Double Ball Clamp

SEG39138680

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Mentors: Glenn Johnson, Alli Westover, George Kessler, Bob Zeek, Roy Bellard, Mike Caberan
Engineers: Bruce Blazine, Don Pettit

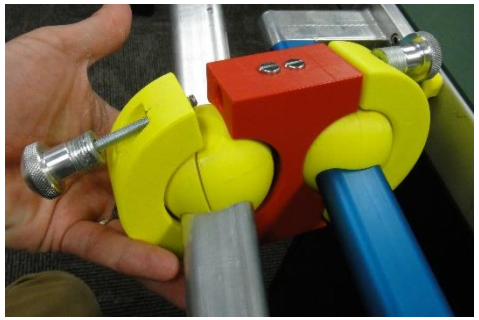
The Double Ball Clamp is an experimental, variable friction based restraint for the Galley Table that allows the crew to rotate and reposition the Table quickly. Because it is friction based and will move when bumped, it minimizes damage to the crew member who might run into the table.

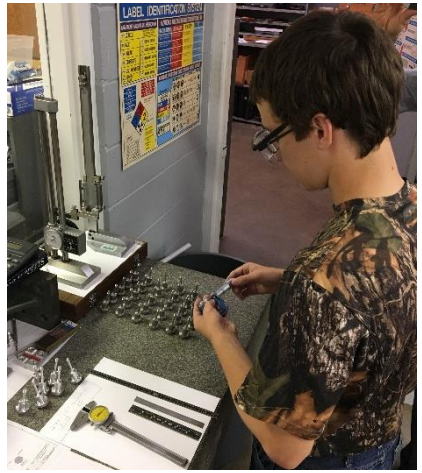
Current set up for the Galley Table

- Most of the time the crew leaves the Galley Table in a position so it can be used. However there are times the Table is moved so the crew can access stowed items or move other station equipment around.
- Currently the Galley Table is held in place rigidly with zipties and IP Clamps. This arrangement requires more time for the crew to move the table out of the way for various options.
- The Galley Table is also held rigidly so that if a crew member bumps into it, the Table doesn’t move and the crew member could be bruised.

Origin story and the long path of engineering and testing.

- The Double Ball Clamp started as an idea from Bruce Blazine looking for a new method of holding the new Galley Table so the astronauts could swing the table into and out of the way quickly and easily. The first demonstration of the idea was cut out of plywood in Bruce's garage. Students took his idea and drew it up in CAD and then HUNCH students and machinists built a demonstration model out of aluminum, brass and plastic.
- NASA engineers and astronauts were impressed with the design and abilities of the prototype but saw that it was limited since it could only rotate in a single plane. Then someone suggested that the friction rings be turned into balls to allow side loads to rotate the clamps. Students redesigned the clamps to handle the new shapes.
  - There were many iterations to make the balls grip the handrail properly and also to go into and out of the clamps easily.
  - The thumb screws went through many changes to make them comfortable to turn, easy to use without using up too much space on the clamps and to make them easier to machine.
  - The clamps went through many iterations to make the hinge strong and simple to minimize the number of parts.
  - Material selection was also a problem that had to be worked through NASA engineering. The Double Ball Clamps could be machined out of aluminum but would take a significant amount of machining time. HUNCH wanted to try to certify the clamps as a 3D printed product. Although ULTEM plastic meets the requirements for flammability and has been approved for flight, it has not been used previously as structural material. We felt it was strong enough but we had to have some proof.
  - NASA does not typically fly friction based hardware because it is difficult to predict how the astronauts will use it. There is safety requirements that prevent any piece of hardware from damaging the Station or other equipment. Testing had to be done to demonstrate that it would behave with the table as predicted.





