Glenn Johnson is working with the HUNCH Team to make improvements on this project and will be mostly done by August 1st 2026. Changes will be made during the school year as students ask questions and need clarifications.

Multi-Purpose Lunar Locker

Bill Gibson with Glenn Johnson

Design, build and test a scaled box that can be used for packing materials to the moon and then once on the moon and unpacked, the crew can take it apart quickly and reassemble it into different configurations so that it could be a different structure—a wall, an arch, a road, a table, a bench,...

Problem:

The Artemis program will be sending lots of equipment, supplies and experiments to the moon that will eventually become a Lunar base. This will require lots of boxes and packing materials to keep the supplies safe during launch from Earth and landing on the moon. There is no expectation that any of the packing supplies would come back to Earth (cost prohibitive). It would be helpful if the boxes and packing materials could be used for something on the Lunar surface once the supplies have been unpacked. Some of the boxes and bags will be used to contain packing material and trash. They could also be filled with lunar regolith (dirt) and packed around the lunar habitat to protect it and the astronauts from radiation and meteorites. I am sure some will be used this way but it is time consuming to have astronauts shoveling dirt. It may be more helpful to the Artemis program if some of the packing materials could help with developing some of the infrastructure of the Lunar base instead of being left over packing trash.

Lunar Supply Locker Requirements

Objective:

Design, build and test a 1/3 scaled box that can be used for packing materials to the moon and then once on the moon and unpacked, the crew can take it apart quickly and reassemble it into different configurations so that it could be a different structure or equipment—a wall, an arch, a road, a table, a bench, a shovel,…(your better idea here).

Requirements:

- Make a rigid packing box with similar scaled dimensions to a 1/3 scaled ISS Locker that can be taken apart quickly and those parts can be repurposed into something useful for the Lunar Base. Needs a handle.
- 1/3 scale or smaller so you can demonstrate how you can make other structures with it.
- Show photos of at least 3 different things your team can build with your box design
- HUNCH is looking for rigid boxes that will probably be made of aluminum, stainless steel or maybe titanium because of the potential uses we might have on the moon. Your version may be 3D printed or laser cut plastic or similar materials for your demonstration. We are not looking for cardboard boxes although your first prototypes might be made of cardboard (easy to manipulate and work with).

Helpful thoughts:

- How difficult is your box to manufacture? (not everything will be 3D printed)
- How rigid is your box for launch from Earth and landing on the moon?
- What is the time required to take apart your box?
- Can it be done without tools or with few tools (not required but helpful)?
- What kind of handle should it have and where do you put the handle for the easiest method of carrying it? Should it be detachable or built in?
- How difficult is it to put it together into another structure/tool/equipment?
- How will you hold the pieces together when being repurposed?
    - Same Pins, Clips, something else, Combination of?
    - How many pins/clips/bolts are needed?
- How many boxes are required to build your coolest structure?
- What other materials do you need to make your other object with your box materials?
- What is the most valuable structure (even if it isn't the coolest)?
- Do the locker parts need to be rigidly held together or do they get rigid by adding dirt or other packing materials.

Some collapsible crates can be very rickety while others are more rigid. How do they do it?

The ISS Locker

This is an ISS Locker that is similar to the size HUNCH would like you to emulate for the size and dimensions for this project. These lockers were originally designed the 1980s to fly in the Space Shuttle with experiments and equipment. They are machined from thick pieces of aluminum to have ribs and angles. They are exceptionally light weight and very rigid during launches due to the ribbing. Many rivets are used to attach the six sides together and minimize vibrations. Later, the lockers were repurposed to be used on the International Space Station for transporting and running experiments that could be transferred directly from the Shuttle to the EXPRES Racks of the ISS so they could remain powered for the whole flight from the ground until arrival to the Station. Although they were designed and built during the 1980s, currently NASA HUNCH is the sole provider of these lockers. High school students in machine shop classes make various parts and send them to HUNCH where they are inspected, go to metal finishing and then are assembled by our HUNCH specialists. These completed lockers fly to the International Space Station with experiments from many different companies and countries.

