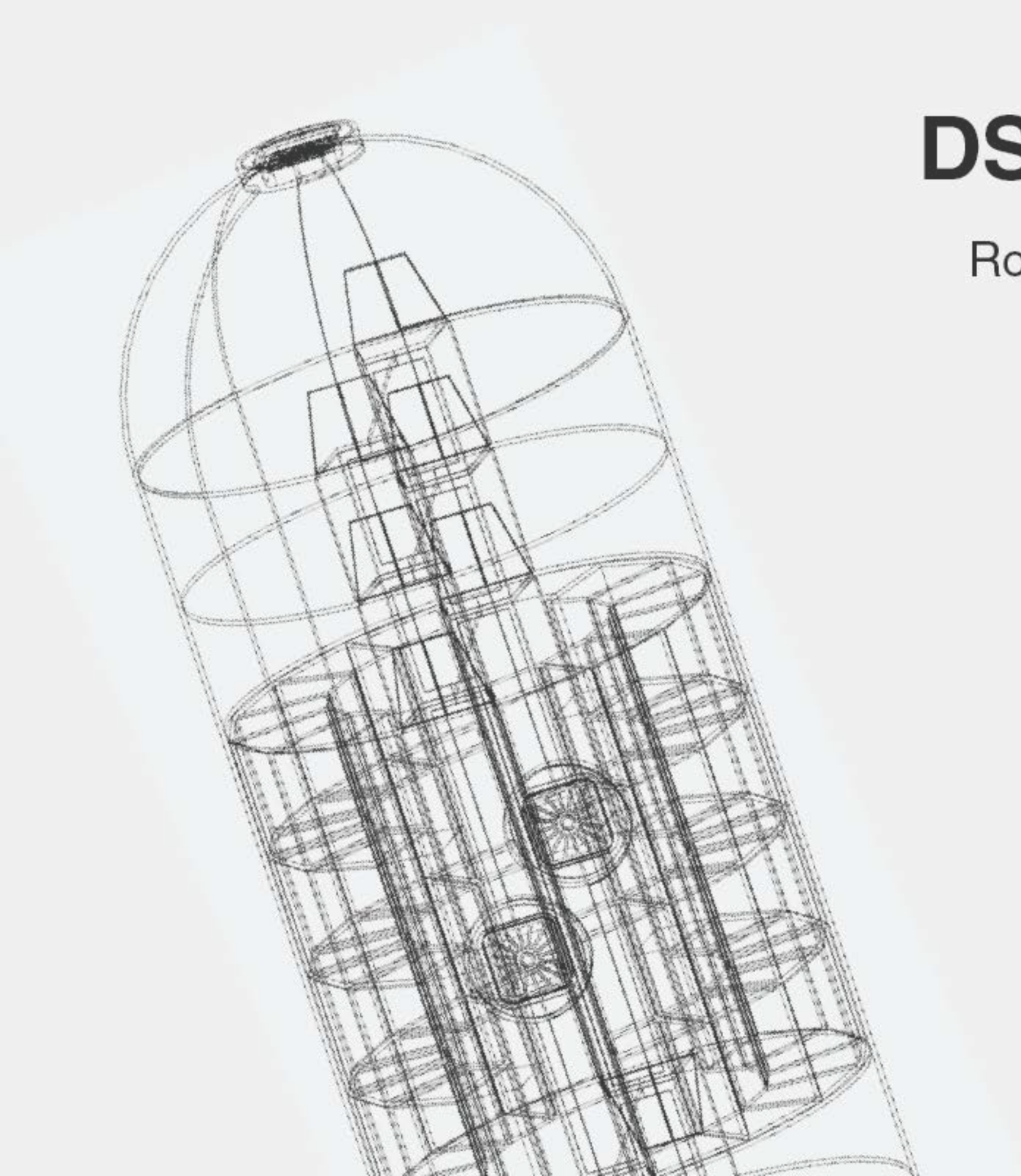


DSSV: Crew Quarter

Rohit Sen · Sam Zaref · William Zhang

How do we design a crew quarter that improves mental and physical health and accouts for an individual's social relationships while aboard the DSSV?

Project Parameters

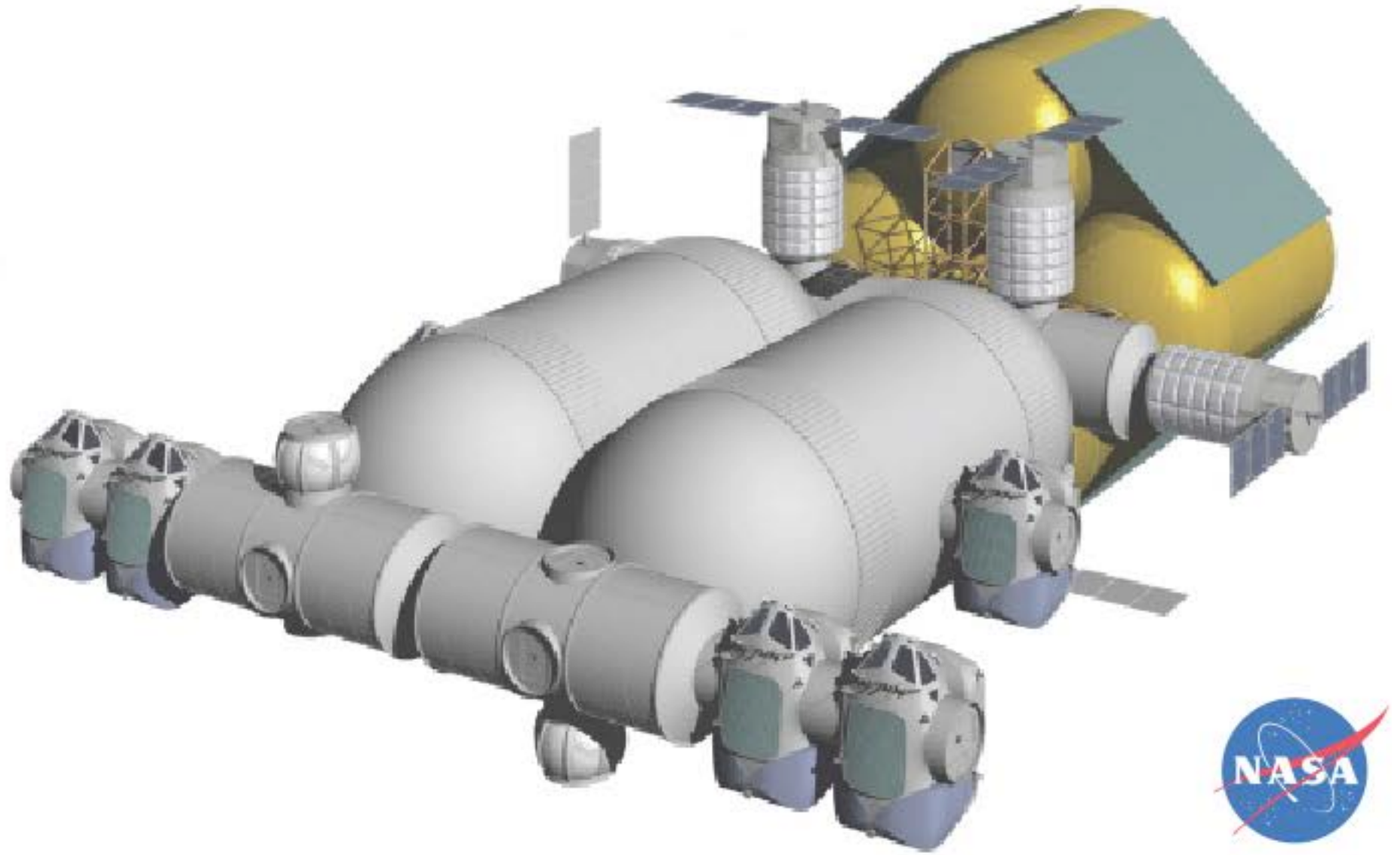
NASA Parameters:

— Accommodate 48 crew members
— Unit height is less than 2.5 meters
— Applicable in both 0G & 1G situations
— Standardized Units

Team Objectives:
— Isolation therapy and mental wellness
— Ventilation design
— Home Entertainment
— Maximization of space allocation
— Wireless interiors

Initial CAD Concept

Initial concept presented to RISD. Sets general parameters and provides a foundation for RISD teams to work on.

