Restated Project Scope and Project Plan

EML 4551C – Senior Design – Spring 2013 Deliverable

Team 13: Smart Materials Museum Exhibit Design

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Project Sponsor

Challenger Learning Center

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Needs Assessment

Smart materials are materials that respond to an external stimulus. Smart materials have a variety of uses in both space and every day life. However, public knowledge of these materials and their applications are still very limited. Education for school aged children about these materials would be beneficial in order to get them excited about science and engineering. The Challenger Learning Center needs another museum exhibit in order to attract patrons and to use in conjunction with their mission to Mars simulation. By incorporating the need for education about smart materials and their applications, and the desired museum exhibit for the Challenger Learning Center, this senior design project was formed. The Challenger Learning Center requests interactivity of the exhibit as well, in order to truly capture the attention of the school children.

Project Scope

Problem Statement

The Challenger Learning Center requested that we design a display featuring a smart material. Their requirements were for it to be interactive and educational, to stimulate interest in smart materials, and to have a space theme. They also requested that, if possible, it could be used in conjunction with their simulated space mission as part of the Communication Controller's job.

Justification and Background

The piezoelectric effect is understood as the linear electromechanical interaction between the mechanical and electrical state in crystalline materials. Essentially converting force into electricity (voltage), or the reverse electricity into force. A voltage can be applied through an amplifier and that voltage will cause the piezoelectric material to change shape. This project will use this property to control the path of a laser light source. The piezoelectric material utilized in this project is called macro fiber composites (MFC), produced by Smart Material Corporation. The MFC consists of rectangular piezoceramic rods sandwiched between layers of adhesive film. Voltage is transferred to and from rods within the materials via tiny electrodes in the film.

The inspiration behind our exhibit design was based on the fact that smart material is used in space today. They are used in adjustable antennas for satellite communications. The smart material used in this is of the piezoceramic type, which is the same that we utilize in our exhibit. Self-adjustable antennas are possible when piezoceramic patches are attached to the back of a reflector. When this piezoceramic is given voltage, it expands and since it is attached to the reflector, it bends its surface as well. With the surface bending, the overall shape of the structure can change, which alters the properties of the antenna itself. Changing the shape of the reflector while in orbit can improve its signal quality. Doing all this with piezoceramics is quite the upgrade, as all that has to be done is apply the proper voltage. Prior to this, the whole mechanism beneath an antenna would have to be moved to change communication direction.

Our exhibit is not a direct representation of this application in space, but it is very similar. Piezoceramics are used as part of the design to adjust a satellite. Once the satellite is adjusted, communication can be made with a different part of Florida, as will be shown on the map. The main concept that is to be portrayed by our exhibit is how piezoceramics can be used to in satellite communications.

Objective

The objective of the Smart Materials Museum Display design project is to produce an interactive display with the ultimate goal will be to teach the Tallahassee community the science behind smart materials and how they are used in engineering applications. The project will be installed in the lobby of the Challenger Learning Center in Tallahassee, FL. The Challenger Learning Center is an aerospace themed facility that promotes interest in science, math, and engineering technologies by providing interactive learning experiences including a Space Mission Simulator, IMAX® 3D Theatre, and the Downtown Digital Dome Theatre & Planetarium. The target audience will mainly be elementary school aged children so the display must be interactive and entertaining. It must also accomplish the ultimate goal of facilitating education of the properties of piezoelectric smart materials. This design utilizes these piezoelectric ceramics to control and guide the projection of a laser light onto a large map of Florida displayed in the Challenger Learning Center's lobby. This laser signifies communication from outer space to various Florida cities. The project will be coupled with the Space Mission Simulator and represent the communications station. The idea behind this project is to stimulate the operator's interest by creating a game out of the display. The display will be interactive and entertaining as well as educational.

Methodology

The main focus of this project will be on the control of the laser via mirrors mounted on the ends of two thin cantilever beams. The cantilever beams will be oriented in two perpendicular planes with the long axes of the beams 90 degrees relative to each other. The cantilever beams will be actuated, or bent, via the piezoelectric mounted on the surface of the cantilevers, one per cantilever beam. This will give us two degrees of freedom, however some testing will still need to be done to determine the range of motion the cantilever/piezo which directly affects the range of motion of the reflected laser. The piezoelectrics with be controlled via a micro-controller, most likely an Arduino Uno, in some sort of closed loop feedback, either based off of tip deflection or strain. A digital joystick, controlled by the user, will increment the position variables inside the control loop. Also there will be a separate module controlling servos, indirectly controlled by the user, via an array of photo-resistors.

Constraints

As with all projects there are restrictions, or constraints, that must be worked with. It is vital to keep these in mind in design and prior to construction so as to stay within scope. Certain constraints were given by our sponsors and some we implemented ourselves. The constraints are the following:

- *Budget:* The budget is currently at $1500. We are well below that limit as our most expensive items such as the piezoceramics and the amplifier are being donated by the FAMU/FSU College of Engineering.
- *Interactivity:* We want are exhibit to be entertaining and user interactive
- *Safety:* The exhibit must be safe for use with kids as young as kindergarten. No exposed electrical hazards or other potentially dangerous mechanical devices
- *Theme:* We want it to be related to space/NASA so that it goes hand in hand with their current program for students.
- *Audience:* Though we want to inform the whole general public on the use of smart materials, we are specifically gearing our exhibit to 5th to 8th grade students.