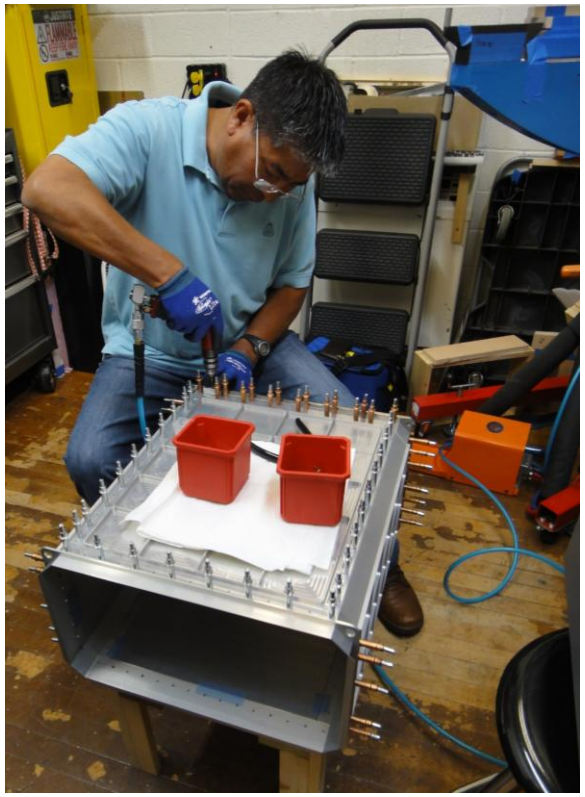
Commander Peggy Whitson unloading an experiment with HUNCH student names.

Because of their size and dimensions, there is a good chance that some of these may go to the moon at some point. Once they get to the moon and are no longer needed for the experiment or the supplies that they contained, they could get another life. By filling each of these up with lunar regolith and stacking them outside the habitats, the lockers could help protect astronauts from radiation and micro meteorites. This is a great use for what might otherwise become unwanted packing material. HUNCH students' work helping protect astronauts on the moon.

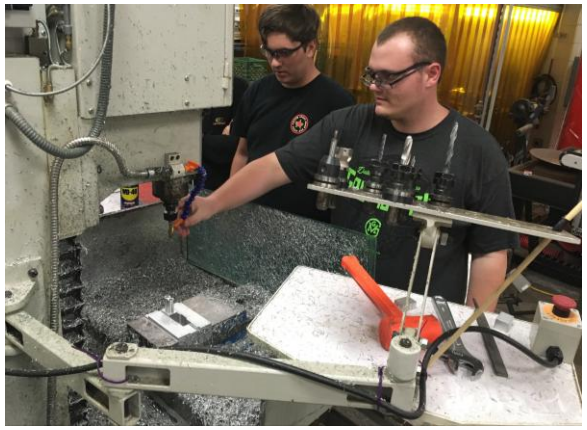
The ISS Lockers are assembled with more than 200 rivets. They do not come apart easily.
What if we could do more?
Wouldn't it be great if the locker could be taken apart easily and use the parts for making other structures?
Are there ways that clips or pins could hold it together for the flight to the moon and then the clips or pins could be removed quickly and the 6 sides could used independently to make other materials for the lunar base?

Roy Bellard works with students at Cypress Woods High School to run the milling machines that cut the parts. They use MasterCAM software with multi axis HAAS machines to make parts that are accurate to .005 inches and better.

Students measure parts to ensure quality then the parts are sent to the HUNCH facility where they are checked again.



Carlos Valencia assembling an ISS Locker. Assembly takes about 2 weeks once all the parts are ready. Clekos are clamps that go through the rivet holes and are used to temporarily hold the pieces together while holes are match drilled and then rivets are installed.

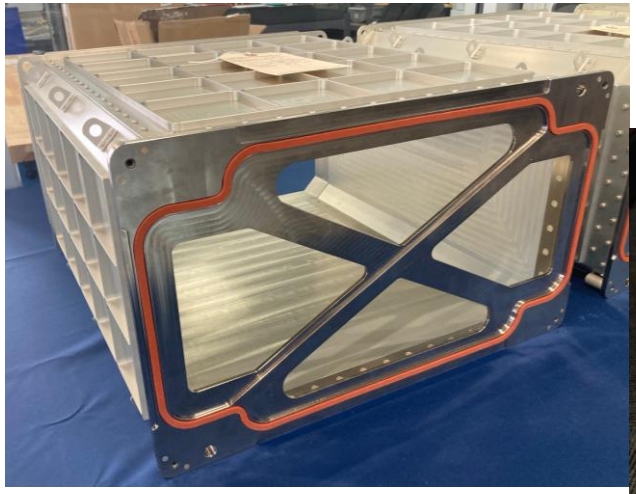


ISS Locker Data and Information

533mm long x 272mm tall x 462mm wide (full size)

