Regional Class Research Vessel

Oregon State University

Ocean Engineering Challenge: Save the Soup

Timeframe
45-60 minutes

Target Audience
Grades 4th- 12th

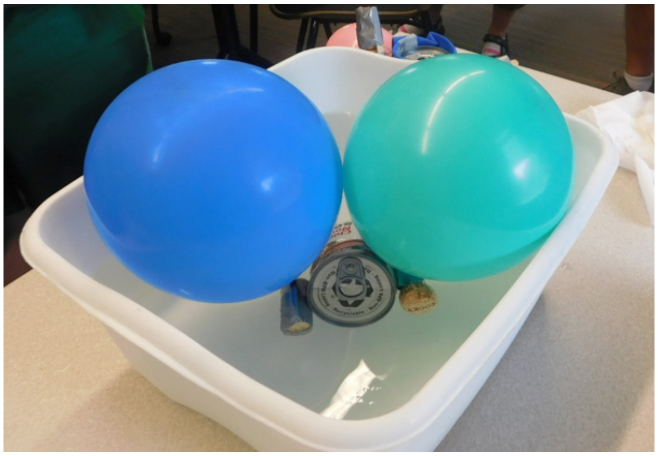
Suggested Materials
- Student Worksheets (optional)
- Cost Sheet (optional)
- Water Source
- Bucket or Sink area for Testing
- Soup or Vegetable Cans (must be identical for each team
- Paper Cups
- Straws
- Paper Towels
- Rubber Bands
- Paper Clips
- Tape
- Balloons
- Plastic Bags
- Glue
- Corks
- Foam Pieces
- String
- Foil
- Pipe Cleaners
- Small Containers
- Miscellaneous Items

Contact:
SMILE Program
smileprogram@oregonstate.edu
http://smile.oregonstate.edu/

Description
In this lesson, students will design, build, and test a "life jacket" or personal flotation device (PFD). The PFDs are a practical model of the influences of science, engineering, and technology on society. Each design team will test and evaluate their design relative to specific design criteria that allows students to revise and redesign their PFD within the constraints of the engineering design challenge.

Objectives
Students will:
- Learn about PFDs.
- Engage in the engineering of a PFD to meet specific criteria.
- Design, revise, and redesign their PFDs
- Evaluate design solution that best meet the design criteria.

Essential Question
How can we design a PFD for a can of soup that can be put on it by one group member in less than 20 seconds and allow it to float for more than one minute using the available supplies?



Background Information

Life jackets or Personal Flotation Devices (PFDs) first became widely used in 1854 when Captain Ward from the Royal National Lifeboat Institution in the United Kingdom. The first widely used PFD was made of cork for buoyancy and used vegetable oil pouches for comfort, protection, and insulation. Other materials were also used, such as air-filled pockets – punctured easily, horse hair – not durable, and other woods that proved too expensive. In the 1900s fine cotton was used, and by the 1960s synthetic foam became common in PFDs.

In the United States all PFDs must meet Coast Guard approval. They must also be in good and serviceable condition and the appropriate size for the intended uses. They must also be easily accessible so that they can be put on during an emergency. They cannot be stowed in locked containers, and should be worn at all times while a vessel is in motion. They have adult, youth, and child sized PFDs designed for near to offshore to specialized water activities.

1. Type 1 - Offshore Life Jackets

Next Generation Science Standards

PERFORMANCE EXPECTATIONS:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-EST1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

DISCIPLINARY CORE IDEAS:

Defining a Problem
Developing Possible Solutions
Optimizing the Design Solution

SCIENCE AND ENGINEERING PRACTICES:

Asking Questions and Defining Problems
Analyzing and Interpreting Data
Engaging in Argument from Evidence

CROSSCUTTING CONCEPTS:

Influence of Science, Engineering, and Technology on Society and the Natural World

2. Type 2 - Near-shore Vests

3. Type 3 - Flotation Aids

4. Type 4 - Throwable Devices

5. Type 5 - Special Use Devices

PFDs are also rated in the "Buoyancy Force," or weight they can support in rough conditions at sea. N for Newton is used as a unit of force. 4 Newtons (N) is equal to 1lbs of force.

