IEEE Lesson Plan:

Life Vest Challenge

Explore other TryEngineering lessons at www.tryengineering.org

Lesson Focus

Lesson explores the engineering behind life vests or personal flotation devices and the challenges met by these devices. Students work in teams to design and build a flotation device out of everyday materials that can keep an unopened can of soup or vegetables afloat in a bucket of water or sink for a minute. They design their life vest, build and test it, evaluate their designs and those of classmates, and share observations with their class.

Lesson Synopsis

The "Life Vest Challenge" lesson explores how engineers work to solve the challenges of a society, such as creating and improving devices that can help prevent loss of life in water. Students work in teams to devise a system using every day materials that can keep an unopened can of soup or vegetables afloat for at least a minute in a bucket of water or sink. Student teams sketch their plans, build their system, test it, reflect on the challenge, and present their findings to their class.

Age Levels

8-14

Objectives

- Learn about engineering design and redesign.
- Learn about personal floatation devices (PFDs).
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- engineering design
- safety and society
- teamwork

Lesson Activities

Students explore how engineers have solved societal problems such as developing and improving equipment that helps save lives in water emergencies. Students work in teams to develop a flotation device out of everyday materials than can keep an unopened can of soup or vegetables afloat for a minute in a bucket of water or a sink. They evaluate their results, and the results of other teams, and share their reflections with the class.

Resources/Materials

- Teacher Resource Documents (attached)
- Student Resource Sheet (attached)
- Student Worksheet (attached)

Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Personal Flotation Device Manufacturers Association (www.pfdma.org)
- BoatUS Foundation Life Jacket Design Competition (https://www.boatus.org/design/)

Recommended Reading

- What Floats? What Sinks?: A Look at Density (ISBN: 978-0761360551)
- Experiments with Water: Water and Buoyancy (ISBN: 978-1432923204)

Optional Writing Activity

- Write an essay or a paragraph describing how life vests have changed over the past 50 years as new technologies and materials have become available.

Optional Extension Activity

- Have students develop a system to keep a brick afloat in water.
- Have students consider how new materials might improve how life vest are used and how well they save people.

For Teachers:
Teacher Resource

Lesson Goal
"Life Vest Challenge" lesson explores how engineers work to solve the challenges of a society, such as creating and improving devices that can help prevent loss of life in water. Students work in teams to devise a personal floatation device or "PFD" using everyday materials that can keep an unopened can of soup or vegetables afloat for at least 1 minute in a bucket of water or sink. Teams sketch their plans, build their system, test it, reflect on the challenge, and present their findings to their class.

Lesson Objectives
- Learn about engineering design and redesign.
- Learn about personal floatation devices (PFDs).
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.
-

Materials
- Student Resource Sheets
- Student Worksheets
- Classroom Materials (water source, bucket or sink area)
- Student Team Materials: soup or vegetable cans (must be identical for each team), paper cups, straws, paper towels, rubber bands, paper clips, tape, balloons, plastic bags or lunch bags, glue, corks, foam pieces, string, foil, hose or tubes, small containers, paper towels, other items available in the classroom.

Procedure
1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. The device 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 floatation 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.
3. 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.
4. Teams of 3-4 students will consider their challenge, and develop a plan for their design.
5. 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.
6. Students build their soup can PFD, and test it, and also observe the PFDs developed and tested by other student teams.
7. Teams reflect on the challenge, and present their experiences to the class.

Time Needed
Two to three 45 minute sessions.

Student Resource:
What is a Life Vest or PFD?

A personal flotation device (abbreviated as PFD; also referred to as, lifejacket, life preserver, life vest, life saver, cork jacket, buoyancy aid, flotation suit, etc.) is a device designed to help keep a person or animal afloat -- whether they are conscious or not.

In most of the world, lifejackets or life vests are now mandatory on airplanes that travel over water. These usually consist of a pair of air cells or bladders that can be inflated by triggering the release of carbon dioxide gas from a canister -- or can be inflated by blowing into a tube with a one-way valve to seal in the air.

