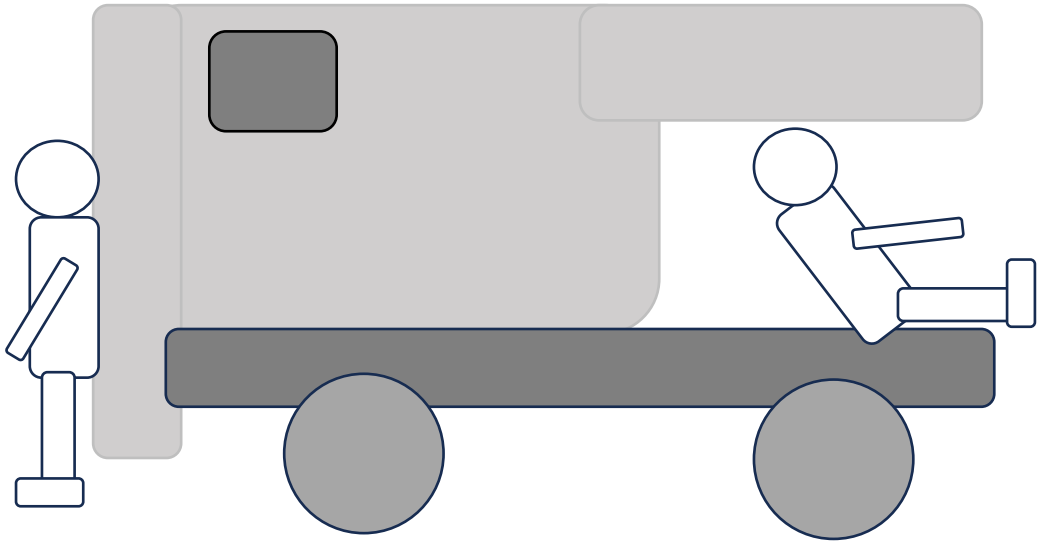
Lunar Camper/Lab

While on the moon, there will be times that the astronauts will need to explore and find samples beyond the reach of the Lunar Base. To do this the astronauts will need a Lunar Terrain Vehicle (LTV) to get further out and some kind of temporary habitat that will allow them to stay at the location for a few days and then come back. This temporary habitat will need to have space suits, sleeping quarters, food and life support. It will need some testing equipment and some storage for samples. It will need power for the habitat but also for charging the LTV. This will only be for use during the Lunar daytime.

Problem:

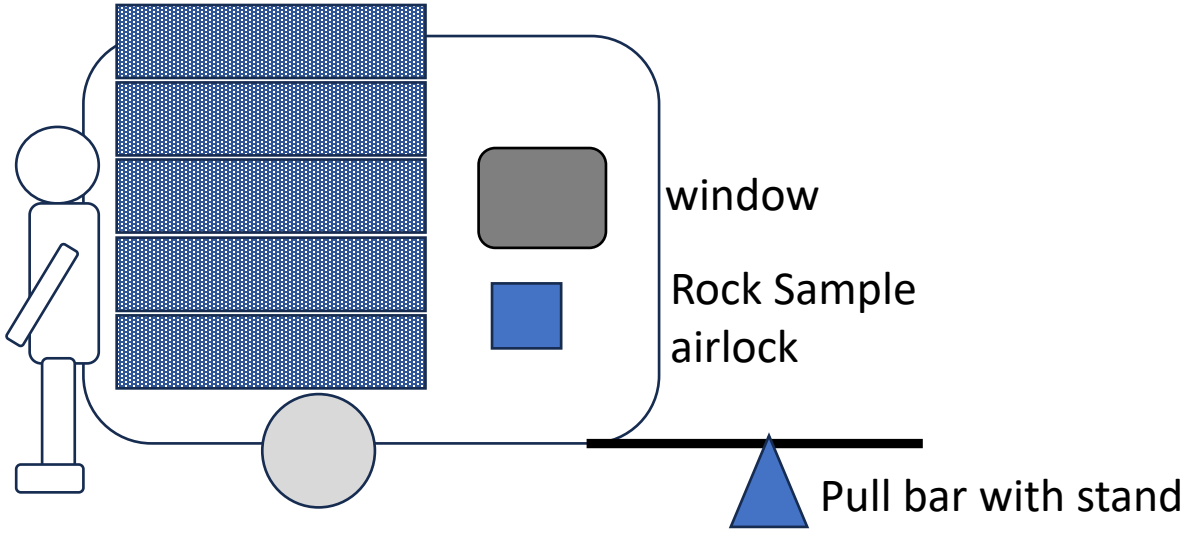
- Design and build a scaled model of a 'camper-like' trailer that
  - Arrives to the moon in a volume no larger than 1.5m wide x 2m long x 1.5m tall
  - Expands to allow for two crew
    - to live
    - perform EVAs and
    - do minimal testing on lunar samples for 7 days independent o the Lunar Base
  - Can be pulled by or fit onto the LTV
  - Can dock to the habitat when not in use
  - Can supply power for itself and charge up the LTV
  - Can have flexible components as well as rigid components
  - Can have tools and equipment that are set up after expansion—minimal if possible.



