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Lesson Focus

Lesson focuses on how engineers improve assistive devices such as a cane to meet the needs of the elderly. Students work in teams to re-engineer a cane for a "client." They are assigned a client profile, develop a design to suit the needs of the user, and those in older grades build a working prototype of their design.



Lesson Synopsis

The "Engineer a Cane" activity explores customization of assistive devices. Students work in teams to reengineer an existing assistive device integrating technology to meet the needs of a "client." They present their new designs to the class; older students will build a prototype of their new device.

Age Levels

8-18.

Objectives

- ◆ Learn about assistive devices and technology.
- ◆ Learn about engineering design and redesign.
- ◆ 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:

- ◆ assistive devices and technology
- ◆ interaction of technology and societal issues
- ◆ engineering design
- ◆ teamwork

Lesson Activities

Students explore the impact of assistive technology on meeting the needs of society. They work in teams to reengineer an assistive device -- in this case a cane -- to meet the needs of a client. They develop a new design with features to assist the client's specific needs, present new designs to their class, and older students will develop a prototype of their design.

Engineer a Cane

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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)
- ◆ Assistive Technology Industry Association (www.atia.org)
- ◆ Microsoft Accesibility (<https://www.microsoft.com/en-us/accessibility/>)

Recommended Reading

- ◆ The Illustrated Guide to Assistive Technology and Devices: Tools and Gadgets for Living Independently (ISBN: 978-1932603804)
- ◆ 21st Century Complete Medical Guide to Assisted Living and Assistive Devices (ISBN: 978-1592486830)
- ◆ Assistive Devices, Adaptive Strategies, and Recreational Activities for Students with Disabilities (ISBN: 978-1571674999)

Optional Writing Activity

- ◆ Write an essay or a paragraph about how technology has improved assistive devices over the past ten years. How has technology and engineering improved the day to day lives of people or animals living with physical challenges?

Optional Extension Activity

- ◆ Involve a person at your school who may have physical challenges to participate in this project. Have them describe the tools they might need to help improve their mobility or the ability to accomplish a task such as picking up a cup, or carrying a package while walking with a cane or walker. Then have students work in teams to create an engineered support device.

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For Teachers: Teacher Resource

◆ Lesson Goal

Lesson focuses on how engineers improve assistive devices such as a cane to meet the needs of the elderly. Students work in teams to re-engineer a cane for a "client." They are assigned a client profile, develop a design to suit the needs of the user, and those in older grades build a working prototype of their design.

◆ Lesson Objectives

- Learn about assistive devices and technology.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

◆ Materials

- Student Resource Sheets
- Student Worksheets
- Wooden cane (about \$10), additional materials based on student designs might include flashlights, bulbs, batteries, wires, GPS devices, fabric, rubber feet, pvc piping, tape, paint, buzzer device, or other materials.

◆ Procedure

1. Show students the student reference sheet. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider asking the students how engineers develop assistive devices such as wheelchairs and walkers. Prompt them to think about someone they know who has challenges in movement, such as someone who has broken a leg, or an elderly person with arthritis. Have them consider how listening to someone who might use a product might impact the final product design.
3. If possible, have students discuss how at any age, people may need assistive devices to help them complete daily tasks. They may discuss individuals they know and consider the various devices and equipment they use to help them.
4. Assign each team of 2-3 students one of the "client" profiles which are attached. Explain that they are working as a team of engineers to reengineer a cane -- which is an assistive device -- to meet the specific needs of the client. Alternatively, you may have a real person in your school or community who could be the "client."
5. Teams consider their client's needs and determine what technology or other features could be added to the cane to help the individual. Teams research the cost of each addition and also draw a diagram of their cane either on paper or via design software.
6. Teams next present their designs to the class, along with an itemized cost for manufacture. You may wish to encourage student teams to add a consulting or engineering design fee to their design.
7. If budget allows, older students may build a prototype of their new cane to explore how the design may change during implementation.

◆ Time Needed

One to two 45 minute sessions.

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Student Resource: **What are Assistive Devices?**

Assistive devices are used to help people with disabilities at various stages of life. Someone may break a leg and need crutches for mobility until their leg heals, or an elderly person may not have confidence in walking and need the support of a sturdy walker to maintain balance and to be able to walk with confidence.