Lifejackets are also provided on both recreational and commercial seafaring vessels -- so all crew and passengers can wear one in an emergency. Not only people wear personal flotation devices; some are available for dogs and other animals to wear. Most people are familiar with the story of the Titanic, which struck an iceberg a century ago -- many know there were not enough lifeboats on board to rescue all the people, but interestingly, there were enough life-jackets (see example on the right) for all the people aboard, and most everyone was wearing one. Of course, in the frigid water of the North Atlantic, the life vests alone were not enough to save many people.

Simple flotation devices are used by many children learning to swim, and can be a vest or arm "bubbles."

◆ History and Inventors

The most ancient examples of "primitive life jackets" can be traced back to inflated bladders of animal skins or hollow, sealed gourds, for support when crossing deeper streams and rivers.

Personal flotation devices were not part of the equipment issued to naval sailors up to the early 19th century, for example at the Napoleonic Battle of Trafalgar. Seamen who were press-ganged into naval service might have used such devices to jump ship and swim to freedom. It wasn't until lifesaving services were formed that personal safety of boat crews heading out in pulling boats generally in horrific sea conditions was addressed.

Student Resource:
What is a Life Vest or PFD? (continued)

◆ **History and Inventors (continued)**
Purpose-designed buoyant safety devices consisting of simple blocks of wood or cork were used by Norwegian seamen. The modern lifejacket is generally credited to one Captain Ward, a Royal National Lifeboat Institution inspector in the United Kingdom, who, in 1854, created a cork vest to be worn by lifeboat crews for both weather protection and buoyancy.

The rigid cork material eventually came to be supplanted by pouches containing watertight cells filled with kapok, a vegetable material. These soft cells were much more flexible and more comfortable to wear compared with devices utilizing hard cork pieces. Kapok buoyancy was used in many navies fighting in the Second World War. Foam eventually supplanted kapok for "inherently buoyant" (vs. inflated and therefore not inherently buoyant) flotation.

◆ **The Goldfish Club**
In November, 1942, During World War II, C. A. Robertson was the Chief Draftsman at the United Kingdom's PB Cow & Co., one of the world's largest manufacturers of air-sea rescue equipment. He formed "The Goldfish Club" after hearing of the experiences of airmen who had survived a "ditching" at sea. The club was reserved for airmen who owed their lives to their life jacket, or flotation device! By the end of World War II, the club had 9,000 members from all branches of the Allied Forces. Find out more at www.thegoldfishclub.co.uk.

◆ **Innovation in Life Jacket Design Competition**
Each year, the U.S. Boat Association sponsors the "Innovation in Life Jacket Design Competition" to encourage and solicit innovative ideas to revolutionize the design of life jackets that the majority of average boaters might wear. In one of the challenges, the first place winner was the "See-Tee," a design from Jeff Betz of the Troy, NY based Float-Tech Inc. This isn't Betz's first life jacket innovation - his company started as the result of a graduate school project that designed the firm's first non-traditional inflatable life jacket based on a foul weather coat. The Sea-Tee is a standard shirt that many water sports enthusiasts are used to wearing - but with a twist. It has a built-in inflatable bladder similar to most inflatable life jackets. Find out more at https://www.boatus.org/design/.

Student Worksheet:

◆ Engineering Teamwork and Planning
You are part of a team of engineers given the challenge of developing a personal floatation device (PFD) or life vest out of everyday materials that can provide enough support to float an unopened can of soup or vegetables for at least one minute. There are some rules:

1. The device must be in one attached piece and able to be affixed to the can within a 20 second period
2. Some part of the can itself must be touching the water.

◆ Research Phase
Read the materials provided to you by your teacher. If you have a life jacket or vest at home take a look at the design and consider the materials used in manufacture. Also consider all the materials provided by your teacher and how they might be used to create a system that can be quickly attached to the can -- in 20 seconds.

◆ Planning and Design Phase
Draw a diagram of the PFD you will build for the can…be sure to make a list of all the materials you will need for the construction phase.

