Lesson 15: "Ship the Chip"

Activity Credit: **Developed by the Institute of Electrical and Electronics Engineers (IEEE) as part of TryEngineering at www.tryengineering.org**

Objectives:

Students will learn the importance of providing the correct packaging material to protect their "chipanaut" during transport. Students will be able to apply this activity to the STS-133 mission and the preparation of Robonaut 2 for transport.

National Standards:

National Science Standards:

Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard E: Science and Technology
- Abilities of technological design
- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives
- Science and technology in local, national, and global challenges

Content Standard G: History and Nature of Science
- Science as a human endeavor

Materials:

For each team of 2-3 students:
- Student sheet (next page)
- Project materials: one potato chip, paper, cardboard, glue, tape, string, cotton balls, plastic wrap, toothpicks, popsicle sticks, foil, other materials you have on hand, items students may suggest to bring in for everyone's use, and a preaddressed mailing label to your school
- Graph paper and pencils

Note: Be sure each team has the same materials available to them.

Background:

STS-133, Space Shuttle Discovery, launched to the International Space Station (ISS) on February 24, 2011. This was the last flight of the Space Shuttle Discovery. The crew members included a former CAP cadet and current CAP senior member, Col Eric Boe. Col Boe was the mission pilot for STS-133. The mission of STS-133 was to take the Permanent Multipurpose Module (PMM), the Express Logistics Carrier 4, and critical spare components to the International Space Station. This mission also transported a VIR (Very Important Robot) named Robonaut 2 (or R2), to the ISS. Robonaut 2 (R2) was the first human-like robot to go into space. This robot will remain aboard the ISS permanently. R2 was transported to the ISS in a carefully-constructed box inside the PMM. Many modifications had to be engineered for this sensitive piece of equipment to travel to the ISS. Such considerations as launch vibrations, lack of repair parts for R2, noise requirement level for the ISS, and harmful electromagnetic waves were addressed by the engineers and other scientists prior to launch. The scientists came up with a way to protect R2 and its delicate systems, while also allowing for time, space, and weight requirements for the mission. NASA and its engineering partners tackled this problem with ingenuity and the ability to overcome seemingly insurmountable odds and time tables to come up with a protective box that would reduce the launch-induced vibrations, but also allow R2 to be removed from the box with minimal effort. Mission accomplished!

Robonaut 2 with crew of STS-133 (Col Boe is the middle astronaut on the left)

Procedure:

1. To find more background material to begin discussing the manufacturing engineering and packaging process, go to this complete lesson at: **http://www.tryengineering.org/lessons/shipthechip.pdf**.

2. Divide students into groups of 2-3 students, providing a set of materials per group.

3. Explain that the students must work as teams of "engineers" who have been given the challenge of designing the smallest, lightest package of all the engineering teams in the classroom that will protect a single potato chip (representing the "chipanaut") as it travels through the mail from a remote location to your school. The arriving chip must be edible, although 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 will construct their packages and provide them to the teacher for mailing.

7. Once all mailed packages have arrived back at the school, students will weigh, measure, and evaluate the contents of the packages.

8. Students will complete the evaluation sheet and present their reflections to the class.

Top: Robonaut 2 shaking hands with astronaut

Left: Robonaut 2 "tweeting"

Review:

This activity involves teamwork and engineering. 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.

Extension:

Require teams of students to engineer a system for safely shipping the chip in a six-sided box with specific dimensions or envelope with specific weight and cost requirements for mailing. By establishing the required shipping container or other specifications the challenge will be engineering the product to fit the expectations.

Student Worksheet and Evaluation for "Ship the Chip"

Engineering Team Names:________________________

________________________ ________________________

Date: ________________________________

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 - your "chipanaut" (provided by your teacher) shipped through the mail from a remote location back to your school.

• Planning and Design Phase

Each team should be provided with a set of materials. Review these as a group and draw your packaging design on a sheet of graph paper. 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 mailing! 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 (on the back side of this paper):

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 the revisions.

• Shipping Phase

Your teacher will devise a mailing system for all the packages created in your classroom. Be sure your package has a unique code on the outside to identify to which team it belongs. Packages may be marked fragile. No overnight shipping!

Evaluation Phase:

Once all packages have arrived in the mailbox back at your school, you will work in teams to evaluate the packages. You will not evaluate your own package.

Scoring:

The following three measurements must be made for each incoming package (the mass and volume measurements must be rounded to three significant digits):

1. Mass/weight of the package in kilograms/pounds. (Use a scale to determine mass/weight.)
2. Volume of the package in cubic centimeters/inches. (To find the volume of a rectangular box, multiply the length x width x height of the box after measuring each in centimeters/inches.)
3. Intactness score of the "chipanaut" 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:

$$\text{Overall Score} = \frac{\text{Intactness score (c)}}{[\text{mass in kg/lbs. (a)} \times \text{volume in cc/in}^3 \text{ (b)}]}$$

Example:
mass/weight (a) = 0.145 kg /.32 lbs
volume (b) = 240 cc / 94.49 in^3
intactness score = 100
100 / 0.145 Kg (.32 lbs) x 240 cc (94.49 in^3) = 2.87 (3.31)

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

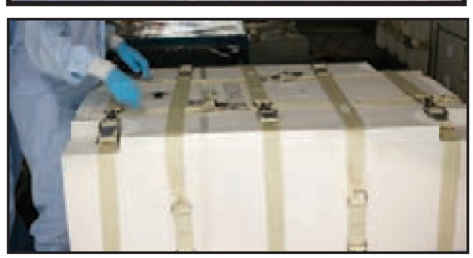
Reflection:

1. What aspect of the design of the package that had the best overall score do you think led 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 and how this activity illustrates how important packaging design and engineering are to the process of shipping delicate materials, such as R2, or your "chipanaut."

Engineers placing R2 in his protective box



R2 secured in his box for the STS-133 mission