

Design a Boat Challenge

Primary Audience: Varies

Description: Work independently or in small groups to build boats that can hold the weight of many pennies. Each team should consider during the process how they can learn from a boat's failure. Consider how this process relates to the field of engineering.

Concepts:

- Engineering Design Process
- Role of failure in learning and design
- Open-ended problem solving

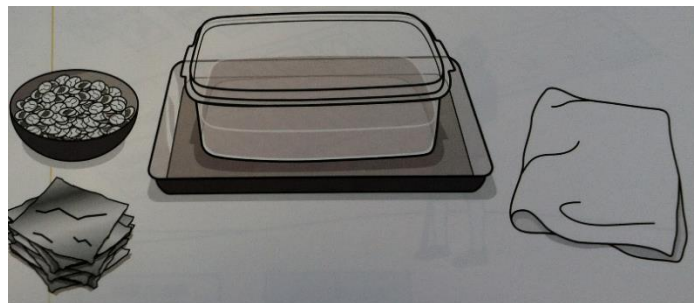
Materials:

Per group or individual:

- Two 12"x12" pieces of aluminum foil (this can vary, if needed!)
- Bowl of pennies, washers, or paper clips
- Cookie sheet, plastic tray or hand towel
- Paper towels or an extra hand towel
- Water

Per adult/challenge leader:

- Paper and pen for recording data



Instructions:

Set-Up:

1. Cut the aluminum foil into 12"x12" squares
2. Add water to the plastic container until it is half full
3. Place the container on a cookie sheet, plastic tray, or hand towel to catch splashes.
4. Provide paper towels or an extra hand towel on the table for drying hands.

Activity:

1. Encourage learners to create a boat out of one piece of aluminum foil that will float in the water and hold as many pennies as possible without sinking. Predict how many pennies the boat will hold before it fails and sinks.
2. Once a boat is ready, place it in the water.
3. Place pennies in the boat gently, one-by-one. Count how many pennies the boat can hold before it sinks.
4. Once the boat sinks, have learners modify their boat design to make the boat work better. (But the pieces of foil cannot be combined to make one large boat.)
5. Once learners have a new and improved design ready, test it again (Steps 2 – 4).

6. Discuss: How many pennies did each boat hold? Which designs worked best/worst? How did everyone learn from their failure? How does this relate to the field of engineering?
7. Repeat if desired!

What's Going On?

When designing your boat, you want to make sure that it is *less dense* than the fluid it will float in. Density is defined as the “degree of compactness” of a substance, or the mass per unit volume. Something that is *denser* than water will sink in water. Something that is *less dense* than water will float in water.

Try this: crumple up the foil into a tiny ball. Does it sink or float? This ball of aluminum foil has the same *mass* as a boat made out of that size of foil, but a very small *volume*. Thus it has a larger *density* than a sheet of foil that is not crumpled into a ball.

So as you can see, volume plays a big role in this! When a boat is placed in the water, gravity will pull it down and it will *displace*—or push aside—some of the water. The water also exerts an upward force on the boat called a buoyant force. It is this buoyant force that makes your boat float.

When you tested different designs, you may have found that failure plays an important role in the engineering design process. When you fail, you can learn from your mistakes and build a better design on the next iteration.

Further Exploration:

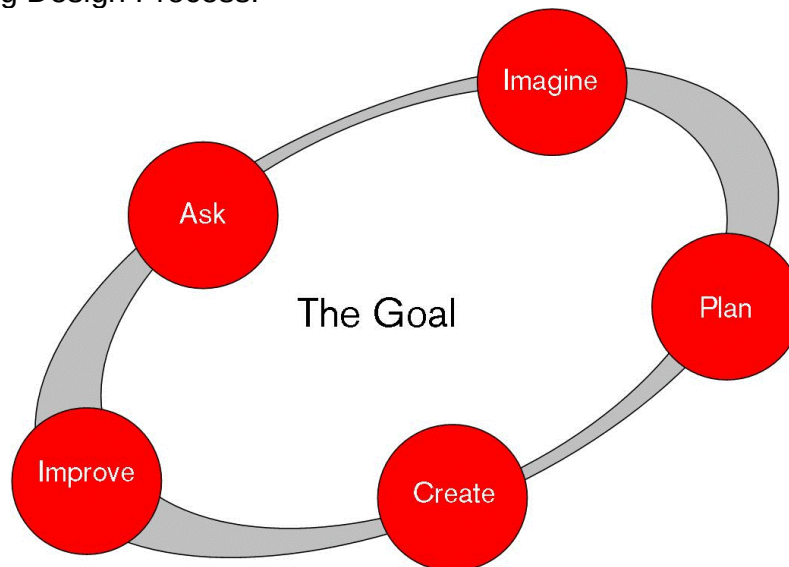
- Calculate the boat hull’s surface area and compare/graph to the number of pennies held.
- Design and build sail boats and use a fan for wind.
- Participate in the Sea Perch Challenge (http://seaperch.org/seaperch_challenge)
- Explore the Boat Building Challenge:
<http://celebrating200years.noaa.gov/edufun/book/BoatBuildingChallenge.pdf>
- Check out NOAA Research Ships:
<http://oceanexplorer.noaa.gov/technology/vessels/vessels.html>

Activity Source:

- This activity was adapted from “Learning from Failure” in [Family Engineering: An Activity and Event Planning Guide](#) and the [Boat Building Contest from NOAA](#).

Additional Resources:

The Engineering Design Process:



Many variations of the engineering design model exist. This model focuses on young children, and details a simple process that depicts fewer steps than other renditions and that uses terminology that children can understand. The Engineering Design Process is cyclical and can begin at any step, or move back and forth between steps numerous times. Moving through the Engineering Design Process might involve asking the following questions or making the following decisions:

ASK

- What is the problem?
- What have others done?
- What are the constraints?

IMAGINE

- What are some solutions?
- Brainstorm ideas.
- Choose the best one.

PLAN

- Draw a diagram.
- Make lists of materials you will need.

CREATE

- Follow your plan and create it.



- Test it out!

IMPROVE

- Talk about what works, what doesn't, and what could work better.
- Modify your design to make it better.
- Test it out!

After you improve your design once, you may want to begin the Engineering Design Process all over again to refine your technology. Or you may want to focus on one step. The Engineering Design Process can be used again and again!

Source: [Engineering is Elementary](#)

Show us your completed Science Challenges! Just tag us at @cosi (Twitter) or @cosiscience (Instagram and Facebook), and we'll share it with our followers too!