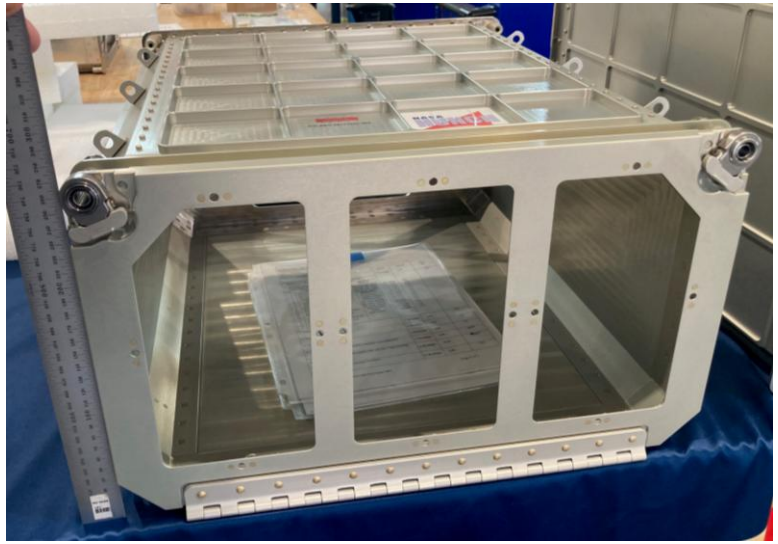
- There are 3 removable covers for the front door that can be removed or altered to allow for control panels or power cables to be connected for the experiment.
- The top and bottom pieces are flat except for the ribbing. The side pieces are machined to have 45° angles as well as the side ribbing. All 200+ of the rivets are counter sunk to provide a very smooth interior.
- **Your Lunar Locker does not have to have the exact same <u>scaled</u> dimensions but it should be close.**
- **If you zoom in to this page, you should be able to see mm.**

Tops and bottoms are the same

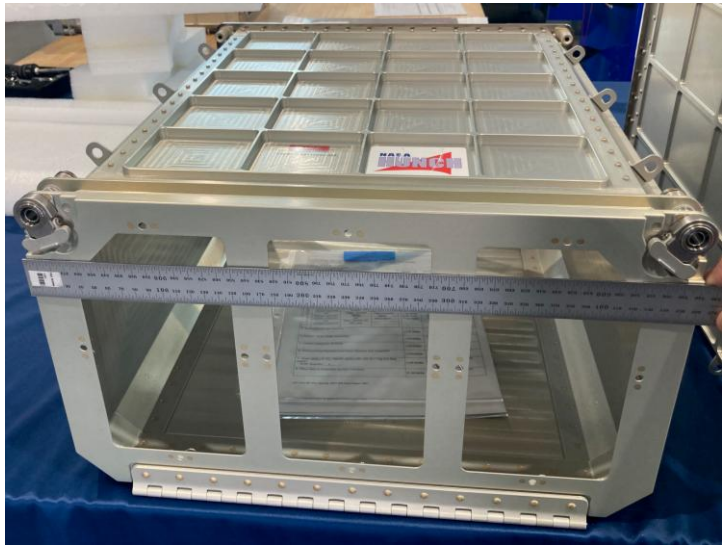


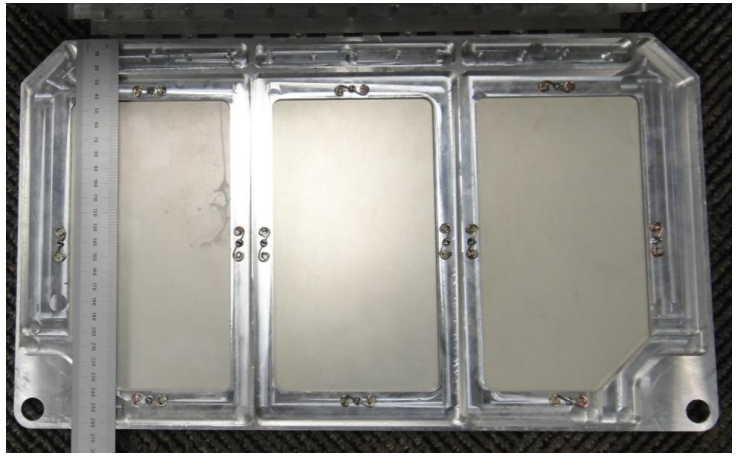
The back side has 4 ventilation holes so cool air can be pumped in to cool the experiment. A cover can be placed on any or all of the holes if desired.

Front panels installed.