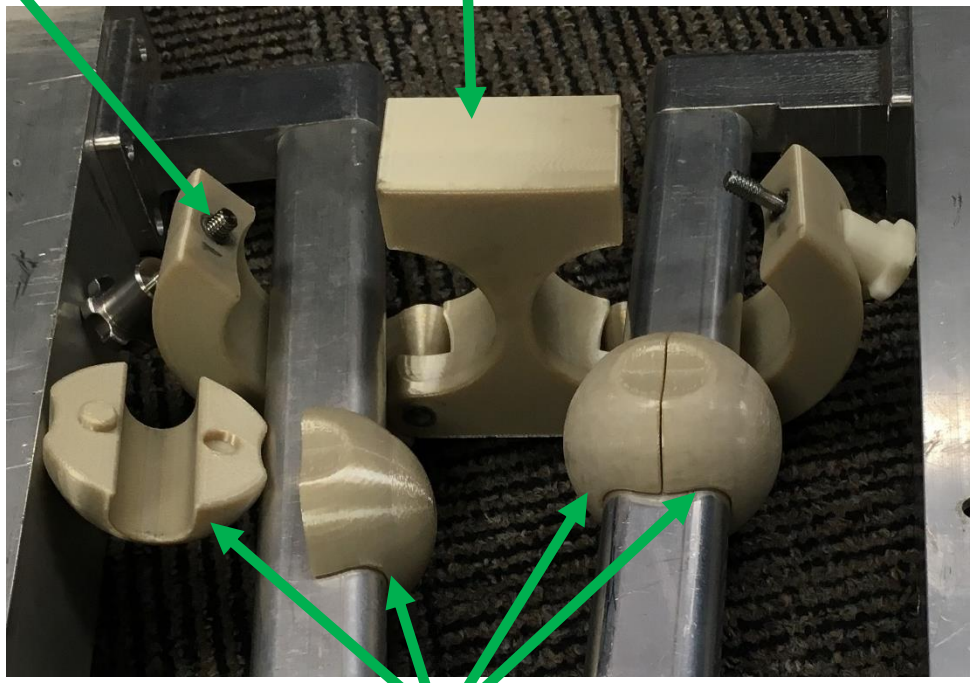
Good engineering includes good ideas from many sources and many people working together!! HUNCH is all about having students providing input and ideas and being involved in as much of the engineering process as possible.

Functionality

- Each double ball Clamp is composed of 5 pieces:
  a double clamp base and 4 identical hemispheres
- These hemispheres attach around a handrail and are the bearing surface for the clamps to rotate around. (hemispheres stay together by friction fit on or off the handrail)
- One clamp can rotate 180 degrees around an attached handrail and ball.
- The tightness of the thumbscrew determines the amount of friction applied to the ball. Tighter= more friction
- The thumb screw is intended to be tightened by hand but if too tight by one person, another person can use a 1/4" wrench to loosen. (it could also be tightened by wrench if needed)
- The stainless steel Thumb screw is captive to the clamps by way of threaded inserts in the arms of the clamps
- Double Ball Clamps are made of certified ULTEM plastic from a 3D printer with stainless steel shoulder bolts (act as hinge for clamp arm), inserts and thumbscrew.

