

## #6 Lesson Emergency Rescue Vehicles Engineering Design Assessment

The engineering design process has its own built in assessment phase as the students create their inventions, test them and improve them. The teacher however may want to have a concluding assessment that gives them an idea of what concepts the students have learned in terms of how solve a problem by approaching it with the methodology of an engineer.

### **Synopsis**

A meteor has struck the International Space Station and is leaking oxygen. There isn't time to send up a rocket to rescue them so they will have to return to Earth. When they return, the chances are very good they will land in the ocean. Students will be given materials to construct a lifeboat that will float and support the weight of the astronauts.

### **Ask**

What is the engineering criteria (goal) for this mission?

*Answer: To design a craft that helps astronauts float safely on water until help can arrive.*

### **Imagine**

What types of vehicles or devices would help the astronauts float in the ocean? What materials could be used?

*Possible Answers: Vehicles: boats, canoes, rafts*

*Possible Materials: Wood, paper, aluminum, plastic*

### **Plan**

What should we do to help us select the best designs for the job?

*Answer: Test different vehicles and materials to determine which float the longest and are able to support the required amount of weight.*

### **Create**

Given materials, students create buoyant craft which support a certain amount of weight for a given amount of time.

## Improve

Which designs met our engineering criteria?

Share results and discoveries. Select designs that work the best and focus on finding ways to make them work even better.

## Materials

- Popsicle Sticks
- Pennies
- Aluminum Foil
- Paper - variety of types; copy, construction, wax, etc.
- Tape
- Rubber Bands
- Rulers
- Scissors
- Balloons
- Straws
- Paper Astronauts (attached black line master)
- Paperclips
- Plastic aquarium or tubs with water (to serve as “testing areas”)
- Timers or Clock
- Any other materials you think would be useful

## Step-by-Step

1. Describe the emergency scenario on the International Space Station.

2. **Ask** - What do we need to create to guarantee the astronauts' safety if they land in the ocean?

*Answer: Vehicles that float and support the weight of the astronauts.*

There are design criteria that must be met for the craft to be considered a successful lifeboat design.

**Engineering Criteria:** The lifeboat must float for at least one minute while supporting the weight of six astronauts (astronaut image + paper clip or a penny to represent each astronaut)

**Design Constraints:** Limited materials

3. **Imagine** - What sorts of vehicles could help them float?

*Possible Answers: rafts, boats, canoes, kayaks, etc.*

**4. Plan** - This is really where the assessment begins.

Have students learned how to consider variables and ways of testing materials and prototypes?

Display the materials they will be using so they have some idea of what they're working with.

For younger students, one would have to provide more guidance, but give them the opportunity to suggest how they will try a variety of designs or materials. Ask them what can be done to compare the vehicles they create (*i.e. Time how long they float, count how many astronauts are supported by the lifeboat*)

For older students, the attached worksheet can be used as the assessment tool to record their ideas.

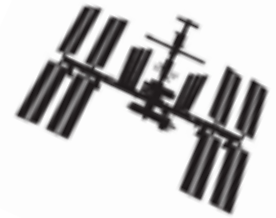
Have students share with their partner ideas for a lifeboat. Both younger and older could draw sketches. Older students could detail the materials they would use and their rationale for using them.

**5. Create** - Give the students materials to work with. Each engineering team needs at least six "astronauts" (paper with paperclip or coins) to use while testing their lifeboats. Unlimited access to all materials doesn't necessarily engender greater creativity so you can decide how best to distribute materials for each set of partners or group.

**6. Improve** - Students will naturally tinker with their lifeboats. Remind them that their criteria for success is supporting the weight of 6 astronauts for 1 minute. Students will likely want to go beyond the time and weight considerations and try to make it float for longer and with greater weight.

**7. Ask / Reflect** - Have students share their discoveries and engineering designs. Younger students can share verbally while older students can record responses and then share out to the class.





## Emergency Rescue Vehicle

Engineer (s) \_\_\_\_\_

What is the engineering goal for this project? \_\_\_\_\_

\_\_\_\_\_

What kinds of designs might work to help the astronauts if they land in an ocean?