Materials you will need:

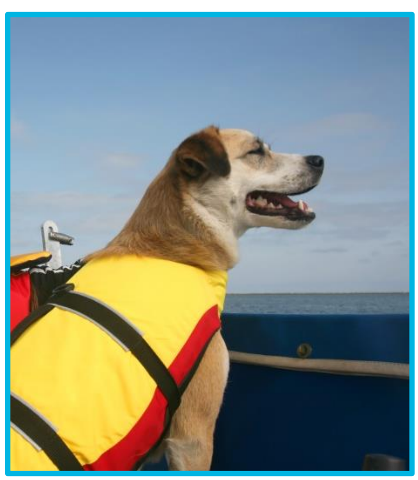
Student Worksheet (continued):

◆ **Presentation Phase**
Present your plan and drawing to the class, and consider the plans of other teams. You may wish to fine tune your own design.

◆ **Build it!**
Next build your PFD. You can practice putting it on and taking it off the can so you are within the 20 second limit, but you'll only have one chance to test it -- under the supervision of your teacher. During the building phase, you may share unused building materials with other teams -- and trade materials too. Be sure to watch what other teams are doing and consider the aspects of different designs that might be an improvement on your team's plan.

◆ **Test it!**
You'll test your PFD along with other student teams and earn points in the grid below.

PFD on can within 20 seconds? Yes 30 points No 0 points	Float time: 1 minute: 70 points 45 seconds: 45 points 30 seconds: 30 points 15 seconds: 15 points Never floats: 0 points	Total Score?



Student Worksheet (continued):

◆ **Reflection**
Complete the reflection questions below:

1. Were you able to design a PFD for the can that you could put on the can in 45 seconds? Was this part of the challenge harder than you thought? Why or why not?

2. Did you redesign your PFD after presenting your drawing to the class? Why or why not?

3. How similar was your final drawing to the actual PFD your team built to support the can?

4. If your team found it needed to make changes during the construction phase, describe why the group decided to make revisions.

5. Which PFD in your class worked best? What was it about that design that made it superior?

6. Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?

7. If you could have used one additional material (tape, glue, wood sticks, foil -- as examples) which would you choose and why?

8. Do you think your design is scalable? Would it work efficiently if it had to float a brick or a bicycle? Why or why not?

For Teachers:
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:
- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆National Science Education Standards Grades K-4 (ages 4-9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop
- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of
- Properties of objects and materials
- Position and motion of objects

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop
- Abilities of technological design
- Understanding about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of
- Personal health
- Types of resources
- Science and technology in local challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of
- Science as a human endeavor

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop
- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of
- Properties and changes of properties in matter
- Motions and forces

CONTENT STANDARD E: Science and Technology

As a result of activities in grades 5-8, all students should develop
- Abilities of technological design
- Understandings about science and technology

For Teachers:
Alignment to Curriculum Frameworks

◆**National Science Education Standards Grades 5-8 (ages 10-14)**

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Risks and benefits
- Science and technology in society

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor
- History of science

◆**National Science Education Standards Grades 9-12 (ages 14-18)**

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Motions and forces
- Interactions of energy and matter

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Personal and community health
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor
- Historical perspectives

◆**Next Generation Science Standards Grades 2-5 (Ages 7-11)**

Matter and its Interactions

- 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

- 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

For Teachers:
Alignment to Curriculum Frameworks

◆**Next Generation Science Standards Grades 2-5 (Ages 7-11)**

Engineering Design

Students who demonstrate understanding can:

- 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-ETS1-2.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.

◆**Next Generation Science Standards Grades 6-8 (Ages 11-14)**

Engineering Design

Students who demonstrate understanding can:

- 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.

◆**Next Generation Science Standards Grades 9-12 (Ages 14-18)**

Engineering Design

Students who demonstrate understanding can:

- 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.

◆**Standards for Technological Literacy - All Ages**

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology.

For Teachers:
Alignment to Curriculum Frameworks

◆**Standards for Technological Literacy - All Ages**

Design

- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.
- Standard 13: Students will develop abilities to assess the impact of products and systems.