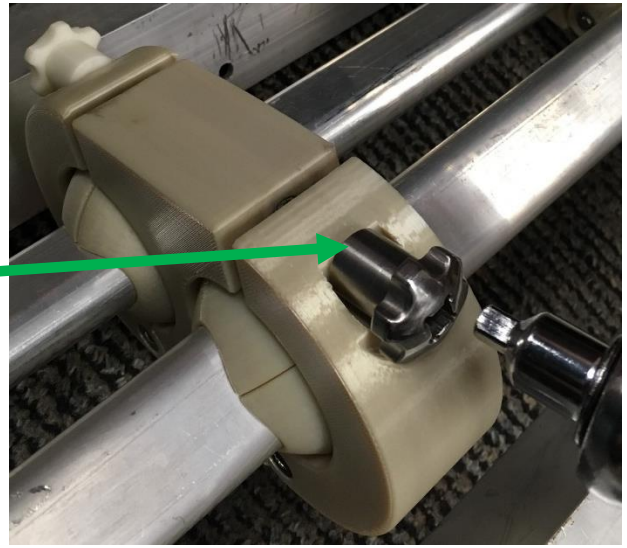
Thread insert for captive thumbscrew

Double Clamp Base

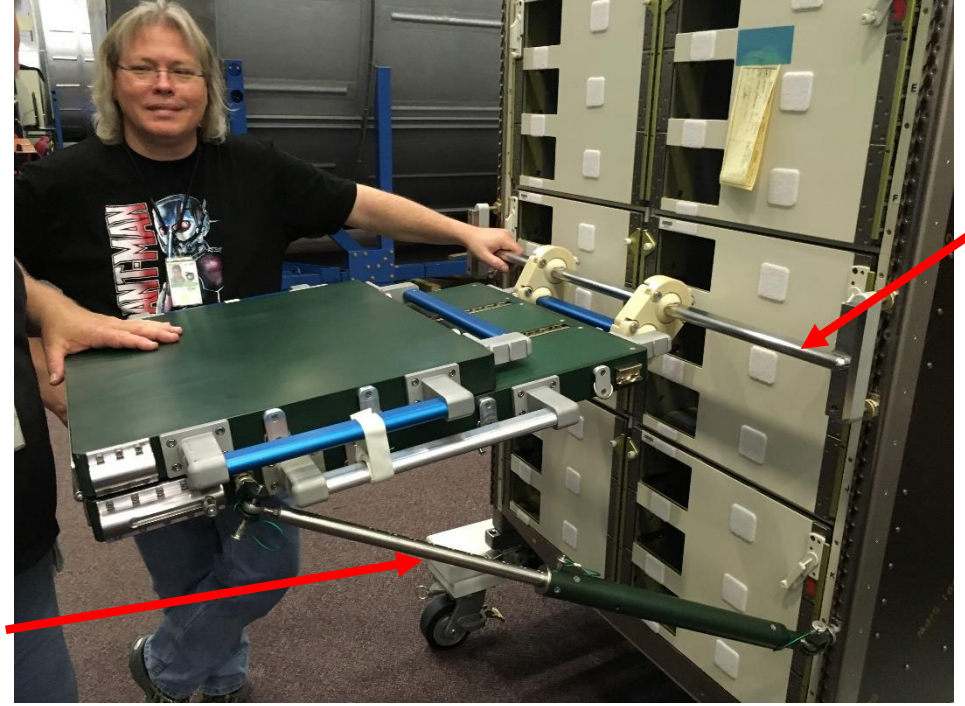


Ball hemispheres

Stainless Steel Thumbscrew with ¼" socket



Double Ball Clamps on the Table

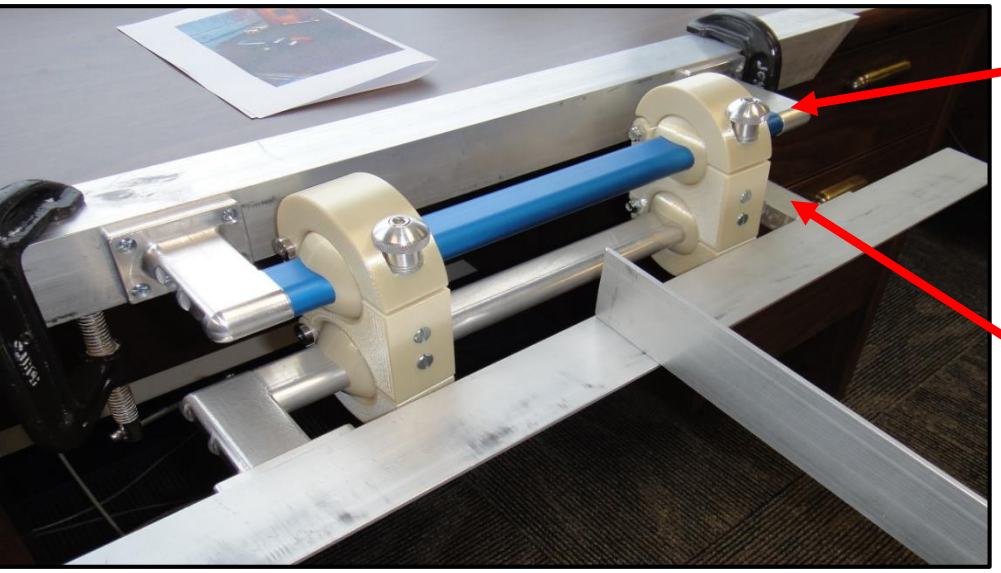


Galley Table in use but folded

Galley Table in stowed position

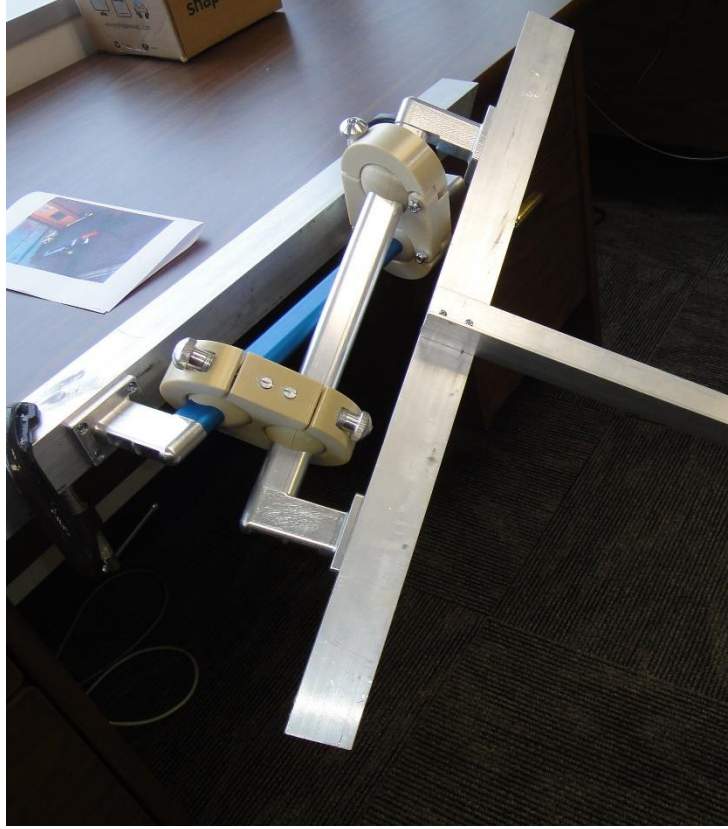
The Double Ball Clamps allow the Galley Table to be pivoted into position for use or into a stowed position. The Galley Table will be attached to the solid stainless steel Galley Table Bracket that has the same cross section as an ISS handrail. One ball is attached to the Bracket and one ball is attached to the Galley Table handrail. When one Clamp attaches to both of the balls and tightened, the Galley Table is restrained in a zero-g environment. Adding the second Double Ball Clamp will further restrain the table by diminishing the swiveling and increases the friction that will control the table's motion.

