My X-Hab Contributions

Claire Hudak, MAE Senior

May 10, 2017

Abstract

As part of the National Aeronautics and Space Administration (NASA) eXploration Habitat (X-Hab) 2017 Academic Innovation Challenge and the MAE 4374 Capstone class, Space Engineering and Architecture Design and Construction, I worked this semester to implement new designs within the Reconfigurable Habitat (ReHAB) analogue. ReHAB is a habitat designed for use on Mars, and it is located at Richmond Hills Research Lab, Stillwater, Oklahoma. This year, the topic for the team was Command and Control, which largely focused on the communication among different analogues, i.e. in space, on Mars, on the moon, and on Earth. The team also needed to repair and improve the current systems in place. My main goal was to create a more open and safe floor plan for the ReHAB by implementing a retractable ladder and some safety elements. I finished the semester with a working retractable ladder, new hatch and safety measures for the second floor, and improved floor and medical bed wall. My Honors Thesis for my senior design is to summarize my contributions to the project.

Honors Thesis Summary

For MAE 4374 X-Hab senior design, I joined Team Ares and took charge of building a retractable ladder in ReHAB in order to eliminate the obstruction of the former fixed ladder, improve the accessibility of the medical bed, provide an open floorplan, and eliminate weight for the Martian analogue concept. After brainstorming ideas with my team from designing a rope ladder to implementing a collapsible attic-style ladder, we decided on a fire escape ladder with a pulley system. This ladder worked well because after I drilled holes in the back tabs of the ladder, we were able to feed the rope through the tabs and retract the ladder when not in use. After drilling the holes in the ladder, I worked with my team to mount the frame, to which the ladder attached. We had removed this frame in order to install a hatch for the second floor. We implemented the second floor hatch to eliminate the safety hazard of the previous design, where someone could fall from the second floor to the first. We installed support beams inside the floor, so when the hatch was closed, it supported the weight of someone walking across it. After installing the supports, I had to recut them in order for the ladder frame to properly fit. I then filed away protruding screws on the hatch and covered them with tape to eliminate injury if someone touched them.

Once we installed the hatch and ladder frame, we fixed the ladder to the frame using bolts. The ladder worked, but in order for one to easily climb it, we decided it needed to be fixed to the floor, so we used a circular saw, two eyelet screws, and four carabiners to attach the ladder to the floor, creating tension in the ladder and preventing swinging. Next, I used a similar technique to the circular saw when installing handles on the frame. In order to prevent the U-bolt handles from moving within the frame, I sunk one end deeper which allowed me to add a nut on the back and prevents users from pinching their hands when climbing.

The previous medical bed design incorporated hydraulics to move the wall and lower the bed. However, with this design, the bed often unscrewed from the wall because of how it was threaded. To improve this design in the future, I helped my teammate remove, drain, and store the hydraulic system. We then attached handles to the wall, which can now slide faster and smoother. The goal for the next group is to implement a physical bed, hypothetically an inflatable bed that expands quickly. By using an inflatable bed, the team would, again, eliminate unnecessary weight. Regardless of the bed design, the medical bed wall now moves easily.

After we completed the ladder installation and hydraulic removal, I replaced the floor that was under the medical bed and ladder. The new floor is one complete piece that fits securely in place and covers the former tracks in the floor. After drilling new holes for the eyelet screws and carabiners, I painted the floor to match the rest of ReHAB. We then reinstalled some walls, which were removed to make changes to the lighting, returned most of the workstations, which were removed for the renovation, and cleaned up the analogue.

Lastly, I worked with my teammate to finalize our final presentation for NASA. In order for future students to improve these current systems, they need to know how to operate them, so I wrote the User Manual for ReHAB, which will be stored within the building.

This semester I had the incredible opportunity of creating and implementing designs for a space analogue system. I applied problem solving techniques and Aerospace engineering fundamentals to this project, and I worked with my team to deliver the results to NASA.