\_\_\_\_\_

Describe some ways we can discover which materials and vehicles work best for a water vehicle.

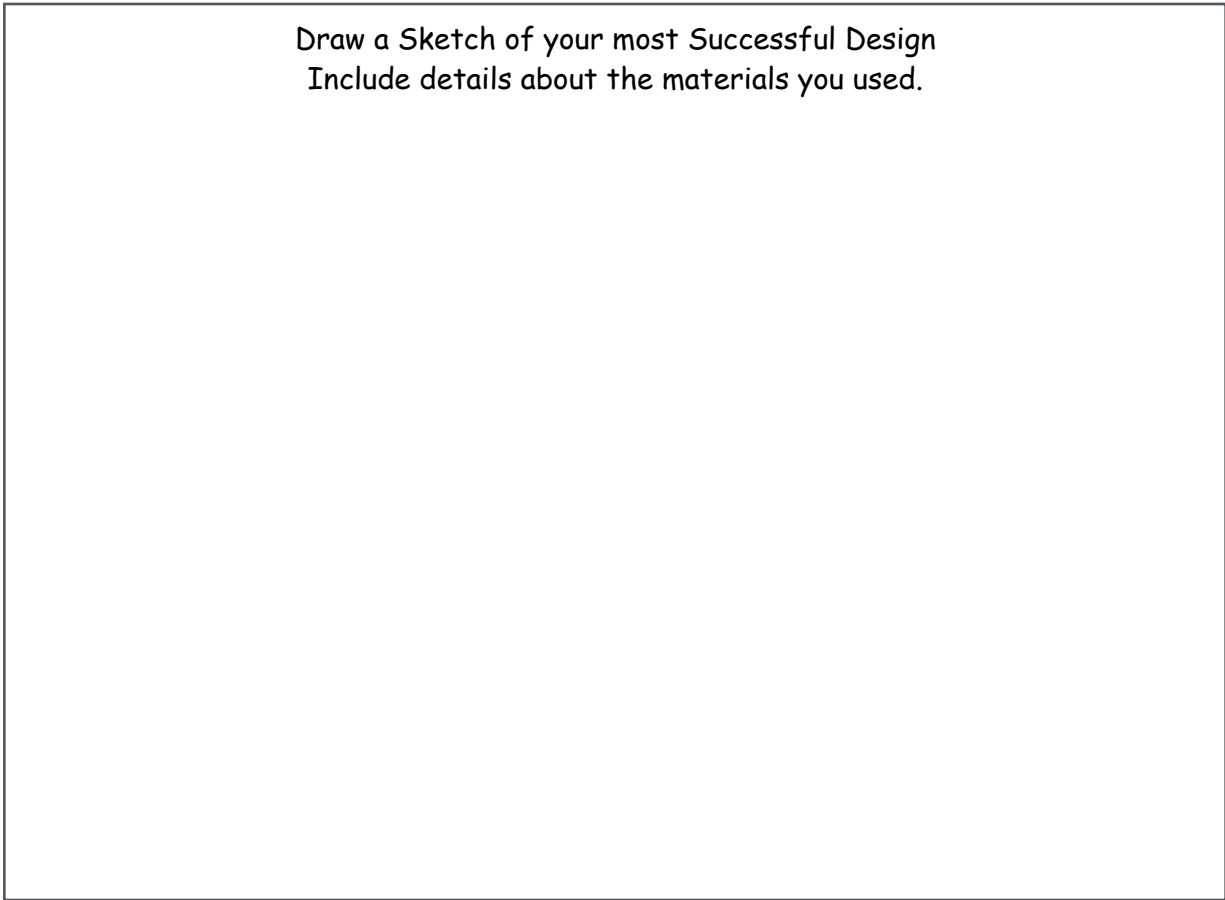
\_\_\_\_\_

\_\_\_\_\_

Draw a Sketch of your Emergency Rescue Vehicle  
Include details about the materials you will use.