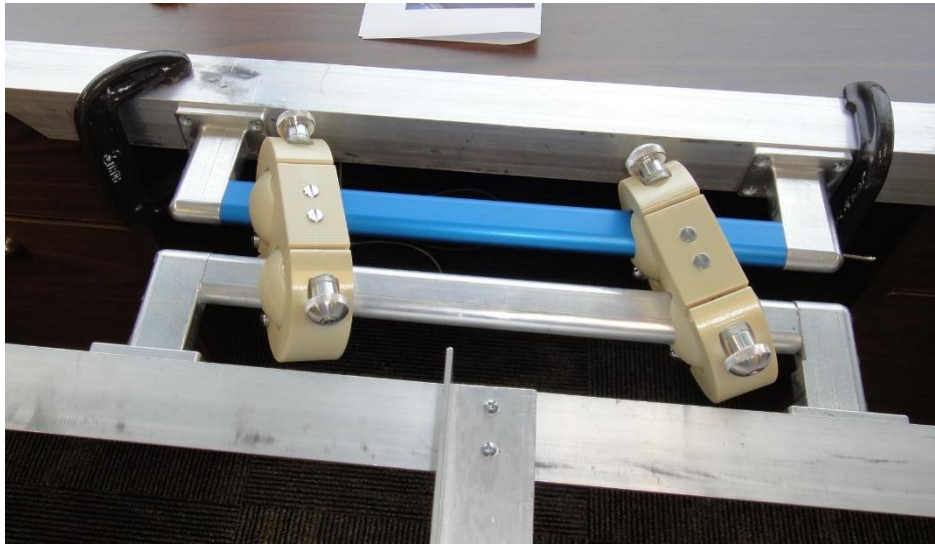
Various positions the double Ball Clamps might attain while being placed in.



Handrail simulating attachment to an ISS rack

Handrail simulating attachment to the Galley Table





The adjustable friction will allow the crew to set the Table's movement to their needs.

Delivery

- The intention is to fly 3 Double Ball Clamps to the ISS in November of 2017. Two will be for use on the Galley Table and the other will be a back up.
- Grissom H.S. in Alabama will print out the flight ULTEM components. The parts will be assembled at Clear Creek H.S. and delivered for flight.
- Once on board the ISS, the crew will install them on the Galley Table and evaluate them for functionality and durability then report back to HUNCH on how they like them.