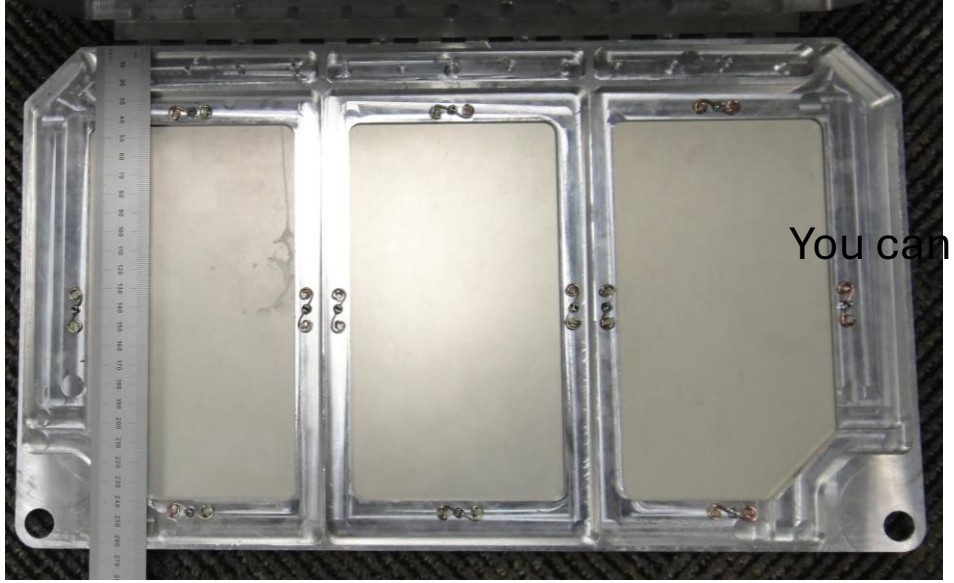


Front of locker with panels removed



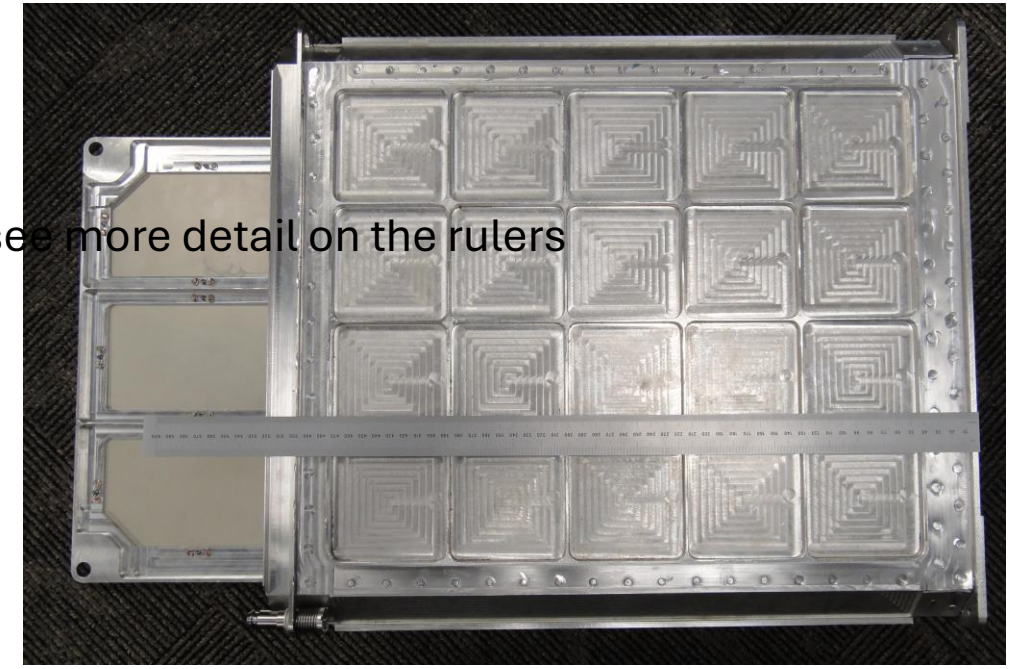


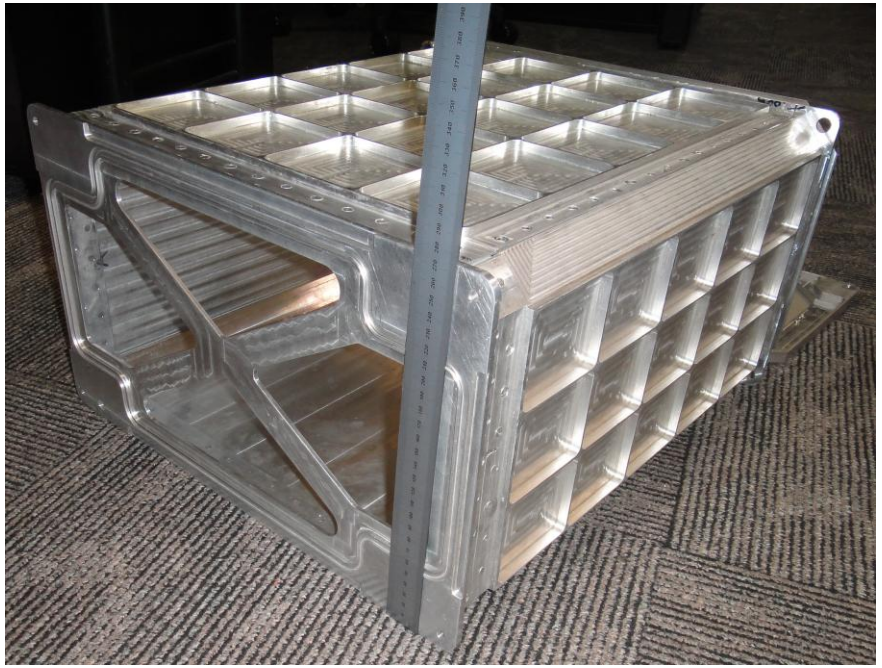
Inside of front door showing the 3 removable panels installed.



