Dispenser Designs

Lesson Focus

Lesson focuses on how engineers have to design objects to meet the needs of users, while considering the limitations of materials, and the implications of cost.

Lesson Synopsis

The Dispenser Designs activity explores how engineers work in a team to solve problems. Students learn how materials, costs, and user needs must be weighed when designing a product, and also how the same product may be redesigned over time as materials, costs, or needs change. Students work in teams to evaluate current designs and to develop a new design for a handheld tape dispenser that can be easily operated by a person who has limited strength and only has the use of one hand. Students develop drawings, execute their dispenser design using everyday materials, and evaluate the strategies employed by other student teams.

Age Levels

11-18.

Safety Precautions

This lesson may involve the use of scissors or a cutting blade. Teacher should use caution when working with younger students. Some teachers may consider using a pointed triangular plastic piece for cutting tape rather than using a blade or serrated metal strip.

Objectives

- Learn how user needs, materials, costs, and manufacturing processes impact the design of everyday items.
- Learn about the process of product re-engineering.
- Learn about patents and ethics issues.
- Learn how engineering teams address problem solving.
- Learn about teamwork and working in groups.

Anticipated Learner Outcomes

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

- product design and engineering
- problem solving
- teamwork

Lesson Activities

Students learn how material selection, costs, and user needs must be weighed when designing or redesigning a product Students work in teams to evaluate current designs and to develop a new design for a handheld tape dispenser that can be easily operated by a person with limited strength who only has the use of one hand. Students execute their design, and evaluate the strategies employed by other student teams.

Resources/Materials

- Teacher Resource Documents (attached)
- Student Worksheets (attached)
- Student Resource Sheets (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Scotch Transparent Tape History (https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/scotchtape.html#invention-of-the-tape-dispenser) and PDF (https://www.acs.org/content/dam/acsorg/education/whatischemistry/landmarks/scotchtape/scotch-transparent-tape-historical-resource.pdf)
- United States Patent and Trademark Office for Kids (www.uspto.gov/go/kids)

Recommended Reading

- The Design of Everyday Things by Donald A. Norman (ISBN: 978-0465050659)

Optional Writing Activity

- Write an essay or a paragraph describing the needs engineers met as they designed and redesigned the can opener -- an everyday item with many variations in cost, structure, function, and design. Consider patent and ethics issues in your work.

For Teachers:
Teacher Resource

◆ **Lesson Goal**

Explore engineering problem solving by working in teams to determine a plan for reengineering the handheld cellophane tape dispenser to meet the needs of a person with limited strength and only the use of one hand. This mimics real world engineering challenges in redesigning and manufacturing items as materials, costs, user needs, or manufacturing processes change.

◆ **Lesson Objectives**

- Learn how user needs, materials, costs, and manufacturing processes impact the design of everyday items.
- Learn about the process of product re-engineering.
- Learn about patents and ethics issues.
- Learn about problem solving, teamwork and working in groups.

◆ **Materials**

- Student Resource Sheets and Worksheet
- One set of materials for each group of students:
  - Example of hand held tape dispenser, roll of cellophane tape, cardboard (sheets, cardboard roll from toilet paper), scissors, cutting strips from roll of foil or plastic wrap, , tape, paperclips, string, wire, glue, popsicle sticks

◆ **Procedure**

1. Show students the various Student Reference Sheets.
2. Consider having students visit the Gold Violin website (www.goldviolin.com), or others and explore products engineers have adapted for the elderly or those with limited mobility.
3. Also consider discussing patent and ethics issues engineers must consider when "re-engineering" someone else's product. Have students visit the United States Patent and Trademark Office for Kids (www.uspto.gov/go/kids) to explore patents.
4. Divide students into groups of 2-3 students, providing a set of materials per group.
5. Show various examples of different designs of tape dispensers, have the groups determine what the needs were that were met by various designs. Students will complete student worksheet for this section. (Note that there are mini tape dispensers, hand held, desk models, disposable, refillable, low priced, high priced.)
6. Student teams are next challenged to re-engineer the dispenser so that it can be used by a person with limited strength and the use of only one hand. Encourage students to be creative in their designs so that the new dispenser is completely different from the ones currently manufactured. Have them consider how the new design might be made, patent and ethics issues, manufacturing costs, and what materials would be used in final production. Students complete worksheet and build working model of their design, then presents their design to the class.
7. Each student group evaluates the designs developed by other teams, and completes an evaluation/reflection worksheet.

