Shear Stress Sensor Design

EML 4552C-Senior Design- Spring 2013

RESTATED SCOPE AND PLAN

Sponsor: Dr. Ben Dickinson, Eglin AFRL

benjamin.dickinson.ctr@eglin.af.mil

Faculty Advisor: Dr. William Oates

woates@eng.fsu.edu

FAMU & FSU College of Engineering, Department of Mechanical Engineering

Project Instructor: Dr. Kamal Amin

FAMU & FSU College of Engineering, Department of Mechanical Engineering

Team 3 Members:

Matthew Carmichael

Tyler Elsey

Luiz Paes

Department of Mechanical Engineering, Florida State University, Tallahassee, FL

Due Date: January 15, 2012

Table of Contents

Executive Summary:

The testing apparatus has been designed. All parts have been machined and ordered. Some of the preliminary testing has been conducted like the calibration of the load cell and spectrometer/LED calibration.

For the upcoming spring semester, testing and analysis of the project will be carried out to see how the liquid crystals are affected by shear forces. Additionally a polymer form of the cholesteric crystals will be ordered and tested since the polymer form of the crystals will be used for the actual application. If time permits and testing goes as planned a prototype sensor might be made.

Project Scope:

Needs Assessment:

A testing apparatus for cholesteric crystals is required to determine if the crystals are able to be used as a consistent visual meter for shear stress.

Problem Statement:

There currently isn't a shear stress sensor that only measures shear stress. The current methods unintentionally measure part of the normal component of pressure on the body as the shear stress. The current methods are also large and expensive. The cholesteric crystals attributes indicate that they might be able to only measure the shear component of stress; decoupling the shear from the normal stress. The cholesteric crystals can also be modularly attached to materials and measured with only a fiber optic spectrometer. This would make it possible to cheaply measure shear stresses outside of the lab environment.

Objectives:

Our first objective is to design, machine, and assemble the testing apparatus. A LabVIEW visual interface will be created to control the experiments and record data. Once this phase is complete, we will collect as much data as possible which will be the main product of this project. The first phase of testing will be for the cholesteric liquid crystal. The liquid crystal will be used to characterize the cholesteric material and provide a proof of concept for using cholesteric crystals as a shear stress sensor. We then expect to determine how the material reacts under static and dynamic shear stress along with how the material reacts to different temperatures, light sources, and measurement angles. We also want to find the maximum and minimum shear values that the materials can detect, if the material has an endurance limit, and the materials sensitivity to shear. Once we have characterized the liquid crystal, a polymerized form of the cholesteric crystals will be ordered and the same experiments will be run on the polymer. The polymer is very expensive and takes a significant amount of time to make; which is why there first needs to be a proof of concept with the inexpensive liquid crystal. With time permitting we will indicate what type of applications the material is suited for, and design a "sensor package" that could be reproduced for future tests.

Technical Plan:

Since the testing apparatus has been built there currently aren't any challenges that are on the horizon. The only possible one was that the original LED light source didn't produce a white light with some intensity across the entire visible spectrum. This was solved by ordering a Bluloop fiber optic light source from ocean optics.