Many are not designed as assistive devices for people with disabilities, but to make life easier for anyone--for instance, a sound sensitive light switch. In the kitchen, eating and cooking utensils can be fitted with oversized handles for easier gripping. This "assistive device" can enable an 85 year old with arthritic fingers and hands to continue to prepare meals for themselves.



Another kitchen-related assistive device is an automatic feeder, controlled by a chin switch or and hand/foot switch, so that people who cannot hold eating utensils due to tremor or spasticity of the hands and arms can feed themselves.

Assistive devices are frequently found in the bathroom. Grab bars around the tub are easily installed and help prevent falls. Shower benches, bathtub lifts and a door on the bathtub not only alleviate some need for human assistance, but make it easier to shower and reduce the risk of slipping.



In the bedroom, guard rails around the bed can make it easier and safer get in and out of bed. Bedside controls for lights and other appliances increase the ability of mobility impaired people to control the lighting, temperature or other conditions of their home without getting out of bed.

For the functionally impaired elderly living in multi-level housing, wheelchair lifts and stair-climbs allow for full access and mobility throughout the house. Individuals with hearing impairments can benefit from a simple blinking light instead of a doorbell. Large handled combs and brushes and velcro fasteners for clothing help people with limited manual fine motor abilities.

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Student Resource: **What are Assistive Devices?**

◆ **Canes**

A cane can serve several different functions to meet the needs of a user: it can aid in balance, it can support a weakened or painful limb or joint, and it can aid in sensing the environment. There are many types of canes, and they often are designed to meet the needs of a specific population of people. For example, "white canes" are designed to assist the visually impaired. They are longer and thinner and allow the user to "feel" the path ahead. They also alert others, such as motorists, to know the user is blind and therefore use caution. In the United Kingdom, red banding on a white cane indicates a deaf-blind user.

◆ **Types of Canes**

There are many types of canes, from basic wooden designs that can be manufactured inexpensively, to more technologically advanced devices. Basic types include folding canes that may have several joints and are usually connected by an internal elastic cord, quad canes that have four legs at the base so they can stand on their own and can be more stable, tripod canes which open in tripod fashion and sometimes include a seat for resting, adjustable canes that can be made shorter or taller to meet the height of the user, canes with straps so they cannot fall away from the user, lighted canes that help a user in dark places, and even some equipped with a buzzer or doorbell device that can alert others that the user needs help. For use on ice, there are metallic cleats that can be used to help the user stay safe when walking on slippery surfaces. And, there are many different handles available to match the size of the user's hands and their medical needs.



For use on ice, there are metallic cleats that can be used to help the user stay safe when walking on slippery surfaces. And, there are many different handles available to match the size of the user's hands and their medical needs.

◆ **Material Selection**

The materials selected for manufacturing a cane can be determined by many factors including the strength, weight, and durability required. For example, an aluminum cane would be much lighter than one made of steel. This might be preferred by an elderly person without much strength in their arms.

Student Worksheet:
Applying Technology to Solve Problems

You are a team of engineers who have been given an assignment to work with a client to develop a new assistive device to meet their needs. You'll start with a standard wooden cane and re-engineer it with additional devices and features to meet the client's specific needs. Likely the resulting device will be useful to a broader population as well, and could be marketed to others and become a profitable product for the company you work for. You'll need to develop a construction budget for your new cane so that the client can consider the cost of the new device. Sometimes engineers will develop prototypes and test a new design before moving into a broad manufacturing and marketing scheme.

◆ **Research/Preparation Phase**

1. Review the various Student Reference Sheets to learn about assistive devices and how they help people. You'll also read a press release about a student group who actually invented a new product while working on an engineering challenge.
2. As a group, discuss how at any age people may need assistive devices to help them complete daily tasks. If you know of any individuals who use assistive devices, you can discuss the various devices and equipment they use to help them.

