Design a Lunar Buggy

DESIGN challenge

To design and build a model of a Lunar Buggy that will carry equipment and astronauts on the surface of the Moon and to determine the best slope of ramp for the rover to travel the farthest distance.

OBJECTIVE

To demonstrate an understanding of the Engineering Design Process while utilizing each stage to successfully complete a team challenge.

PROCESS SKILLS

Measuring, calculating, designing, evaluating

MATERIALS

General building supplies

Meter stick

Digital scale

Small plastic people (i.e. Lego®)

Plastic eggs

Pennies or washers ("cargo")

Wheels

Something to use as a ramp (preferably a flat surface that would enable the buggy to roll for 25 cm or more)

STUDENT PAGES

Design Challenge

Ask, Imagine and Plan

Experiment and Record

Quality Assurance Form

Fun with Engineering at Home

lunar buggy

MOTIVATE

- Show the video about the Apollo 15 Lunar Rover on the Moon:

http://starchild.gsfc.nasa.gov/Videos/StarChild/space/rover2.avi

- Ask students to pay particular attention to the comments made about the difficulties in driving on the lunar surface.

SET THE STAGE:

ASK IMAGINE **& PLAN**

- Share the *Design Challenge* with the students
- Remind students to imagine solutions and draw their ideas first. All drawings should be approved before building.

CREATE

- Challenge the teams to build their Lunar Buggies based on their designs. Remind them to keep within specifications.
- While each group is working, designate one or two students to create a ramp with a slope of 1 to 3 in which all groups will use to roll their buggies and record observations.

EXPERIMENT

- Students must test their designs down the ramp and record the distance travelled for each trial.
- Students should try a “Goldilocks” experiment and test various slopes to give the best distance travelled with their Lunar Buggy. What slope is too large? What slope is too much? What slope is just right? Have the students record their results.

IMPROVE

- Students *improve* their Lunar Buggy models based on results of the *experiment* phase.