Collapsed for launch

1.5m wide x 2m long x 1.5m tall

Solar panels



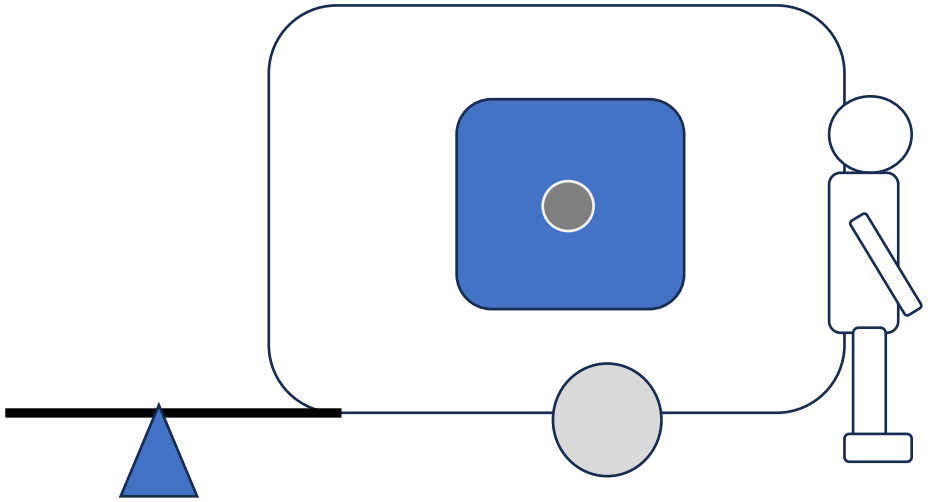
window

Rock Sample

airlock

Pull bar with stand

Hatch for docking to Lunar Base



2 suit ports

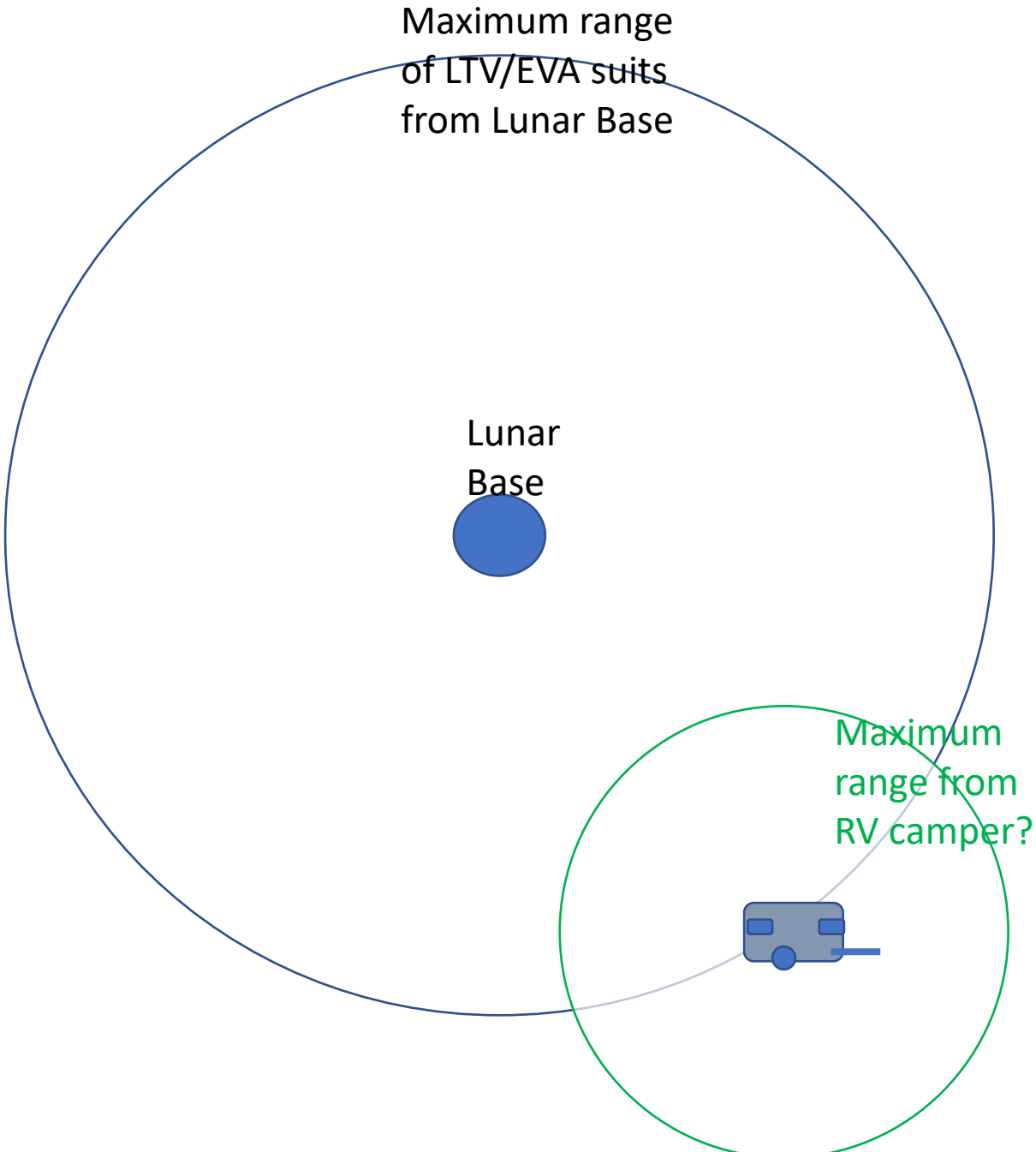
Wheels fold under for shipping

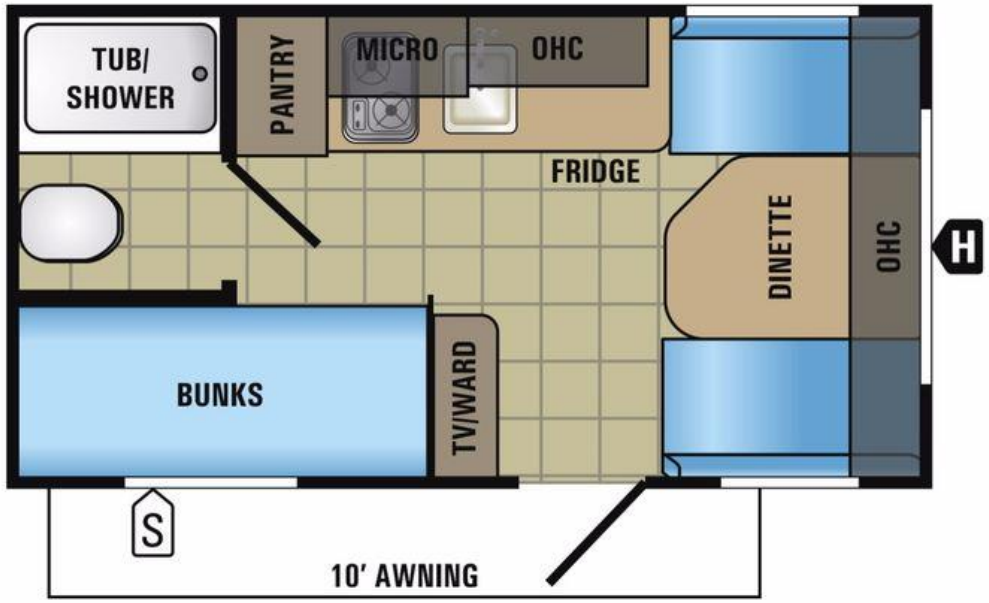
Lunar Terrain Vehicle (still being built)

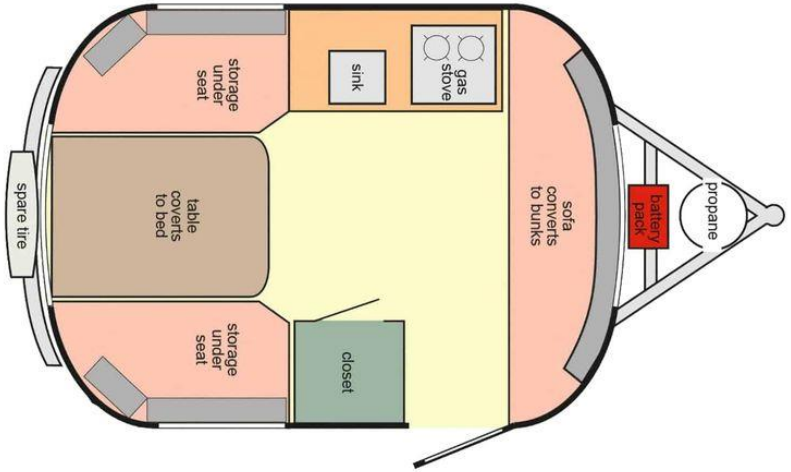
There are 3 LTVs being built by 3 different companies and all 3 look different from each other. They are not very open with their designs so you might have trouble getting detailed information about them. I would suggest choosing one that fits what you want to do and stay with it. Don't try to make your design fit all of them.

You can assume that all three will have a trailer hitch. There are a couple of different type of trailer hitches that have specific uses. Choose the one that makes sense for your need.

- The purpose of the Lunar Camper/Lab is to extend exploration beyond the Lunar Base of operations as a temporary crew quarters between EVAs while exploring for other water or mineral sources. The area of interest may have already been visited by a Remotely Operated Vehicle and indicated it showed promise for having good ice or other resource possibilities.
- To get this to a reasonable size, mass and configuration that NASA could deliver to the moon, we will need the students to think smaller and portable. The hardest part of this is fitting the ECLSS equipment into the volume. We would have to concentrate on the type of system used on the capsules—no recycling of water. There won't be much room for comfort. The beds have to be separate as opposed to most campers for two. Suit ports will save from having an air lock. But if there rocks that need to be studied immediately, there needs to be a small airlock for brining in 1kg samples.
- Two crew would drive the LTV with their Lunar Camper/Lab out to the perimeter of their Lunar Base location and set up their camper. Astronauts would spend most of their time doing EVAs (with or without the LTV) for finding samples they can pack into a large sectioned, exterior box for return to the Lunar base. After taking samples from one location, they drive back to the Lunar Base to hand off samples. They would then resupply with food, water, ECLSS supplies (and get rid of their trash) then go out to another distant location set up the camper and find more samples.
- The real limitation on distance is the space suit. If the LTV breaks, the crew needs to be able to walk back to the Lunar Base. How far can they walk in 8 hours?







It may be wise to start your planning with how much launch volume you are allowed and then see how big you can get from there.

