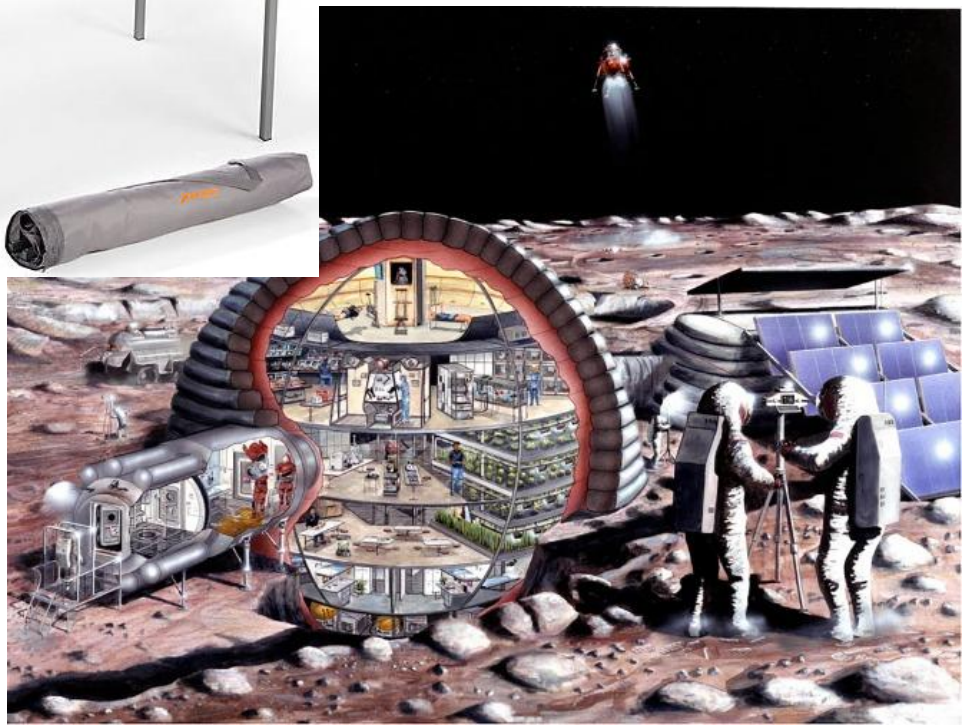
Lunar Habitat Table

Problem:

- Lunar habitats are expected to be inflatable modules. Think of a large ball of several layers of cloth and a plastic pressure bladder being placed on the moon with air tanks inside. Once placed and arranged in the desired location, the air tank valves are opened and the habitat grows and expands similar to how a bouncy house does when the fans are turned on. The habitats are made of several layers (as many as 12 or more) of cloth, foam and pressure bladder to hold the air as well as protect the astronauts from heat, cold, micrometeorites and radiation (to some extent). Other than the air tanks that will be removed at some point and some cloth dividers and shelving, the interior of the habitats will be mostly empty. There will be some electrical wires, outlets and some lights but there won't be large rigid objects like what might be in your house. Many of the types of appliances and furniture that you use on a daily basis won't be shipped up inside the uninflated module partly because the module by itself is a lot of weight to get to the moon. Also any rigid objects inside the habitat could poke a hole or damage the cloth during transportation to the moon.
- Once the habitat is inflated astronauts will need to outfit the inside with equipment that will generate oxygen, remove carbon dioxide, recycle the water, install a galley system for preparing food and install a toilet as well as many other necessary amenities. They will also need to have furniture so they can sleep, sit down, eat at a table, repair equipment, type on their computers, store equipment and supplies, exercise and many other things. (This could be either one very large enclosure or maybe multiple enclosures that are connected together once they arrive but before inflation.)
- Since the moon has approximately 1/6th the gravity of the Earth, the furniture doesn't have to be as sturdy as it is on Earth. However, because of the moon's lesser gravity, it will be easy to nudge furniture and other equipment and knock it over or push it across the room by accident.
- Cargo bags may be turned into bean bag like chairs by filling them up with leftover packing foam but their primary job would be a shipping containers not being made into furniture.