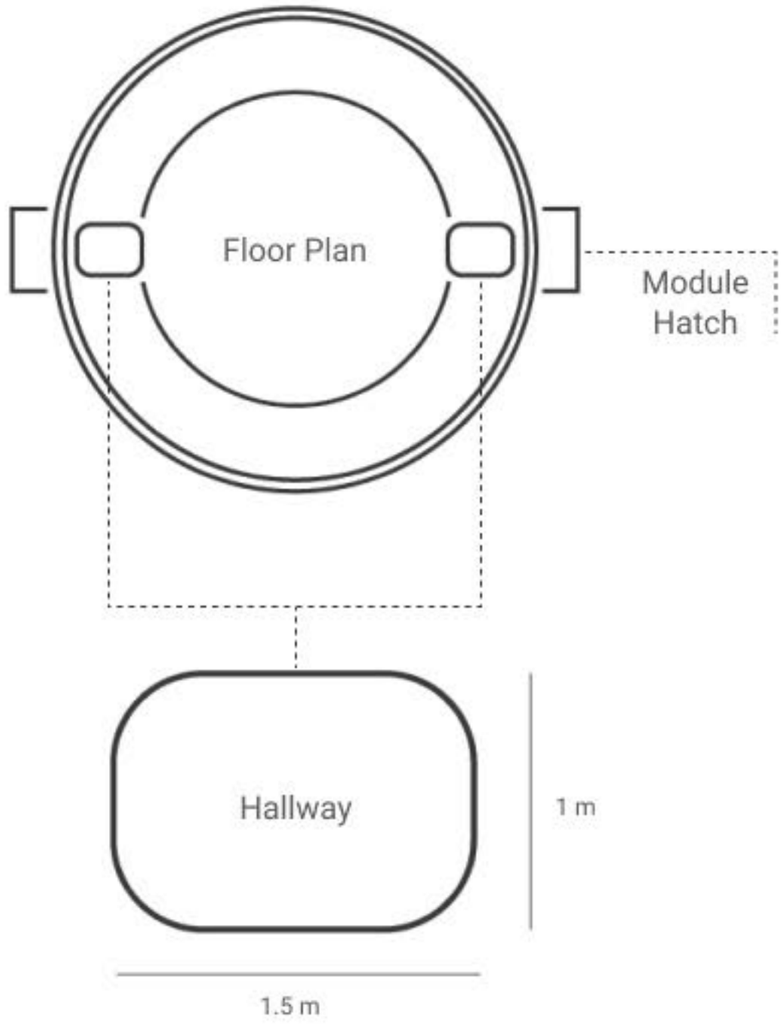


Habitation Module

General Layout

Side View

Top View



Deck Layout

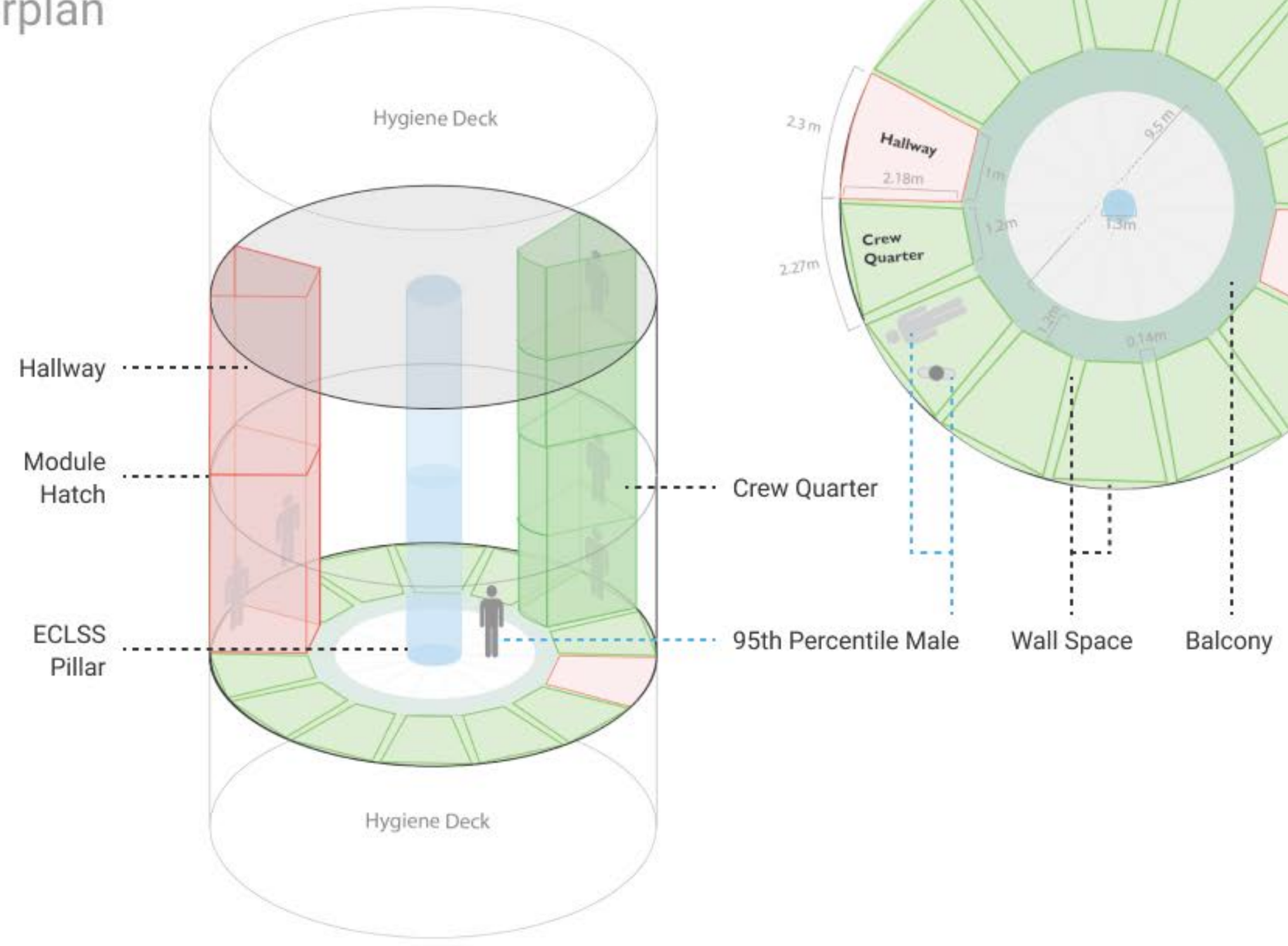
Crew Quarter (CQ) Floorplan

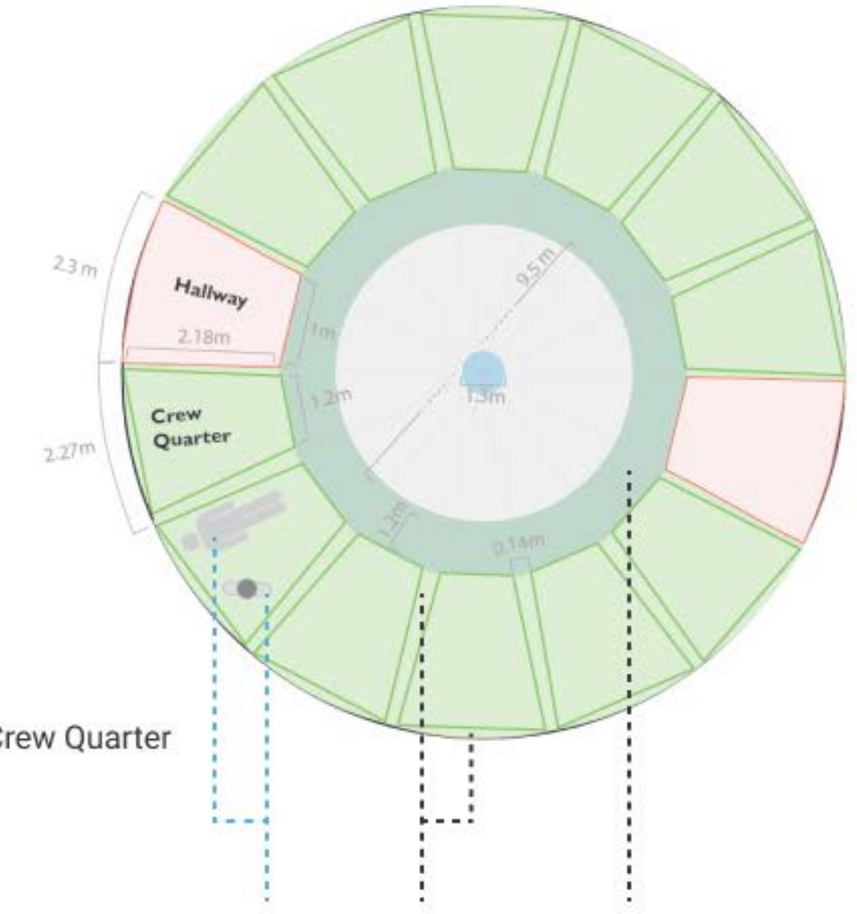
Focused on the social relationsips between three tiers of privacy:

1. Large Space: Entire crew

2. Common Space: Small groups
   - Focused on accessibility of space
   - Large open area allows ease of movement and fast mobilization in emergencies.
   - Accomodates social groups
   - Accelerates deck diagnosis

3. Personal Space: Individual Privacy
   - Allows social detachment
   - Ownership and personalization
   - Home entertainment's main function is to promote mental wellness

