BoatBuilding

39-245

CARNEGIE MELLON UNIVERSITY

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Introduction

The boat building project is designed to teach children basic concepts related to engineering including design, optimization, and cost management. Exposing children to engineering at a young age develops interest in a field that is otherwise unfamiliar. Our project aims to introduce elementary school children to scientific concepts, such as fluid statics, center of gravity, and conservation of volume, through the application of boat construction.

Problem

A noticeable void exists in the primary and secondary school curriculum. Students are not sufficiently instructed in the applied sciences and engineering. To fill this gap in education, we designed a project which would both instruct and engross students in engineering. The idea for our specific project came from our own interests from when we were young. All the members of our team had a common interest in projects and toys involving water, and feel it is an excellent medium to expose engineering to students.

Objectives

Our goal is provide an activity box for use in fifth and six grade classrooms that engages students in an engineering exercise. The students will learn principles of buoyancy and apply them in a problem solving technique. Over thirty students, in

groups of three or four, will be simultaneously involved in the activity for thirty minutes to an hour. The exercise will also give students experience working in groups.

Solution

Our proposal is to provide children with a background in engineering uses the idea of boat building. The instructor will provide several water-tight plastic boxes for the groups of students to use. In this box will be a variety of parts, mainly consisting of buoyant enclosed containers, including soda bottles, jars, film canisters, and other assorted objects. Each of these objects will be fitted with a screw, wing-nut, and washer to provide a firm connection to the peg board (the boat "deck). The now empty box is then filled approximately one-half to two-thirds with water, which can be obtained from a classroom sink or bathroom. One side of the box will be marked with horizontal lines so students can see how much water an object displaces.

The children will then have three basic objectives to confront. Their first objective is to build a boat which will support a specified amount of weight without tipping. This process incorporates conservation of volume, buoyancy, and center of gravity. The students will accomplish this task by attaching various enclosed volumes to their pegboard decks. The instructor will also provide the test weights. After completing this first task, the instructor will assign a new aspect of the boat building problem for the students.

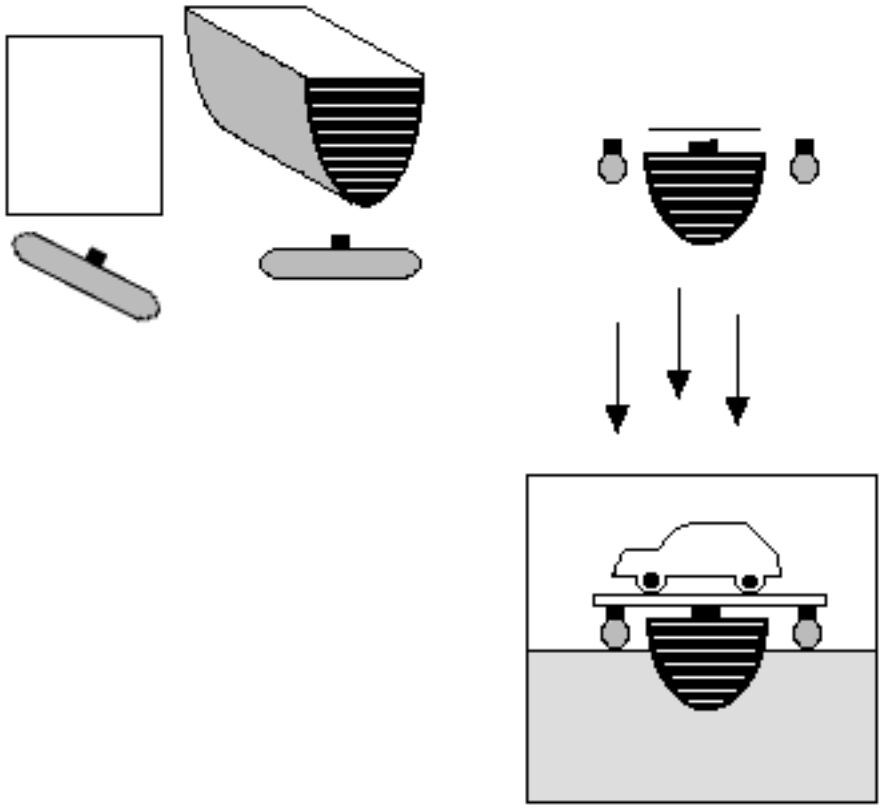
In the second task, each part is assigned a dollar value, with the "best" parts (i.e. those with the largest enclosed volumes with the lowest material density) having the highest costs. The students must then accomplish the same task they just completed, this

time attempting to minimize cost. This will teach the students cost minimization and material selection, both essential tasks in engineering.

Finally, as a more fun activity, the teams of students will go head-to-head to see who can create the design that can support and balance the most weight. The friendly competition, we believe, will encourage different designs among the groups.

Each team will consists of three or four students. This will mean that each team will share one box with another team, as there will be only four boxes. The purpose of this is twofold: first, it limits the amount of materials which the teacher will have to transport, and second, it teaches students to take turns and cooperate, as only one boat can be tested in the box at a time. Once the activity is completed, the instructor will review the principles that were taught, and how they applied those principles to solve an engineering problem. The instructor will be provided with a sheet containing the instructions and all pertinent information necessary for the project to function as planned. Students will receive all instructions verbally from the instructor.

Below is a diagram of the process:



Plan

Our basic project elements are already in place. We have considered several different methods by which to connect the buoyant objects to the deck: Legos, Velcro, and glue, among others. However, our current plan is to use a wooden board with evenly spaced holes (commonly found in hardware stores) as a boat deck, and attach bolts to all of the parts. This way, while not the most universally adaptable for non-dexterous students, is the only effective method which we have discovered to keep the parts securely fastened to the deck. This board must be obtained, in addition to scavenging for

additional buoyant containers. These containers must then be fitted with the screw-washer-wingnut assemblies.

The next task which must be completed is to incorporate one of the rapid prototyping methods into our project. Our plan is to create a “runner” in which two or more screws can slide along the length of a part. The idea behind this is so that the students are not limited to one position (and thus, one orientation of the part) for the screws on the buoyant part, and can attach it anywhere that they chooses along the boat deck. This part must first be designed in CAD, a prototyping method chosen, and several (approximately 10) parts produced.

Budget

While some of the buoyant containers (i.e. soda bottles, film canisters, etc.) may be scavenged, there are still several parts which must be purchased.

• Water-tight boxes:	4 * $10 = $40
• Peg boards:	FREE = $0
• Rapid Proto Runners:	FREE = $0
• Epoxy:	= $8
• Screws, nuts washers:	= $10

grand total = $58

Schedule

Week of April 14:

All group members scavenge materials.
The group goes out and purchases all necessary materials.

By April 21:

As a group, we will have epoxied the bolts onto the buoyant objects making the prototype functional.

Sam will have made an autocad file of the described runners, to be made by a rapid prototyping process.

Umar will make transparencies of horizontal lines, and attach them to the sides of the boxes.

By April 23:

Todd will make an instruction sheet that will be given to the educator along with the project materials.

By April 28:

The runners will (hopefully) have returned and Umar will mount them onto the objects and the bolts into the runners.