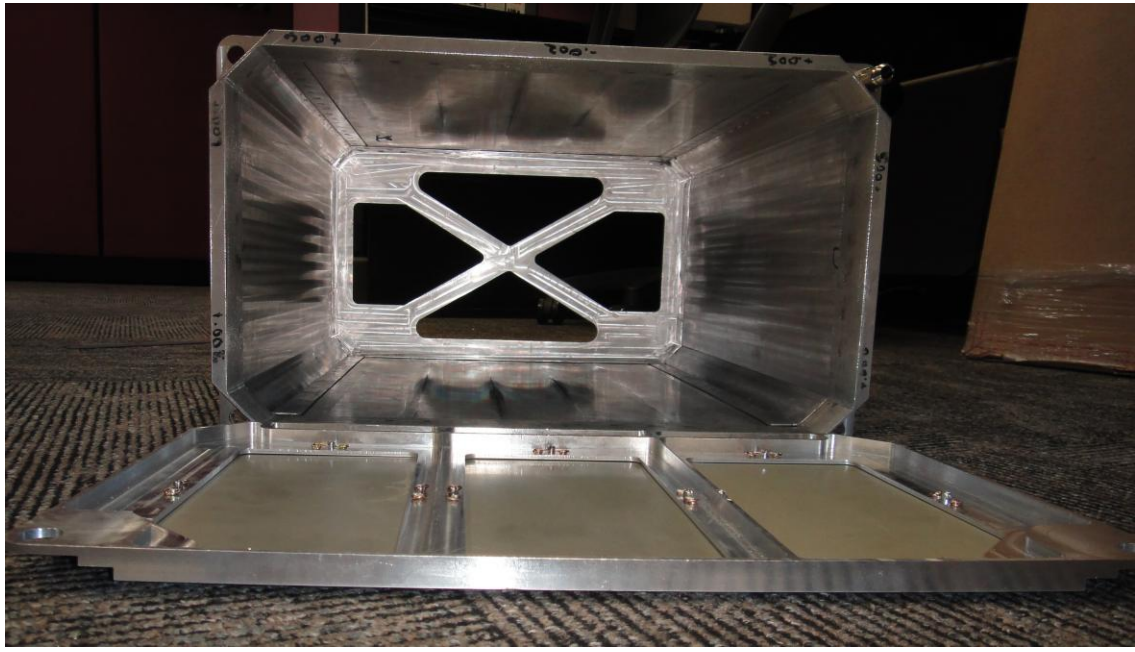
Inside of front door showing the 3 removable panels