A large, empty rectangular box with a thin black border, intended for a student to draw a sketch of their Emergency Rescue Vehicle. The box is positioned below the text instructions.

Draw a Sketch of your most Successful Design  
Include details about the materials you used.



What discoveries and solutions happened as you worked on your vehicle?

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What types of materials seemed best suited for creating a water vehicle?  
Why do you think they worked well?

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## Teacher Tips & Tricks

### What's going on scientifically in this lesson?

The children are really experimenting with **buoyancy**. The vehicles are displacing water. The hollowness of the vehicle means it will automatically be less dense than water because most of that empty space is filled with air. When the “astronauts” are placed on the vehicle their weight, combined with the air and the ship itself is still a lot less than the water that was displaced.

### How does this lesson relate to the real world?

NASA and other space organizations have been working for years to develop a vehicle that astronauts can use to return to Earth in case of an emergency on the International Space Station. There are different terms for such a vehicle, but a common one is Crew Return Vehicle (CRV). The main focus has been on designing a CRV that meets some engineering criteria;

Since it may be transporting astronauts that are already medically fragile, the CRV would ideally . . .

1. Have a minimal amount of g-forces exerted on its occupants.
2. Be capable of landing in autonomously in case the astronauts are incapacitated.
3. Allow a “shirt-sleeve” environment within it since injuries may prevent an astronaut from using a spacesuit.

In 2010 President Obama directed NASA to develop a rescue vehicle using its Orion technology, but those plans have fallen through and NASA is back to dedicating its focus to making Orion spacecraft serve only as a beyond low Earth orbit manned vehicle.

- NASA Videos about its next multi-purpose spacecraft Orion  
<http://www.nasa.gov/exploration/systems/mpcv/gallery/b-roll.html#.U7R4pNzob-Z>

- Video showing NASA concept CRV X-38 for emergency re-entry

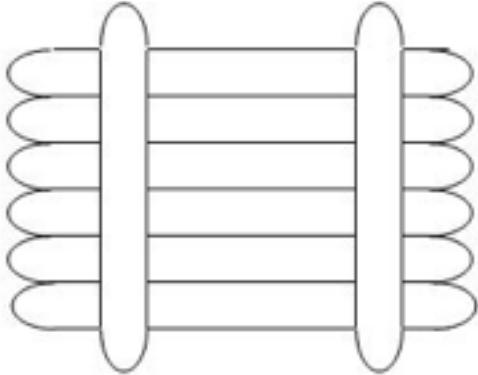
<https://www.youtube.com/watch?v=FEb9jpWV-g0>

### **What are some variations I can do in regards to the lesson or materials?**

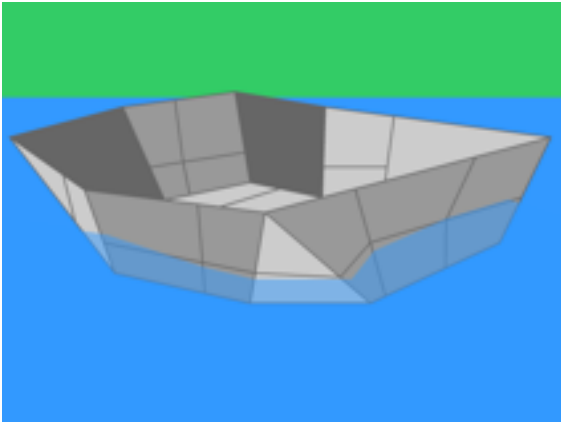
- When discussing the astronauts returning to Earth, toss an inflated globe around the room. When students catch the ball with two hands, have them say “land” or “water” (or one of each) depending on what their thumbs are touching on the globe. Keep a tally chart on the board as the globe travels around the room. Statistically, the number of thumbs landing on “water” should far outnumber those on “land”. This will show the need to have a return craft capable of landing in water.
- Increase the time or weight criteria, or both
- Have students weigh their various craft, record the data, and look for any patterns or insights based on what they find.
- The children can design sails or use balloons to propel their boats.
- Calculate the volume of vehicles by filling them with water (sand?) and pouring the water into a graduated cylinder or other measuring device.
- Build flat bottom crafts and experiment with how the placement of weights (such as pennies, math cubes or paperclips) affects its ability to stay afloat.
- Give students a choice of materials beyond what’s listed in this lesson. It’s amazing what children can come up with when given a variety of materials.

