Rationale for Design Selection

The rational justifying the selection of the final concept for the design selection was based on the main criteria as described above in the criteria ranking. The reasons why the selected design sufficiently achieves most of the criteria compared to that of the other designs is discussed below:

Regolith is an ideal insulation material that is abundantly present on the lunar surface as it is efficient at shielding the structure from harmful radiation. As a result, this material has been used in multiple designs in varying capacity. The chosen method of application here is to pack it in bags and place it around the structure and then spray the regolith into the remaining crevices. Regolith also compresses down on the structure helping negate the internal air pressure. Furthermore, regolith will not be added to the dry mass limit of the structure allowing for additional overall cost savings as this material is readily available on the lunar surface and does not need to be transported on a rocket from earth unlike the structure. The structure also uses ultra-lightweight mylar for emergency shielding if the regolith is blown away due to unexpected events.

The structure meets minimum habitable volume requirement and allows room for expansion if needed. The design also provides adequate space for all the systems to function allowing for an entire section of the floor to be used for air and water filtration systems. As seen in the cross section of the generated.

The structure is small enough to fit inside a rocket and is manufactured on earth. This means it could be assembled on earth to be transported to the lunar surface as a whole or it could be assembled on the lunar surface. The structure also uses the space grade circular tubing truss attachment that is capable of one-handed assembly. This shortens the assembly process.

The geometry of the structure is made from a honeycomb structure which helps save the most space while also being structurally rigid. The structure also distributes the internal air pressure evenly throughout the structure minimizing air loss. In addition, the honeycomb structure also handles the massive vibrations from the rocket’s acceleration better than any other structure.

Final Selected Concept

Final Design Selected: Modular Space Capsule

Design Description: The design shown below is named the Modular Space Capsule. As shown below the on the outside is a big cylinder with a window section at the end. The design is generated from CV5 and CV13 and is designed for versatility with assembly. The structure is manufactured on earth and initially assembled on earth for testing. After the testing process, the structure could be taken apart and shipped to space in rockets in modular sections for assembly in space, or on the moon. Another option is to place the structure in a rocket fully assembled and transport it to the lunar site of interest. Currently, all the sub-systems necessary to support 2 individuals exist inside the structure. In addition, the capsule is designed to be a expandable via the airlock chamber where it could use a coupling chamber to connect to extra modules if necessary.

A list of the top four human factors as described by the research as described in section 3.1.2 is presented below:

1. Net Habitable Volume

   The generated concept structure must adhere to the minimum habitable volume (NHV) to accommodate for a safe livable area. According to human factors research, our net habitable volume for 2 individuals for 30 days is 55 +/- 5 cubic meters. This net volume not including the air lock chamber is 3m x 7.5m x 2.5m (width x length x height). This results in a volume of 56.25 cubic meters. The structure is divided in three quadrants based on human factors research. As shown in the figure below, the first quadrant is separated for necessary subsystems. The second quadrant is separated for the workspace and the last quadrant is separated for the living quarters.

2. Workspace

   The workspace area is in the second quadrant of the final concept design. The workspace accounts for laboratory equipment and storage of materials collected on the lunar surface.

3. Main Systems Area

   The subsystem area contains the air management system, water purification system, power storage, temperature control system and pressure management system. The waste management system is planned to be placed in the hygiene area.

4. Personal Living Quarter

   The personal living quarter consists of the capsule bunk bed area, the food preparation area, and a hygiene area. The waste management system and water purification systems are located in this quarter.