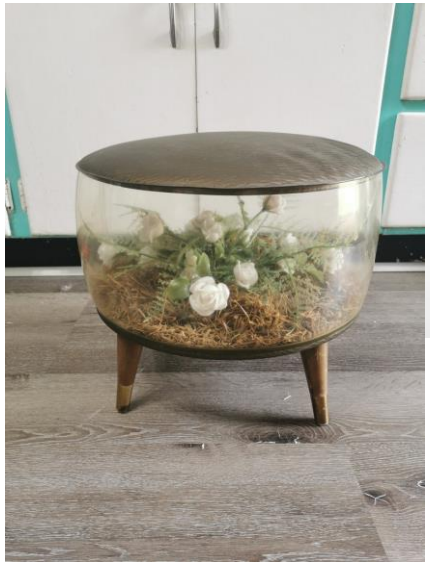


Objective:

- Design and build a prototype of a Table that is
  - light weight—(it costs around $1.2 million per pound to send something to the moon)
    - At the moment there is not a maximum weight but the lighter you can make it the better.
  - For display and transportation reasons, your prototype should not have a tabletop larger than 24inches
  - height should be adjustable to a dinner table of 30” tall or a worktable height of 40” tall
  - packs in a small space (the smaller the better)
  - can be assembled/set-up within 3-5 min.
  - Assembles with no tools or uses a minimum number of tools
  - sturdy for the moon—can hold 100 Earth pounds
  - Easy to clean
  - Low flammability
  - durable for lasting a long time
  - Can be attached to the floor---prevent movement from nudging and bumping in low gravity

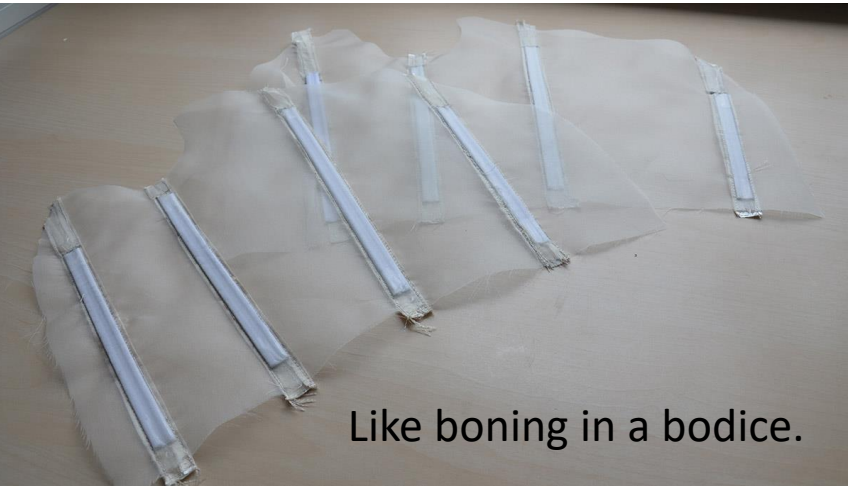
Suggestions:

- Inflatable—there are a few types of inflatable tables but they should have a durable cover to make them resistant to getting punctured
- Camping equipment
- Fishing rods—light weight and flexible
- Expect it will have some cloth components—good sewing



Flexible Rods

- Fiberglass rods and carbon fiber rods are terrific for their low weight and flexibility. Notice how the tent rods are flexed to give more rigidity in a specific direction
- Cloth components with rods or inflated tubing
- Aluminum plates or rods from some other launched items could act as ribs in a cloth to act as rigidizers to give a more flat surface
- Rigid supports for a loose cloth



Rigid inflatable

Like zodiac boats
Inflatable beds
Rigidity of basket balls and footballs, tires
think how rigid different sport balls are:

Ball Pressure of 5 Sports
Association football (soccer) = 8.7 - 16.1 psi
American Football = 12.5 - 13.5 psi
Rugby = 9.5 - 10 psi
Basketball = 7.5 - 8 psi
Volleyball = 4.26 - 4.61 psi