RAFT DESIGNS

Popsicle Stick Raft



Aluminum Foil Boat



Aluminum Foil Canoe



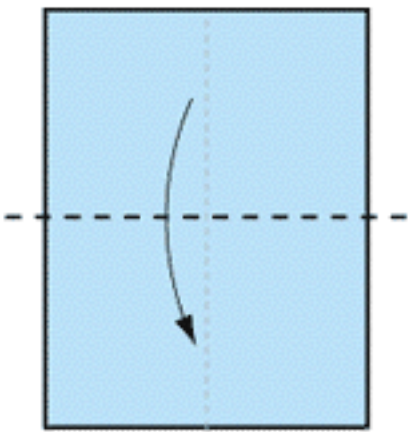
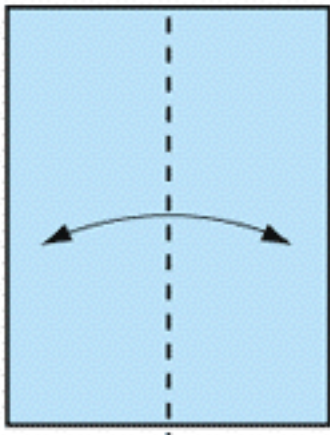
Paper Boat





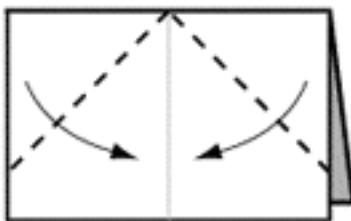
## Origami Boat Directions

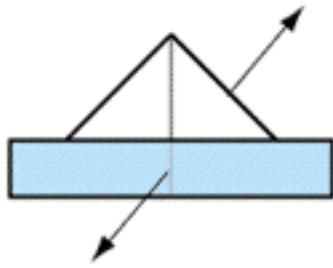
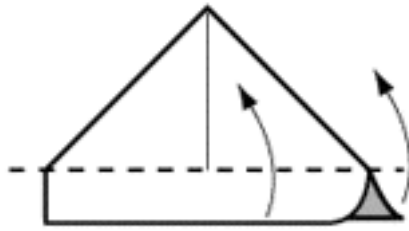
(Usually built with paper, but aluminum foil will work if you're careful)



1. Start with a rectangular piece of paper, coloured side up. Fold in half, then open.

2. Fold in half downwards.

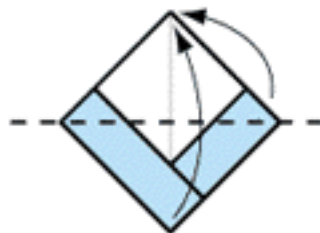


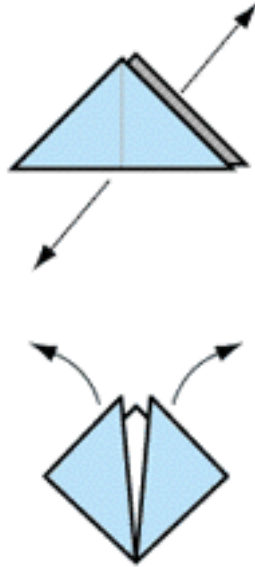


3. Bring corners in to centre line.

4. Fold uppermost layer upwards & do the same to the back. Crease well.

5. Pull the sides out and flatten.





6. Fold front layer up to top, & do the same to the back.

7. Pull the sides outwards and flatten.

8. Gently pull the top parts of the model outwards, making a boat shape.



9. Flatten well to crease all folds. Then open out slightly, forming a boat shape. Finished Boat.