Inside description

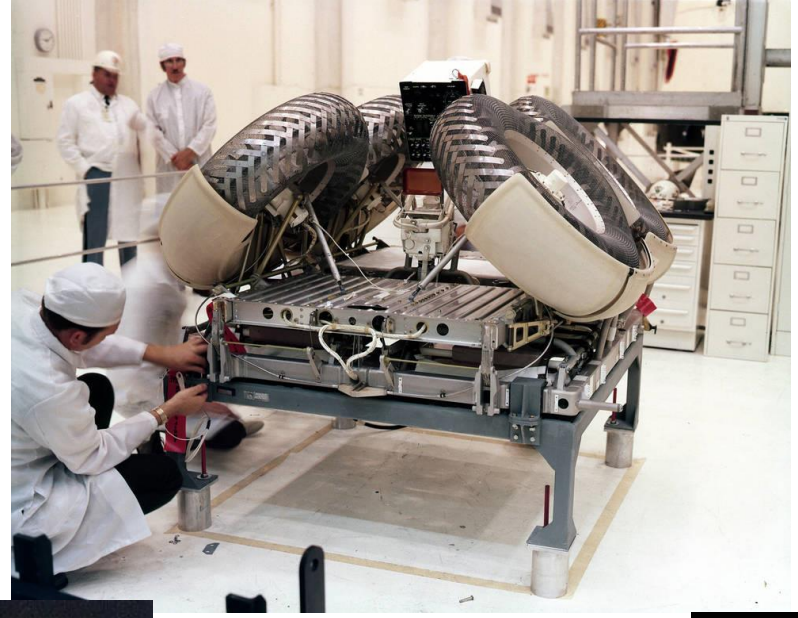
- 2 beds
- Small airlock for samples to come inside
- Food boxes and water for 7 days
- Waste water and solid waste storage for 7 days
- Window
- Table
- Toilet

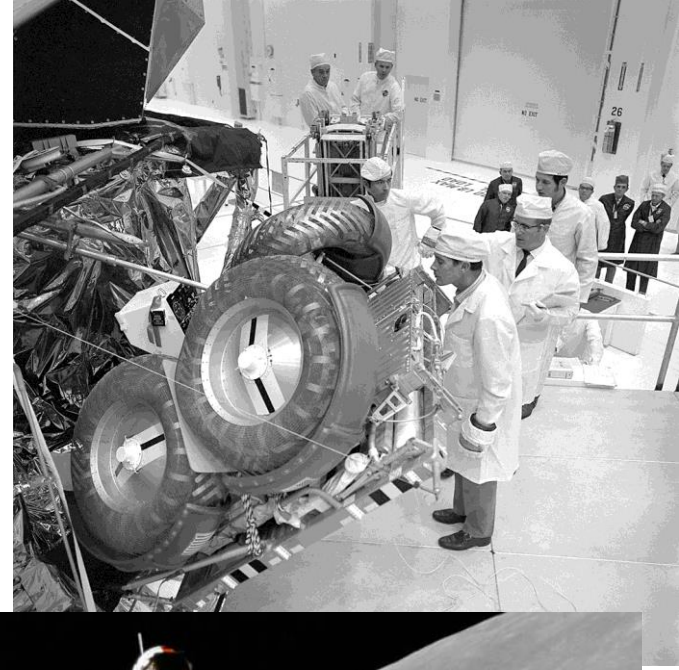
Is it better to be taller or wider? With 1/6th earth's gravity, there may be a lot more bouncing than what we would see on Earth. Wider may be better to increase the stability.
On Earth, a camper is collapsed after camping to drive home so the wind doesn't damage the camper. On the moon, there isn't any air so your camper only needs to deploy. No need to pack it down once it is deployed.

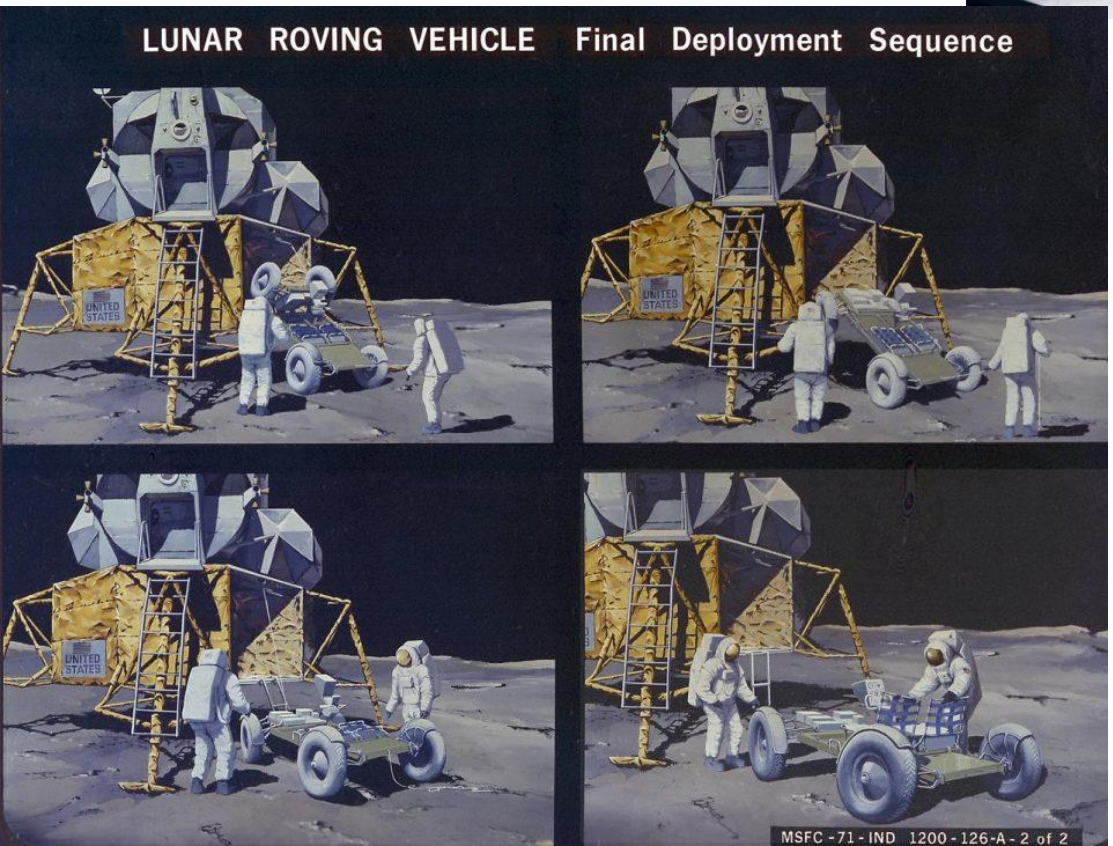
Internal volume of the Artemis capsule (4 chairs)16.5 ft outside diameter, 316 cubic feet inside

