Outreach Activity Box for Engineering Education: Optics Lab

Sean Cho
David Lam
Gioel Molinari
39-245
Rapid design through Virtual and Physical Prototyping
Professor Susan Finger
April 23, 1998

Introduction

Today's children is tomorrow's leader. To help build a better tomorrow for our children, we need to give them enough training when they were young so that they will succeed. Therefore, Carnegie Mellon University has an Outreach program where faculty members from CMU goes to elementary or high school to teach students something about engineering. The students in Professor Finger's Rapid Design through Virtual and Physical Prototyping class were to design and built an activity box that someone can take to a classroom and present to students to illustrate one aspect of engineering.

Our proposed experiment is a simple optics lab that will allow children to experiment with various optical devices such as mirrors, filters, prisms, and ray boxes.

Problem

We are to design and build an activities box in which faculty members from CMU would take into an elementary or junior high school classroom to teach students things about engineering. The activity that we design needs to engage the students in an engineering activity, teach students what engineers do, engage 30 children simultaneously. The activity needs to be safe, durable and suitable for an indoor classroom and that would be able to be transported in a compact car.

Objectives of the Purposed Work

The objective of our project is to instruct children on the functionality of a number of optical tools and the properties of light. Students at this stage usually do not have much exposure to this area of physics, and we believe that light and the effects of light can be one of the most captivating and interesting aspects of science and engineering for a student to learn because of the startling colors and effects that can be generated very easily from just a few components.

It is out belief that students will be eager to learn and experiment on their own with the tools given to them. Many of the projects that we have seen or heard about that are used to instruct children in the classroom do not give them a lot of freedom with both the experimental setup and the outcome of the experiment. In our case, we wanted to give the students a modular kit that can be used in many different ways so that each group could have a different end result.

By providing the groups with the tools necessary to setup an optical experiment we will enable them to learn empirically, and we believe that this method of learning is by far the most direct for the age group we are targeting.

Solution

We propose to build and distribute a number of optical kits that will allow students to experiment with different optical effects. Each kit will be composed of the following materials :

- A wood base board, 18 inches x 24 inches, covered in a black matte plastic sheeting
- 1 triple and 1 single slit plate for mounting on the ray box
- 1 hollow acrylic prism
- 1 double concave lens

- 1 convex lens
- 2 plane mirror
- 1 concave mirror
- 5 different colored filters
- 3 pairs of mirror holders (manufactured with fused deposition)

The necessary ray box will be provided in the activity box, but we will only provide one because of the high cost associated with this piece of hardware. The instructor is expected to demonstrate the usage and effects of each component to the students and then assign the groups a task to complete in a certain time frame. Each group's task should be different, thus allowing for each group to learn from other groups after the experiment is complete.

As the groups design their experiment, the instructor will be available to bring the ray box to a table and test the group's proposed solution. If the solution meets the objectives that the instructor had given them, then they have completed their task and will await while the other groups finish. If the test produces unexpected results the group will have a chance to redesign their experiment. Once all groups have reached the objective, or time has elapsed, the instructor will demonstrate each solution so that other groups can see and learn from other experiments.

The required documentation that will accompany the activity box will be written by our group. In it, we will outline a series of possible experiments that the instructor can draw upon for group tasks. Each outline of the experiment will describe the effects produced and the setup of optical tools that will produce the result. We estimate that there will be 4-6 different experiments documented.

Costing

Costing for the material is as follows - prices are from 1998 Boreal catalog :

Ray Box includes prism, 1 convex lens, 2 slit plates 1 plane mirror, 1 convex mirror, filters, bulb	$75.00 part #69360
Alkaline batteries	$3.50

In addition, for each kit past the first (most of which comes with the ray box) we will require the following :

1 plane mirror	$3.95	part #66522-00
1 concave mirror	$2.95	part #62596-50
1 double concave lens	$13.95	part #69884
1 double convex lens	$14.95	part #69885
Total for each kit after first	**$35.80**	

Total for 1 ray box and three kits $146.60

We have attached the completed order form from Boreal with this information.

This pricing does not include the cost of wood and plastic laminate, which we believe will be approximately $10 for 5 kits.

Plan

Our plan for the completion of the project is as follows :

Task	Assigned To	Due
Proposal	All	Now
Order parts	Molinari	Apr 10
Table build for prototype	Cho	Apr 14
CAD design of mirror mounts	Lam	Apr 14
Assemble Prototype	All	Apr 16
Obtain mirror mount via FD	Lam	Apr 20
Table build for all kits	Cho	Apr 24
Assemble all kits	All	Apr 26
Documentation	Molinari	Apr 26