Outreach Activity Box for Engineering Education

Bell Tower

Formal Proposal

4/14/98

To:

Professor Susan Finger

Carnegie Mellon, Department of Civil and Environmental Engineering

From:

Nathan T. Danielson

Carnegie Mellon, Dept. of Civil and Environmental Engineering

Kurt Faulhaber

Carnegie Mellon, Dept. of Mechanical Engineering

Jeffrey W. Graybeal

Carnegie Mellon, Dept. of Mechanical Engineering

Introduction

Our outreach engineering project's main purpose is to expose junior high school students to the principles that factor into cost effective engineering. Engineering principles like design creativity, group cooperation, structural integrity, and obedience of specified parameters are also exposed to the students who complete our Bell Tower project.

We came up with our Bell Tower project as a way to teach the students about cost effective engineering and let them experience it for themselves. In our activity, the class will be divided into groups of three . Each group will be presented with the activity's purpose and instructions. This purpose is multidimensional. The main idea of the project is for a group of three students to work together to build a bell tower out of wooden blocks. The blocks will be supplied along with other items that will be needed during the completion of the project. These specific details will be discussed during the rest of the presentation. Each of the blocks will have a cost and their will be a money and time restriction put on each group. The project is intended to be fun for the children and effectively teach them aspects involved in engineering projects.

After the activity, the presenter is encouraged to talk with the students to both receive feedback and to explain the purpose of the activity in more detail. This will allow the presenter to evaluate the effectiveness of the exercise and to again stress the importance of cost effective engineering.

Problem

Cost effective engineering is one of the more important aspects of being a good engineer. Many times, an engineer will be limited in the amount of funds he or she can work with. He or she knows the problem statement and the budget, but solving to problem while staying under this budget is an engineer's job and responsibility. No company wants to hire an engineer who is incapable of saving that company money. This is why we feel that it is important to expose children to this concept at a young age. Our project will present the children with thought processes that engineers must go through when solving a problem.

Objectives

As discussed earlier, The Bell Tower project will teach children about the many aspects involved in an effective engineering project. This will include basic structural design and integrity, design uniqueness, cost benefit analysis, and group cooperation and how to work within a budget and time frame. While working with his or her teammates, a student will be required to build a Bell Tower which holds a bell within it. Students must work within a budget while choosing which pieces to their design should incorporate. The different pieces available to build the tower will cost different amounts. Also, the higher the tower the students build, the more points they will receive. Hopefully, while learning these principles of engineering, the students will also have fun and learn how to work in a group.

The students will learn about structural design when they experiment with the different pieces provided to them to see what will yield a high yet stable tower which will hold their bell. They will learn about design creativity when they design a tower which is also aesthetically pleasing. They will learn about the economics involved with design when selecting a piece to put into their tower. They will learn to deal with a budget, and also how to keep the overall goal of staying as low in cost as possible. They will learn about group cooperation by working with their teammates to accomplish their design goals. They will also learn how to work in a specified time frame.

Solution

Occupying the attention spans of the children was a problem. Children can many times have a short attention span, and can easily get bored if they are not kept busy. So, if there are three people on the team, it is easy to see how two children might take charge and lead the design process while the third student is not able to participate to his or her full ability. To help correct this we have added the roll of banker/transaction processor to each group. The banker will be in charge of the distribution and recording of the parts used in the exercise. The other two team members will have to "buy" each piece that

they want to use from the banker. At the end, the amount of "money" left over in the team's budget can be turned in again in exchange for candy, stickers, and various other small rewards. With the problem of motivation solved, our project should function much more smoothly.

As earlier stated in the introduction, materials explaining the activity will be distributed to the teacher/presenter and to each group. The presenter's copy is much more detailed. It is intended to explain the purpose of the project to the presenter. The presenter then follows the directions on the sheet to explain the activity to the children. The presenter's copy is included in Appendix 1.

The students' copy of the instructions is much simpler. It is intended to be a quick reference guide. The students will be involved in the project and will not have time to refer to a complicated list of instructions. The students' copy is included in Appendix 2.