You can zoom in to see more detail on the rulers

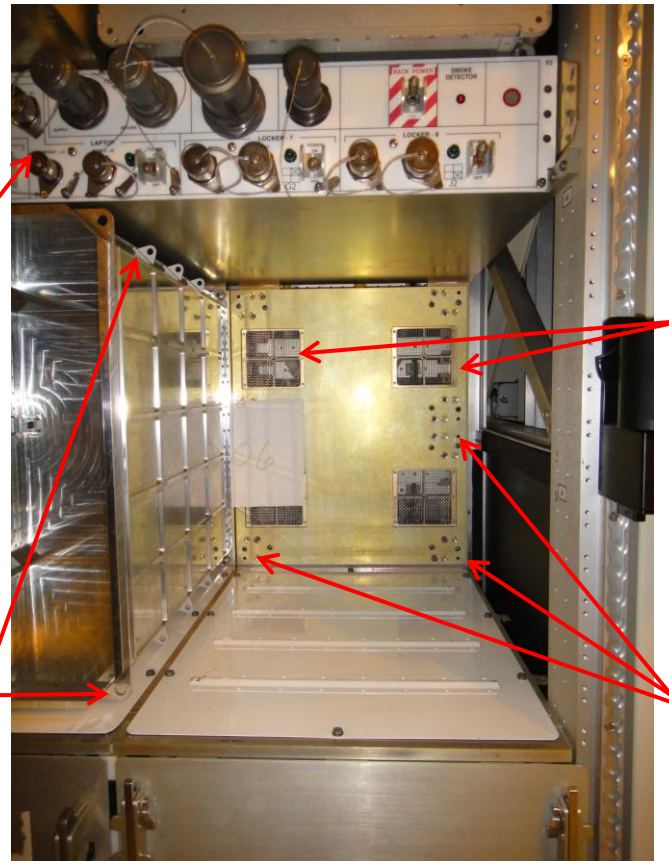




Mounting bolts on the back of the locker.



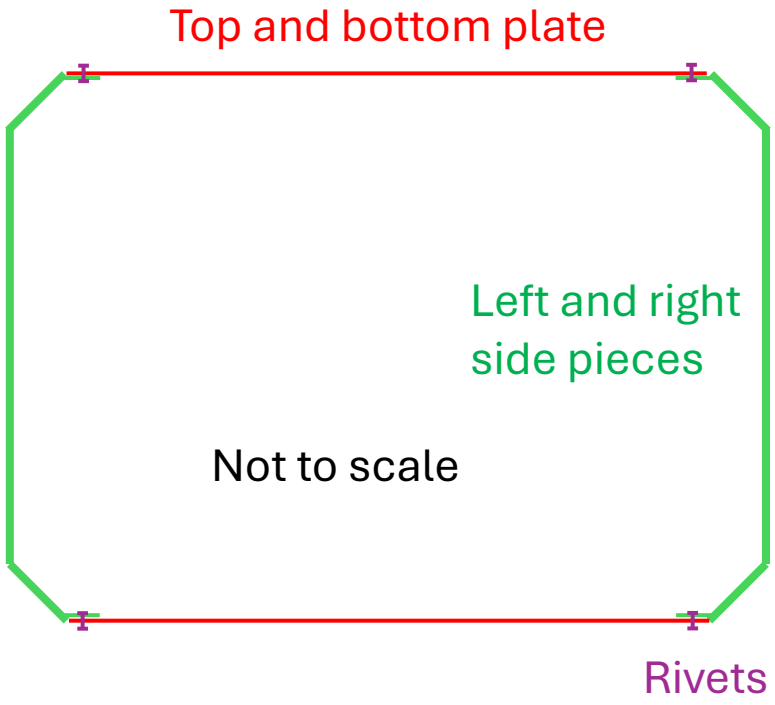
Front door is open, looking in.