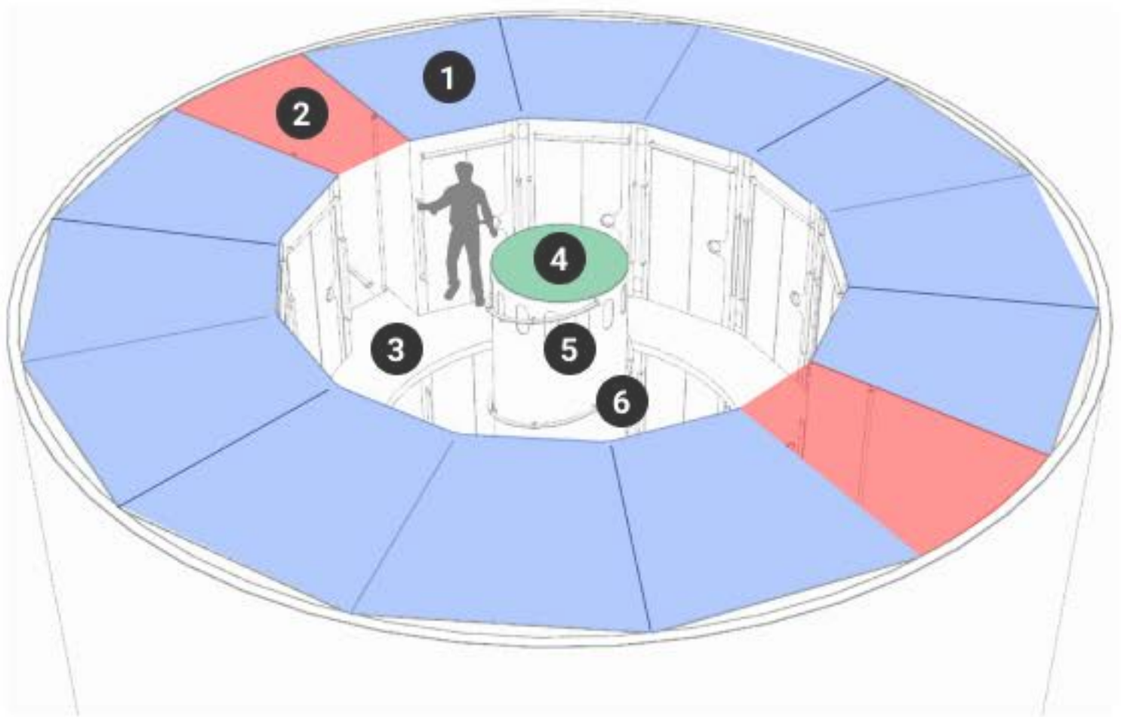


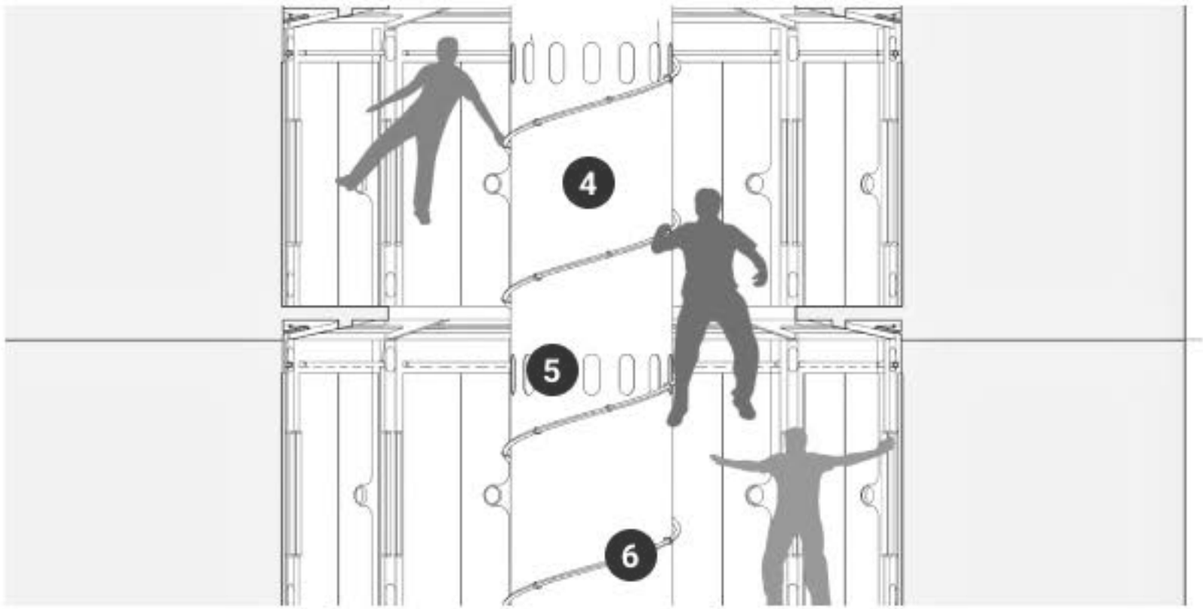


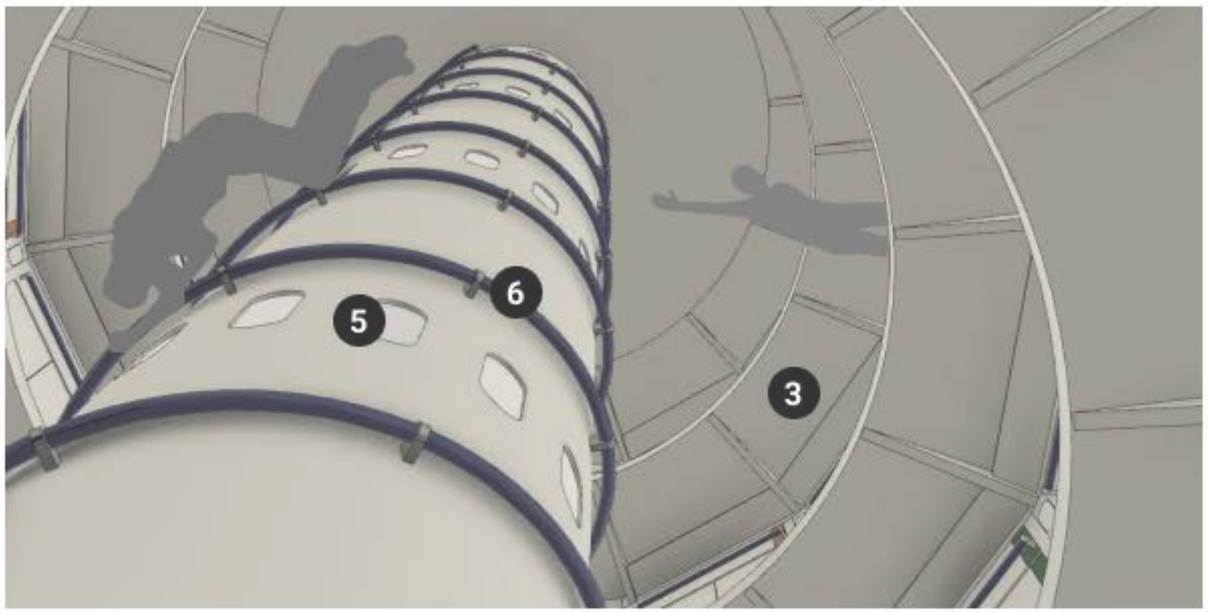
Deck Layout

CQ Deck

1. Crew Quarter
2. Hallway
3. Balcony
4. ECLSS Pillar
5. ECLSS Vent
6. Spiral Handrail



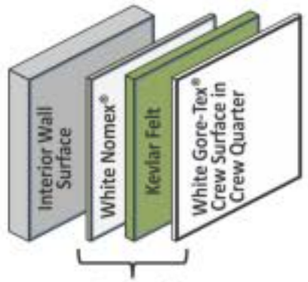




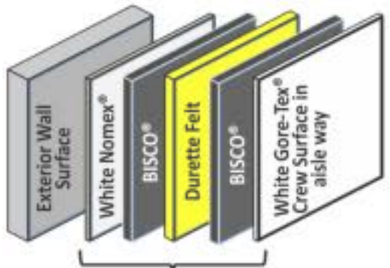
Sound Abatement

Materials and Panel Proposal

Current Sound Abatement Materials on CQ:



Quilted Interior Blanket



Quilted Exterior Blanket

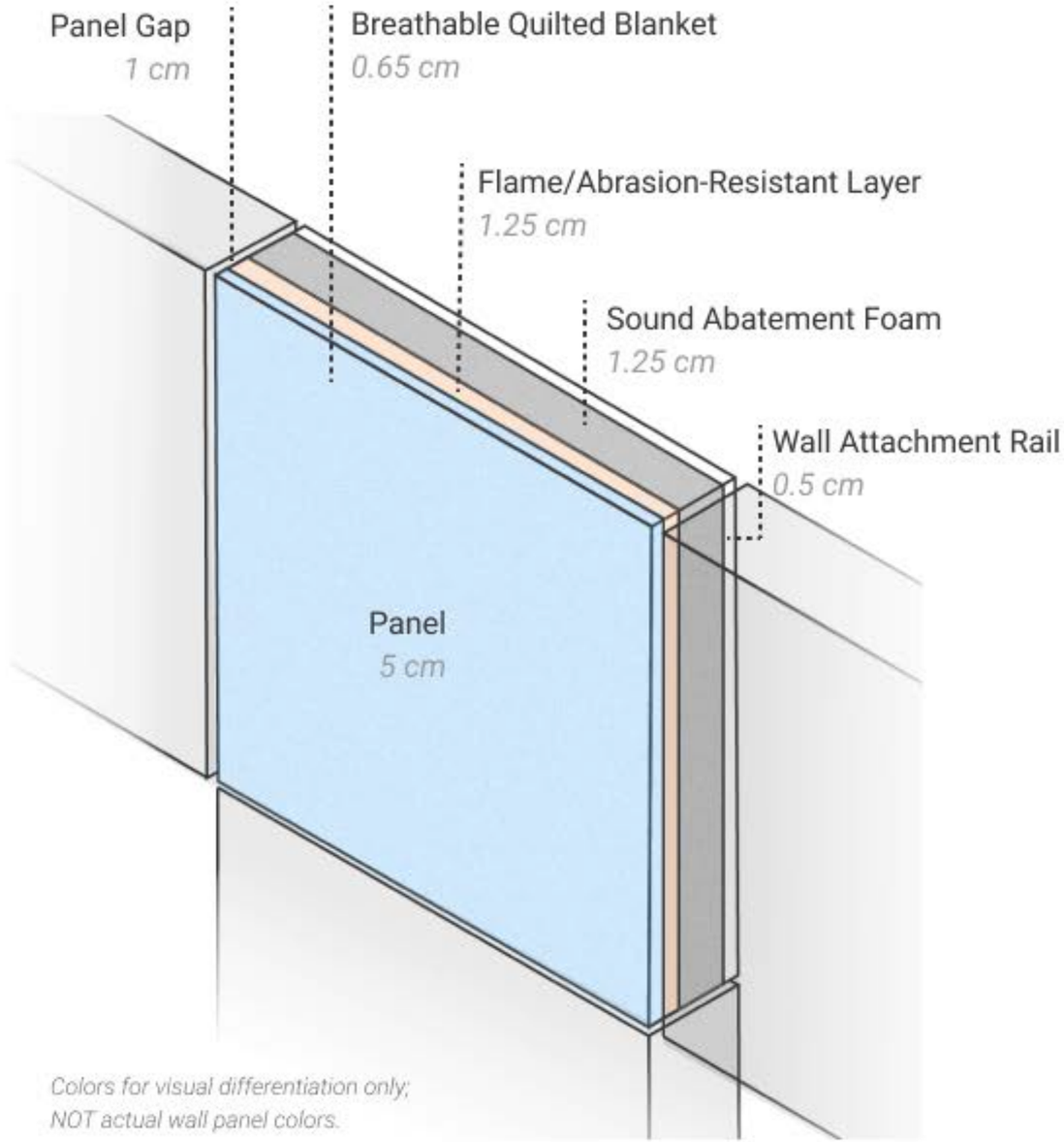
Material Research:

- ***Nomex***: Flame-resistant Textile
- ***Kevlar Felt***: Flame/ abrasian-resistant
- ***Gore-tex***: High moisture vapor transmission rate
- ***BISCO***: Noise-abatement foam
- ***Durette Felt***: Flame-resistant Fabric

Noise Levels:

- **CQ interior** between noise criterion (NC) curves 25 and 40
- **CQ Exterior** between NC curves 40 and 52.