◆ **Time Needed**

Two to three 45 minute sessions

Student Resource
Tape Dispenser Details

◆ A Sticky Subject
Have you ever thought about the engineering that went into developing transparent tape or the dispensers you use to cut it into usable strips?

◆ What is Transparent Tape?


Transparent Tape or "Sticky Tape" like Scotch Tape and Sellotape is cellulose-based and transparent. Adhesive tape is an adhesive-coated fastening tape used for temporary or, in some cases, permanent adhesion between objects. Adhesive tape that will stick with application of pressure only (i.e. without activation by water, solvent or heat) is known as pressure-sensitive tape.

Adhesive tape was invented in 1926 by Richard Drew of 3M. The original tape was a paper-backed masking tape. Transparent and other tapes grew from this invention. Like 'Hoover', used to refer to vacuum cleaners in general, Scotch Tape (in the USA and other countries, such as Argentina), Sellotape (in the United Kingdom), Tixo (in Austria) and Tesa (in Germany) have become almost-genericized trademarks, being used to refer to adhesive tapes in general.

◆ But How Do We Cut It?
Many systems were developed to cut transparent tape into smaller, more usable strips. There have been hundreds of dispensers throughout tape history! Some are more effective than others in different situations.

Student Worksheet: You are the Engineer!

- You are a team of engineers which has to tackle the challenge of reengineering the handheld cellophane tape dispenser to be used by a person with limited strength and the use of only one hand.

- Activity Steps

1. Review the various Student Reference Sheets.
2. Your team has been provided with examples of different designs of cellophane dispensers. Review these and determine the decisions engineers made (cost, durability, design, user needs) when developing this variation on the product. Complete the questions below:

Pick two dispenser designs and compare them, then answer the questions below:

a. Which design do you think was less expensive to manufacture? Why do you think it cost less to make? (consider materials, size, other factors)

b. What are the needs met by the more expensive dispenser? What do you think the engineers thought the prospective users cared most about? (consider aesthetics, durability, other factors)

Student Worksheet: You are the Engineer! (continued)

3. Next, your team of "engineers" must develop a new design for a dispenser that can be used by a person with limited strength and the use of only one hand. Think about the needs of the user and how your design might be an improvement on what is currently available. Consider aesthetics, and the ethics of making only minor adjustments to someone else's patented design.

4. Draw a sketch of your design on a separate page, then build a working model, and present to the class.

5. While your team's working model will be made of simple classroom materials, what materials your final dispenser would be made from.

6. How would this impact the manufacturing process?

7. What is the price you would sell this dispenser for? Can you make it for this price?

8. In redesigning the product, what rights does the patent holder of the original product have? Should they be compensated if your new design sells well?

9. Evaluate/reflect on your design and those developed by the other "engineering" teams in your class using the attached worksheet.

Student Worksheet: Evaluation/Reflection

Use this worksheet to evaluate the different designs developed by the "engineer" teams in your class.

1. What challenges did you face in executing your working model?

2. Did you find you needed to rework your plan when going through the model phase? If you did, how did your design change?

3. Which design created by another team did you think worked best? Why?

4. Based on what you saw the other teams develop, do you think you could now create an even better design? What aspects of other designs would you incorporate in your team's model? Why?

5. Did you find that there were many ways to solve this challenge? If so, what does that tell you about the engineering of everyday products created in real life?

6. Do you think you would have been able to create your new design if you had not been working in a team? What are the advantages of teamwork vs. working alone?

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 5-8 (ages 10 - 14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- 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
- 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

- 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

- 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

- 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

- Historical perspectives

For Teachers:
Alignment to Curriculum Frameworks

◆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
The Nature 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 6: Students will develop an understanding of the role of society in the development and use of technology.

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.