Packing

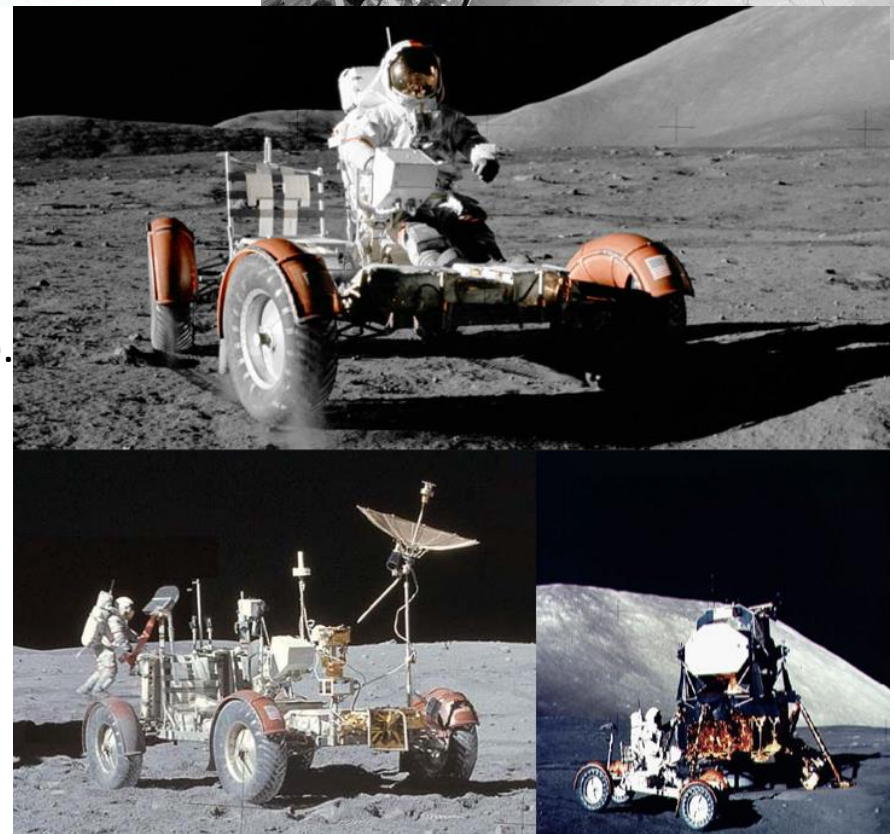
The space available for shipping things to the moon is going to be very precious. Notice how the Apollo Rover was packed up and removed once on the moon. Your Camper/Lab will also need to take up little space when shipped and be easy to expand once delivered. This could be done with inflation or springs or electric motors. Your model needs to demonstrate the mechanics of how it opens but not necessarily the electric motors or springs or whatever.