Proposed Wall Panel: Thickness



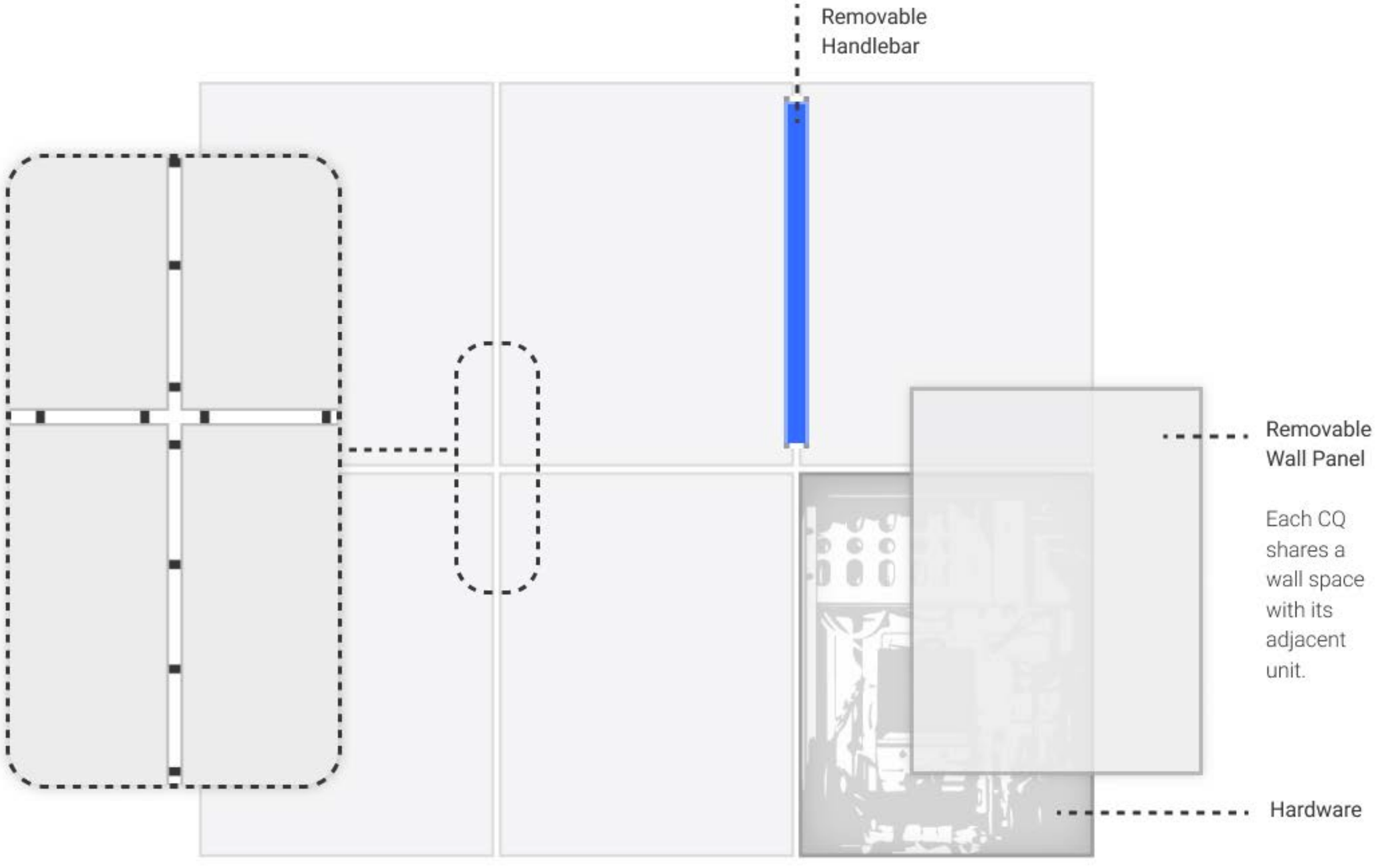
Colors for visual differentiation only; NOT actual wall panel colors.

Wall Panel

Design

Connector Joint Grid System

Connection points between each panel allow residents to customize handlebar and sleeping bag positions by hooking and locking onto these joints.



Wall Panel

Build

Wall panels are removable to allow access to wiring, piping, and other hardware between each CQ.

Ventilation
ECLSS

Current ECLSS

- **ISPR** stores ECLSS units
- **Volume**: 1.6 m³

ECLSS Test Facility

ECLSS set prop in *The Martian*

Proposed ECLSS
Central Pillar

Pillar
- 1.3 m in diameter, 2.5 m tall
- 3.32 m³ volume

ECLSS Units
- Two full ECLSS units per pillar, supporting 12 residents
- 1.41 m³ volume ea. (proposed downsize in future)

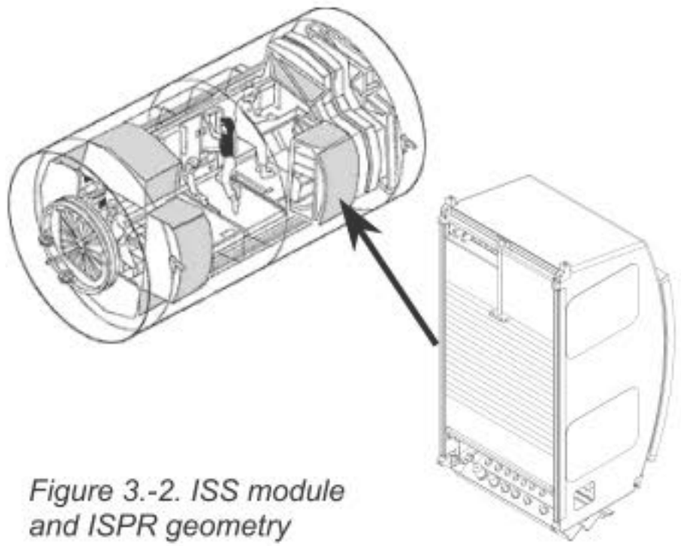
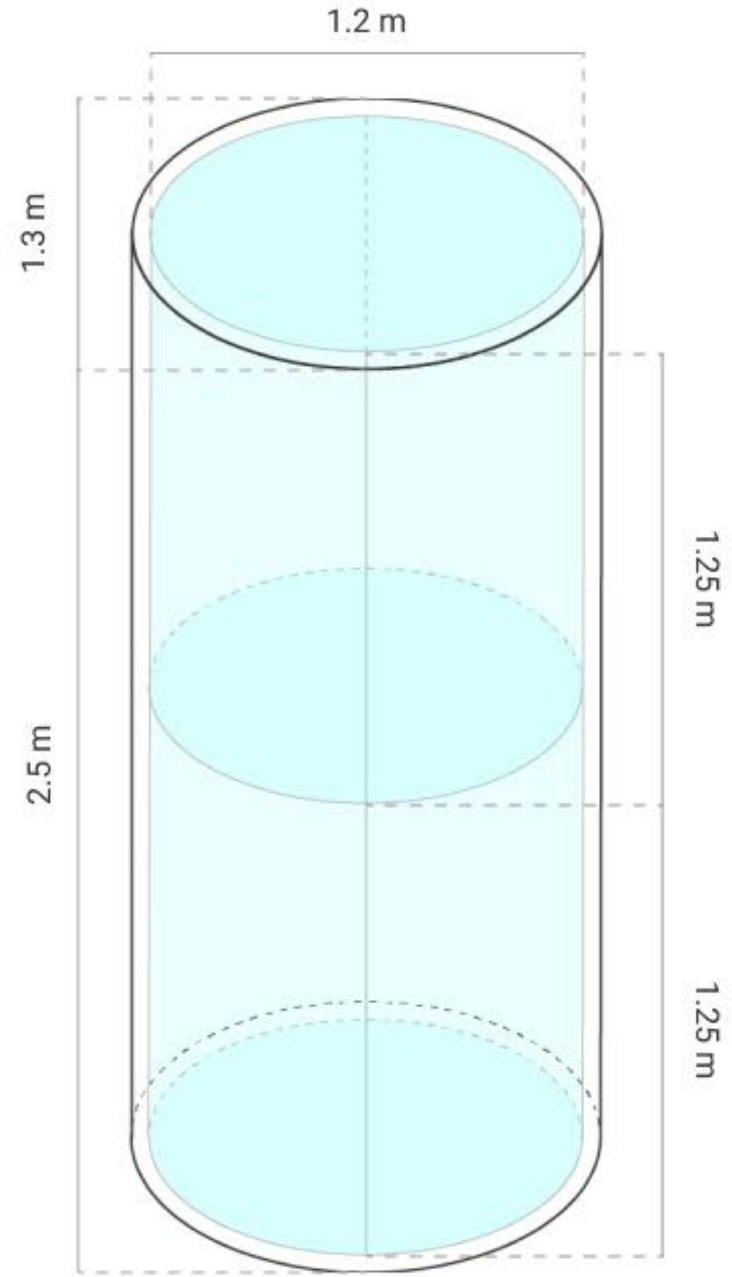


Figure 3.-2. ISS module and ISPR geometry

ISPR Geometry



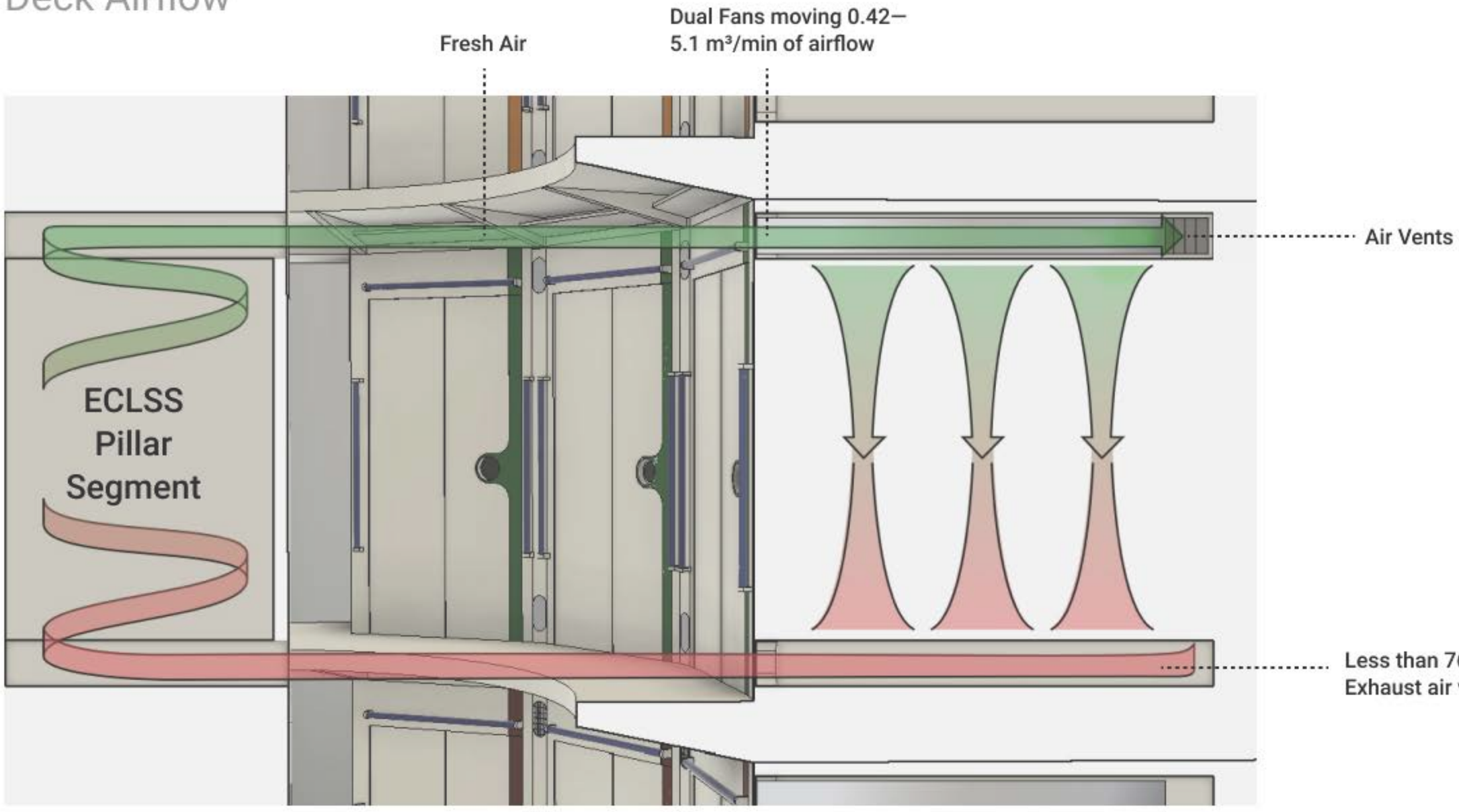
ECLSS Pillar

Design

Central pillar creates a more sculptural common space that allows residents to congregate.

