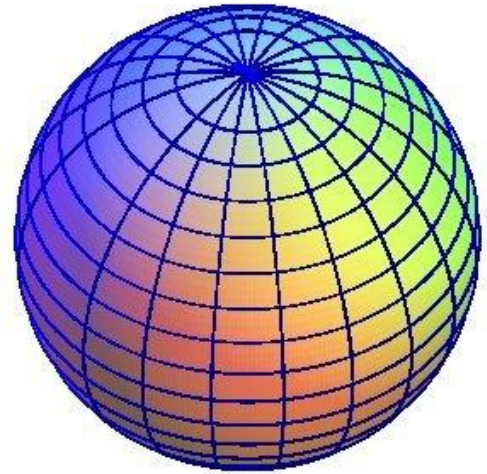


# Lunar Supply Pod Mover

Develop a scaled supply pod tool/transporter/mover that will be able to pick up, pull or retrieve a Supply Pod after it stops rolling so it can be taken back to the lunar base where the pod's water, food, batteries,... can be unloaded for use at the Lunar Base.



# Lunar Tractor

(students are not being asked to make the lunar tractor.)

- Landing on the moon and trying to develop a base or settlement will be a little like the pioneers moving west and trying to set up towns and farms in places without any stores and supply shops. They will have minimal supplies and lots of space and dirt. There won't be any value of taking oxen and horses but modern farming tools provide some good inspiration for equipment that could be useful.
- A farming tractor is kind of like a mobile power system that all kinds of other tools can be attached to. A farmer might buy a John Deer or Kubota tractor and then buy a hydraulic front end loader that can either operate a forklift or a bucket for scooping loads of dirt. They might also buy a box blade for the back so they can even the soil out for a road or buy a Bush Hog to attach to the Power Take Off (PTO) for mowing the grass or an auger for drilling post holes. Depending on the crop, they may have a hay bailer or a thrasher.



# Space Exploration Vehicle

- The point is that it would be wise for some of the first tools sent to the moon to be versatile. It is easier to send something like a 'lunar tractor' with several tools that can be powered by the 'tractor' or attached to the 'tractor' to get a job done. NASA has not built a 'lunar tractor' but they have built the Space Exploration Vehicle (SEV) also called the Lunar Electric Vehicle that has a lot of the aspects of a very high tech tractor.
- <https://www.youtube.com/watch?v=nPSbOsOJ9Ro>
- The base is kind of like the tractor. It has the motors, the batteries and the brains. It can be driven by people riding on top or controlled remotely. The 12 wheels allow it to drive up and down nearly any slope, rotate on its own axis, drive sideways or even diagonal (of course it can also drive like a normal car).
- <https://www.youtube.com/watch?v=VtzR4iXY6vg>
- You may also have seen it with a habitation module on it—kind of like putting a camping shell on a pick up truck. There are space suits attached to the back so they can get in and out of their space suits without opening the hatch and losing air to go in and out.
- The first teams to the moon will be small since they don't have many resources and living quarters so the tools that are sent could all be powered off only one or two SEVs. The SEV will be the muscle for all the tools that would be needed for the job. Although there are times the astronauts might drive it, I expect it will also be robotic so people from the ground could program it to do some of the jobs before the people arrive and also after the crew is there.
- What kind of tools will they need for building a lunar base?
  - Box blade and/or bull dozer blade for smoothing out the soil
  - Auger for drilling holes
  - Front end loader for moving dirt
  - Tow bars for moving modules and other equipment to the desired locations.
  - Jack hammer for breaking up rocks that are in the way
  - etc.
- HUNCH job:
  - Some kind of tool for lifting up/moving/transporting the Lunar Supply Pods that land on the moon.