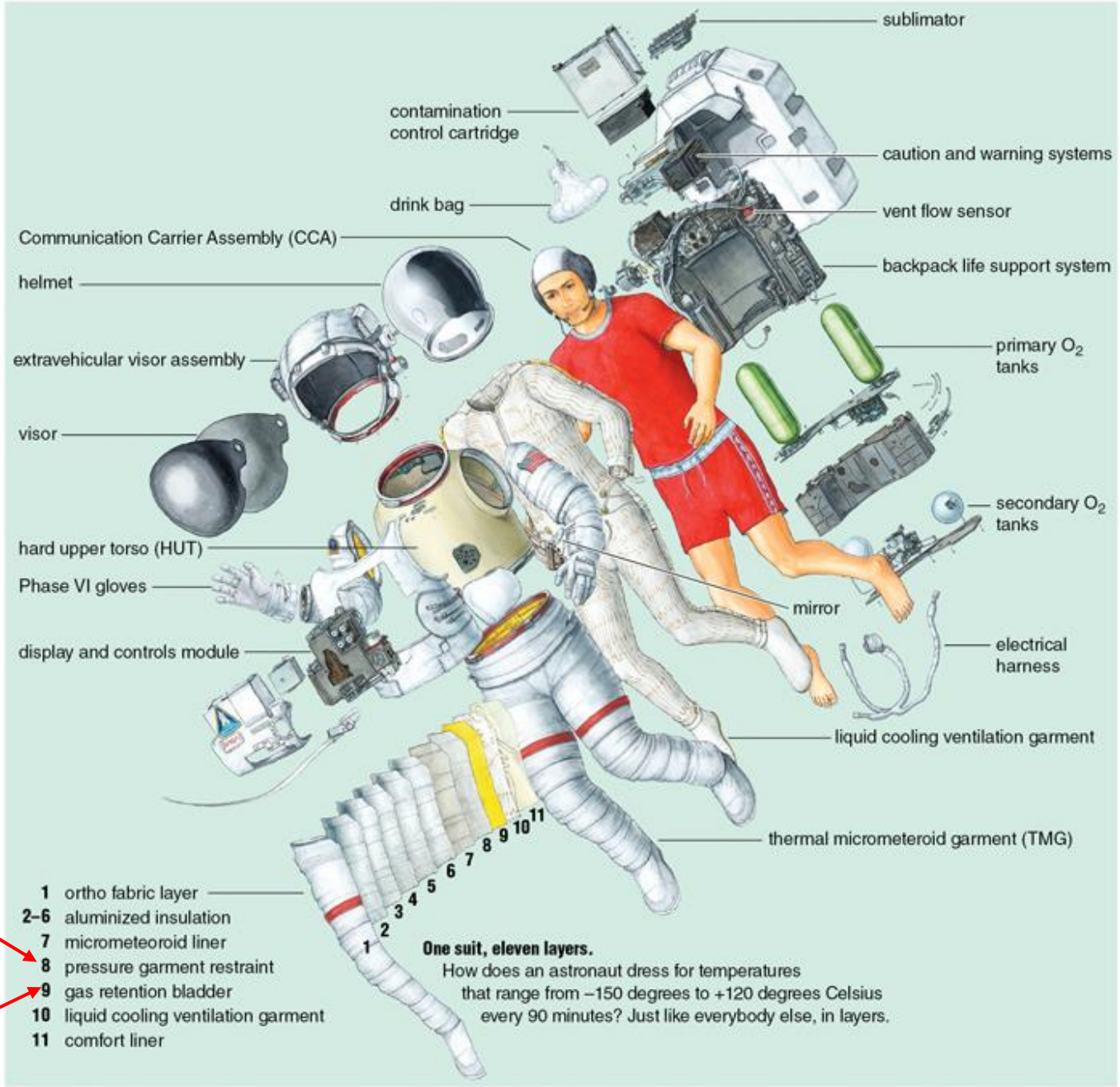
Not very high pressure but rigid structures

Layers

One of the keys to making a rigid inflatable instead of just a balloon is making the outer cover slightly smaller than the bladder that holds the air. This prevents the bladder from continuing to expand and prevents it from popping. The outer covering also prevents the bladder from being scratched or popped from the outside. All of the space suits are built in a similar fashion but with more layers for insulation and protection for the astronaut. Space suits are only inflated to about 4psi so the astronauts don't have to fight against a rigid suit. An inflatable chair or table will probably only need inflation to maybe 5 or 6 psi (a guess).

