



Lesson Focus

Lesson focuses on engineering package designs that meet the needs of safely shipping a product. Students work in teams of "engineers" to design a package using standard materials that will safely ship a single chip through the mail to the school address.

Lesson Synopsis

The Ship the Chip lesson not only explores how engineers develop packaging design requirements, but also evaluates the external stresses that engineers must consider when developing a package or product design. Students work as teams of engineers, evaluating material selection, manufacturing, testing and evaluation of their package design.

Age Levels

8-18.

Objectives

- ✦ Learn about engineering product planning and design.
 - ✦ Learn about meeting the needs of society.
 - ✦ Learn about teamwork and working in groups.
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Anticipated Learner Outcomes

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

- ✦ Package design planning and testing
 - ✦ problem solving
 - ✦ teamwork
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Lesson Activities

Students learn how engineers develop packaging design requirements, and work in a team to evaluate the external stresses that engineers must consider when developing a package or product design. Students develop a plan, select materials, manufacture their package, test it, and evaluate their results. Student teams present their reflections to the class.

Resources/Materials

- ✦ Teacher Resource Document (attached)
- ✦ Student Worksheets (attached)
- ✦ Student Resource Sheet (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- ✦ TryEngineering (www.tryengineering.org)
- ✦ ITEA Standards for Technological Literacy: Content for the Study of Technology (www.iteaconnect.org/TAA)
- ✦ NSTA National Science Education Standards (www.nsta.org/publications/nses.aspx)
- ✦ NCTM Principles and Standards for School Mathematics (<http://standards.nctm.org>)

Recommended Reading

- ✦ Structural Package Designs (ISBN: 9057680440)
- ✦ Successful Food Packaging Design (ISBN: 2940361339)
- ✦ Special Packaging Designs (ISBN: 9057680548)

Optional Writing Activity

- ✦ Write an essay or a paragraph about a packaging design that you think could be improved to either reduce the amount of plastic or other materials used, or take up less space on store shelves.

Ship the Chip



For Teachers: Teacher Resource

◆ Lesson Goal

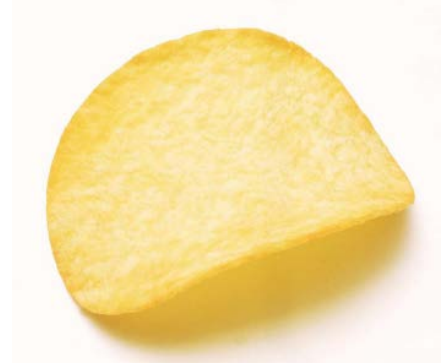
Lesson focuses on engineering package designs that meet the needs of safely shipping a product. Students work in teams of "engineers" to design a package using standard materials that will safely ship a single chip through the mail to the school address.

◆ Lesson Objectives

- ✦ Learn about engineering product planning and design.
- ✦ Learn about meeting the needs of society.
- ✦ Learn about teamwork and working in groups.

◆ Materials

- ✦ Student Resource Sheet
- ✦ Student Worksheets
- ✦ Construction Materials
 - One set of materials for each group of students: one chip, paper, cardboard, glue, tape, string, cotton balls, plastic wrap, toothpicks, popsicle sticks, foil -- other materials you have on hand, and a preaddressed mailing label to your school. Be sure each team has the same materials available to them.



◆ Procedure

1. Show students the various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.
2. Divide students into groups of 2-3 students, providing a set of materials per group.
3. Explain that students must work in teams of "engineers" who have been given the challenge of designing the smallest, lightest package of all the engineering teams in your classroom that will protect a single potato chip shipped through the mail from a remote location to your school. The arriving chip must be edible, though students shouldn't eat them after their journey through the postal system. This rule simply prevents students from applying any substance to the chip to make it stronger.
4. Students will need to research their local postal regulations to determine if there are minimum sizes, weights, or other considerations they'll need to consider in their design.
5. Students will first meet, plan, and draw their planned package.
6. Next, students construct their packages and provide them to you for shipping.
7. Once all packages have arrived at the school, students will weigh, measure, and evaluate the contents of the packages, using the scoring system below.
8. Students complete evaluation and reflection sheets, and then present their reflections to the class.

◆ Optional Extension

1. Require teams of students to engineer a system for safely shipping the chip in a specific dimension six-sided box. By establishing the required shipping container the challenge will be engineering the interior to fit.

Ship the Chip



For Teachers: Teacher Resource (continued)

◆ Scoring

The following three measurements must be made for each incoming package:

1. Mass of the package in Kg's to at least 3 significant figures.
2. Volume of the package in cubic centimeters to at least 3 significant figures.
3. Intactness score of the chip on the following scale:
 - 100 Points: like new, perfect
 - 50 Points: slightly damaged; cracked but still in one piece
 - 10 Points: broken in 2 - 5 pieces
 - 5 Points: broken in 6-20 pieces
 - 1 Point: broken into more than 20 pieces; crumbled

Determine the overall score for each package to determine the top scoring "engineering team." Use the following equation:

$$\text{Overall Score} = \frac{\text{Intactness score (c)}}{[\text{mass in Kg (a)} \times \text{volume in cc (b)}]}$$

Example: a. mass = 0.145 kg b. volume = 240 cc c. intactness score = 100
Overall Score: (c) 100 / [(a) 0.145 kg x (b) 240 cc] = 2.87

◆ Tips

1. Be sure each package has a unique code on the outside to identify which team created it.
2. The teacher needs to select chips (potato, corn, other) that are similar, or better yet, identical in size, weight, and thickness to ensure the project is fair to all.
3. All packages should be shipped from the same location on the same day at the same time. To add a little excitement, perhaps another teacher or school employee who is traveling a distance could ship the packages from a remote location back to the school.
4. Packages may be marked fragile.
5. No overnight shipping is allowed.
6. Develop a plan ahead of time for having your class measure the volume and mass of the sealed package as it returns.
7. It is the responsibility of the teacher to make sure that incoming packages are fairly evaluated. Select honest and responsible people to measure and check the package and its contents, and tell them to gently open the package. If you trust your class, they can check each others packages, but it may be better to have a different group of students do the measuring, perhaps in a math class.
8. Students should check with the local postal service regarding minimum size, weight, or other requirements for packages to be shipped.