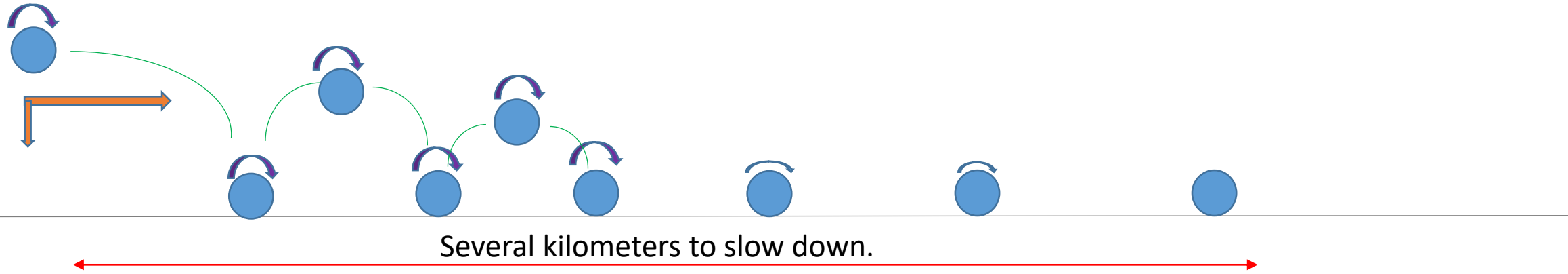


## Lunar Supply Pod Mission:

We expect that, just like a golfer can aim a ball pretty close to a hole, NASA would be able to aim a supply pod within ½ mile radius of where the astronaut could pick it up. But this still means that it may be too far for astronauts to walk to and it will be too heavy for them to move by hand or foot. We will need to use the SEV to bring it back to the Lunar Base. This means we will need some kind of tool either on the front or the back of the SEV that could pick it up, drag it or roll it to the Lunar Base.

[http://www.hunchdesign.com/uploads/2/2/0/9/22093000/landing\\_materials\\_on\\_the\\_moon\\_and\\_mars\\_with\\_less\\_fuel\\_and\\_engines.pdf](http://www.hunchdesign.com/uploads/2/2/0/9/22093000/landing_materials_on_the_moon_and_mars_with_less_fuel_and_engines.pdf)

Lunar Supply Pod bouncing and rolling to a stop on the moon before being picked up/transported by a SEV with some kind of tool.



Not all supplies to the moon need to be placed gently onto the surface. Water, food, nuts, bolts....supplies that are unlikely to get damaged by touching down harder can handle a rougher delivery as long as the pod doesn't break open. Placing materials on the moon costs around \$1.2 million per pound. If we can cut down on the amount of mass we have to send that isn't supplies (fuel, engines, landing gear), we will be able to send more supplies for less cost and have less trash on the moon.

The purpose of the supply pod is to decrease the mass used to get supplies to the Moon without breaking open:

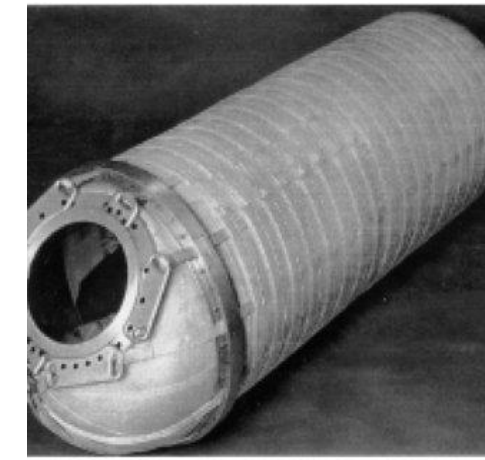
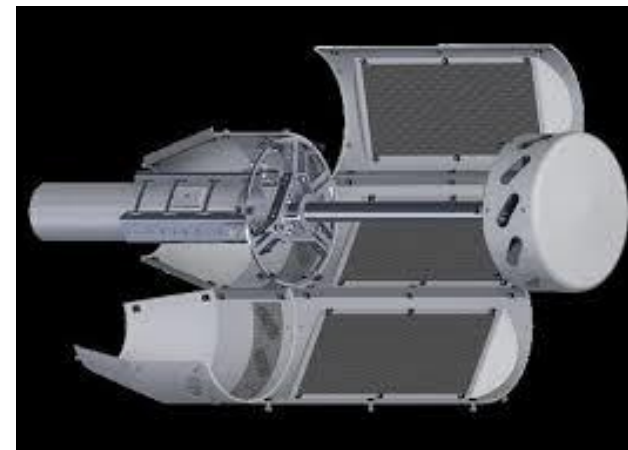
- Minimize the amount of fuel needed to slow down the supplies
- Decrease the amount of landing gear
- Decrease the amount of materials left on the moon

# Lunar Supply Pods

- Lunar Supply Pods are a project that were worked by HUNCH students in 2019 to 2020.
- In the same way that you wouldn't want to bring supplies and leave the whole truck behind but instead just leave the bags of groceries, Lunar Supply Pods are the bags of groceries that are dropped off on the moon from orbit and allowed to bounce and roll to a stop using friction from the lunar soil and rocks to slow them down. We are planning for them to roll to a stop within a  $\frac{1}{2}$  mile radius from the Lunar Base. The exact design of the Pods have not been determined but we expect them to be either spherical and/or cylindrical so they can roll easily. They will have some kind of attachment points that can survive the touchdown and rolling without being damaged. You can help determine what those attachments will look like by the design you come up with. They may come in different sizes but you don't have to plan on that yet.



These are not Lunar Supply Pods but images of similar structures for different purposes.