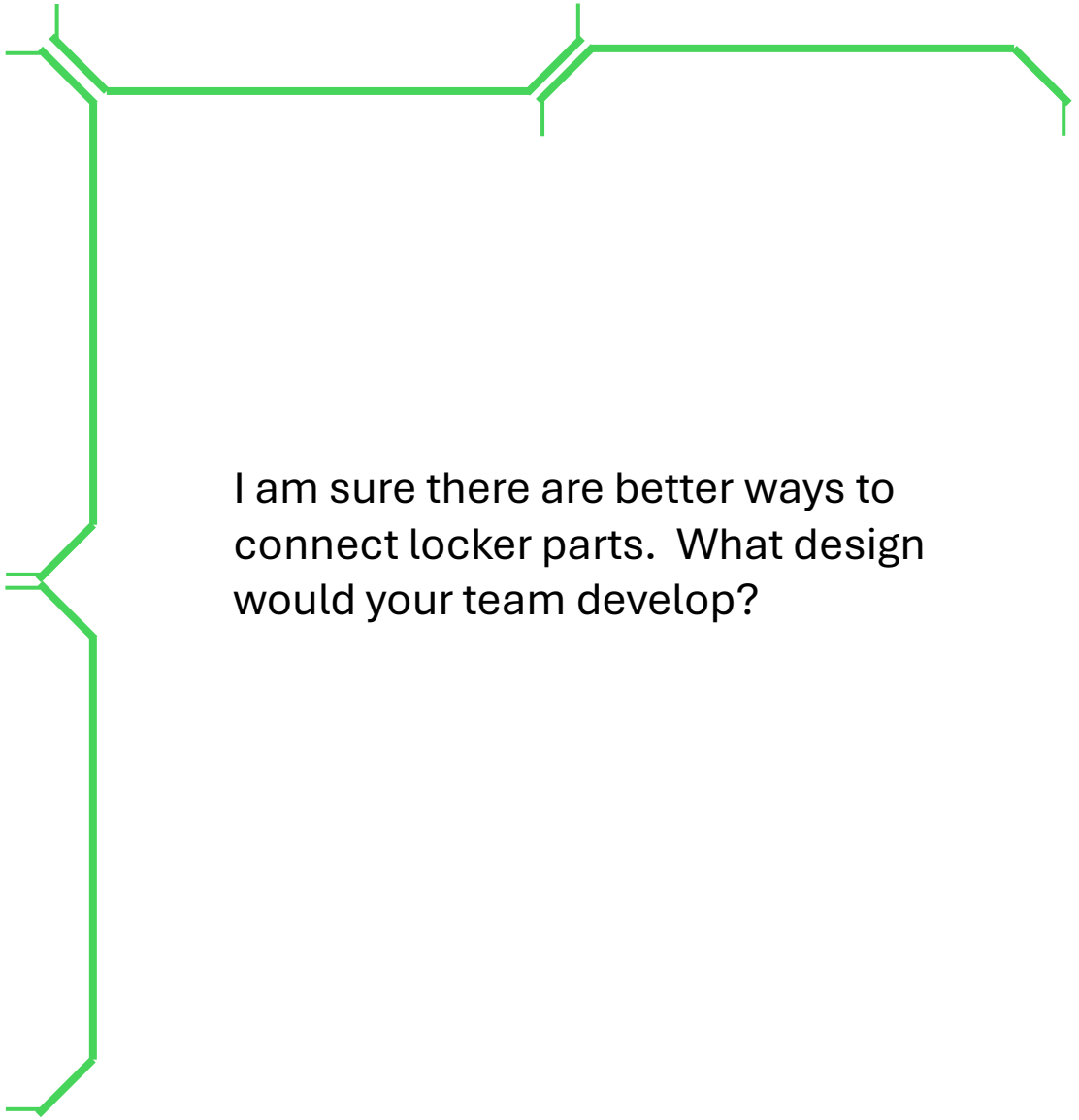


The lockers are rear mounted. This means the lockers are installed with long tools (specialized Allen wrench about 600mm long) sliding through the front latches to attach the lockers with bolts to the mounting frame of the EXPRESS rack.
George Kessler is doing a fit check of a double locker inside a flight like EXPRESS rack using the ISS Locker Tool through the front of the locker to engage the bolts in the back of the locker to the EXPRESS Rack.

Construction of ISS Locker

This is a simplified description of how the ISS Lockers are put together. You do **not** have to put yours together like this. We need lockers that will hold their shape and be rigid during launch vibrations but we also want to take them apart quickly. Ideally it would be great if the astronauts could take your lockers apart while in their space suits with their gloves on but I don't think that is realistic. It is more likely that crew will bring the lockers inside the habitat, remove the important supplies/experiments, take apart the box, then transfer the parts outside where they can be used. Is it possible to assemble them into these new structures while in their suits.

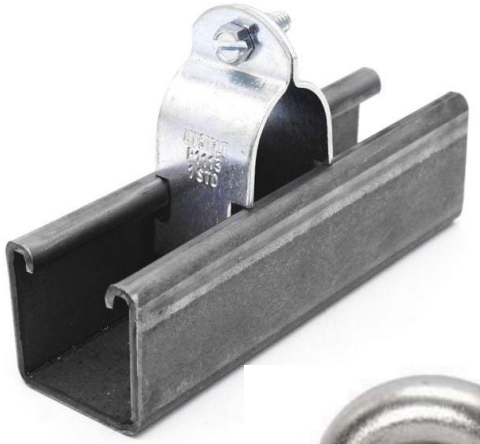




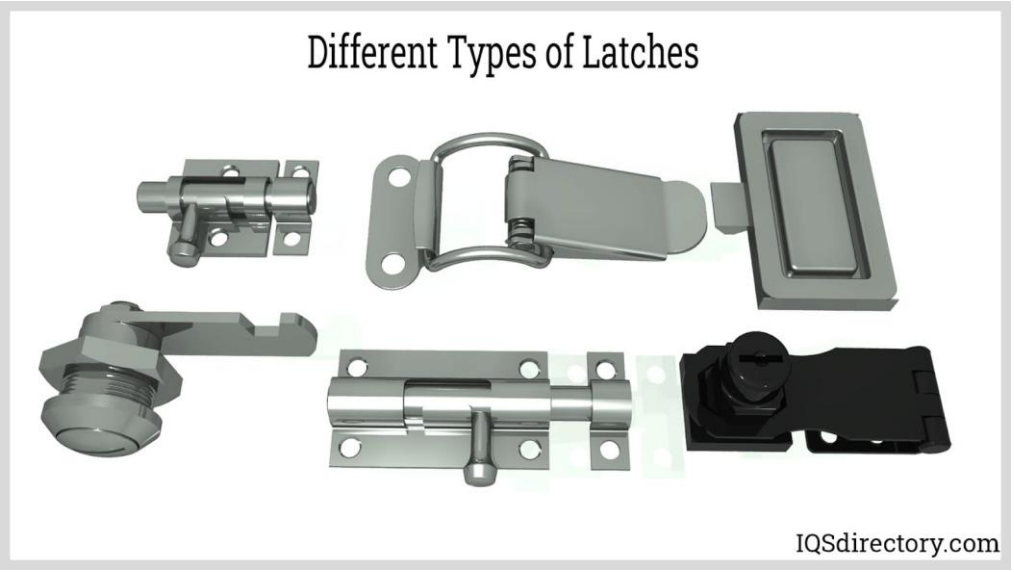
I am sure there are better ways to connect locker parts. What design would your team develop?