◆ Time Needed

Two to three 45 minute sessions.

Ship the Chip



Student Resource: Manufacturing Engineering and Packaging

◆ What do manufacturing engineers do?

Manufacturing engineers often work in teams. They will frequently meet with other engineers and others outside engineering to review the manufacturing process, goals, and current status. Manufacturing engineers may be involved in workforce planning and use, work flow, and the design and space planning for the manufacturing process. They may be involved in product planning, providing input into original product design -- with an eye to what will be required to ultimately manufacture the product. Their expertise in production efficiency is helpful in product design, and packaging planning. Graduates with an accredited degree in engineering management may also be involved in packaging engineering. They work in most industries, particularly on larger projects or programs which require overarching organization and planning to ensure success. Engineering management students take courses such as accounting, finance, marketing, operations management, general management, strategic management, management of technology, industrial and quality engineering, and manufacturing and packaging engineering.



◆ Packaging Options

Engineers often work with marketing, sales, and perhaps a creative department when recommending packaging requirement for a product. Good packaging must protect the product, eliminate any damage while moving, shipping, or storing the products, and also make the product attractive if it is to be displayed in a consumer environment such as a grocery store, hardware store, or department store. For this reason, packaging is a critical part of a product's design and engineering process, and engineers must take many factors into consideration including appearance, function, and costs.



◆ Material Selection

Engineers have to consider the durability, cost, and performance of different materials when designing products and the package they will ship or be displayed in. Many factors will help determine which materials to use, such as how long the package will be on the product, how fragile or expensive the product is, and whether exposure to temperature or humidity would impact the performance of the product.

Ship the Chip



Student Worksheet: Ship the Chip

◆ Engineering Teamwork and Planning

You are a team of manufacturing engineers given the challenge of designing the smallest, lightest package of all the engineering teams in your classroom that will protect a single potato chip shipped through the mail from a remote location to your school.

◆ Planning and Design Phase

Each team has been provided with a set of materials. Review these as a group and draw your packaging design in the box below or use another page. Think about package strength, size, and weight as you design your package. You might want to consider how well your package will survive if it finds itself at the bottom of a stack of heavy boxes during shipping! There are also several rules you must follow, which your teacher will review with you so your package is not disqualified.

◆ Construction Phase

Build your package, and then complete the questions below:

1. How similar was your design to the actual package you built.

2. If you found you needed to make changes during the construction phase, describe why you made revisions.

◆ Shipping Phase

Your teacher will devise a shipping system for all the packages created in your classroom.

Ship the Chip



Student Worksheet: Evaluation

◆ Evaluation Phase

Once all packages have arrived at your school, you will work in teams to evaluate the packages.

◆ Scoring

The following three measurements must be made for each incoming package:

4. Mass of the package in Kg's to at least 3 significant figures.
5. Volume of the package in cubic centimeters to at least 3 significant figures.
6. Intactness score of the chip on the following scale:

100 Points: like new, perfect

50 Points: slightly damaged; cracked but still in one piece

10 Points: broken in 2 - 5 pieces

5 Points: broken in 6-20 pieces

1 Point: broken into more than 20 pieces; crumbled



Determine the overall score for each package to determine the top scoring "engineering team." Use the following equation:

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Example: a. mass = 0.145 kg b. volume = 240 cc c. intactness score = 100

Overall Score: (c) 100 / [(a) 0.145 kg x (b) 240 cc] = 2.87

Make a chart to keep track of the packages for each engineering team in your class and see who has the best overall score.

| Package ID # | Mass (KG) | Volume (CC) | Intactness Score | Overall Score |
|--------------|-----------|-------------|------------------|---------------|
|--------------|-----------|-------------|------------------|---------------|

◆ Reflection

1. What aspect of the design of the package that had the best overall score do you think lead to its success?

2. If you had a chance to do this project again, what would your team have done differently?

◆ Presentation

As a group, make a presentation to the class about what you learned during this activity.

Ship the Chip



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
- ✦ 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
- ✦ 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

- ✦ 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 B: Physical Science

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

- ✦ Properties and changes of properties in matter

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

- ✦ Science and technology in society

For Teachers: Alignment to Curriculum Frameworks (continued)



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

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 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

- ✦ 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

◆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.
- ✦ 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.

For Teachers: Alignment to Curriculum Frameworks (continued)

◆Principles and Standards for School Mathematics

Understand meanings of operations and how they relate to one another

- ✦ understand the effects of multiplying and dividing whole numbers;
- ✦ identify and use relationships between operations

Problem Solving

- ✦ Solve problems that arise in mathematics and in other contexts

Connections

- ✦ Recognize and apply mathematics in contexts outside of mathematics

◆ Common Core State Standards for School Mathematics Grades 3-8 (ages 8-14)

Measurement and data

- Solve problems involving measurement and estimation.

- ✦ CCSS.Math.Content.3.MD.A.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l).1 Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.2

◆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.

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 19: Students will develop an understanding of and be able to select and use manufacturing technologies.