# Requirements for a Lunar Supply Pod Mover

## Problem:

Supply Pods are going to roll to a stop on the Moon with food, water and other supplies for the astronauts. NASA will need a way to bring the pod back to the habitat where it can be unloaded. They will already have a rover that can be driven out to the pod but they will need some kind of tool to either pick it up or roll it back to the habitat.

## Objective:

Design and build a scale model of a hand operated or electric tool that will be used with the SEV to pick up or move a Lunar Supply Pod

- Build a prototype that will fit on your desk. The one that goes to the moon would need to be able to lift 3 tons on Earth.
- Don't let the supply pod swing and bang into the SEV while driving back to the habitat
- Your prototype can be hand operated but have a plan for how your team would power it.
- Plan on supply pods being at least two different sizes—small and large
- Needs to be easy to attach and remove from the SEV

## Pointers and thoughts:

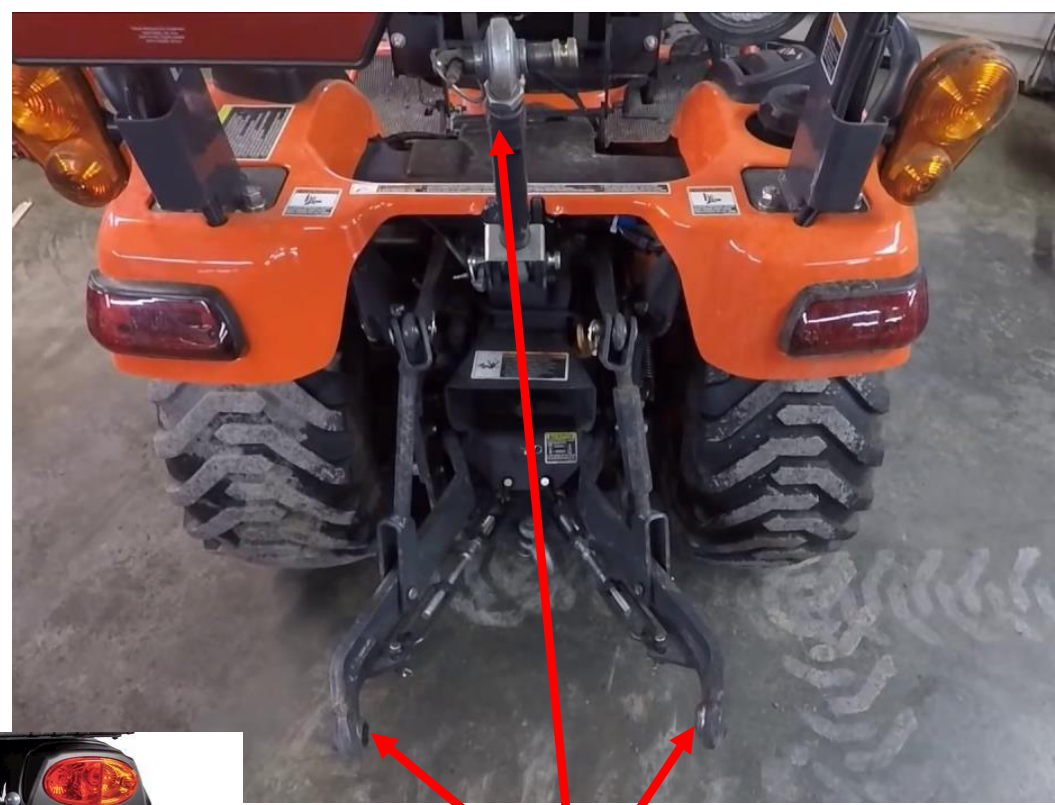
- Keep it simple
- Light weight
- Does the pod need to be lifted? How high?
- Since grappling points might be damaged after touchdown and rolling to a stop, it would be wise to have more than one way to pick it up or move it
- The first and simplest ideas are what will lead the engineering to keep it operational for a long time.
- Hydraulics won't work in the temperature swings of the moon—the fluid or the seals may expand and contract too much in the temperature swings and cause leaking and other problems.
- There could be different sizes for different equipment. Make yours so it can handle a small and a large size pod.
- If it is damaged from the rolling of the touch down, it may not roll very easy.
- I am certain there will be a time for supply pod retrieval to be done robotically but if everything can be done with robots, why send people.



# 3 point hitch option?

Some of the advantages of a 3 point hitch on a tractor is that it is set of very strong attachment points that are on hydraulics that can be lifted up a few inches. They can also be adjusted for different loads and equipment. It is also much more stable than a ball hitch because of the number of connections. However it does not have the same articulation that comes with a ball hitch.

Don't be afraid to stop at a tractor dealer and ask questions.



2 Ball connection points



Power Take Off (PTO) – drive shaft from engine to power other equipment

Location for ball hitch