CHALLENGE CLOSURE

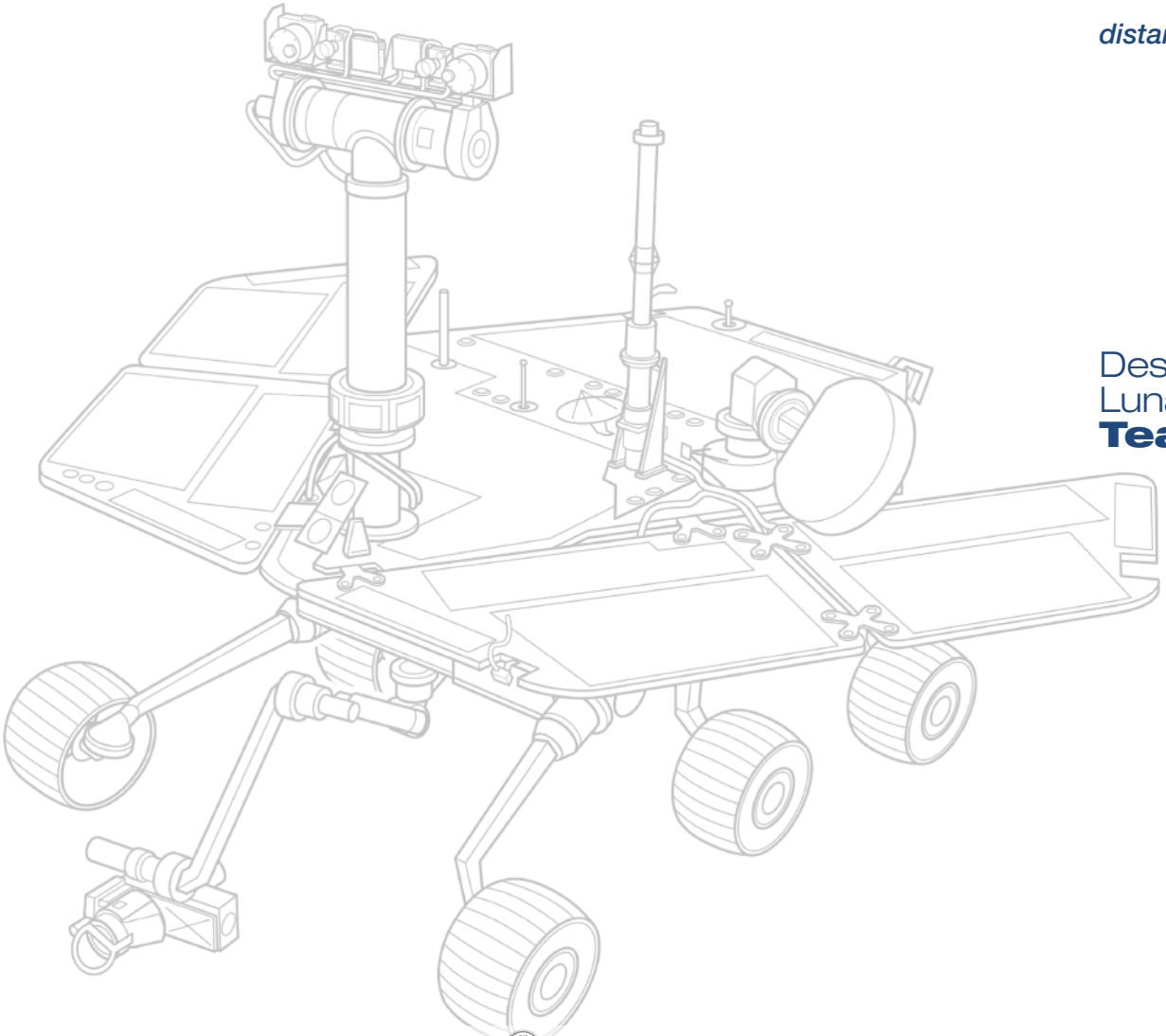
Engage the students in the following questions:

- *Did the cargo mass make a difference in your Buggy's performance?*
- *How did the slope of the ramp affect your Buggy's performance?*

PREVIEWING NEXT SESSION

Ask teams to bring back their Lunar Buggy models for use in next session's challenge. You may want to store them in the classroom or have the facilitator be responsible for their safe return next session.

Ask teams to think about potential landing pods during the next session. Tell students they will be building the landing pod out of the materials that have been available to them. The pod will be dropped from as high as possible (out a second story window, off a tall ladder, or from the top of a staircase).



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Design a Lunar Buggy
Teacher page

