

Habitat Demonstration Unit Medical Operations Workstation Upgrades

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Abstract

This paper provides an overview of the design and fabrication associated with upgrades for the Medical Operations Workstation in the Habitat Demonstration Unit. The work spanned a ten week period. The upgrades will be used during the 2011 Desert Research and Technology Studies (Desert RATS) field campaign. Upgrades include a deployable privacy curtain system, a deployable tray table, an easily accessible biological waste container, reorganization and labeling of the medical supplies, and installation of a retractable camera. All of the items were completed within the ten week period.

I. Background

THE Habitat Demonstration Unit Project was initiated in the spring of 2009. The project is developing operational habitat configurations for planetary surface and deep space testing scenarios. The first architectural component constructed was the main cabin, which was configured as a 5-meter diameter vertical axis cylinder. The main cabin has four rectangular docking hatches at 90 degree intervals along the outer wall of the shell, and at the center of the upper dome is a circular hatch.

The main cabin shell was constructed with eight wedge sections which consisted of a pair of steel ribs molded into a shell of resin impregnated fiberglass. [1] The habitat currently consists of a main cabin with a Tele-robotics Workstation (TRWS), a GeoLab, a General Maintenance Work Station (GMWS) and a Medical Operations Work Station (MOWS). Connected to the main cabin is the Hygiene Module and Dust Mitigation Module. Above the main cabin is the inflatable habitation loft where the crew galley and quarters reside.

The MOWS at the beginning of the project consisted of a 72 inch by 22 inch work table. Below the work table was a 67 inch by 22 inch surgical table that could be stored under the work table or roll out for use during medical procedures. Above the work table was a set of 64 inch by 24 inch by 13 inch deep

cabinets for storing medical supplies. The cabinets consisted of eight drawers total -- two columns of four drawers high with two cabinets, one on each end of the cabinet section.



Figure 1. Initial Medical Operations Workstation

II. Upgraded Design

Upgrades designed and implemented for the MOWS were a deployable tray table, a deployable privacy curtain, a bio-waste trashcan that could be hooked in different locations, a retractable camera, and organization and labeling for the MOWS supplies. Due to surface area constraints, a deployable tray table was needed to allow for extra work space during life sciences experiments or during medical procedures. The deployable tray table was designed so the tray could be accessed while the MOWS is in a number of different configurations.

The design consisted of the tray resting on a pivoting arm which allowed for easy stowage or deployment of the tray table. Mounted under the surgical table against the small leg section, the tray could be deployed from the front or back end of the surgical table. Additionally, the arm configuration allows for the tray to be swung to the outer end of the surgical table, allowing for space to walk past a deployed surgical table without removing the items.

The arm consisted of a mounting base, which was positioned 7 inches from the bottom of the surgical table surface and centered between the surgical table legs, two 12 inch arm sections which could pivot 360

degrees if unobstructed and a 6 by 6 inch pivoting plate. The tray consisted of a 15 by 22 inch plate that was mounted to the pivoting plate of the arm. The arm was rated for a 100 pound load capacity. With the addition of the tray, load capacity of the system was lowered, but it was determined to be an acceptable reduction as long as the total configuration maintained a minimum 30 pound load capacity. Two brackets were added to the leg of the surgical table to accommodate the mounting of the tray table.

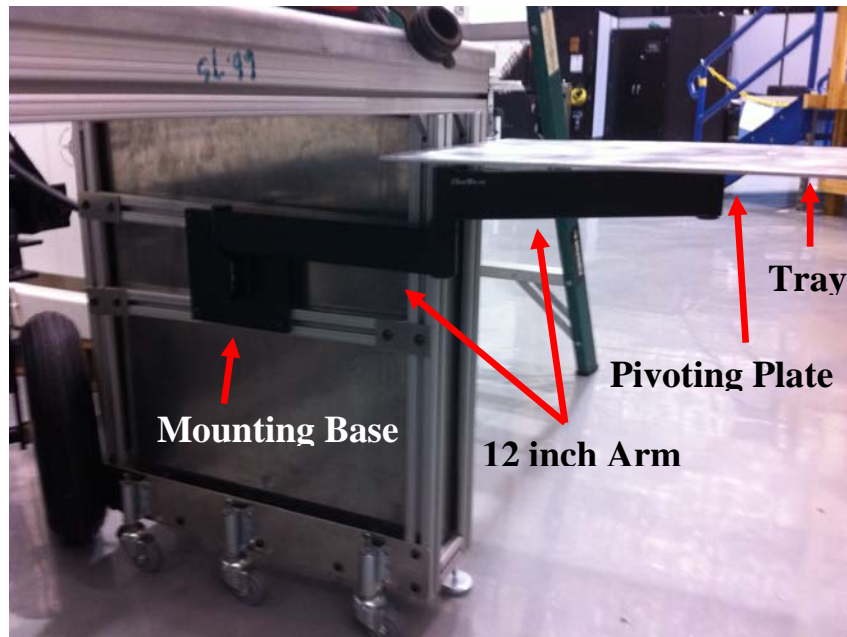


Figure 2. Completed Tray Table

The need for privacy during some medical procedures warranted the inclusion of a privacy curtain system in the HDU. The curtain system needed to be flexible enough to be able to adapt to the different medical situations while not encroaching upon the main cabin space while not in use. Simplicity in design was also critical to allow for smooth deployment. Due to the storage constraints within the HDU, the deployable privacy curtain was designed to remain stowed above the MOWS cabinets when not in use.