A cost chart also must be distributed to the class, or at least displayed. The cost chart can be made by the presenter ahead of time. It will vary with the types of blocks that are available to the class. As a rule, the pieces that are easiest to use in construction (squares, rectangles, cylinders) will be made more expensive than pieces that are harder to use (arches, semi-circles, triangles). String should be a little bit cheaper than hooks. The hooks can easily be screwed into the blocks while the string takes a little more manipulation to be effective.

Budget

Our project does not require a huge budget. The block can be purchased at Toys R Us for 13.00 dollars. The hooks, string, and ruler can be purchased at Walmart or K-Mart for 10.00 dollars. The bell will be made using JP Systems and will be fairly inexpensive to complete, with a minimal materials and machining cost. Here is a layout of our budget:

Item	Cost	
Building blocks	**$**	**13.00**
Hooks	**$**	**3.00**
String	**$**	**2.00**

Ruler	**$**	**5.00**
Bell		**JP Systems**
Total Cost	**$23.00 + Systems Part**	

Schedule

Here is a list of tasks that we feel still require completion and a completion date for each of them:

Date	Task Completed
April 7, 1998	**Formal Proposal**
April 9, 1998	**Working prototype for Beta Child**
April 14, 1998	**Modifications and changes**
April 16, 1998	**CAD drawing for bell production**
April 21, 1998	**Final prototype with manufactured bell**
April 23, 1998	**Submission of final project**

Appendix 1

Bell Tower Project (1 hour)

Instructions

(Teacher)

* Explain these directions to your students. Tell them they will do better in the competition if they listen closely and follow the directions.

Purpose:

This project is intended to teach you some of the many factors that effect projects in many fields of engineering. In this project, you are required to manage cost, build a structure, and follow directions as given.

You will be divided into groups of three. One group member will be the banker, keeping track of the parts used. The other two members will cooperate in order to build the project. Your group will be given a box. In this box there is a set of wooden blocks, a ruler, string, a paper bell, written instructions, and a cost chart.

Project:

1. Your goals as a group is to design and build a bell tower out of the wooden blocks. This tower must be able to suspend your group's bell so that it hangs completely inside your tower. No part of the bell may stick out. String and blocks with hooks will be supplied to allow you to do this.
2. Your tower must be at least one foot tall. Each group's project will be judged in various categories, including height, aesthetic value (is it pretty?), function, and cost. The higher, prettier, and cheaper you can make your tower, while the bell still hangs inside of it, the better. How does cost factor in?
3. Each block has a different size and shape. Each shape has a specific cost assigned to it. The string and hooks do too. The costs are based on construction use. Blocks that are harder to use in your tower cost less than blocks that are easy to use. The idea is to use the cheapest blocks for your tower. This is because

every time you use a block in your tower, its cost is added to your group's total cost. The children want the cheapest possible cost for a functional tower. They will figure this out as part of the exercise.

4. At the end of the class each group will present its finished tower. Awards will be given based on height, cost, looks, creativity, and a variety of other categories. However, each group that finishes a tower, despite its success or failure to meet the requirements, will receive some sort of reward (as long as they have tried to succeed).

5. In the groups, the children will be assigned different roles on their teams. This is because we found that children's attention spans sometimes are not totally occupied by a single activity. One child will assume the role of banker. The banker will be in charge of the distribution and recording of the parts used in the exercise. The other two team members will have to "buy" each piece they want to use from the banker. We are also considering making one of the other two children the truck driver. He or she will have the responsibility of making the exchange with the banker and transporting each block, one at a time, back to the construction site. At the end of the exercise, the "money" left over in each team's budget (that can be set before class, depending on the age group) can be turned in again in exchange for candy, stickers, and various other rewards.

Appendix 2

Instructions

(Student)

Parameters:

- at least one foot tall
- bell hung inside

Factors:

- cost efficient
- sturdy construction
- how does it look?

REMEMBER:

Make your tower as high as possible with the lowest possible cost. Don't forget to consult your banker and the cost chart! Also…turn the money left over in your budget back in to buy prizes!