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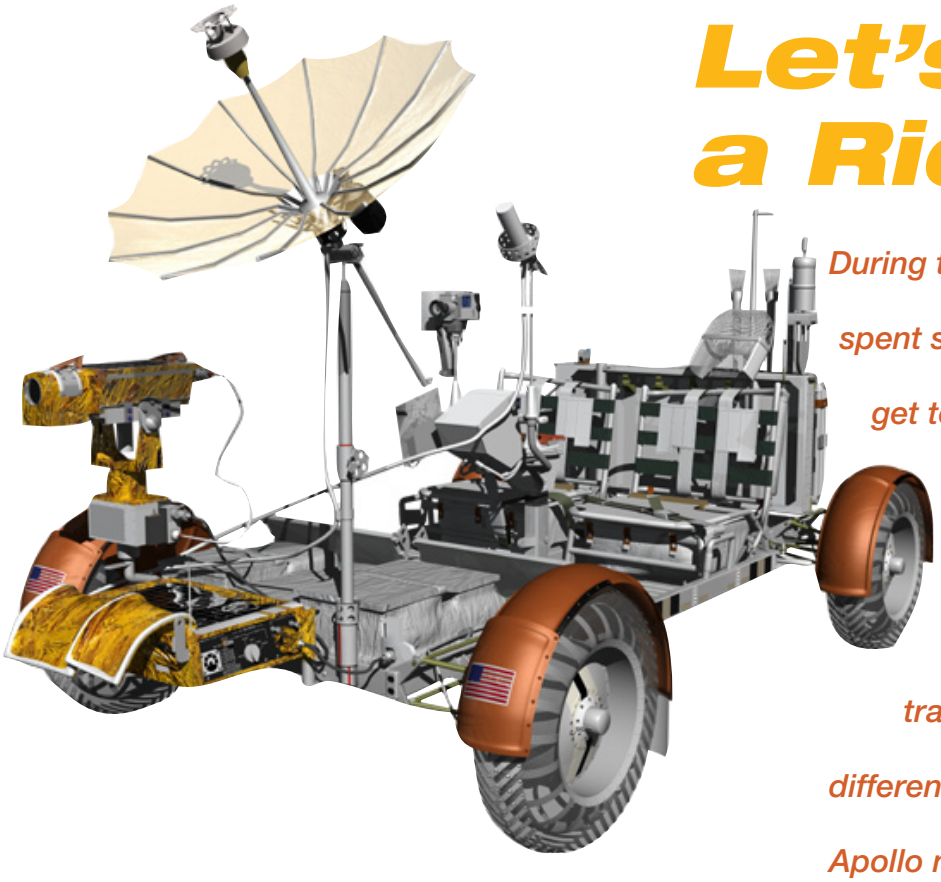
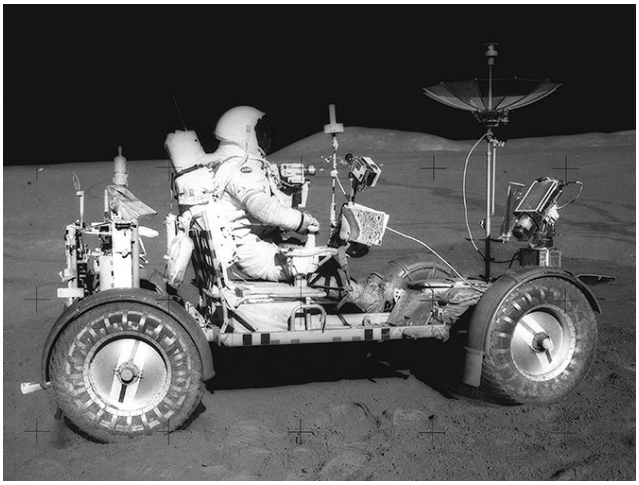


Let's Go for a Ride!

During the first set of activities, you have spent some time thinking about how to get to the Moon. Now you need to think about landing on the Moon, and how to deliver cargo to the Moon. Astronauts will need a mode of transportation in order to investigate different areas of the Moon. During the Apollo missions, astronauts drove a Lunar Buggy several kilometers away from their spacecraft. Today you get to be the engineers designing a new Lunar Buggy that can perform functions the Apollo Lunar Buggy could not. Your challenge is to build a model of a Lunar Buggy that astronauts will eventually use to carry astronauts and cargo on the Moon.

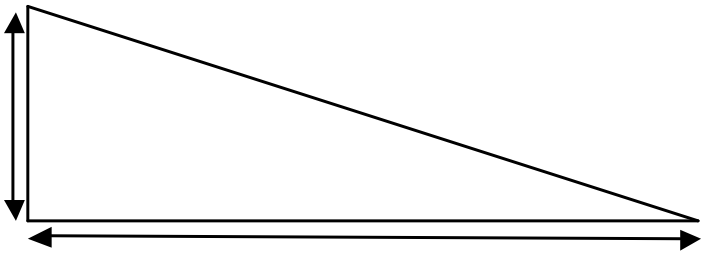


THE CHALLENGE:

Each team must design and build a Lunar Buggy with the following constraints:

1. ***The Lunar Buggy must carry one plastic egg snugly. The egg may not be taped or glued into place. (The egg represents the cargo hold.)***
2. ***The Lunar Buggy must be able to roll with the cargo hold carrying 10 pennies (or washers).***