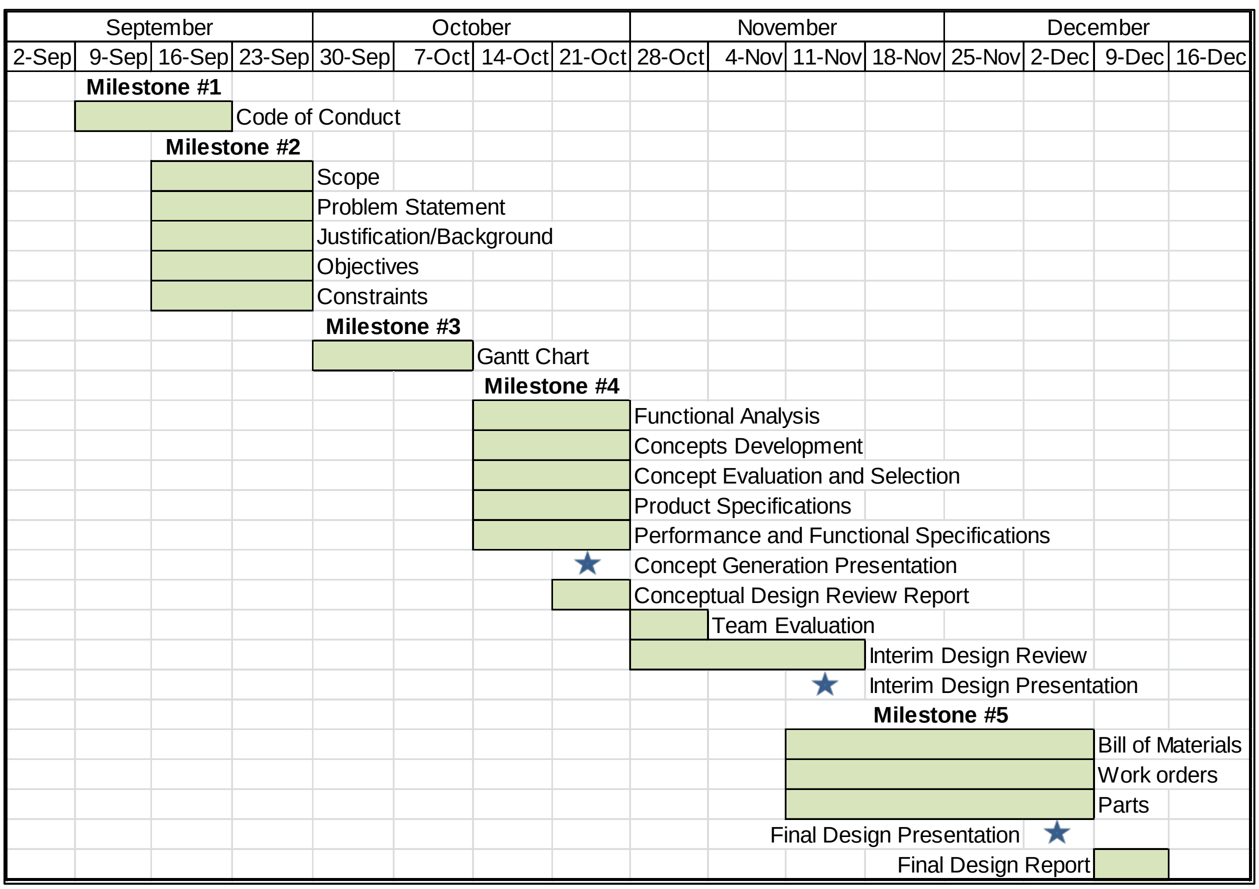
Expected Results

The Challenger Learning Center plans to receive a fully functional museum exhibit, delivered and installed by the end of the spring semester. The exhibit should be safe to use, as well as educational. The exhibit should be robust enough in order to withstand everyday use from children, and should require little maintenance. An operation manual describing its features and use will also be provided to the Challenger Learning Center.

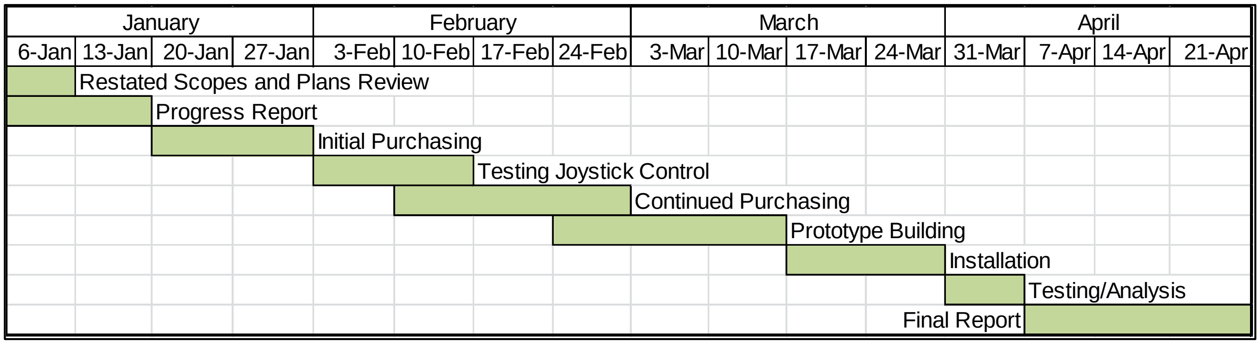
Project Plan

Below are the Gantt Charts that will be used to track our progress throughout the project. These time allotments allow for adequate completion of the tasks involved. The milestones are labeled to ensure we stay on track. If there are changes in the schedule the Gantt Charts will be updated to reflect these changes.

Fall 2012



Spring 2013


January
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10-Mar
17-Mar
24-Mar
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21-Apr
Restated Scopes and Plans Review
Progress Report
Initial Purchasing
Testing Joystick Control
Continued Purchasing
Prototype Building
Installation
Testing/Analysis
Final Report