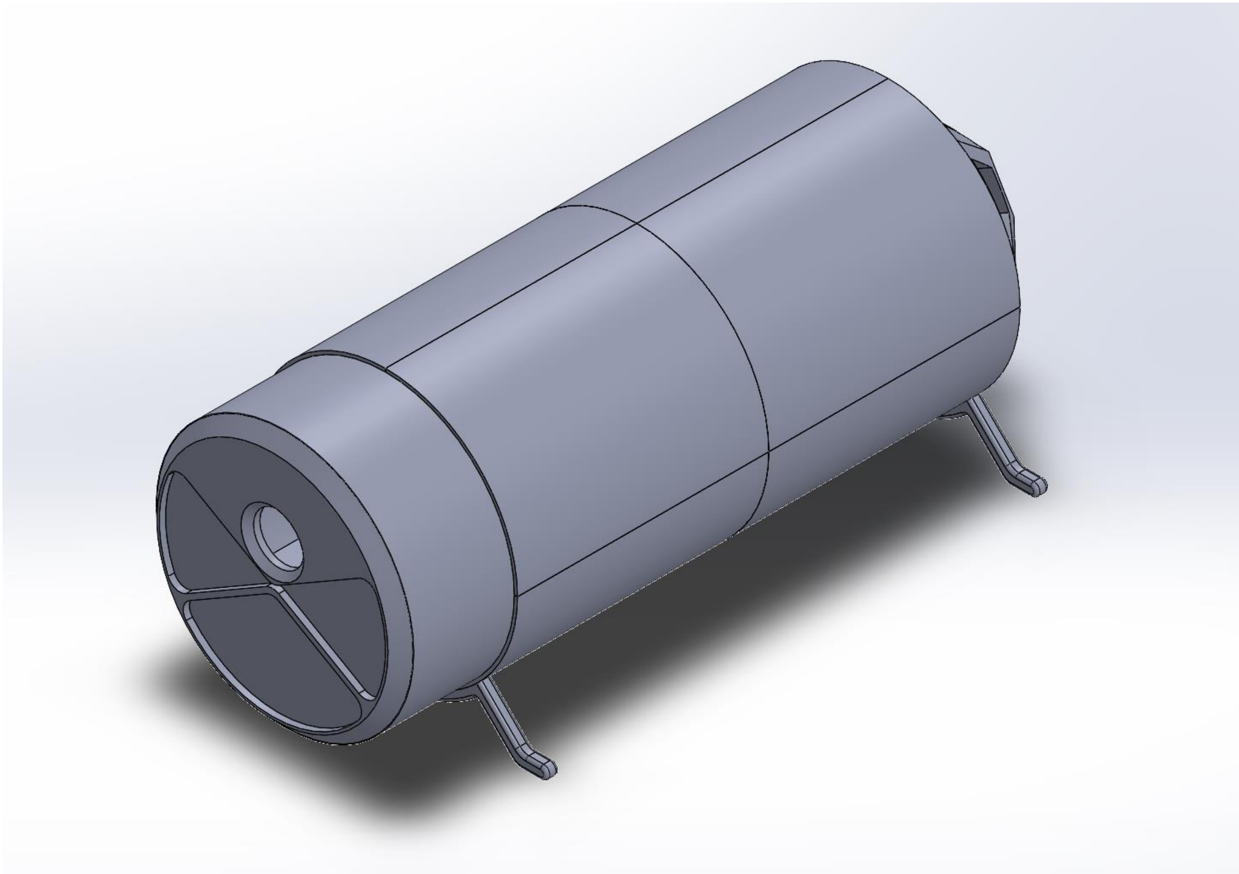

Figure XA. Isometric view of the front of the preliminary CAD model generated in SOLIDWORKS.