3. ***The Lunar Buggy must have room for two "astronauts". You may use plastic people provided to you or make your own. Your astronauts may not be taped or glued into place.***
4. ***The Lunar Buggy must roll on its own down a ramp with a rise-over-run of 1-over-3 for a distance of approximately 100 cm in a straight line beyond the end of the ramp.***
5. ***The Lunar Buggy must be able to hold cargo and astronauts in place and intact as the Buggy rolls down the ramp.***



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Student page

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ASK IMAGINE &PLAN

What questions do you have about today's challenge?

What parts do you need in order to make your buggy roll?

What will hold the egg in place?

What will hold the astronauts in place?

What is the height of the ramp (rise) and the horizontal distance (run) for this Challenge?

Rise	cm
Run	cm

Draw your Lunar Buggy and provide a close-up view of your wheel and axle design. Make sure to label all the parts of your design.

Buggy design:

Wheel and axle design:

Approved by: _____

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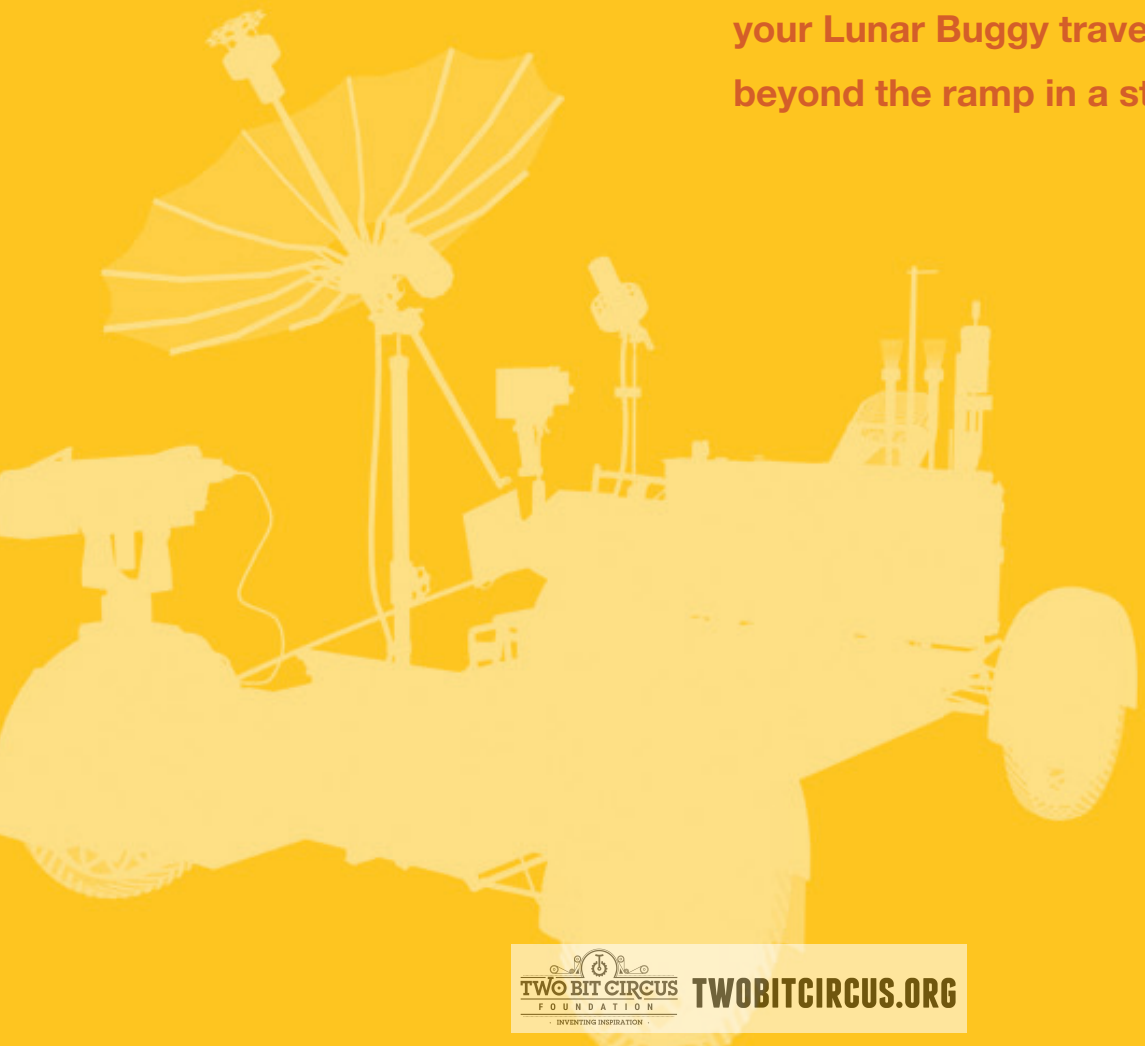
Experiment & Record