Pins and hinges

Clips and Clamps



Latches?



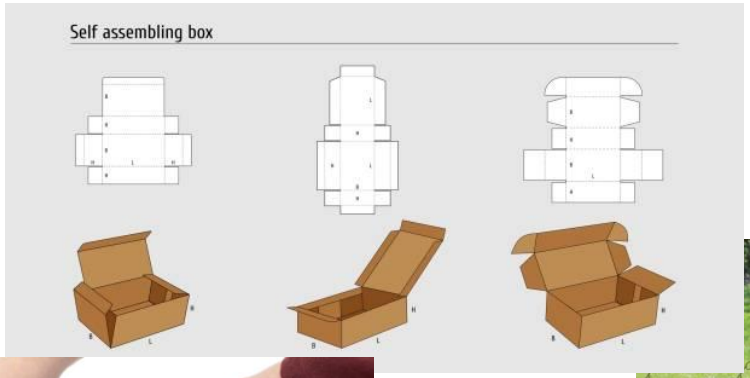
McMaster-Carr is a website that will have a large variety of latches, pins, clips and clamps that might give you good ideas. It also has CAD drawings of all the parts for you to download.

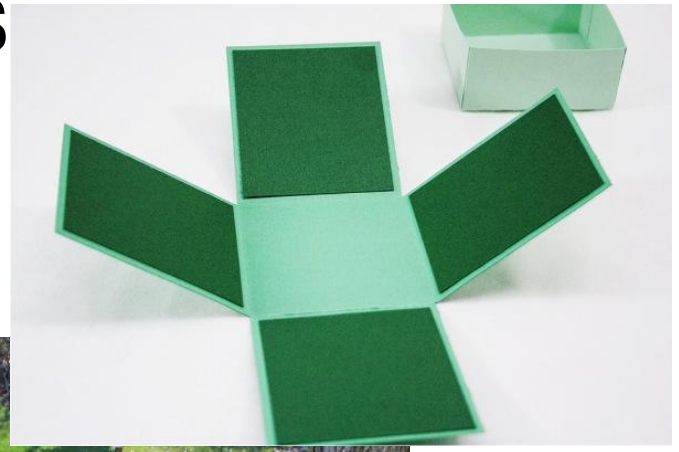
I would suggest that you choose one latch that will work for your project that can be used for both when it is a locker and for when it becomes something else. Similar for a pin or hinges or clips and clamps. However you utilize these simple mechanisms, make choices that work together and won't block the other in either configuration.

If you only use pins to hold your locker together, you may limit the way they can be turned into other structures. If you only use latches or clips, you may have the same problem. Examine your options for how to hold your boxes together and your options for turning them into new structures and carefully choose your attachments.

These lockers may end up being expensive to build but if they have a longer and more expansive use on the moon making other infrastructure, it could be worth the upfront cost.

Reusing shipping crates and boxes





We are not looking for toys but this might remind you of what you and your parents made out of cardboard

a wall, an arch, a road, a table, a bench, a garage, a shovel

The box does not have to be disassembled for all components of whatever you build. There might be value in having it full of dirt for radiation protection or as a weighted box or stacking them together as a post or pillar.

Are there some kind of clips or pins you need to make the box parts hold together tightly?

Reuse parts when possible.

How many forts did you build out of boxes when you were a kid? HUNCH is looking for the creative kid in you that can build the infrastructure of the moon by developing the lunar packing box.

testing

- How much weight would we put into this
- Drop test
  - You box should be able to handle being dropped from 3 ft
- Vibration test—hand held massager?
- How many different shapes can you make out of the pieces you make your box out of

- Handle that is good for EVA gloves