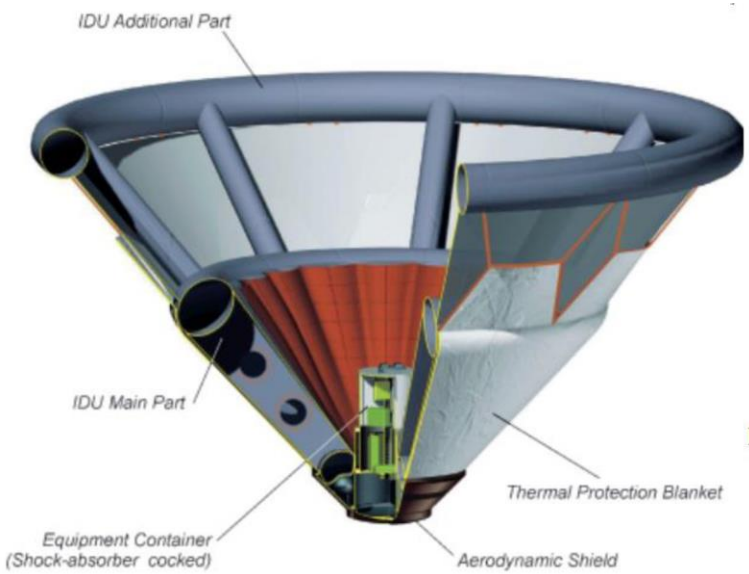
One layer keeps the pressure bladder from expanding too much.

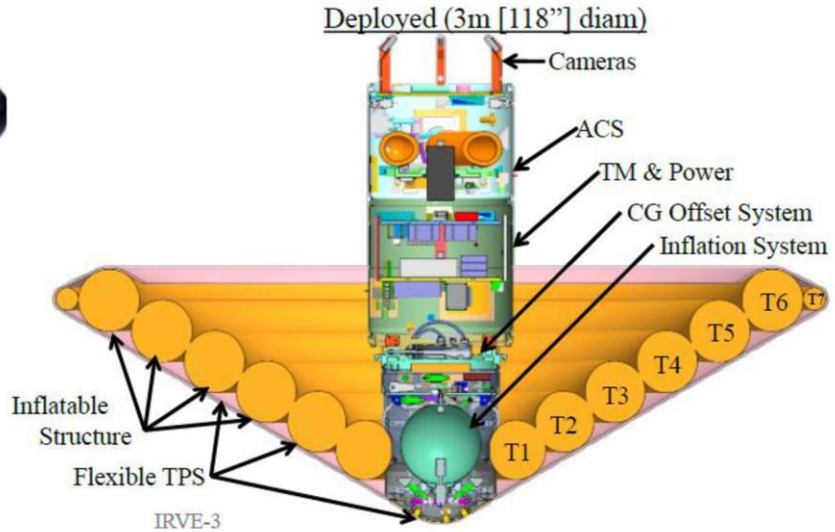
This layer holds the air inside the suit.



Inflatables in space

This Bigelow Expandable Activity Module (BEAM) has remained rigid on the ISS for over 6 years with 1 atmosphere of pressure.
https://www.youtube.com/watch?v=aciRYFKdaRU





New inflatable heat shields for re-entering the atmosphere have to stay rigid as the space craft come into the atmosphere.
https://www.nasa.gov/mission_pages/tdm/loftid/index.html

Inflatable tips

Plastic welded seems using a clothes iron

https://www.youtube.com/watch?v=9F0fjaHhgzo

Plastic inflatables using table clothes

https://www.youtube.com/watch?v=THhGG1s-6sw

Inflatable raft using hot iron and glue for a valve

https://www.youtube.com/watch?v=_iYYXfNHm0c

Make a bladder that holds the air then make a cloth cover that is slightly smaller than the bladder. The cloth cover prevents the air bladder from expanding too much. Space suits and inflatable space craft are made the same way. You will probably only need to hold 5 to 7 psi. A soccer ball is only at 8psi and is very rigid.

Different inflation valves that you could use to close your inflatable.