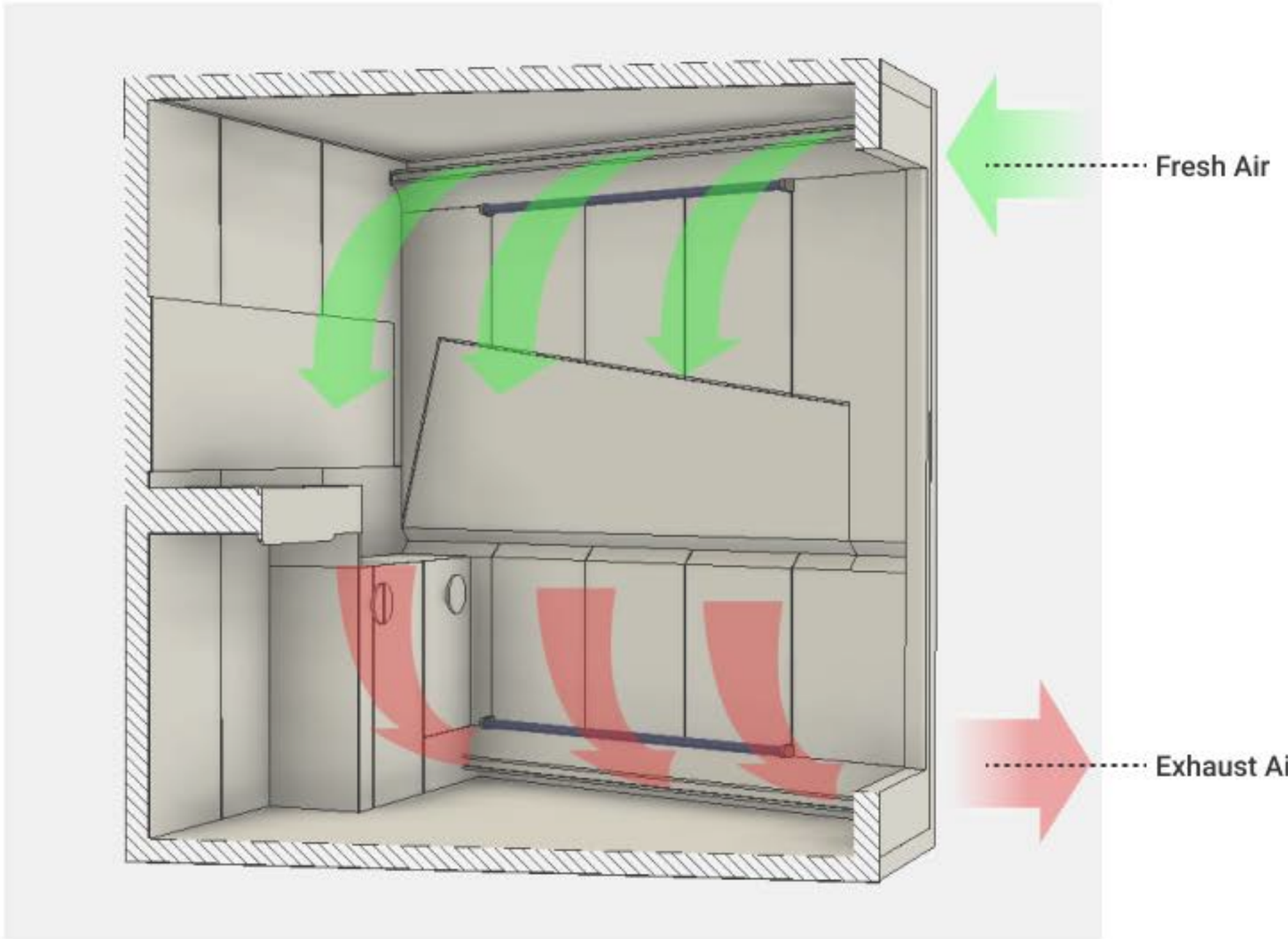
Ventilation

Deck Airflow



Ventilation

CQ Interior



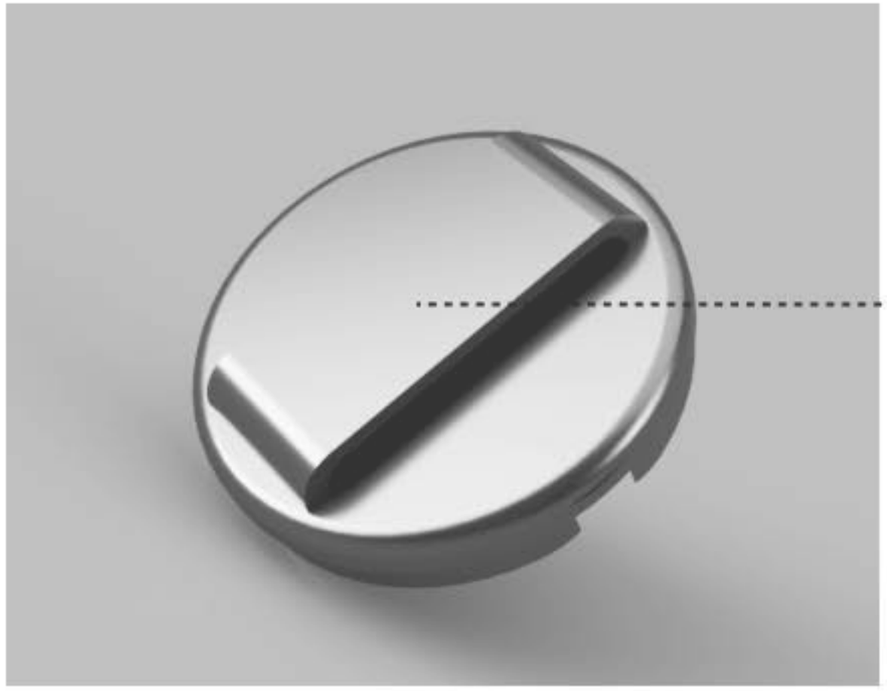
Omnidirectional Mobility Gear

Physical Navigational Tool

Hook Rail

Allows wearer to hook objects from this railing

Squeeze both rails to retract rope



Buckle Slot

Allows wearer to clip OMG onto their pants or belt

Omnidirectional Mobility Gear

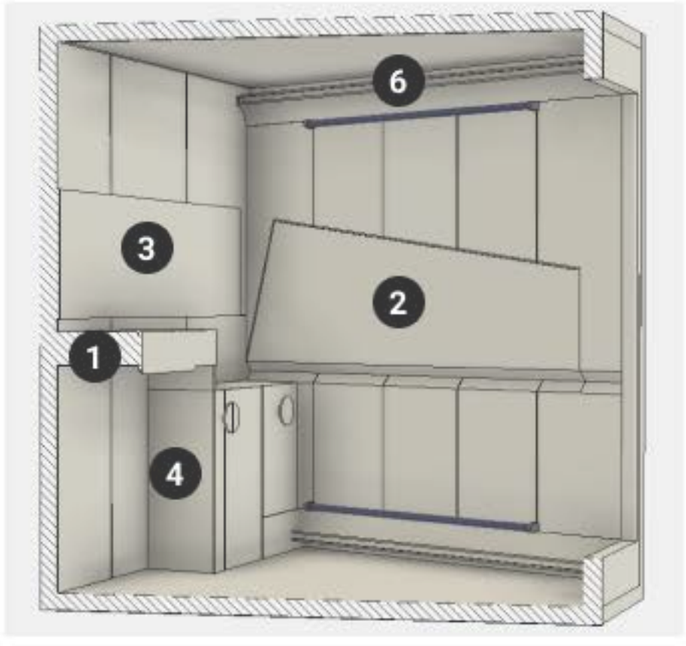
Physical Navigational Tool

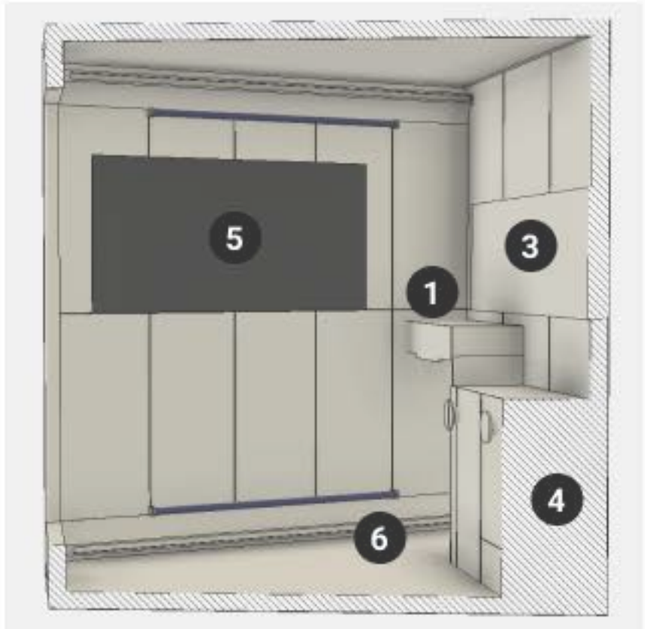
OMG being clipped into a handrail to keep a resident in place and hands-free