50N – Buoyancy Aid

Designed for competent swimmers in sheltered water where help is close at hand. They only provide support to conscious people who can help themselves, and are an aid to flotation only. They have 50 Newtons (11 lbs.) of flotation.

100N – Life Jacket

For swimmers and non-swimmers in inshore waters. They give reasonable assurance of safety from drowning in relatively calm waters. Not guaranteed to self-right an unconscious user, and should not be expected to protect the airway of an unconscious person in rough water. They have 100 Newtons (22 lbs.) of flotation.

150N – Life Jacket

For swimmers and non-swimmers for use in all but the most severe conditions. They give reasonable assurance of safety to people not fully capable of helping themselves. May not immediately self-right an unconscious person wearing heavy waterproof clothing. Has 150 Newtons (33 lbs.) of flotation.

275N – Life Jacket

For swimmers and non-swimmers. A high performance device for offshore and severe conditions when maximum flotation is required or where heavy clothing or tools are worn. They give improved assurance of safety from drowning to people who are not capable of helping themselves while they cannot be guaranteed to self-right an unconscious person wearing heavy clothing or tools, they should in the great majority of cases. They have 275 Newtons (61 lbs.) of flotation.

Procedure

1. Setup testing area and materials prior to starting the lesson.

2. To introduce the lesson, consider asking the students whether they have ever worn a life vest and if they have heard of anyone whose life was saved by using one.

3. Use the PowerPoint and information provided to frame the engineering challenge for students.

4. Explain to them the PFD must be in one attached piece and able to be affixed to the can within a 20 second period (so students cannot just add foam or balloons to it for an hour – but they could assemble their flotation device and then put their can in it, or attach the can to it). Some portion of the can must touch the water and get wet. The can should not be placed in a boat, for example, where it would remain dry.

5. Teams of 3-4 students will consider their challenge, and develop a plan

for their design.

6. Teams then consider available materials and develop a detailed drawing showing their life vest including a list of materials they will need to build it.

7. Students build their soup can PFD, and test it, and also observe the PFDs developed and tested by other student teams.

8. Teams reflect on the challenge, and present their experiences to the class.

Wrapping-Up

Once students have built, tested, and revived their designs, have each group share out how their designs changed through the testing process. If using the student worksheet, you can have students work through the reflection questions.

Scaffolding/Extensions

Modeling the Forces Acting on the Soup Can
Students can draw a "force diagram" or "free model" of the forces acting on the soup can. You can have students draw the forces acting on the soup can in water and out of water. Each diagram should include: Neutral (or when in water Buoyant) Force that is in opposition of the gravitational force. When using models like this, make sure students are using length of the arrows to show the magnitude of the force acting on the soup can. When the soup can is in the water, the buoyant force provided by the PFD.

Phet at University of Colorado has an excellent simulator on basic forces that can support students thinking regarding the forces acting on the soup can. This also relates to the buoyancy ratings of each life jacket, as a Newton is the unit used to measure force on an object.

http://phet.colorado.edu/sims/html/forces-and-motion-basics-latest/forces-and-motion-basics_en.html

Cost Effective Solution

Students may rush through the design and testing phases. Therefore, it is important to have students think deeply about what materials they are using and how that impacts the design challenge. If you use the cost sheet provided, it will need to be updated to match your supplies. Encourage students to come up with the most cost effective solution by trimming down their original design or creating a new design. Allow each team to tabulate the supplies they get from you as they go, and allow teams to turn in un-used supplies.

References

1. This lesson was developed by Try Engineering and adapted here. The original lesson plan provides more background information and connections to additional standards.
   https://tryengineering.org/teacher/life-vest-challenge/

2. The Royal Navy Life Boat Institution is still in operation today and provides a real-time example of individuals using science and technology to support social needs. The website also provides a history of life saving measures used on the open seas.
   https://rnli.org/about-us/our-history/timeline/1854-first-lifejackets

3. The US Coast Guard has several webpages dedicated to PFDs and water safety. While this lesson is an engineering challenge, the practical real life understanding of how to use a life jacket and what one is, is very valuable for youth and adults.
   https://www.uscgboating.org/recreational-boaters/life-jacket-wear-wearing-your-life-jacket.php

Acknowledgments

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https://ceoas.oregonstate.edu/ships/rcrv