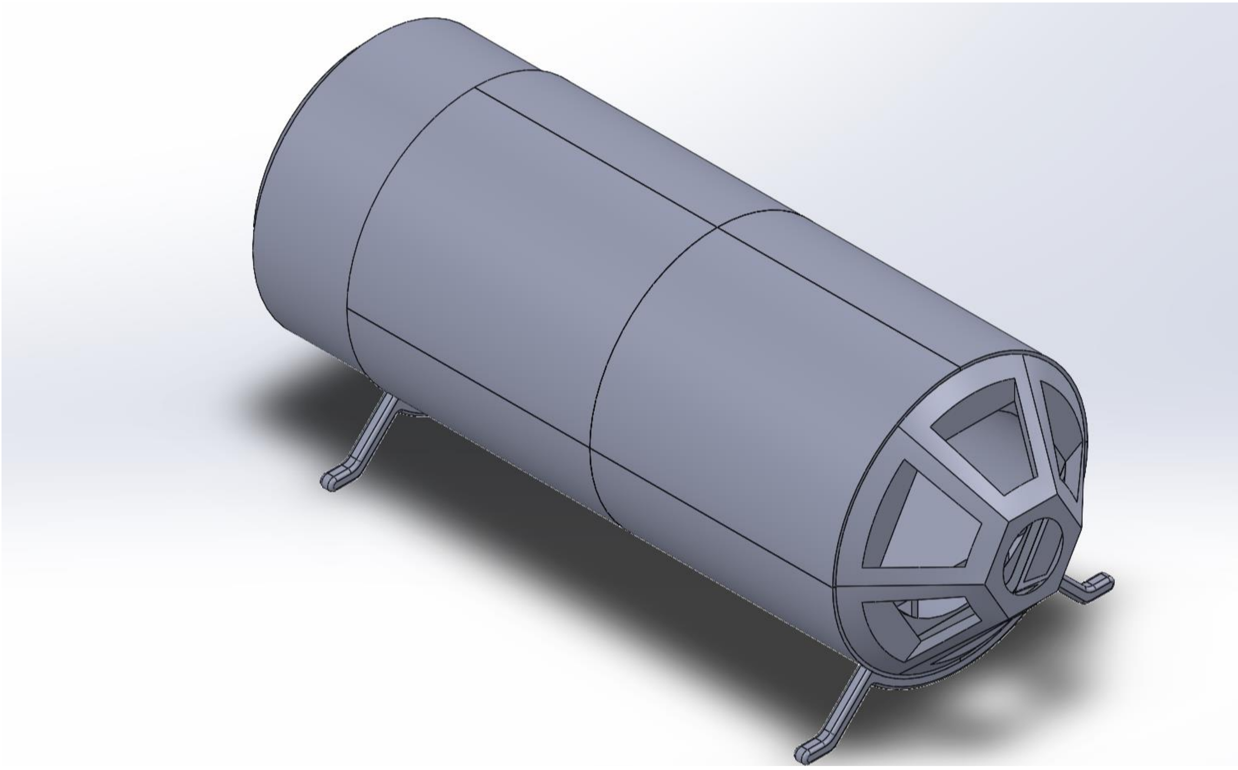

Figure XB. Isometric view of the rear of the preliminary CAD model generated in SOLIDWORKS.