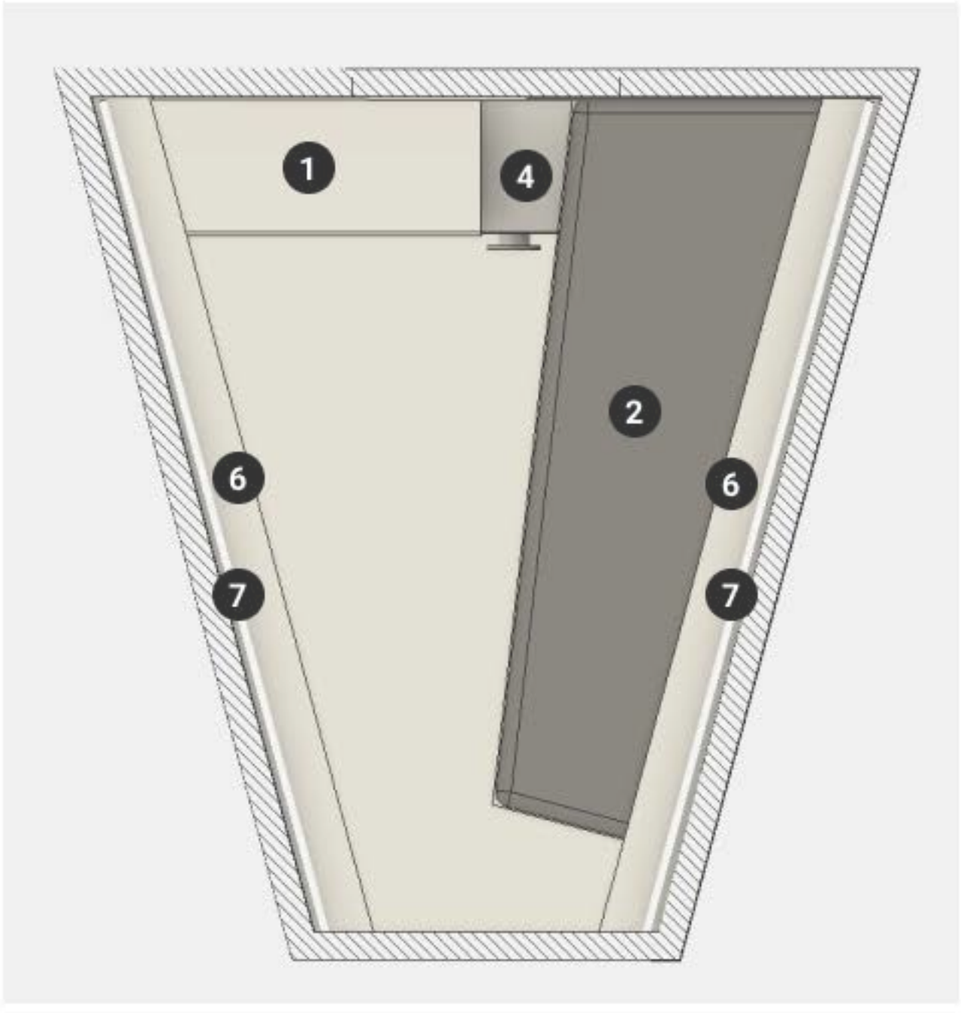
CQ Interior

General Functions

1. Desk
2. Bed
3. Bulletin Board
4. Storage Units
5. Home Entertainment System
6. Arch Vents
7. SSLED Lighting

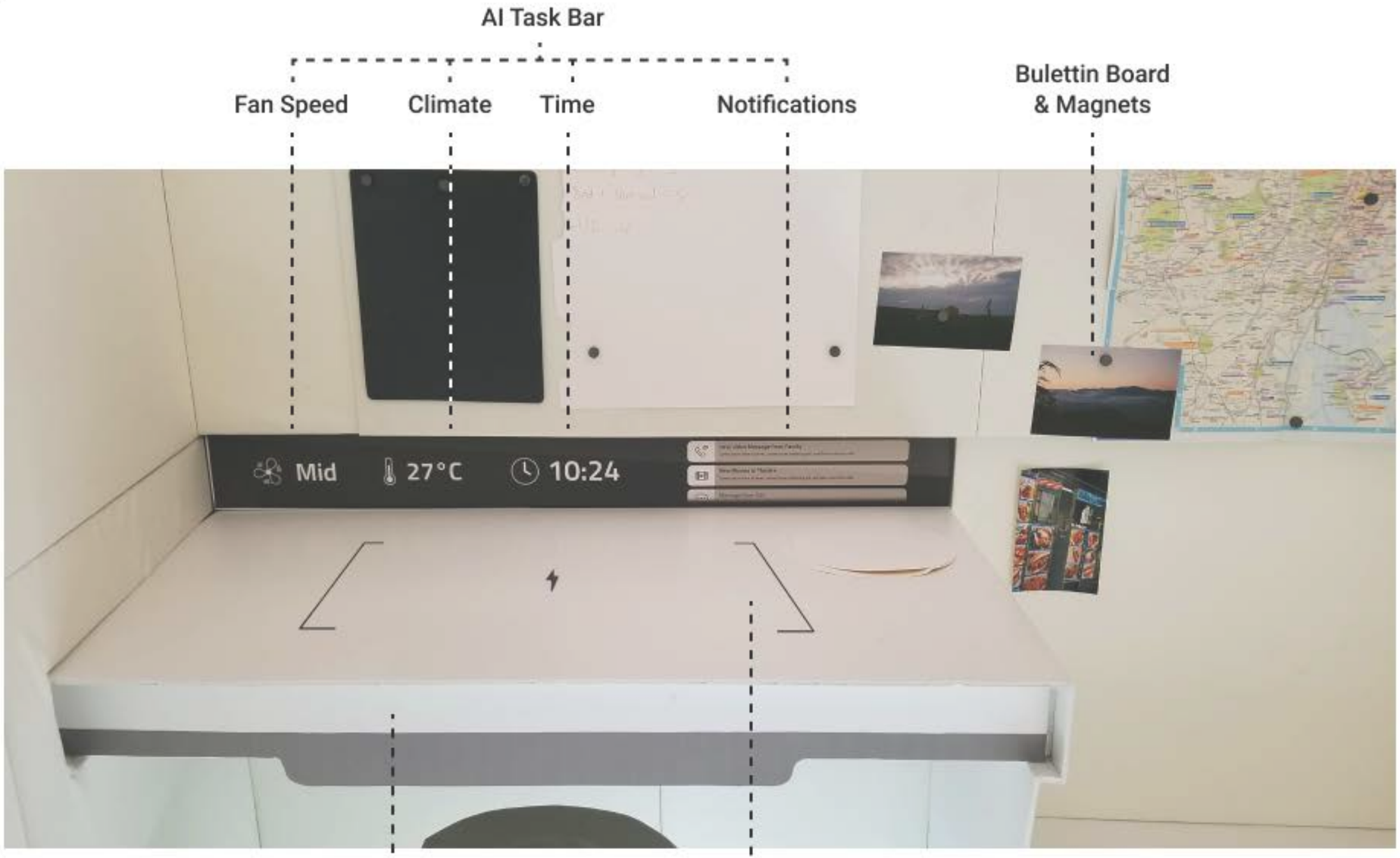






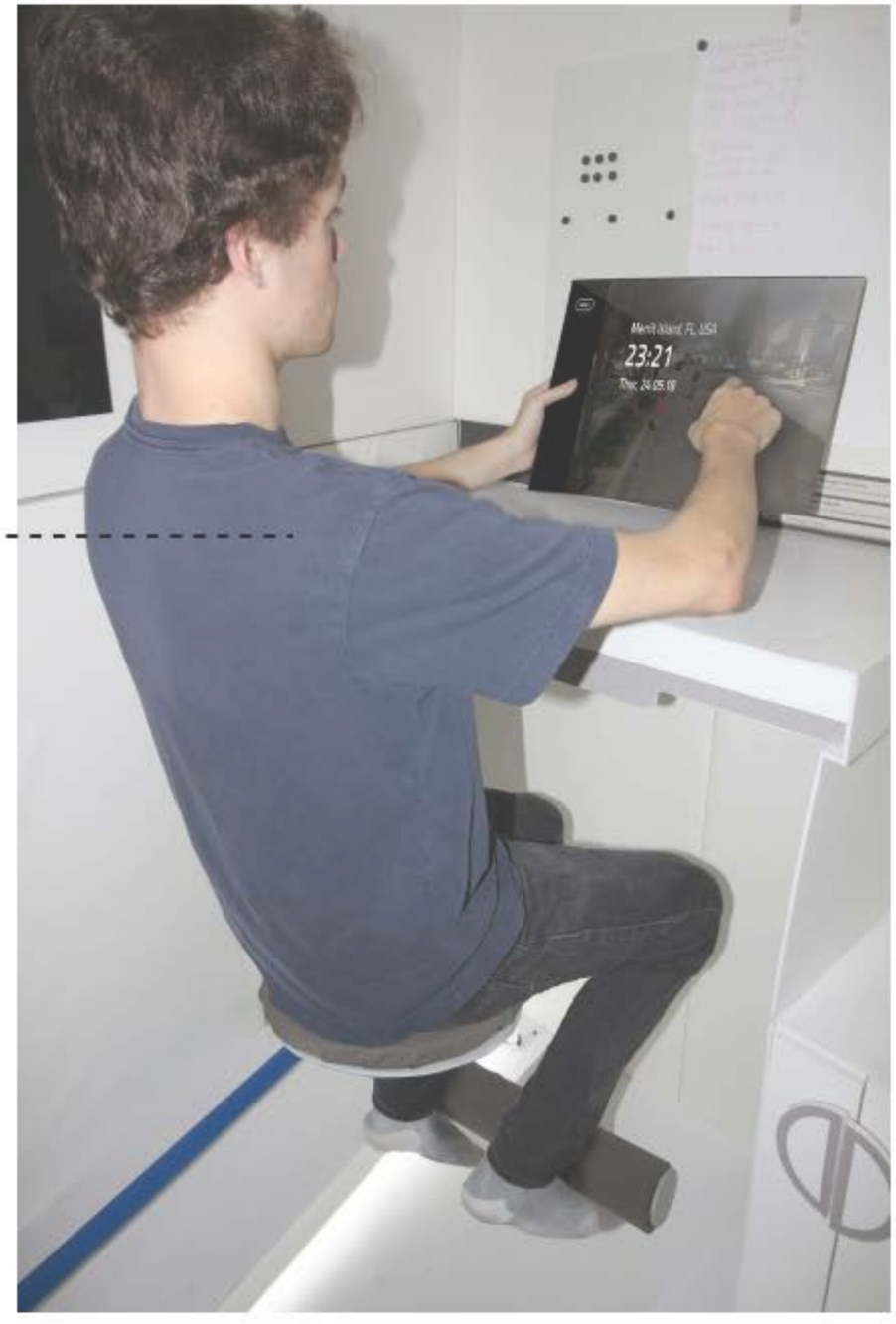
CQ Interior

Desk



CQ Interior

Adjustable Stool



CQ Interior

Bulletin Board

Customizable

Allows for a greater degree of personalization by creating a space to pin up posters, photos, or other items