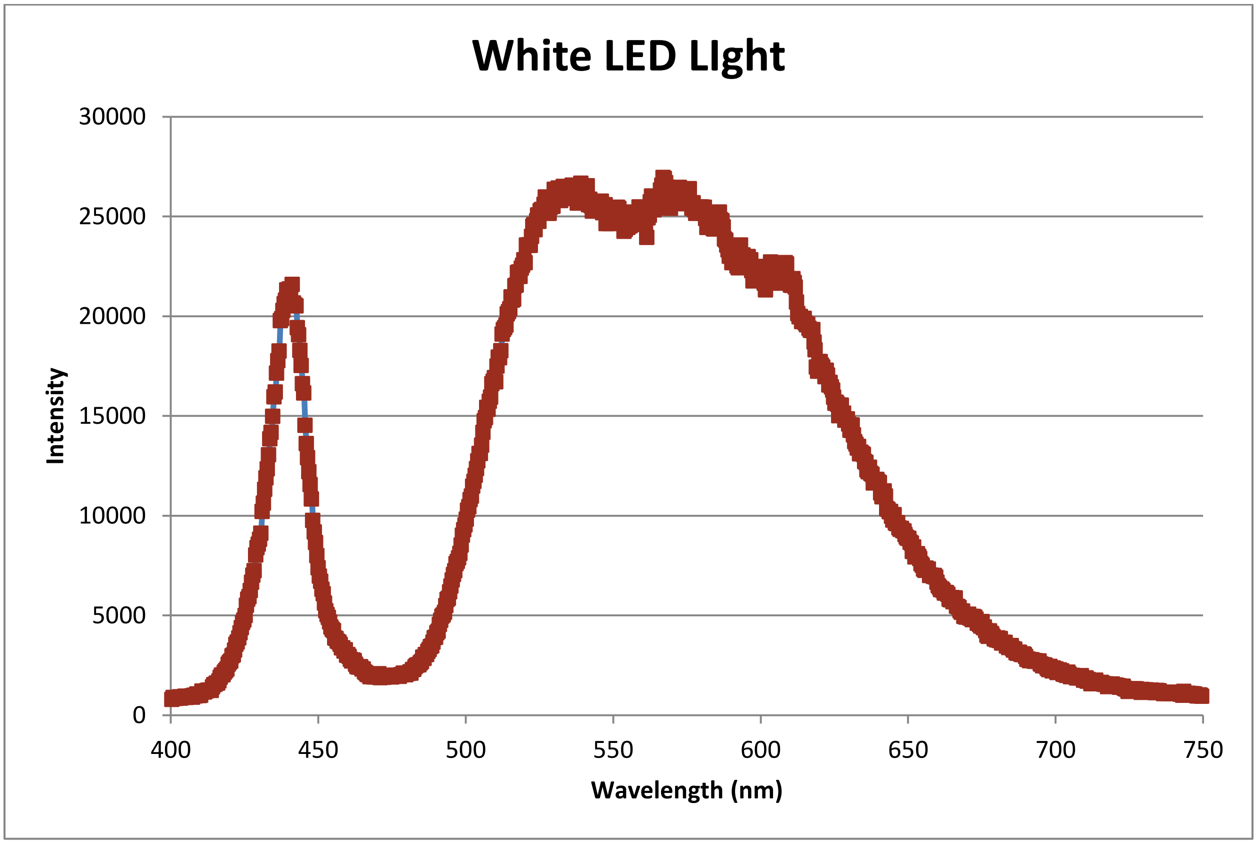


Figure 1-White LED Distribution

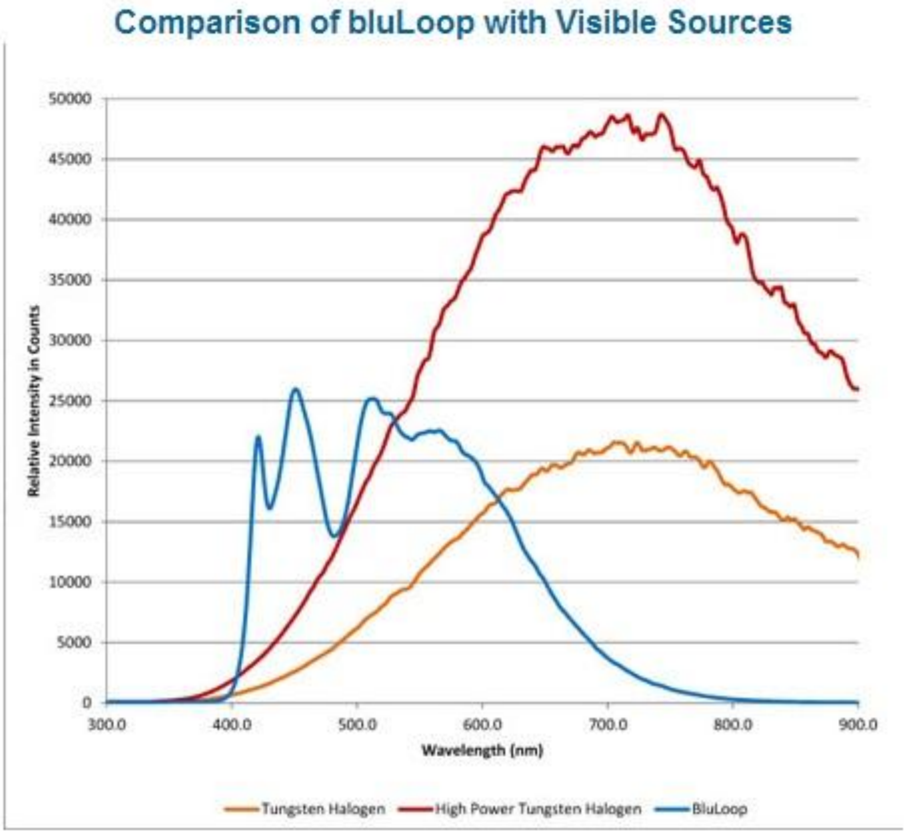
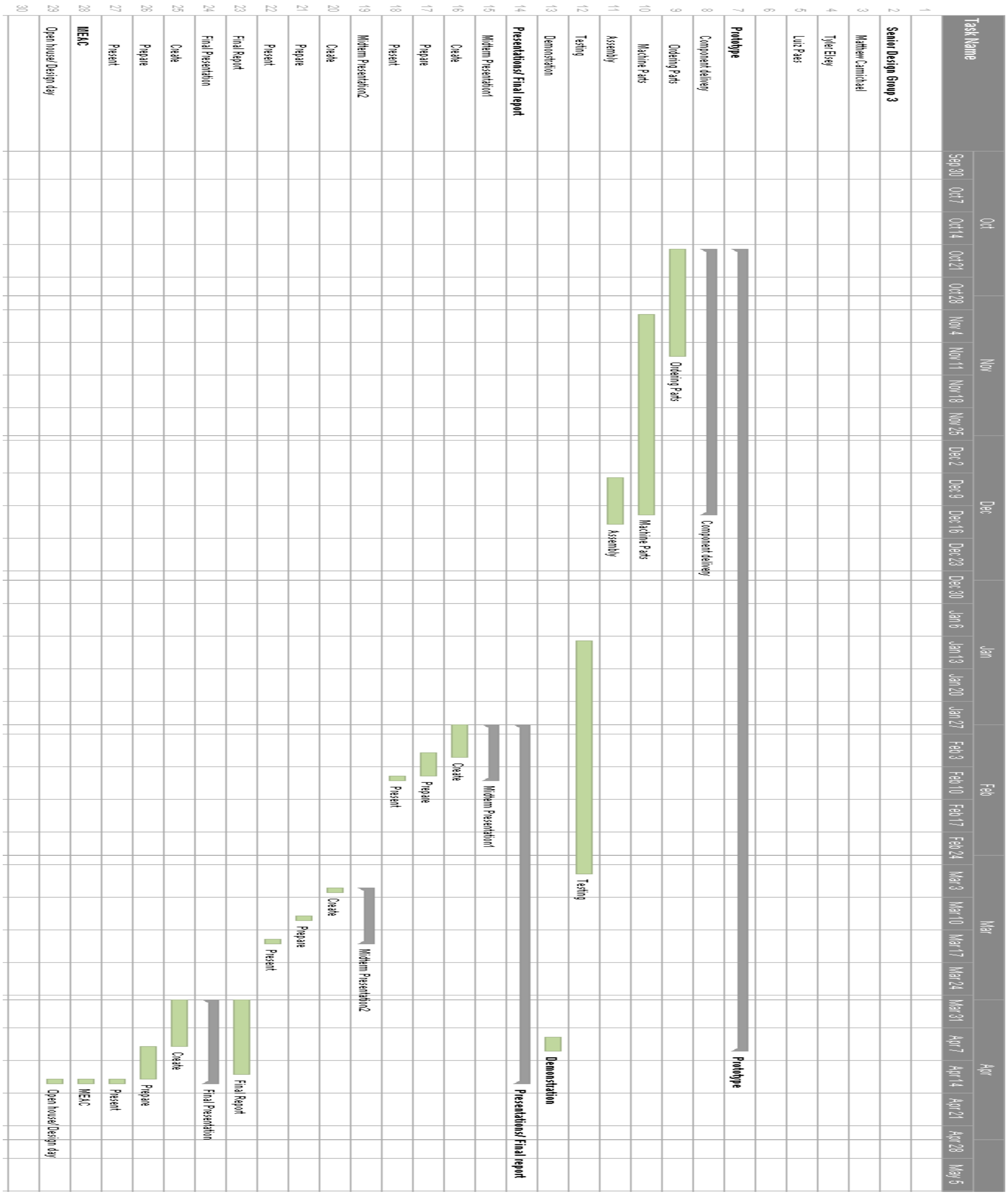


Figure 2- Bluloop Fiber Optic Light Source Distribution

Schedule/Gantt Chart



Appendix

Cost Analysis (Supplied Parts)

Part	Unit Price	Quantity	Price
Teflon Bearing	$3.11	1	$ 3.11
Insulation	$9.03	1	$9.03
Heat sheet	$38.90	1	$38.90
Fasteners	- -	- -	$21.84
LEDs	$23.74	3	$71.22
Liquid Crystals	$75.00	3	$225.00
	Total		**$369.10**

Table 1- Purchased Parts

Part		Quantity	Price
Aluminum		- -	$64
Load Cell		1	$935
Fiber Optic Spectrometer		1	$2771
Linear Servo Motor		1	$230
Software		1	$60
	Total		**$4,060**

Table 2- Supplied Parts from Optics Lab