INTRODUCTION

Our team was assigned to make an activity box in which children can learn engineering and science through hands on labs. Many children have difficulty understanding a scientific or an engineering concept through regular elementary school teachings. By creating this activity box, children will gain intuition about a hard concept in less time and with enjoyment. During the course of making this activity box, we will make a prototype, test it, and make the final product to be used in a real elementary school classroom. Our goal is to make the activity box as interesting as possible, yet be educational. We need to make this activity box in order for children to pick up engineering and science by hands on experience. By creating these activity boxes children will gain intuition about the foundation of engineering, such as mechanical advantage, fluid flow, thermodynamics, action vs. reaction, and etc. What our team took on is that problem of how to teach mechanical advantage through the activity box. Our motive is to demonstrate mechanical advantage to a group of children in 5th grade through the use of a pulley system.

PROBLEM

Many children of elementary school age will encounter an engineering concept in everyday life, yet not understand it. Even university students who have never taken a university level engineering courses do not understand engineering concepts. What we need is a portable activity box which will make it easier for teachers of elementary schools to teach children of an engineering concept with ease, or at least easier.

The idea of mechanical advantage is very simple, yet hard to explain. Through lecture or reading, children can not grasp this idea as much as getting involved in a hands on experiment. If there is a better and easier way of teaching, we should use that technique to teach children, who need food for the mind. The problem with teaching children hand on is that it is not inexpensive… until now.

OBJECTIVES

Our primary objective was to create an activity that would teach children the basic concept of mechanical advantage. This concept is a cornerstone to many fields in engineering, and we feel that it is important to expose children to this at an early age. Our design process centers around engaging many children at once and sparks enthusiasm about the topic of mechanical advantage. We want to keep the instructive nature of our activity intact but we want to remove any dryness in our attempt to do this. Transporting several kits is not ideal, so our activity is to be the focal point in the classroom; we felt that it was also equally important to prevent our activity from becoming a boring demonstration. Once again, designing an activity that involved participation from the children and fed off of their enthusiasm seemed to

be the answer. Concerning practicality we wanted the activity to be durable and safe. Equally important we wanted the activity to be transportable in a compact car, and any further transportation of the kit to be easy as well.

SOLUTION

Every child in elementary school loves two things: substitute teachers and fun games. We didn't feel that kick-ball or tag would be an effective tool in teaching an engineering principle, but we thought that tug-of-war could be instructive. Our main objective was to institute the concept of mechanical advantage into the classic game of tug-of-war; we did this through the use of pulleys. Children could directly experience the effects of mechanical advantage if they were able to pull the equivalent of three times their weight. These children would not be lectured about pulleys or taught about tension- they would simply experience the reality of mechanical advantage. The excitement of tug-of-war in itself would keep all 30 children amused and desiring to participate. The twist that the pulleys introduce into this game would escalate this excitement. Each individual experiment would last only a minute or two so this presentation would stay fast-paced.

The physical instrument in this experiment is quite simple. The base piece consists of two wood slabs attached in the shape of a T. A pulley system, arranged to provide mechanical advantage of three or five, is attached to the top portion of the T. The pulley system is entirely metal to ensure the safety and durability of this activity. The cross piece of the T is larger than the width of the door, therefore, as the children pull on the ropes (which are threaded through the pulleys) their combined force is balanced by the doorjamb acting against the T.

This is the sketch of the system:

Due to the high levels of stress that will be created by the tug-of-war game it seemed unwise to employ parts made from a rapid prototyping system. As was stated in our objectives, we did not want to jeopardize the safety of the children.

Accompanying the physical instrument of our activity would be a short handout describing how our activity should be used and the basic principle that it illustrates. The children would not need to receive any handout, and this fact reflects our desire to maintain the free-ness and simplicity of our activity.

PLAN

Our original plan for the final project was to have a small mechanism that was capable of demonstrating mechanical advantage through the use of pulleys and a lever. The number of pulleys and the length of the lever was interchangeable so that the children were able to test out the different magnitudes of the mechanical advantage. The actual demonstration was performed by attaching the free end of the rope to an object, and the child would push down on the lever, causing the object to be lifted. The main problem with that idea was that we were aiming towards a group of children with a shorter attention span than we were expecting. Also, this mechanism was not capable of getting 30 children involved at the same time. The lever itself also did not contribute that much to the mechanical advantage. Because of these problems, we decided to modify our mechanism. The basic concept of the mechanism is the same, although we took out the lever. Instead of having to lift an object, we decided that it would be much more entertaining if we could turn the mechanism into a game of 'tug-o-war'. The structure looks as follows:

As we can see, this set-up allows all of the children to be inside of the room. A single child will hold one end, and one or more children will hold onto the other end, depending on the number of pulleys used. Also, this is more fun for the children, thus helping them to learn about mechanical advantage, while having fun at the same time.

The Auto-CAD part which we will be getting will be for a smaller scale version of our mechanism to demonstrate how mechanical advantage works.

SCHEDULE

Toshi Takano bought the necessary supplies for the mechanism on Monday April 6th. The Auto-CAD designs for our project is to be done on Thursday April 9th by Eduardo Espinal. The sketches of our mechanism will be done by Chris Bates. This proposal, worked on by Ryohei Ota and Chris Bates will be done Thursday April 9th also. The actual working prototype, due Tuesday April 14th, will be primarily worked on by Toshi Takano. The poster, which will be worked on by all four members of our group, will be done by May 6th. Also, the handouts will be done by Ryohei Ota.

BUDGET

wood(poplar) @ 2.95/ft	17.70
pulley	2.48 * 9
Staple zin(the hook)	1.35 * 2
Nuts, bolts	1.26 * 2
washers @ .03$/each	.12

subtotal:	53.33
tax:	3.73
total:	57.06

Activity Box:

Mechanical Advantage

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Date:

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