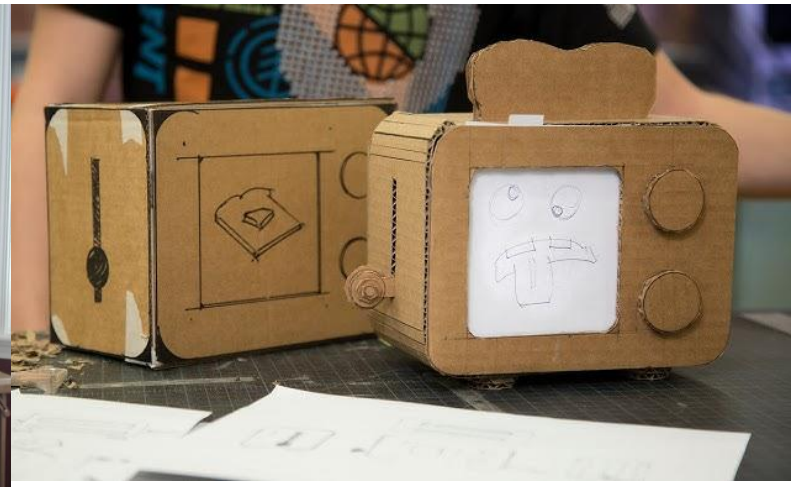


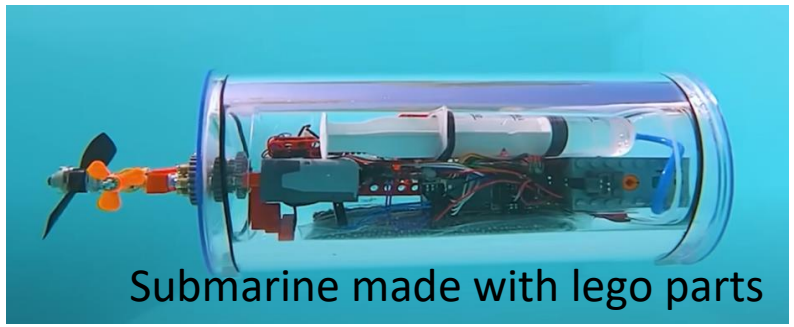
On earth we collapse the camper down when driving to a new location because wind will rip it up. On the moon it will be deployed but since there isn't air, there won't be a need to collapse it again.



Scaled model

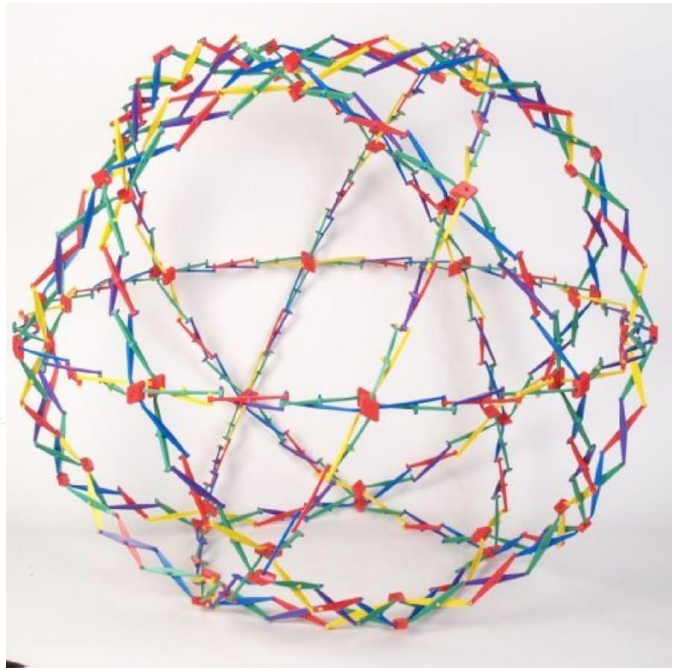
- Plan for your model to be no larger than 18inches long so that it will be transportable and fit on half of a table.
- Materials to use for your model
  - 3D printing
  - Cardboard
  - Wood
  - Plastic parts
  - Metal parts
  - Cloth parts
  - Off the shelf parts from store





Submarine made with lego parts

Toys that change shape



Fold up trailers

Inflatables

How rigid is an inflatable?