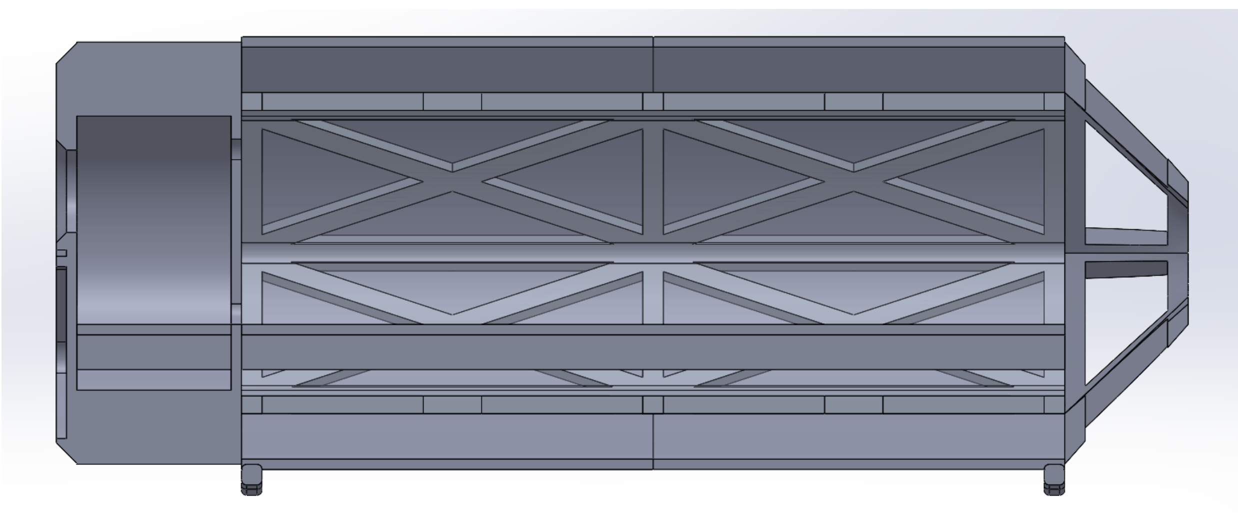

Figure XC. Cross-section of the preliminary CAD model generated in SOLIDWORKS.

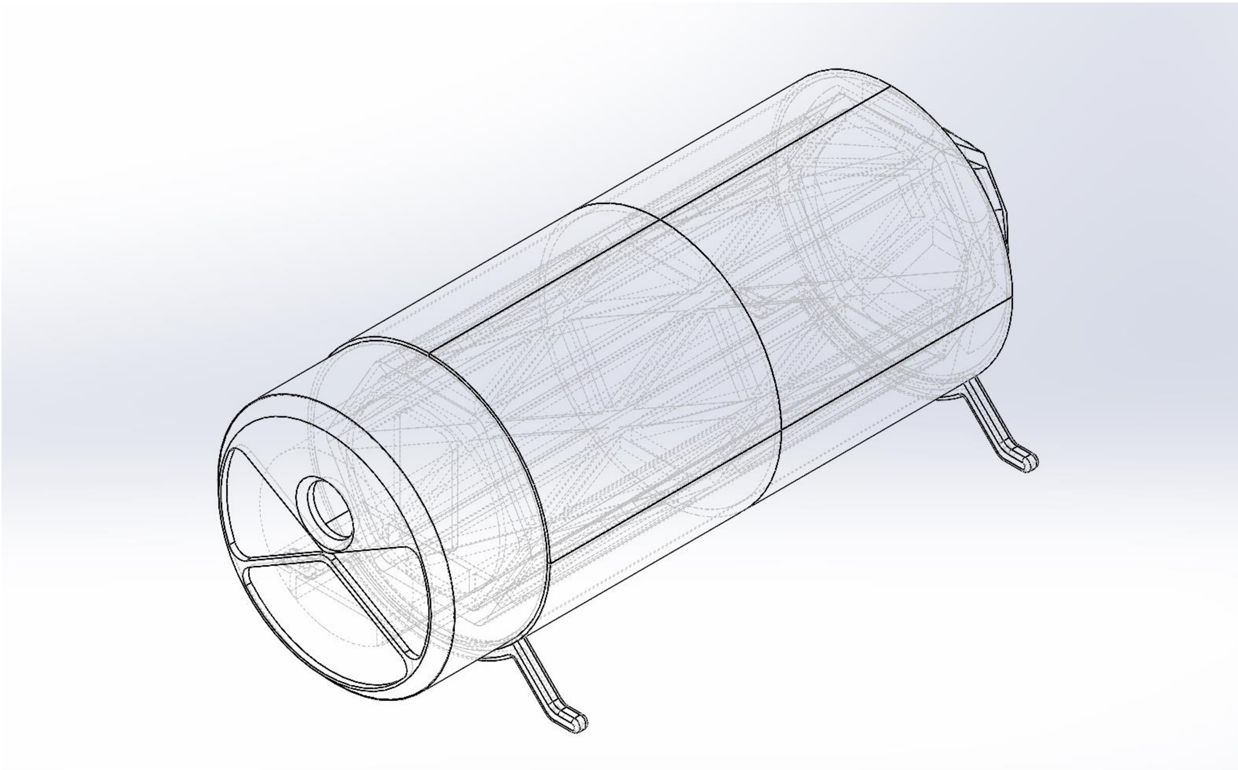

Figure X. Skeleton (hidden lines shown) isometric view of the front of the preliminary CAD model generated in SOLIDWORKS