

Hexominoes and the Box Problem

Objectives for Student Activities

- Determine how many different designs are possible when making a six-sided box from one piece of folded paper.
- Design and construct a fully enclosed box to package and ship a given product at a minimum cost.
- Develop critical thinking skills.
- Develop technical writing skills.
- Enhance basic math skills and develop cost analysis skills.
- Enhance linear measuring and weighing skills.
- Enhance Internet skills.
- Learn to work in groups.
- Enhance communication skills.

Resources

If possible, visit a company that boxes the products they manufacture.
CORD, Book 22

Materials

- Boxes
- Graph paper
- Scissors
- Tape
- Ruler or meter stick
- Poster board or card board (box cutter if using card board)
- Material to be shipped (egg(s) or light bulbs)
- Postal scales (or access to postal scales--school office)
- UPS and/or U.S. Post Office shipping charge
- Packing material (shredded paper, Styrofoam, etc.)
- Tape (masking or clear)

Instructional Concepts

*One week before the project begins, each student will bring at least one box that can be used in the activity.

** The students and teacher will collect various types of packing material

The students will be divided into groups of two or three. The students will disassemble the boxes they brought to class to discover the basic T design that is used most often in the manufacturing of boxes. A discussion would be held as to the possible reasons a manufacturing company would use the design they did for the various boxes. Cost saving factors could be discussed at this time.

The students will use graph paper to draw as many possibilities of a box pattern that is possible. Using a 1” square makes the construction of the sample boxes easier to assemble.

The students will cut out and fold each new design into a box. Any design that is rotated will be a duplicate and not acceptable.

Have the group that designed the most boxes in the given time the opportunity to show the other students the designs they developed. If other groups develop different designs, they may want to share their ideas.

Have student groups evaluate each design and predict which designs would be the most structurally durable

OR

have each student select the design they feel will be the most structurally durable.

Project Development

Packing and Shipping

The product will be provided to the student and he/she will have to determine the appropriate size of the box. The teacher should remind the students that, when constructing the box, they need to leave at least 1/2 inch on all sides for packing materials.

Oral communication is important in the world of work. A class discussion could be held and each student will have to justify the size, construction, and packing materials he/she chose for the product.

Several different products could be used but the students enjoy working with eggs best. The students are told that some of the eggs may not be boiled--they all are. The students may decorate the eggs by drawing faces, attaching “hair”, taking pictures of their creation and developing a very creative design to be glued to their box.

Technical Writing – The knowledge of technical writing is very important in industry. To incorporate technical writing in this project the students could be required to write detailed instructions on how to construct the box. These instructions may be given to students in

another class (these students may be grouped so they can work together) and they may construct a box according to the written instructions. The students may make notes on the instructions concerning the ease of following instructions and if the instructions were complete. This enables students to evaluate the work of other students.

After the students have completed construction of their boxes, they need to choose a packing material. The packing material will need to protect the product from damage during transportation from producer to consumer. Please ask your students to take into consideration the heavier the packing material, the higher the shipping cost.

Cost control must be used in all aspects of production. The students will determine the cost of shipping the product (via U.S. Postal Service, UPS, Air freight, etc.) from point of origin to a given destination determined by the teacher. Shipping costs can be obtained from your local post office, UPS, or by researching the information on the Internet.

After the product has been produced, packed, and shipped, the student must determine the retail cost of the product taking into consideration all cost of producing and shipping the product. (Cost of the product, designing the product (boiling the egg), packaging materials, shipping cost, and labor cost). A class discussion can be held when the groups have determined the retail cost of their product. Students may compare the cost they had determined to decide if any cost cutting measures could be used to reduce the retail price of the product.)

In place of shipping the package or before the package is shipped, the package may be tested for durability. The package may be dropped from the top of a table and then checked to see if there was any damage to the product. If the product passes the first drop test, the package may be dropped down stairs. Again the product will be tested to see if the product was damaged. The product can also be tested in other ways; such as, thrown out the window of a classroom, rolled down the stairs at the football stadium or gym, or all boxes placed in a larger container and ask a local trucking company to let the packages ride in a truck for a delivery.

The students enjoy the drop tests and they become very competitive.

***Extra credit may be given for creativity. (Decorating the product or box, making an attractive label for the box, etc.)

Assessment

This project can be evaluated in a variety of ways. An example of a rubric follows:

1. Quality of scale model
2. Maximum number of boxes cut from a sheet of poster board
3. Quality of a prototype
4. Establish quality control specifications
5. Pass quality control test
6. Selection of most cost-efficient shipping material/method
7. Creativity in design of box

8. Neatness in design

Grades (low to high)

0 = Nothing

1 = Scale model

2 = 1 plus constructing a prototype

3 = 1 + 2 plus pass quality control test

4 = 1 + 2 + 3 plus maximum number of boxes

5 = 1 + 2 + 3 + 4 plus creativity in design and neatness

Student Assessment

Have the students assign a grade to each person, including themselves, in their respective groups. The grade will be given and justified. The teacher will determine the grade after reading the responses.

Applications in the Workplace:

- The students further develop critical thinking skills creating boxes from the hexominoes.
- The students further develop technical writing skills creating detailed instructions for designing a box.
- The student's math skills will be enhanced in designing and developing the hexominoes and boxes.
- The students will review linear measuring and weighing skills.
- The students will further develop Internet skills.
- The students will develop group-working skills.
- The students will further develop and implement communication skills.

Integration Across the Curriculum:

- Math, technology and/or English classes may work together to produce a set of instructions to produce a box.
- Math and technology classes will research information needed for the project.