After you have created your model Lunar Buggy based on your drawings, test your vehicle on the ramp and record how far the Buggy travels beyond the ramp. Indicate the changes your team makes to the design to get the best performance for your Lunar Buggy. Remember, the challenge is to have your Lunar Buggy travel at least 100 cm beyond the ramp in a straight line!



Lunar Buggy Distance and Modification Data Table

Trial	Distance Traveled (cm)	Modification to make to design
1		
2		
3		
4		

Use the space below to draw the updated plans for your newly designed Buggy.

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Now that you tested your Buggy at a constant slope of 1 over 3, what slope do you think would make your Lunar Buggy travel the farthest? Write your hypothesis below in a complete sentence.

_____

_____

_____

_____

Set up your ramp with different slopes and record how far your Lunar Buggy travels beyond the end of the ramp each time.

Lunar Buggy and Ramp Data Table

Trial	Rise-Over-Run	Distance Traveled (cm)
1	1 over 3	
2		
3		
4		
5		
6		

At what slope did the buggy no longer roll, but slid or fall off the ramp?

Science Pop Question

What force is acting on the Lunar Buggy to get it to roll down the ramp?

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engineering

QUALITY ASSURANCE FORM

Each team is to review another team's design and model, then answer the following questions.

Name of team reviewed: _____

How far does the Buggy roll on a ramp with slope of 1-over-3?
_____ **cm**

Did the egg or astronauts fall out from the Buggy with slope of 1-over-3?

Using a digital scale, measure the mass of the Lunar Buggy (without the penny cargo). _____ **grams**

Do you think the mass has an impact on the Buggy's performance? Explain your answer.

List the specific strengths of the design.

List the specific weaknesses of the design:

