Design a Lunar Lander

STEM in a Bag is a project of Tulsa Regional STEM Alliance

This activity aligns with the following Oklahoma Academic Standards:

- Dimension 1: Science and Engineering Practices:
  - Asking Questions and Defining Problems
  - Developing and Using Models
  - Constructing Explanations and Designing Solutions

The science of space exploration is making tremendous progress, with NASA and other space agencies planning missions to send astronauts back to the moon, to asteroids, to Mars, and beyond! With spacecraft flying as fast as 18,000 miles per hour (29,000 kilometers per hour), astronaut safety is vital to every mission. The astronauts will need to pilot a craft that can safely land on the moon, Mars, or an asteroid and then return the astronauts to the space station.

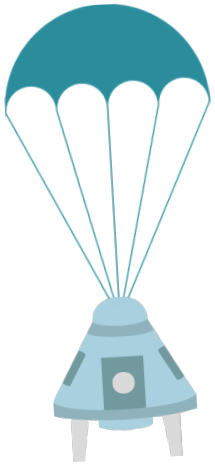
How do you safely land a craft that's traveling 23 times the speed of sound? NASA engineers have tried different methods for landing rovers and other aircraft. The first step is to slow it down. Sometimes this is done using rocket engines that are fired against the direction the lander is moving. Just before landing on the surface, the engines are turned off to avoid dust and debris blowing into the craft and causing damage. This means the lander actually falls the rest of the way to the surface. Parachutes are often included in the landing design. Whatever method is used, the landing craft must be designed to absorb the forces of the impact and keep the astronauts inside safe.

The Goal:

Use the Design Process to build a lunar lander within these constraints:

- The lander must be able to carry at least two astronauts.
- Upon landing, the craft must not tip over, and the astronauts must still be inside.
- The lander cannot have a lid of any kind, and the astronaut cannot be secured to the lander using tape or glue. (This is to show that your lander reduces the shock of impact. If your lander has a lid or the astronauts are restrained, you won't be able to tell if the force of impact is safe.)

Materials:



- Cup – Plastic or Styrofoam
- 3 index cards
- Cardstock or cardboard
- Cotton balls
- Rubber bands
- Straws
- Tape
- Scissors
- Ruler, yardstick, or measuring tape
- Paper and pencil to sketch designs and record observations
- An "astronaut" – plastic-style figurines, mini marshmallows, ping pong balls, or something similar can act as an astronaut. You can use anything that is lightweight and fits inside the cup.

Although you are provided with certain materials, you are encouraged to use other items you may have around the house or classroom. Don't be afraid to experiment with various materials and different designs.

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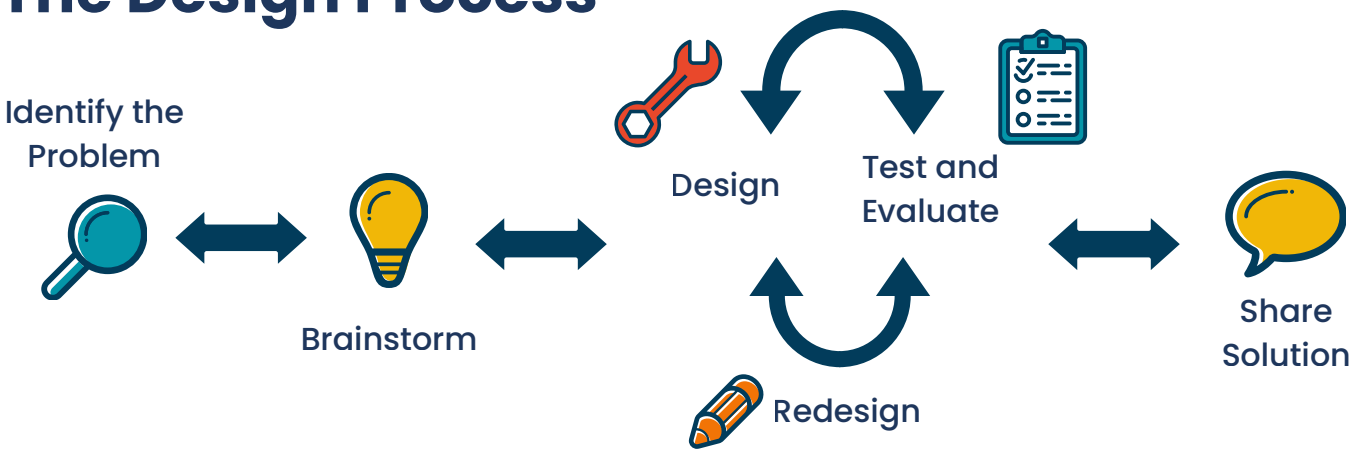
Engineers use the **design process** to solve problems creatively. The Design Process includes identifying the problem or challenge, brainstorming ideas, designing a possible solution, testing and evaluating the designed solution, redesigning based on testing, and sharing the solution. The process can be repeated as many times as necessary to solve new problems, improve existing designs, and find multiple solutions.