<u>Regulation pressure</u>

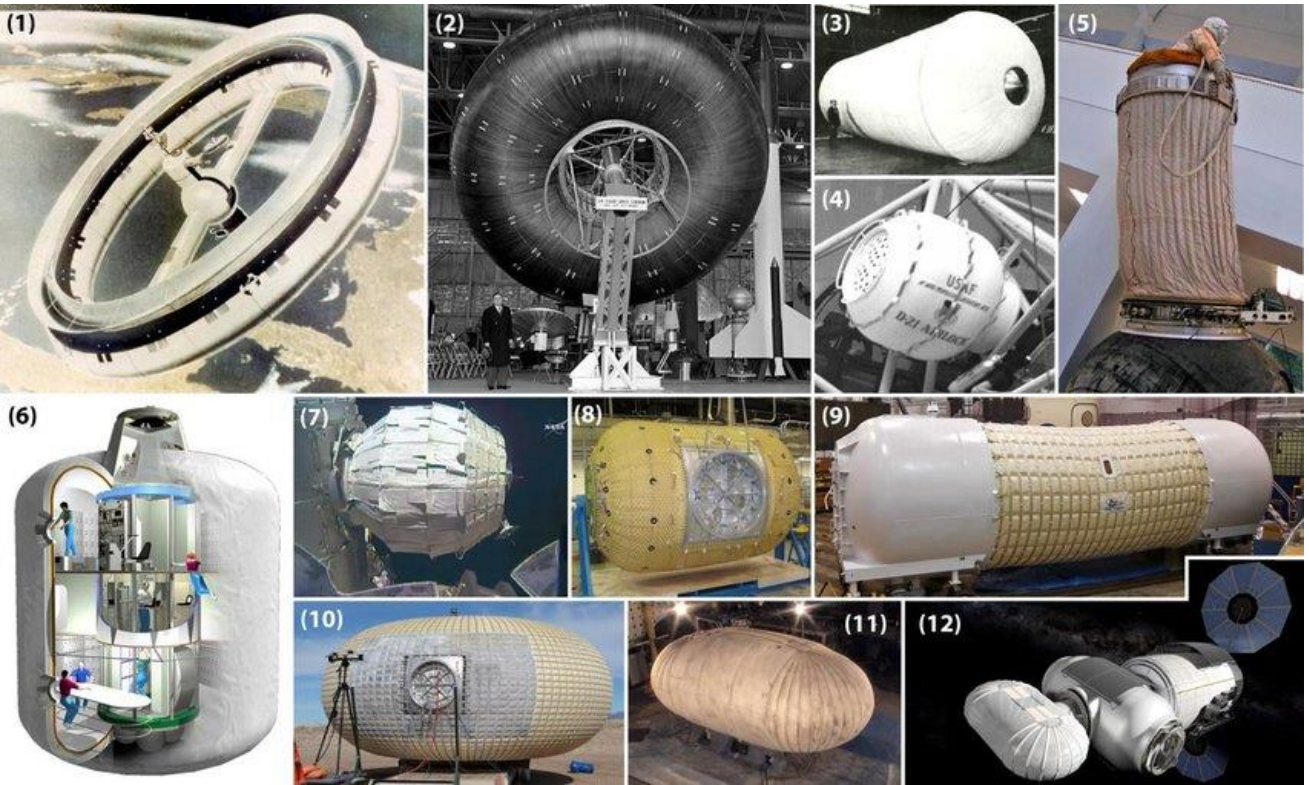
Kick ball—6 psi

Volley ball—7 psi

Soccer ball--

Basket Ball—8 psi

Pressure inside your camper—10.2 psi



Could the furniture be inflated for use and deflated when not being used? Don't release air to space.

NASA vehicle not going to the moon but some good ideas

Exterior description

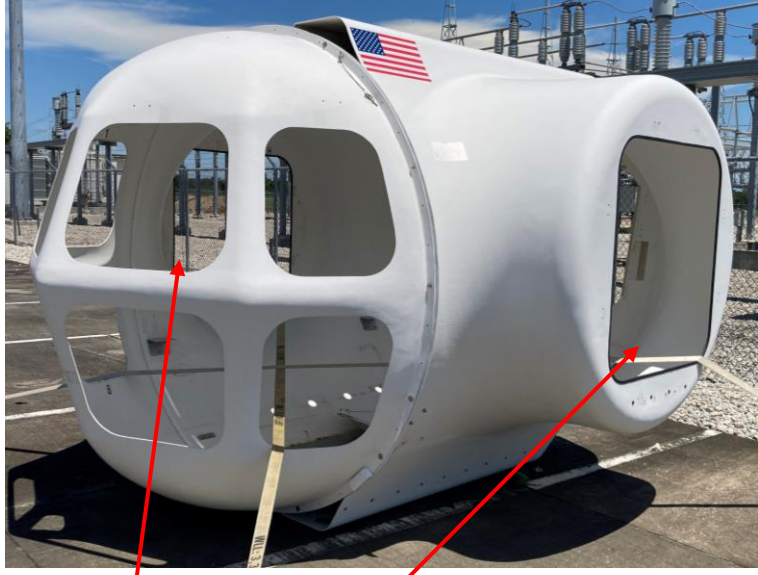
- This may not be much bigger than a space X capsule
- This won't be spacious.
- Because it is only for extended EVA missions, the internal pressure will be kept at 10.2 psi with a high O2 content.
- It will only go out during a lunar day so it can collect solar power to power up the LTV while the crew is sleeping
- Batteries for storing solar power
- Can have inflatable components as well as rigid components
- During launch it can take up no more than
- Trailer so the LTV can be driven around without the lab
- Suit attaches to the camper
- Comes to moon folded up in a small space
- Equipment bins for tools on the outside
- Outside lighting (minimizing shadows)
- Expands out but does not have to fold back up
    - Campers collapse on earth because there is wind when you drive.

Notice that this one does not collapse at all.

This is a rigid, fiberglass mock up of the Lunar Rover that was used for testing at the Neutral Buoyancy Lab and has a future use in another project.

Part of the reason this rover is not going is that it takes up a lot of space when sending it to the moon. Being able to compact your Camper is important.

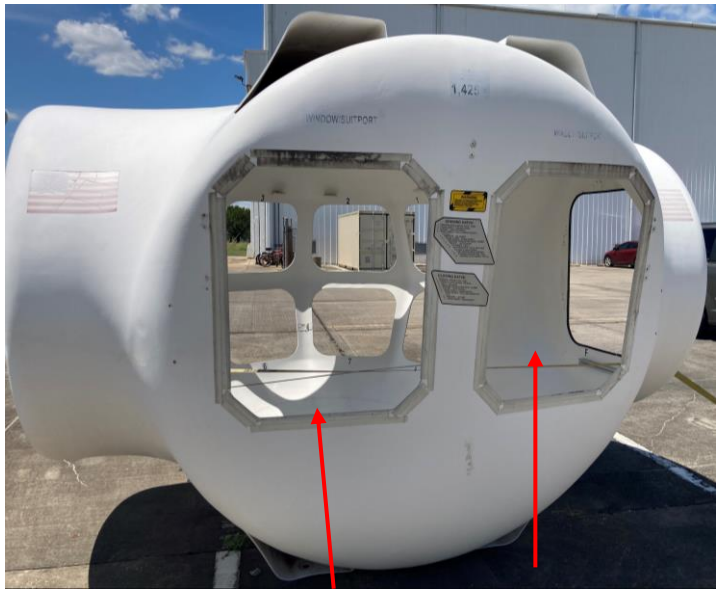
(straps are to keep the wind from blowing it around)



Front windows

Hatch Connection to Hab

Looking forward through the front windows



2 suit ports on the back side

2 suit ports and left side connection to Hab

Tiny houses

- Use spaces for multiple purposes
- Things fold up or deflate when not in use
- No corner or space is unused
- Privacy is not a topic
- Which things can be on the outside of the camper and which need to be inside?

