



Lesson Focus

This lesson focuses on the tools and equipment used during technical rescue operations. Teams of students construct rescue devices from everyday materials. They then test their devices to determine whether they can rescue a puppy from a sewer.

Lesson Synopsis

The "Rescue Rover" lesson explores how rescue devices are designed to aid professionals during emergency situations. Students work in teams of "engineers" to design and build their own rescue device out of everyday items. They test their rescue device, evaluate their results, and present to the class.

Age Levels

8-18.

Objectives

- ✦ Design and build a rescue device
 - ✦ Test and refine their designs
 - ✦ Communicate their design process and results
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Anticipated Learner Outcomes

As a result of this lesson students will have:

- ✦ Designed and built a rescue device
 - ✦ Tested and refined their designs
 - ✦ Communicated their design process and results
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Lesson Activities

In this lesson, students work in teams of "engineers" to design and build their own rescue device out of everyday items. They test their rescue device, evaluate their results, and present to the class.

Resources/Materials

- ✦ Teacher Resource Documents (attached)
 - ✦ Student Worksheets (attached)
 - ✦ Student Resource Sheets (attached)
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Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- ✦ Hurricane Katrina Rescue (<http://videos.howstuffworks.com/discovery/35043-coast-guard-rescue-hurricane-katrina-video.htm>)
- ✦ TryEngineering (www.tryengineering.org)
- ✦ ITEA Standards for Technological Literacy: Content for the Study of Technology (www.iteaconnect.org/TAA)
- ✦ National Science Education Standards (www.nsta.org/publications/nses.aspx)

Recommended Reading

- ✦ Engineering Practical Rope Rescue Systems by Mike Brown (ISBN: 978-0766801974)

Optional Writing Activity

- ✦ Write a newspaper article detailing the daring rescue of the puppy from the sewer.

Rescue Rover



For Teachers: Teacher Resources

◆ Lesson Goal

The goal of this lesson is for students to design and build a rescue device out of everyday materials. The device must be able to rescue a puppy from a sewer within three minutes from a height of at least one meter.

◆ Lesson Objectives

- ✦ Design and build a rescue device
- ✦ Test and refine their designs
- ✦ Communicate their design process and results

◆ Materials

- ✦ Wastebasket (for the sewer)
- ✦ Small stuffed animal puppy
- ✦ Clock or stopwatch
- ✦ 3 meters of string
- ✦ Construction paper
- ✦ Plastic bags
- ✦ Paperclips
- ✦ Brass fasteners
- ✦ Rubber bands
- ✦ Binder clips
- ✦ Clothespins
- ✦ Paper cups
- ✦ Paper plates
- ✦ Popsicle sticks
- ✦ Plastic spoons
- ✦ Tape
- ✦ Meter stick
- ✦ Weights (coins, washers etc.)
- ✦ Scale

◆ Procedure

1. Before the lesson, ask students if they have ever seen person or animal being rescued from a dangerous situation on the news or on TV. Invite students to share what types of situations prompted these rescues and what type of equipment was involved. Discuss that engineers must design equipment to stand up to the various challenges involved in rescue operations.
2. Show students the various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.
3. Divide students into groups of two, providing a set of materials per group.
4. Explain that students must design a rescue device that can save a puppy (weighing approximately 250 grams) from a sewer from a height of one meter in under three minutes. Coins or metal washers can be used to add weight to the puppy. For older students, the height and weight specifications can be increased (e.g. use a heavier puppy, two puppies etc.). If studying simple machines, students can receive a time bonus (e.g. extra 30 seconds) for each simple machine they incorporate into their design.
5. Students meet and develop a plan for their rescue device. They agree on materials they will need, write or draw their plan, and then present their plan to the class.
6. Next, student groups execute their plans. They may need to rethink their plan, request other materials, trade with other teams.
7. Teams then complete an evaluation/reflection worksheet, and present their findings to the class.

◆ Time Needed

- ✦ 1-2 forty-five minute class periods



Student Resource: Technical Rescue

◆ Technical Rescue Equipment

Technical rescue operations are used by professionals in extreme emergency situations. Natural disasters, structural collapses or serious accidents sometimes cause victims to become trapped in confined or complex spaces. These types of emergencies require rescue professionals to use above and beyond normal means to reach and attend to victims. In these instances, specialized tools and skills are needed to save lives. Engineers must design rescue equipment to meet the demands of these very difficult rescue operations.

◆ Rescue from Above

In certain emergencies, rescue operations must be conducted from above. These situations might involve rescuing a person or animal from a cave, mountain, mine or rooftop. After devastating hurricane Katrina hit the US in 2005, many people needed to be rescued from their rooftops via helicopter due to extreme flooding. A rope rescue involves the use of nylon ropes, anchors and a system of pulleys to rescue victims from a height. Rope rescues use mechanical advantage to lift victims to safety. Rescuers must be skilled in rappelling and securely tying various types of knots when conducting a rope rescue. A mine rescue can be particularly challenging due to fires, explosions, floods, hazardous gases, or cave-ins, necessitating additional rescue equipment and techniques.



Rope rescue

◆ Rescue in Moving Water

When a victim is rescued from moving water, such as rivers or flood control channels, this is also known as "swiftwater rescue". These rescues typically occur during flood situations or boating or whitewater rafting accidents. Rope rescue equipment and techniques are often used in these situations. However, due to the fact that moving water is involved, stronger equipment and greater precision is needed when rescuing a moving target. Professionals conducting swiftwater rescue need to have an understanding of the physics of water moving within a channel to know how to identify where danger and safety lie. They must also understand the motion of objects such as debris, cars, and people in moving water. There are many challenges involved in swiftwater rescue including obstacles, bends, entrapments and hypothermia. Victims may be rescued by being pulled to safety with ropes or objects, using flotation devices, through direct contact or by helicopter.