◆ **Investigation Phase**

1. You are on a team of 2-3 engineers and have been assigned a "client" who is seeking to reengineer their cane to meet their specific needs.
2. Review the profile you have been provided and discuss what technology or other features could be added to the cane to help the individual.
3. Research the cost of each addition and list each part in the box below, or use another sheet:

Parts You'll Need	Cost Per Needed Item
	Total:

***Student Worksheet:
Applying Technology to Solve Problems***

◆ **Design Phase**

1. Draw a diagram of what your new cane will look like in the box below, and label each new part you have added or adjusted.

◆ **Presentation Phase**

1. Teams present their designs to the class, along with an itemized cost for manufacture. You may wish to encourage student teams to add a consulting or engineering design fee to their design.

◆ **Optional Prototype Phase**

1. If budget allows, older students may build a prototype of their new cane to explore how the design may change during implementation.

Student Worksheet:
Client Profile - Suzanne MacMillan

◆ **Situation**

Suzanne is an 80 year old woman living in a retirement home in Australia. Like many others her age, she has some difficulty moving around, yet wishes to remain active in her community. She was a talented actress when younger and now acts in a short play every few months within her retirement home.

During rehearsals and performances, Suzanne needs to move quickly around on the tile floor of the cafeteria where the play will be performed. She often uses a walker to move from her room to the lobby, but she would prefer to use a cane for performances. Sometimes it is dark with only a spotlight on certain actors, so it is hard for her to see the floor when she is moving around.



Suzanne is right handed, and will be wearing gloves during the upcoming play she is in. She also is not expected to memorize her lines, but can carry note cards with her to read from. She is five feet tall, and slim. She uses reading glasses to read fine print words.

Can you help Suzanne design a cane that will be perfect for the performance?

Notes/Observations:

Student Worksheet:
Client Profile - Mark Burkson

◆ **Situation**

Mark is 74 years old and has led a very active life. He has hiked in three countries, and as he has aged, still enjoys taking long walks and camping. He cannot carry a backpack any longer, but still likes to get out by himself without relying on someone else to carry his belongings for him.

Mark is 6' tall and is of average weight.

Mark uses a cane just as an extra support and to give him a little more confidence on long treks. But he fears that he may get lost at some point while in the woods and not be able to find his way back or reach someone for help. He likes to listen to music, and also is a wildlife photographer. He used to carry a few cameras with him on hikes, but this is no longer possible as he is not as strong as he used to be.

On a perfect hike, Mark would plan on walking for about two hours, resting with some lunch, and then returning. It is a long day but with certain provisions and perhaps a custom designed cane, he should be able to enjoy a safe hike by himself.

Can you help him design a cane with features that will help Mark keep up an activity he enjoys so well?



Notes/Observations:

Student Worksheet:
Client Profile - Rene Shea

◆ **Situation**

Rene is 72 years old and is looking forward to attending her daughter's wedding in a few weeks. Unfortunately she has sprained her leg and needs to use a cane for additional support. She has never used a cane before and has found that the single footed cane she has been provided doesn't feel sturdy enough for her.

She is also self-conscious because she had a beautiful pink dress made to coordinate with the bridesmaids dresses. She feels that the wooden cane she was given will look bad, and she doesn't want to use it. She also wanted to take lots of photos at the wedding, and it will be hard to carry a camera and hold the cane at the same time. She is also supposed to make a short speech at the wedding reception, and is concerned about using the cane to walk up a short flight of stairs as they are not well lighted.



Rene knows that she needs to use the cane for safety reasons, but she wished it were more functional and more attractive too.

Can you help Rene by engineering a cane with features that will help her enjoy her daughter's wedding safely?

Notes/Observations:

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
- ◆ Understanding about 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 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
- ◆ 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
- ◆ Understandings about scientific inquiry

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

CONTENT STANDARD F: Science in Personal and Social Perspectives

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

- ◆ Personal health
- ◆ 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

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◆ **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
- ◆ Understandings about scientific inquiry

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
- ◆ 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

Students who demonstrate understanding can:

- ◆ 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.

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.

◆ **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 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.
- ◆ MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

◆ **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 more manageable problems that 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 7: Students will develop an understanding of the influence of technology on history.

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.

The Designed World

- ◆ Standard 14: Students will develop an understanding of and be able to select and use medical technologies.

Engineer a Cane