Outreach Activity Box for Engineering Education

Bell Tower
Formal Proposal

4/7/98

To:
Faculty involved in outreach activities

From:
Nathan T. Danielson
Dept. of Civil and Environmental Engineering

Kurt Faulhaber
Dept. of Mechanical Engineering

Jeffrey W. Graybeal
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 being a cost effective engineer. Engineering principles like design creativity, group cooperation, structural integrity, and obedience of specified parameters are also exposed to the students who complete our project.

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.

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. This purpose is multidimensional.

First, each group will be supplied with a sufficient number of wooden blocks, string, hooks, a ruler, and instructions. The teacher will also read off instructions, but the students’ copy will remind them of the project’s most important aspects. The blocks will be different shapes. Each shape has a specific cost assigned to it. So do the hooks and string. A cost chart will be made available to the entire class.

When a block is used during construction, its cost is added to the group's total cost. One of the three group members will be assigned the job of banker. He or she is responsible for recording the blocks used in construction. The other two members will work together to complete the structure. The idea of the activity is for each group to build the cheapest and tallest possible bell tower out of the blocks so that a part can be suspended from the tower by string or hooks. The part (a bell) must hang entirely within the tower.
In order to make the activity more interesting and more challenging, a minimum height will be assigned for the tower. This height can be varied based on the age group, but one foot is a good general height. The “winning” group will combine the cheapest cost with the highest structure. However, the projects will be judged on a variety of categories. Height, function, aesthetics, and cost all will be rewarded. In the end, all students who cooperated will receive a prize. This will keep the students focused on task and prevent them from giving up when their tower begins to fail quickly.

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.

Materials to be Distributed

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 follows:

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 will be 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 goal 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. So do the string and hooks. 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. You want the cheapest possible cost for a functional tower.

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 we feel that they have tried to succeed).

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 follows:
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…work hard to earn a prize!

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.

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.

**Solution**

The students will learn about structural design when they experiment with the different pieces provided to them to see what will yield a high, but 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.

A problem we faced when examining how people performed in the design exercise was the attention spans involved. 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.

**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:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building blocks</td>
<td>$13.00</td>
</tr>
<tr>
<td>Hooks</td>
<td>$3.00</td>
</tr>
<tr>
<td>String</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ruler</td>
<td>$5.00</td>
</tr>
<tr>
<td>Bell</td>
<td>JP Systems</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$23.00 + Systems Part</strong></td>
</tr>
</tbody>
</table>

**Schedule**

Here is a list of tasks that we feel must still be completed, and an approximate completion date for each of them:

<table>
<thead>
<tr>
<th>Date</th>
<th>Task Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 7, 1998</td>
<td>Formal Proposal</td>
</tr>
<tr>
<td>April 9, 1998</td>
<td>Working prototype for Beta Child</td>
</tr>
<tr>
<td>April 14, 1998</td>
<td>Modifications and changes</td>
</tr>
<tr>
<td>April 16, 1998</td>
<td>CAD drawing for bell production</td>
</tr>
<tr>
<td>April 21, 1998</td>
<td>Final prototype with manufactured bell</td>
</tr>
<tr>
<td>April 23, 1998</td>
<td>Submission of final project</td>
</tr>
</tbody>
</table>

**Conclusion**

Whenever considering new designs in engineering, cost is a major factor. Different attributes of designs must be weighed against the costs of obtaining them. The main objective of our exercise is to introduce kids to cost-effective engineering. Some designs may be more accurate or efficient, but must be eliminated due to the financial constraints on the designer. Not everyone can afford 30,000 dollar cars, so the engineers design a simpler car that many more people can afford, but may be less efficient. Minimizing costs while maintaining structural characteristics is an extremely important concept that engineers must be able to utilize.