Magnetic

Eliminates other affixing methods such as tape, velcro, or push-pins

Smart Door

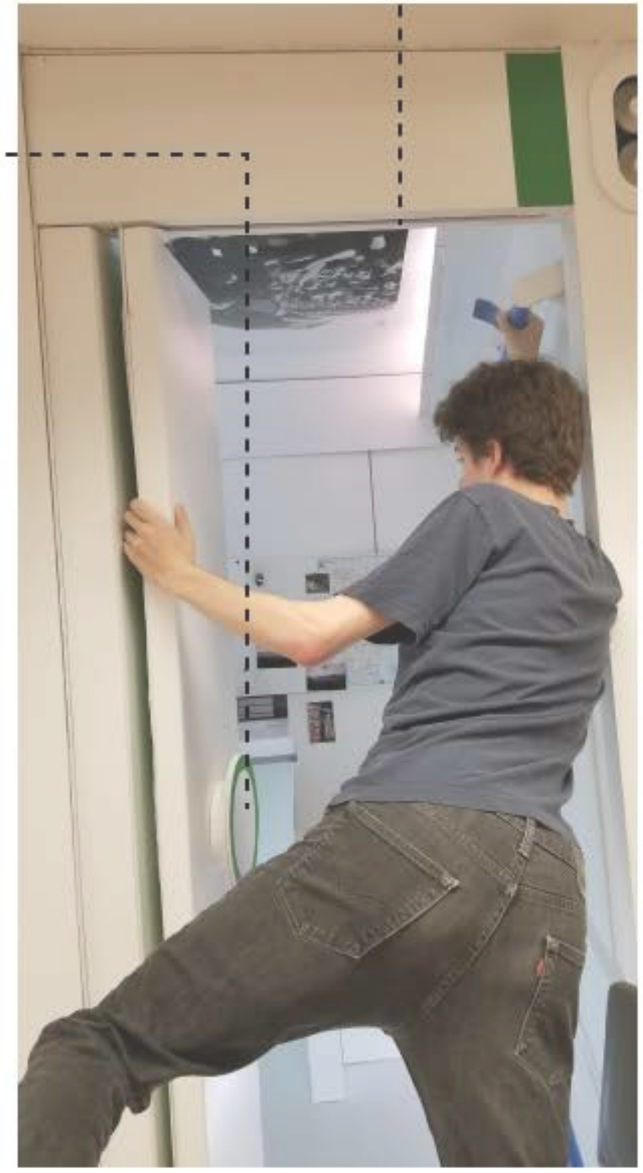
Build + Functions

Facial Recognition Security

Door Folds in on itself to subtract physical footprint

Omnidirectional Handle can be gripped in any orientation

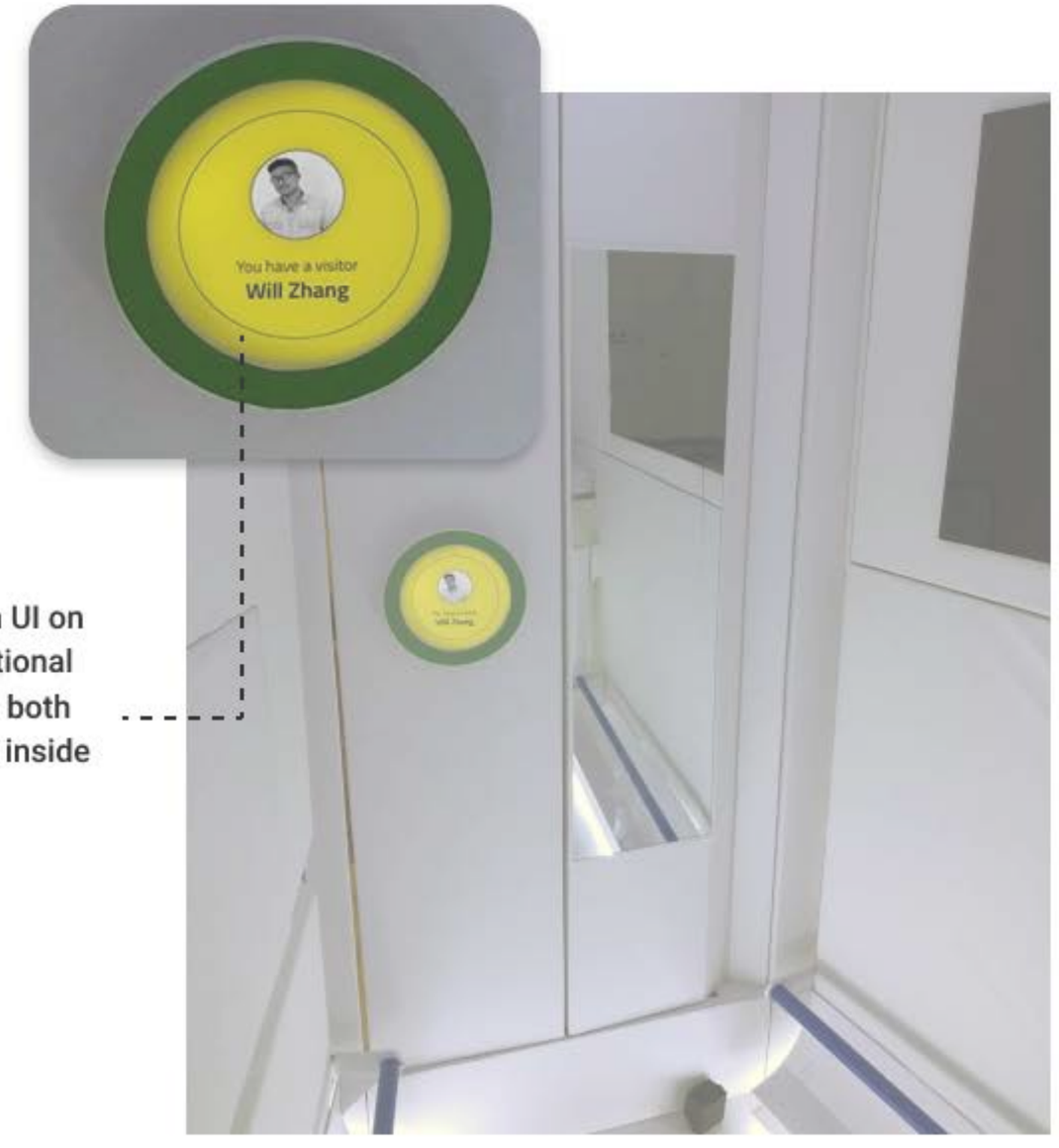
Door Sliding Paths



Smart Door

Build + Functions

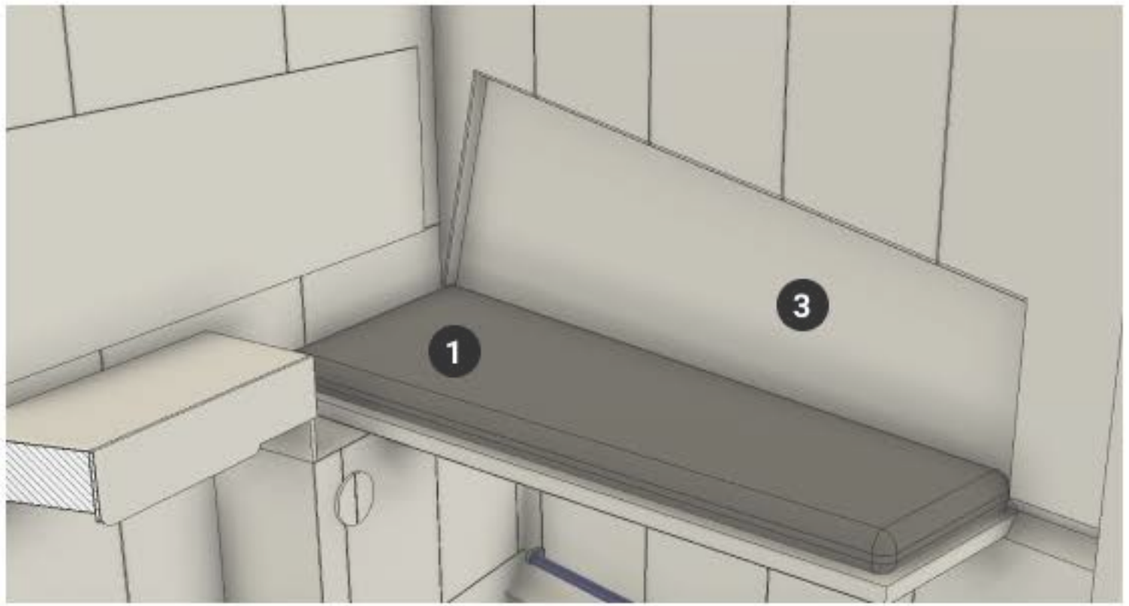
Notification UI on Omnidirectional Handle for both outside and inside



Fold-out Bed

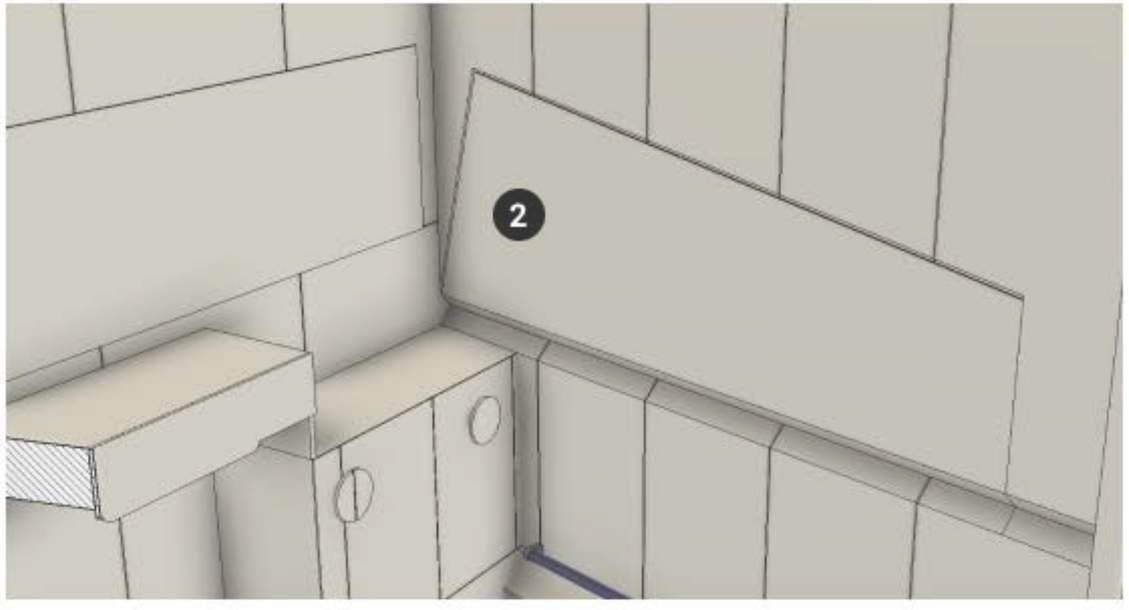
General Functions

1. Mattress
2. Bed Frame
3. Inside Wall



Gravity Configuration

Provides a sleeping surface for full or partial gravity environments.



Micro-Gravity Configuration

Traditional bed not needed in a micro-gravity environment.