The complete curtain system consisted of two telescoping poles and an additional curtain that could be manually hung. Each telescoping pole was 46 inches collapsed and 96 inches long when fully extended. The pole was made of three sections. The largest pole section diameter was 1.125 inches and the smallest pole diameter 0.875 inches. Each pole was mounted five inches above the MOWS cabinets, three inches from the front face of each side of the cabinet.



Figure 3. Stowed Privacy Curtain

The large end of the pole was attached to the mount by the cabinets to a 90 degree pivoting nub which allowed the pole to rotate 180 degrees along the horizontal plane. This movement made it possible for the pole to be stored over the cabinets and then deployed out into the HDU to make a privacy barrier along the corridor sides of the MOWS. To cover the area next to the lift, a separate curtain was hung with clamps along the lift rail. This design was implemented to allow the maximum amount of private area during a surgical or medical procedure while not encroaching upon the space of the main corridor and work stations when not in use. This design is also very versatile in configuration, so the deployment can adapt to the needs at the time.



Figure 4. Deployed Curtain, Right Side

The curtains used were three 72 by 72 inch curtains made of vinyl-laminated fiberglass. The material was chosen due to the fire-resistant qualities. One curtain was attached to each pole with standard shower curtain rings. The curtains were folded up with the poles above the MOWS cabinet. The third curtain was stored above the cabinet and was clipped manually onto the far end of the MOWS against the HDU lift.

Organization of the medical supplies required a system that was user friendly to both medical and non-medical personnel. Some important aspects of the configuration to consider were the accessibility of items in lower versus higher drawers, location of commonly used items, and logical placement of items in relation to each other. Development of a label system for quick procurement and proper stowage after use was critical to keeping an organized work space.

In order to keep consistent labeling of medical supplies across agency projects, the label system that was implemented followed the model used for the International Space Station (ISS) Medical Kits. Examples from the ISS Medical Kits included blue labels for all medical diagnostic supplies, pink labels for the minor treatment pack, red for the emergency treatment pack, and gray for the IV supply pack. [2]



Figure 5. ISS Medical Diagnostic Kit

The addition of a trashcan for biological waste was required for the MOWS. The container added was a biological waste wall container measuring 12 inches high by 11.5 inches wide by 7 inches deep. This container was large enough to handle all of the biological waste items used in the HDU MOWS. Velcro was added to the back of the container at the top so the biological waste container could be hung in a variety of locations about the MOWS. Locations for hanging the container included the bottom of the cabinets, the bottom of the worktable, and the sides of the surgical table.



Figure 7. Biological Trashcan Mounted on Surgical Table

Advantages of this design were ease of accessibility to the trashcan while working in a number of different configurations, simplicity in changing biological waste trash bags from the biological waste wall container, and the ideal size of the container, which was sufficient for storage while not causing undue loss of valuable space in the MOWS area.

A camera was installed for the MOWS to be used during surgical procedures. In order to mount the camera in a proper vantage point while not permanently blocking the use of the privacy curtains and the material handling system, a pivoting arm was designed.

The arm consists of two sections, one 28 inch piece of 1.5 inch aluminum extrusion, and a second 22 inch length of 1.5 inch aluminum extrusion. The two pieces were connected with a pivoting nub that allowed 180 degree rotation of one of the beams. The longer arm was attached to a short mounting piece by the back of the HDU wall, 4 inches above the cabinets. The camera was mounted to the extreme end of the arm on a flat plate. This design allowed for the camera to be swung out into the main cabin when needed, and stored by the HDU wall when not in operation.



Figure 8. Stowed Camera Arm Mount



Figure 9. Deployed Camera Arm Mount

III. Conclusions

The upgrades installed were adequate for the current stage of development of the HDU – however, there is room for improvement in each design. The tray table design could be improved by including an arm system that could be tightened into position instead of being fully free moving. This would prevent the table from being accidentally bumped in an undesired direction and possibly knocking over any items on the tray table. This design improvement would also make it safer when removing the surgical table from the HDU during integration. Additionally, a lighter arm system for the tray would be preferred.

The curtain system design could be improved by having fewer individual components to set up. An initial design for the curtain system involved a permanent curtain pole to be installed by the lift. This would allow the two telescoping pole ends of the curtain system to connect to either end of the permanent curtain pole. Two curtains would be used, which would extend onto the permanent pole and meet at the middle to enclose the whole MOWS area. However, due to head space concerns this design was changed to the clip-on curtain design.

A major problem with the cabinets in the MOWS was the difficulty in viewing the items in the top two levels of drawers. The placement cards were one solution to help individuals locate items in drawers not easily viewed without the need to take the shelves out. Another improvement would be to include a mirror for viewing items in the selves. Additionally, the cabinet space is confined, limiting the kind of items stocked in that location due to shape and size. This made it difficult to organize all items into the new categories, so additional work to organize the side cabinets is still needed.

The completed upgrades improved the functionality of the MOWS and increased the scope of activities and simulation testing variations in the MOWS. They will be used and evaluated by test crews during the Desert RATS field campaign in August 2011.

References

- [1] Tri, T. O., Kennedy, K. J., Toups, L., Gill, T. R., & Howe, S. A. (2010). *The Habitat Demonstration Unit (HDU) Pressurized Excursion Module (PEM) In-Field Demonstration at Desert RATS 2010*. Houston: American Institute of Aeronautics and Astronautics.
- [2] U.S. Systems Operation Data File (SODF), *ISS Medical Checklist*, retrieved June 30th 2011, from <https://modpops.jsc.nasa.gov/mod/DO/do3/SODF/SODF%20Publications/SODFGenericProcedures.aspx>