Wonder Factory Interactive Refraction Box

Mohammad Almaie, Cameron Munger, Abdulaziz Omar, Jonathan Witherspoon

College of Engineering, Forestry & Natural Sciences

Department of Mechanical Engineering, Northern Arizona University, Flagstaff, AZ 86011

Abstract

The Wonder Factory is a non profit organization whose goal is to create a interactive science center for all ages. The center is to be family oriented and geared towards children to encourage learning through play. The Wonder Factory Northern Arizona Capstone team worked in conjunction with the Wonder Factory in order to choose a design for their future science center. The project chosen was an interactive laser box design to teach children about refraction with mirrors as well as about geometry used in everyday life. The team designed a wooden prototype that helped in the final design which was constructed out of aluminum. The aluminum was machined in the Northern Arizona University machine shop for construction. The device was then tested before revealing final device to clients for inspection

Introduction

Project Goal: The goal for the team is to help promote the Wonder Factory's goal in promoting awareness and interest in science through the device. The device needs to be simple, safe, realistic, and entertaining to children.

Design Process: The team started the project by identifying the customers requirements on what was needed to fit the clients vision for the project.

Table 1: Customer Requirements

Customer Requirements	Weighting
Safety	5
Wow Factor	5
Hands-on	5
Integration of STEAM concepts	4
Simple Instruction	4
Durability	4
Visually Appealing	3
Narratives	3
Easy Assembly	2
Multiple Visitor	2
Mobility	1

With the guidance of the criteria the team then generated 100 different concepts of possible project devices and ideas. All 100 concepts were analyzed individually based on the Customer Requirements until the top idea was selected based on the team vote which ended up being the Refraction Box.

Specifications

With the design selected the targeted specifications were selected using the customer requirements and team requirements.

Table 2: Specifications to Device

Engineering Requirements	Target
Total Weight	50 lbs
Laser Frequency	650 nanometers
Cost of Production	$800
Expected Life Span	2 years
Dimensions	3 ft^3

The design criteria gave parameters to make sure the device was practical. Also to ensure the team did not lose focus on overall purpose of the device.

Design

Materials:

- 2.5 X 4 Aluminum Billet
- 2 Sq. T3 Aluminum Billet
- 2 18 X 29 Aluminum Sheet Metal
- 24 1in Square Mirrors
- 650 nm Laser

:

Figure 1: SolidWorks Image of Refraction Box

Construction

Working with metal the team used the machine shop on NAU campus. With training from the machinist the team was able to use the following machines for the project.

Figure 2: Drill Press

The Drill Press was used for the majority of the project ensure that holes could be generated for the mirrors as well as spacing for electronic wires

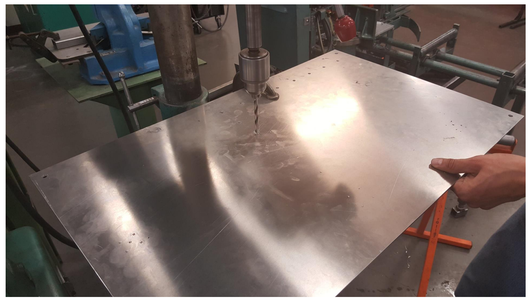

Figure 2: Drilling of Aluminum Sheet Metal

The Lathe Machine is used for circular metal pieces which is needed for the metal shafts. The shafts will be used for the hand crank in order to rotate the mirrors.

Figure 3: Turning Lathe for Aluminum Billets

Testing

After construction the team tested targeted criteria by the following tests:

- A scale measured the weight of the device
- When purchasing the laser the team checked specifications of the laser wavelength to ensure it was within 500-700 nanometers
- The illumination was tested by placing a message at the bottom of device with size eight font according to Microsoft Word in a dark room to see if lettering was visible with the laser on.
- Degrees of freedom was tested by taking multiple pictures of different positions of the hand crank to ensure the laser stayed only in the X-Y plane.
- The WOW factor will monitored by studying the audience interactions with the device at future event to measure how often the audience smiles and has a surprised expression on their faces.
- To test if the device's solvability stopwatches were used to see how long it takes for the targeted audience to solve device. In addition for ease of use the time was tracked on how long it takes to set up device.
- Durability of the device was tested by having one team member stand on the display case to ensure the device could handle the compressive forces.
- After testing the team was able to make adjustment to device in order to provide a quality devise that would be donated to the Wonder Factory for it's future location.

Acknowledgments

Instructors: Drs. Jennifer Wade, Drs. Sarah Oman
Client and Sponsors: Steve and Jackee Alston

Engineering Design