◆ Rescue from a Confined Space

Sometimes a person or animal must be rescued from a confined space such as a sewer, silo or underground vault. In these situations, time is of the essence because oxygen may be limited in these small spaces. Ventilation equipment must be used to ensure that victims and rescue professionals get enough oxygen and are not exposed to toxic gases. Video and sound equipment is often used to see and hear the victim trapped in the confined space. A piece of equipment known as a wristlet is often used to free trapped victims from confined spaces. The wristlet gets looped and pulled around the victim's wrist or ankle and then used to pull the victim from the space.

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Student Resource (continued): Technical Rescue

◆ Ski Rescue

Rescues often need to be conducted in snowy conditions. These types of rescue techniques are employed during skiing or snowboarding accidents or during avalanches. Professionals who are trained to assist and rescue people in these situations are known as the Ski Patrol. The Ski patrol often uses equipment such as helicopters, rope rescue gear, toboggans and snowmobiles during rescue operations.

If a victim has been buried by snow in the case of an avalanche, beacons or probes may be used. A beacon is a piece of equipment which uses radio signals to communicate with another beacon worn by the victim. The closer one gets to the victim, the louder the beacon beeps. A new type of beacon known as a digital avalanche rescue dog has also recently been developed, which is programmed to work using cell phones. Once the general vicinity of the victim is known, a long stick-like instrument known as a probe can then be pushed into the snow find his or her precise location. Suffocation is a serious risk for victims buried in an avalanche. To help prolong survival time, Denver psychiatrist and avid skier Dr. Thomas Crowley invented a sling-like device called the Avalung. The Avalung provides oxygen to a victim buried in an avalanche by drawing in fresh air from the snowpack, and diverts away carbon dioxide. The Avalung can buy rescuers additional time when attempting to locate and reach a trapped victim.

◆ Vehicle Rescue

When car accidents occur, victims sometimes become trapped in their vehicles. In some cases, a vehicle becomes so damaged that the doors can't be opened, or a victim gets pinned in a seat or is unable to exit the vehicle due to an injury. Hydraulic rescue equipment, including cutters, spreaders and rams (also known as the Jaws of Life) must often be utilized in these situations. Cutters are used to cut through metal components of the automobile, such as the frame. Spreaders are used to pull apart pieces of the automobile that may have been crunched together during an accident. Rams are used to push parts of the automobile such as the dashboard, away from a victim. These tools save precious time when trying to reach a trapped victim.



Jaws of Life

◆ Rescue from a Collapsed Structure

When a building or mine collapses, victims may be trapped beneath mountains of debris. In this scenario, rescue professionals must use various techniques to either lift or steady the debris. This is a dangerous operation because there is the risk that the debris can further injure the victim. Sometimes rescue professionals can dig out victims manually. In other cases levers or inflatable devices can be used to lift debris up off of a victim. Cranes, bulldozers, saws, chains, cables, and ropes may be used to remove larger types of debris. Debris can also be stabilized by creating a wooden structure, known as a crib, which is placed beneath the debris. After a magnitude 7.0 earthquake occurred in Haiti in January 2010, rescue professionals and residents used many of these techniques to rescue and recover thousands of victims trapped beneath debris from collapsed structures.

Rescue Rover



Student Worksheet: Design a Rescue Device

You are a team of engineers who have been given the challenge to design a device that will be able to rescue a puppy from a sewer from a height of one meter. There is limited oxygen in the sewer so it is critical that you rescue the puppy within three minutes.

◆ Planning Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a design for your rescue device. You'll need to determine what materials you want to use.

Draw your design in the box below, and be sure to indicate the description and number of parts you plan to use. Present your design to the class.

Design:

Materials Needed:

You may choose to revise your teams' plan after you receive feedback from class.

◆ Construction Phase

Build your rescue device. During construction you may decide you need additional materials or that your design needs to change. This is ok – just make a new sketch and revise your materials list.

Rescue Rover



Student Worksheet (continued): Design a Rescue Device

◆ Testing Phase

Each team will test their rescue device. Be sure to watch the tests of the other teams and observe how their different designs worked.

◆ Evaluation Phase

Evaluate your teams' results, complete the evaluation worksheet, and present your findings to the class.

Use this worksheet to evaluate your team's results in the "Rescue Rover" lesson:

1. Did you succeed in creating a device that could rescue a puppy from a sewer in under three minutes? If so, how long did it take? If not, why did it fail?

2. Did you decide to revise your original design or request additional materials while in the construction phase? Why?

3. Did you negotiate any material trades with other teams? How did that process work for you?

4. If you could have had access to materials that were different than those provided, what would your team have requested? Why?

Rescue Rover



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 the 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

CONTENT STANDARD E: Science and Technology

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

- ✦ Science and technology in local challenges

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

CONTENT STANDARD A: Science as Inquiry

As a result of the 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

- ✦ Motions and forces

CONTENT STANDARD E: Science and Technology

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

- ✦ Science and technology in society

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

CONTENT STANDARD A: Science as Inquiry

As a result of the 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 understanding of

- ✦ Motions and forces

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For Teachers: Alignment to Curriculum Frameworks (cont'd)

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

CONTENT STANDARD E: Science and Technology

As a result of the 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 the activities should develop an understanding of

- ✦ Science and technology in local, national, and global challenges

◆Next Generation Science Standards Grades 3-5 (Ages 8-11)

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-ETS1-2 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

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.