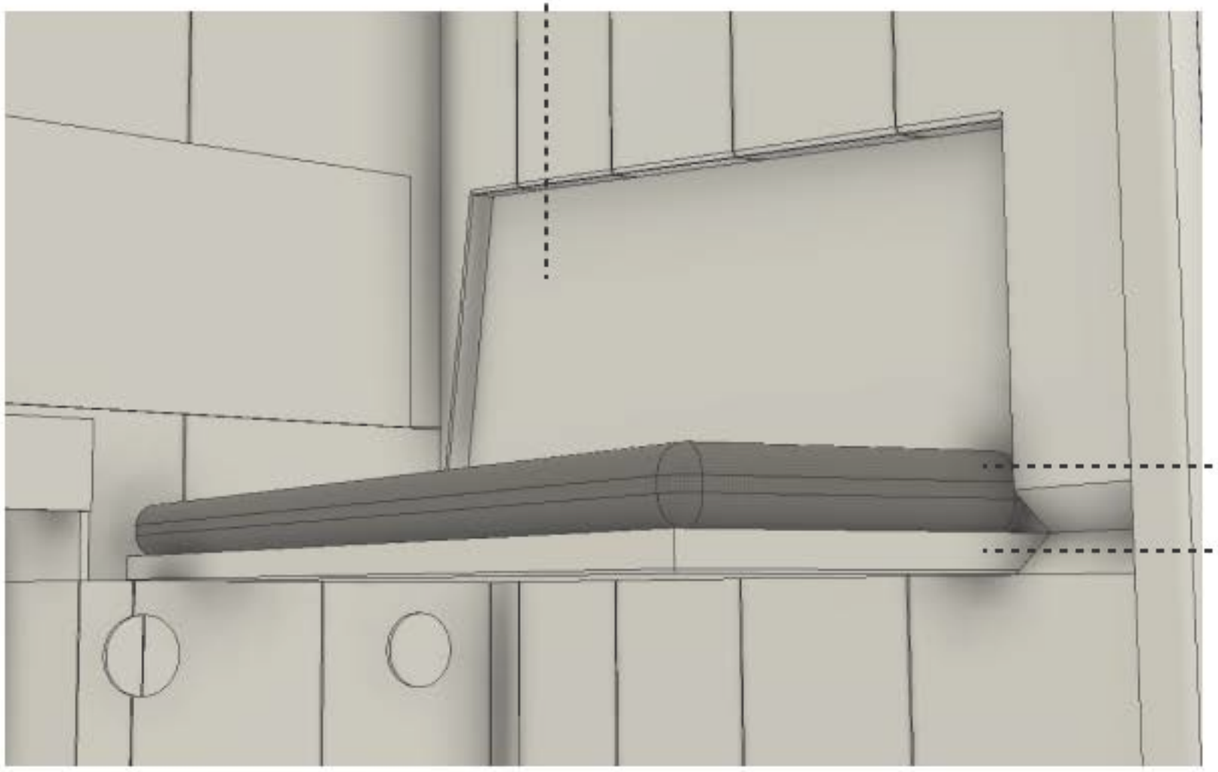
Sleeping bag affixed to the wall provides a comfortable sleeping experience.

Fold-out Bed

Physical Design

Inside Wall

When bed is folded down, sound insulation is lost where the bed occupied. However sound insulation in adjacent rooms compensates for this.



Mattress

Provides enough padding and support while still being able to fold into the wall.

Serves as sound abatement when folded up.

Designed to accomodate up to 95th percentile males.

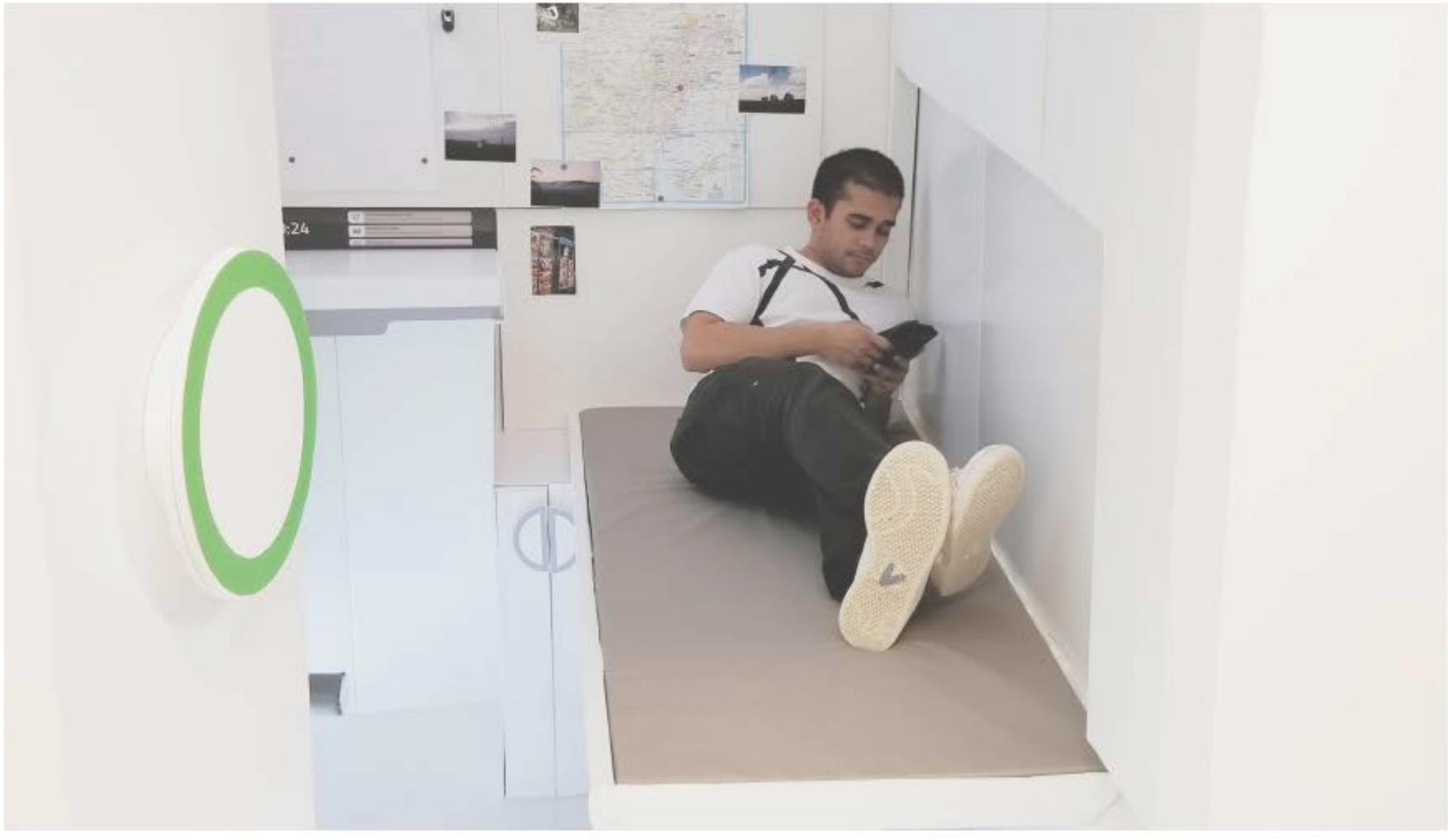
Bed Frame

Supports mattres.

Rests on angled wedges within wall pannels, keeping the bed parallel to the floor when folded down.

Fold-out Bed

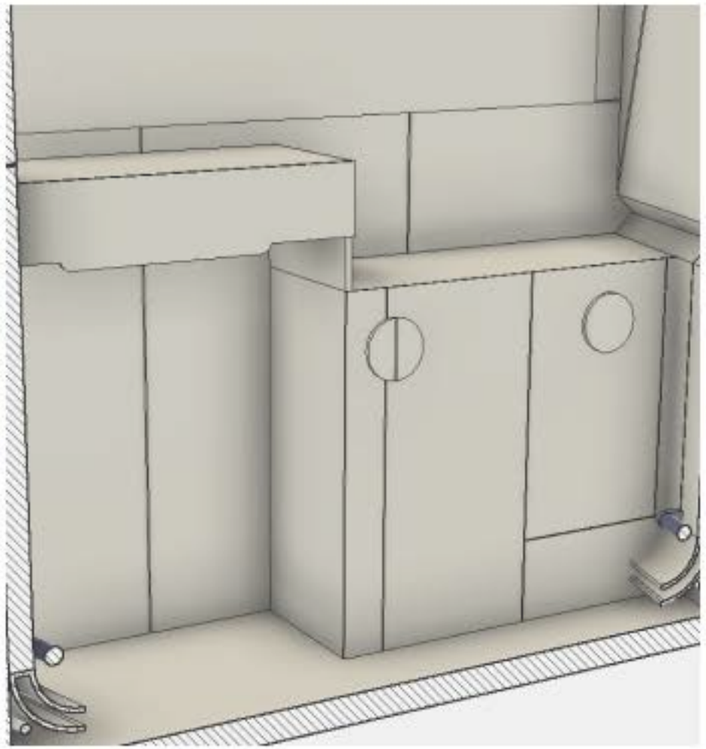
Build



Storage

Design & Build

- Consists of trash bin, clothing storage, vacuum pump, and personal storage safe
- Clothing storage used to store vacuum bags containing 4 weeks worth of clothes per bag.
- Personal storage safe provides a secure place to store valuables and personal items that can be accesses only by the resident of the room.



Clothes Per Crew Member DSSV (Per Year)

Clothes packed in vacuum bags to save space. Bags are stored in storage lockers on the crew quarters deck. Bags taken out of storage an put into individual rooms every 2 weeks and every 4 weeks depending on the bag type

2 week bag - WORK (x27)	2 week bag - GENERAL (x27)	4 week bag - EXERCISE + WARM CLOTHES (x14)
shirts - 1	**underwear - 7**	**shirts - 8**
shorts - 1	**socks - 7 pairs**	**shorts - 8**
	sleepwear - 2	**warm socks - 1 pair**

SSLED Lighting

Color-Shifting

Lights shift color throughout a 24-hour cycle to simulate day/night lighting conditions found on earth. Helps to facilitate normal circadian rythm cycles.

Night

Warmer shift simulates sunset as well as reduces amount of blue light astronauts are exposed to before they go to sleep.

Day

Cooler shift simulates daylight. Shifts blue as astronaut wakes up.

Lighting

Emergency

Lighting will change color to flashing red to indicate an emergency situation. Such situations may include sudden depressurization of the room, fire, carbon dioxide or carbon monoxide build up

Resident equipping an oxygen mask

Home Entertainment System

Build

Each CQ has its own 60 inch interactive screen that contains a Home Entertainment System.

The screen size was determined by field of view limitations of the room and the amount of blue-light astronauts take in on a daily basis.

Research Citations

Sound Abatement & Ventilation Statistics:
- http://spacearchitect.org/pubs/AIAA-2010-6018.pdf

Noise Criterion:
- https://www.engineeringtoolbox.com/nc-noise-criterion-d_725.html

ECLSS Reference:
- Real: https://en.wikipedia.org/wiki/File:ECLSS_at_the_ECLSS_Test_Facility.JPG
- Movie: The Martian
- Model: http://www.spaceref.com/iss/ops/ISS.User.Guide.R2.pdf

Vertical panorama
of CQ build