Engineering for Reuse

Overview

A video introduction describes how a science teacher creates a bicycle-driven apple grinder that uses human power to reduce food waste and save electricity. Students then design their own person-powered food-preparation machines.

Guiding Question

How can we use human power as an energy source to do things?

Objective

Students will be able to design a person-powered food-preparation machine.

Background

In pre-industrial times, human power did everything from cooking to constructing irrigation systems. Domestic animals helped with agricultural and industrial tasks. Later, people used moving wind and water to power mills and machines. Eventually, humans invented engines (which use the expansion of steam or burning fuel as a source of motion) and motors (which convert electrical energy into motion). Today, engines and motors do an enormous amount of both household and industrial work.

While engines and motors save labor, they have environmental costs as a result of extracting fuel, generating electricity, or releasing pollution. One way to reduce the harm caused by using fossil fuels for energy is to return to human power. However, humans can still use engineering to make that power more efficient, such as by pedaling a bicycle to quickly grind apples. A machine such as this makes preparing food easier by transferring energy from one place to another.

Time: 15–20 minutes

Grade Level: 4

Vocabulary

- **Gear**
- **Design**
- **Transfer**

Standards

NGSS 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

NGSS 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.

Preparation

For this activity, the educator will need the following:

- *Video: Engineering for Reuse* (2:30)
- A way to show the video to students

For this activity, each student will need the following:

- 1 copy of *You Have the Power* (English | Spanish | Answer Key)
- 1 pen or pencil

EiE® Connections

Learn more about the Engineering Design Process in the EiE Video Library.

Continue your classroom activities with these units:

Engineering Essentials™

- *Designing Solar Ovens*

Engineering is Elementary®

- *Designing Solar Ovens*
- *Designing Windmills*
- *Making Work Easier*

Engineering Adventures®

- *Engineering Recycled Racers*

Museum of Science Connections

The *Engineering Design Workshop,* Powered by *MathWorks* includes real stories of people using the engineering skills of creativity, breaking down problems, and iteration. Access these videos online through the *Engineering Stories virtual exhibit.*

Family Connections

Continue the engineering at home with these activities:

- Pass the Peppers!
- Bye Bye Bug!

Continue the learning at home with these games:

- I Spy Technologies
- Technology Categories
- The Technology Deck

Credits

The Engineering for Reuse video was developed with the generous support of MathWorks, Sophia and Bernard M. Gordon, Margaret and Jim Wade, and Jack Turner and Tee Taggart.

Engineering for Reuse

Activity Instructions

These steps offer support for implementing the *Engineering for Reuse* video introduction and follow-up activity with students.

1. Before showing the video introduction, discuss these questions:

Q: What is your favorite meal?

A: Accept all responses.

Q: It can be a lot of work to get food ready to eat. What kinds of jobs might need to be done to prepare your favorite meal?

A: Accept all responses. Possible responses include chopping vegetables, stirring sauce, and heating up food.

2. Engineers have designed machines such as blenders and microwaves that can do some of these food preparation jobs for us. However, many of these machines are powered by electricity. Electricity is sometimes made by burning coal, oil, or gas.

Q: How does burning coal, oil, or gas to make electricity cause problems in the environment?

A: Possible responses include causing air pollution and contributing to climate change.

Q: How could we make preparing food easier without using electricity?

A: Accept all responses.

3. Play the video Engineering for Reuse (2:30). The video shows how a science teacher builds and improves a person-powered machine to grind up unused apples to make cider.

watch video

4. After showing the video, discuss these questions:

Q: Why does this teacher build a machine to grind up apples?

A: He wants to make a lot of cider without using too much energy.

Q: How does the machine in the video grind the apples?

A: The apples bounce against a rotating drum covered with screws, which grinds them up.

Q: What makes the machine move?

A: A person pedaling a bicycle.

5. Explain to students that the bicycle uses transfer, or the movement of something, such as energy, from one place to another, to make it easier to grind up the apples. A person adds energy in the form of motion by pedaling. Pause the video at 1:47 and identify how the pedals turn around an axle, which turns gears connected by a chain. The gears, or toothed wheels, can change the direction or the size of the force. The chain transfers the energy to the drum of the apple grinder. Remind students that most kitchen machines also make motion, but they are powered by electricity instead of a person.

6. Distribute the You Have the Power (English | Spanish) handout to students and introduce the follow-up activity. Tell students that they will choose a machine or tool that helps make food and design a way to make it person-powered so that it doesn't harm the environment. Students can start with an electric appliance such as a blender or a simple tool such as a potato masher, or they can make up a new invention.

7. Have students describe or draw a design, or a plan for how to create a solution to a problem, for a person-powered machine. If you have the time and materials, allow students to experiment with interlocking gear toys to observe how gears can be used to transfer energy. If time allows, have each student share their design with a partner.

8. After students brainstorm their ideas, encourage them to improve their designs by asking the following question:

Q: What problems did the teacher have while building the machine, and how did he solve them?

A: Responses include the hand-powered crank being too tiring, which he solved by using a bicycle and the bicycle chain falling off, which he solved by using an exercise bike.

Encourage students to think about their designs and the problems they might have. Testing and improving designs is an important part of the engineering design process. Ask:

Q: When you imagine your design at work, what problems do you think might happen? Could it be tiring? Could it be dangerous to use in a kitchen?

A: Accept all responses.

Q: How could you improve your design?

A: Accept all responses. Possible responses include finding materials to build with, planning the design in detail, or asking more questions.

1. Wrap up by discussing these questions:

Q: How did you transfer energy from human movement to your machine?

A: Accept all responses.

Q: What are the advantages of your person-powered machine, and what are the disadvantages?

A: Accept all responses.

Q: How can we use human power as an energy source to do things?

A: We can use energy from a person to move parts of a machine. Then the machine can transfer this energy to different locations in order to do work.

Glossary

Design
a plan for how to create a solution to a problem

Gear
a toothed wheel that can change the direction or size of a force

Transfer
the movement of something, such as energy, from one place to another