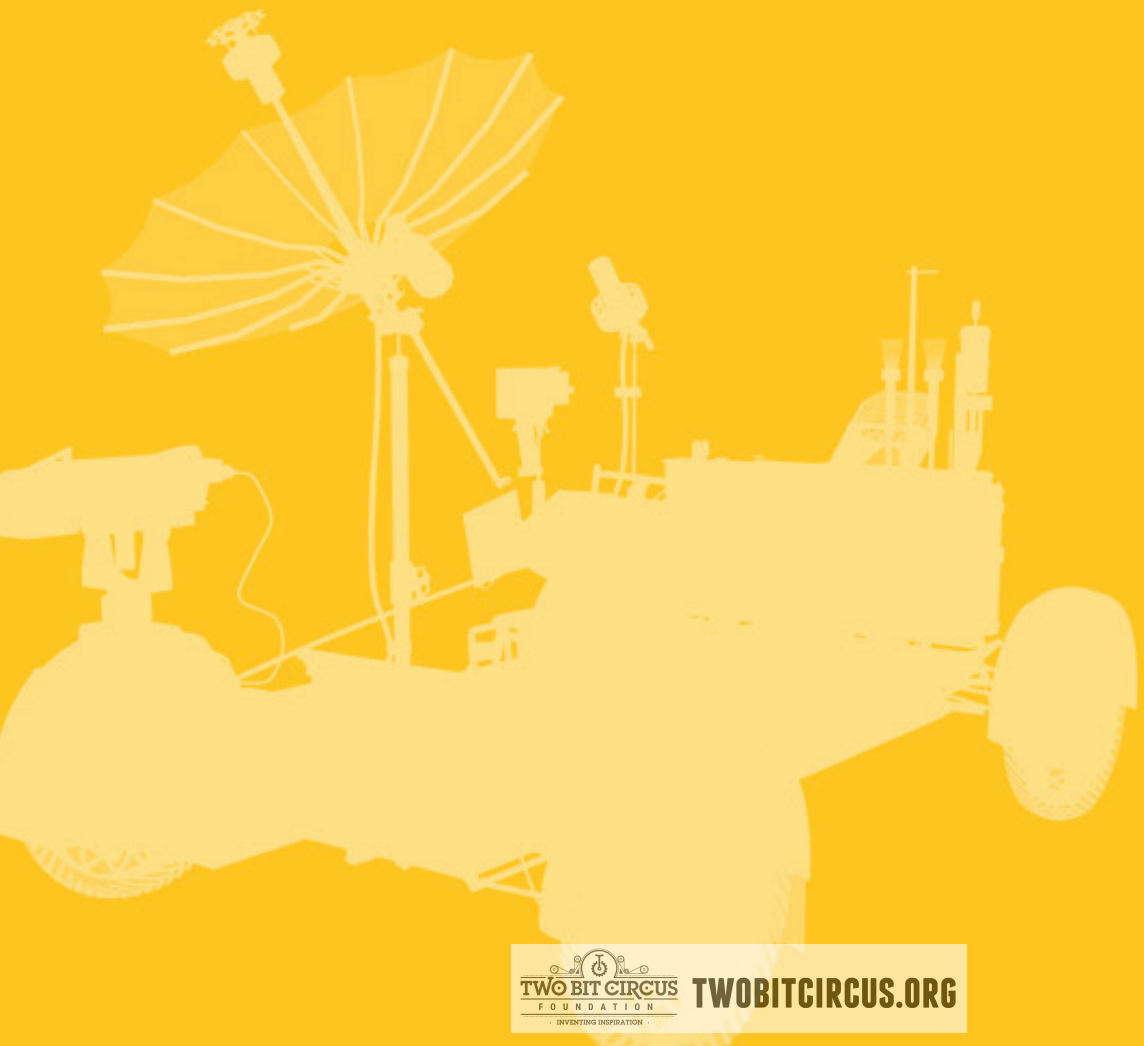
Inspected by: _____

_____

_____

_____

Fun with Engineering at Home



Today you designed and built a Lunar Buggy model to transport astronauts and cargo on the Moon. Before humans can travel to other planets, they first must send robotic rovers to these remote locations to investigate the surface of that planet. While at home, see what you can learn about the robotic rovers that NASA has already built and used to investigate other planets. For example, you can learn about the challenges in building the Mars Exploration Rovers from this website:

http://marsrover.nasa.gov/gallery/video/challenges.html

Here are some questions to discuss with your family members:

1. What Apollo mission used a Lunar Buggy and how was it delivered to the Moon's surface for that mission?
2. Using the imagery from the Lunar Reconnaissance Orbiter, can you locate any remnants of the Apollo missions? www.nasa.gov/mission_pages/LRO/multimedia/index.html
3. What is the most important consideration when designing a vehicle that will carry astronauts and cargo?
4. What kind of cargo might a vehicle need to carry on the Moon for future missions?

YOU BE THE TEACHER!

Explain to your family why the PLAN step in the Engineering Design Process is so important. Use your latest experiment with the Lunar Buggy as an example.

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