The Design Process



The Problem:

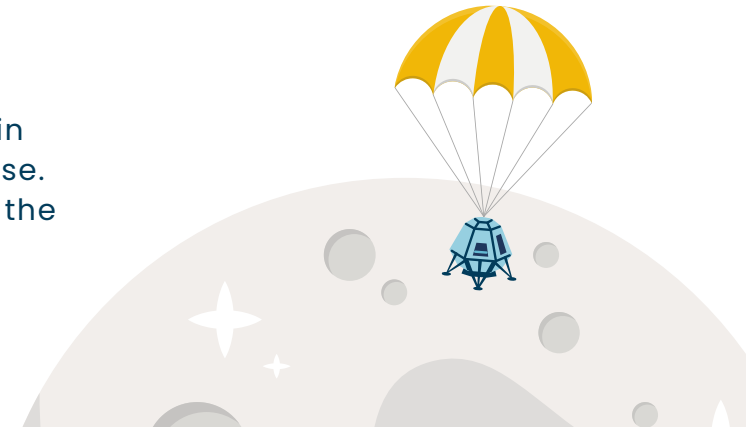
You are a NASA engineer tasked with designing a lunar lander that will safely deliver astronauts to the Moon's surface. The landing will be rough — without a soft runway or cushioning atmosphere, your craft must absorb the shock of impact on its own. Your mission: design a lander sturdy enough to stay upright and gentle enough to keep your crew safe when it touches down.

Brainstorm:

Work with a partner to brainstorm ideas for a lunar lander and try to come up with as many possible designs as you can. The cup can serve as the cabin for the astronauts. Get creative! You may design the lander anyway you choose as long as the constraints above are followed. You may consider including shock absorbers and landing gear in your design. Sketch your ideas on paper. Make sure to label all the parts of your lander, including which materials you will use.

Design & Build It:

Create your lander out of the materials included in the kit or other materials you find around the house. Don't forget to stick to the constraints outlined in the challenge above!



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Test It:

After you have built your prototype, it's time to test, collect data, and evaluate your design. Begin testing by dropping your lander from a height of 1 foot. Create a chart listing the drop height and observations. Does it tip over? Does the astronaut stay inside? Does the astronaut bounce or move?

Redesign & Retest:

You might need to make some adjustments. Consider the following:

- How can you make the lander more balanced?
- Can you make it lighter?
- Can you add structures to absorb shock? Think about objects that are soft and flexible, but hold their shape – like a spring or cushion!

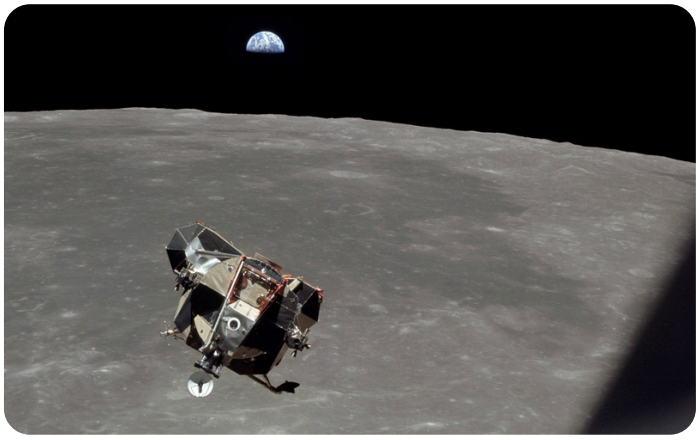
When your craft can land safely from 1 foot, increase the height to 2 feet and beyond. Determine the maximum height from which your craft can fall and still land safely. Each time you perform a test drop, be sure to record your data and observations.

Did you know?

The aerospace company, Blue Origin, is working to develop a lunar lander that uses autonomous technology to land with precision. Using laser beams, the Blue Moon lander scans the terrain to find a safe, flat surface on which to land.

Share Your Results:

Share your solution with others, discuss successes and challenges, and work together to improve upon each other's designs. The first solution is rarely the best solution and engineers work together to iterate – or continually improve – a design. Engineering is a team sport and the diversity of a team and how well they work together can determine success or failure!



You're an Engineer!

You just used the Engineering Design Process! The Test, Evaluate, and Redesign portion of the Design Process can happen many, many times. Even when a product is completed and shared with the world, redesign and improvements continue to happen. Most things are never "finished"—there's always room for change and improvement!

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STEM Hero: Mary G Ross

Mary G. Ross (1908-2008) was a "hidden figure" whose work in aerospace engineering and mathematics helped pave the way for space travel. Born in Park Hill, Oklahoma, Mary was a member of the Cherokee Nation and became the first known female Native American engineer.

Most of her work remains classified, but she was instrumental in developing a variety of defense systems, the Apollo program for manned space flight, the Polaris reentry vehicle, and space probes to Mars and Venus. After retiring, Mary became a guest lecturer at schools to encourage young women and Native American youth to pursue careers in science, mathematics, and engineering.

Read All about it!

Moon Landing
by Jill McDonald

An Igloo on the Moon
by Adrian Buckley

Share your feedback

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