Environmental and Life Support System (ECLSS)

- Air circulation
- Oxygen production/supply
- Carbon dioxide removal system
- Trace contaminants removal (system that removes off gassing from supplies and people)
- Water supply for consumption and hygiene
- Waste water

Because the Camper/Lab is for short missions, this system needs to be much more like one used in a capsule for short missions as opposed to the ECLSS on the ISS that is for long term habitation. For example, it will not be possible to recycle the water for this mission due to volume constraints. Reclaiming water takes up too much space. The equipment on the ISS is bigger because of how many people it needs to serve. Plan to have a waste water tank.

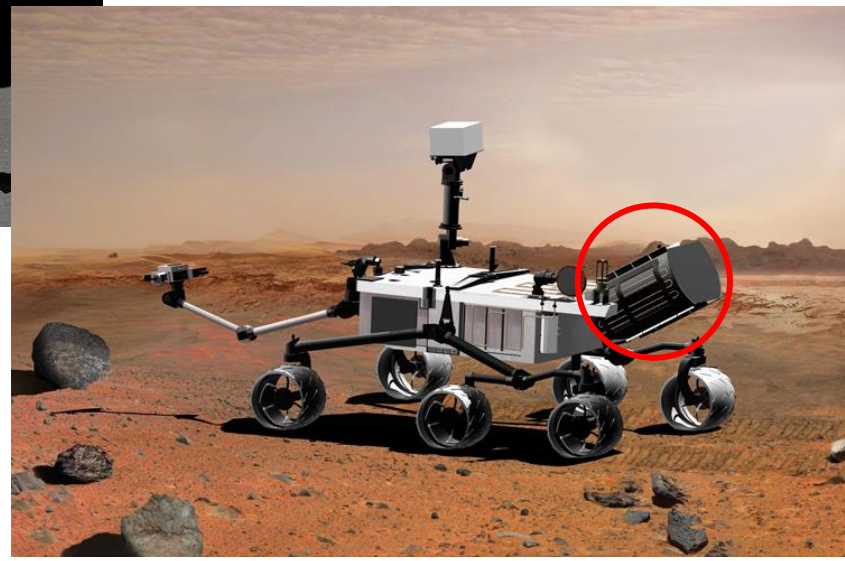
How big does it need to be?

Where can it be placed so it is easy to empty when refurbishing for the next mission?

Power

What kind of options might be valuable?

Weight will be a factor.



Solar—flexible or rigid solar cells?

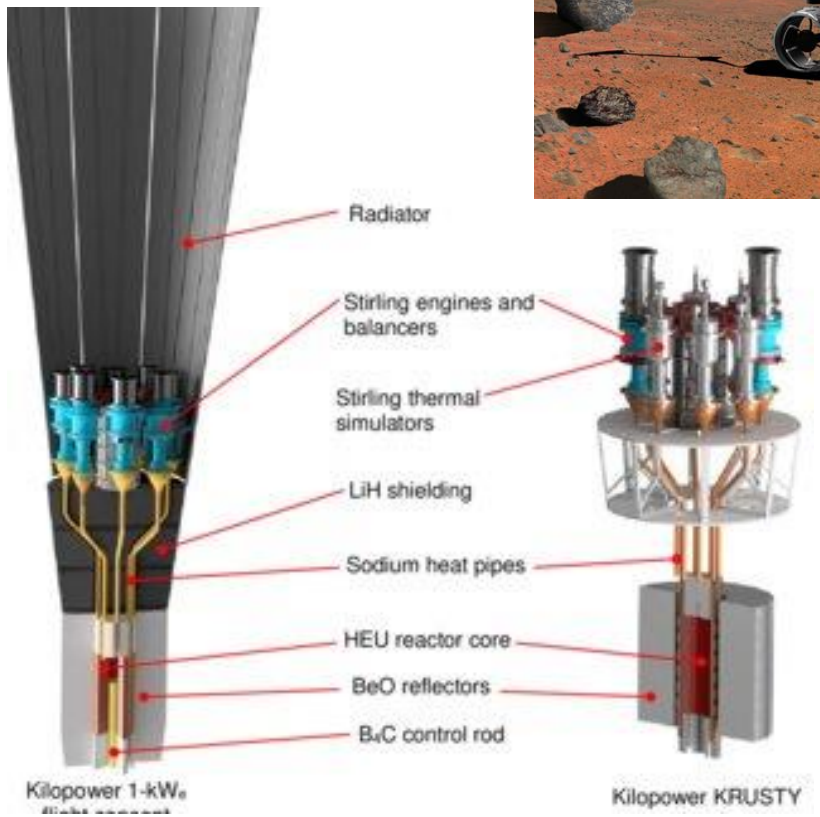
- https://www.youtube.com/watch?v=xKxrkht7CpY
- https://www.youtube.com/watch?v=L_q6LRgKpTw

RTG—heavy, dependable but fairly low power

- https://www.youtube.com/watch?v=l-Puj0uyCAg

Kilopower –new, has moving parts

- https://www.youtube.com/watch?v=DcdfMcjUy_U



Batteries?

There will be times when they need more power than what is coming off the power source. No matter the power source having batteries could supply the extra amperage when needed—like for charging up the rover.

What kind of batteries are needed?

How much power is needed?

Where do you place them?