# ENSC 305W/440W Grading Rubric for Project Proposal

| Criteria | Details | Marks |
|---|---|---|
| **Introduction/Background** | Introduces basic purpose of the project. Includes clear background for the project. | **/05%** |
| **Scope/Risks/Benefits** | Clearly outlines project scope. Details both potential risks involved in project and potential benefits flowing from it. | **/15%** |
| **Market/Competition/ Research Rationale** | Describes the market for a commercial project and details the current competition. For a research project, the need for the system or device is outlined and current solutions are detailed. | **/10%** |
| **Company Details** | Team has devised a creative company name, product name, and a logo. Outlines relevant skills/expertise of team members. | **/05%** |
| **Project Planning** | Details major processes and milestones of the project. Includes Gantt, Milestone, and/or PERT charts as necessary (MS Project). | **/10%** |
| **Cost Considerations** | Includes a realistic estimate of project costs. Includes potential funding sources. Allows for contingencies. | **/05%** |
| **Conclusion/References** | Summarizes project and motivates readers. Includes references for information from other sources. | **/10%** |
| **Rhetorical Issues** | Document is persuasive and could convince a potential investor to consider funding the project. Clearly considers audience expertise and interests. | **/10%** |
| **Presentation/Organization** | Document looks like a professional proposal. Ideas follow in a logical manner. Layout and design is attractive. | **/10%** |
| **Format Issues** | Includes letter of transmittal, title page, executive summary, table of contents, list of figures and tables, glossary, and references. Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted. | **/10%** |
| **Correctness/Style** | Correct spelling, grammar, and punctuation. Style is clear concise, and coherent. | **/10%** |
| **Comments** | | |

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September 15, 2013
Mr. Sjoerdsma
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

**Re: ENSC 440 Proposal – Digital Auto-Focus with Shifting Sensor**

Dear Mr. Sjoerdsma,

The following package outlines Motus's proposal for a digital auto-focus mechanism utilizing a shifting image sensor. Our prototype will allow users to make use of a digital auto-focus for their camera, even if the lens attachment doesn't have a native built-in digital auto-focus. Furthermore, it will eliminate the need to buy costly adapters for various lenses.

Attached, you will find a summary of our system design, as well as a breakdown of the expected project expenditures. Other project-related tasks will be covered as well, including team organization, scheduling, marketability and sustainability, and a company profile.

Motus is comprised of four engineering students with backgrounds ranging from Computer Engineering to Systems Engineering; Jeff Priest, Roy Choi, Bill Xu, and Vincent Chen. If you wish to discuss our project in further detail, or have any questions or concerns, please feel free to contact me via email at jpa30@sfu.ca.

Sincerely,

Jeff Priest
Chief Executive Officer
Motus

MOTUS

# Digital Auto-Focus with Shifting Image Sensor

## Project Members


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## Submitted To

Mr. Mike Sjoerdsma – ENSC 305
Dr. Lucky One – ENSC 440
Simon Fraser University - School of Engineering Science

## Date Issued

September 26, 2013

## Revision

1.0

# Executive Summary

Suppose you're in the market to buy a new camera. You've been doing your research and settled on a camera manufactured by Company X. Meanwhile, you've also been looking at lenses from Company Y, and found one that you really like. Unfortunately, the camera from Company X doesn't support lenses from Company Y, which means you have to buy a special adapter that's quite costly. You aren't sure if your budget will allow for the camera, the lens, and the required adapter.

This is a problem that many photographers face today, and one that we hope to solve with our prototype. We intend to solve this problem by developing an auto-focusing mechanism that resides in the camera, rather than in the lens. This provides us with a couple of benefits.

First, the need for a special adapter to accommodate a third-party lens will be eliminated. Any lens can be used with a camera that makes use of our auto-focusing mechanism. Secondly, any lens that doesn't have auto-focus built in will be able to use our camera to achieve auto-focusing.

In order to remain competitive, a company that adopts our auto-focusing mechanism into their line of camera products will have a strong marketing edge over their competitors. They will be able to provide more value to their customers, and they will be able to do so in a way that is environmentally responsible.

With our design, you can now buy that camera from Company X with a lens that you like, all within your budget. You won't need to purchase any adapters or worry about whether a certain lens will work with a certain camera. We believe that our design will benefit both consumers and manufacturers, and provide significant value to both.

MOTUS

# Table of Contents

# Introduction

Nowadays, DSLRs and MILCs are very popular in the consumer market. The success of this is due to easy control systems and significantly faster auto focus features.  In today's market, auto focus systems rely on the image sensor being fixed in place behind the lens. After the sensor detects the focal point, the processor sends the signal to the integrated motor in the lens. The motor drives the focal glass to move forward and backward in order to adjust focus the image on the image sensor. Figure 1 demonstrates what happens when the image is out of focus, and how it can be corrected by moving the lens back and forth. By moving the image sensor backwards and forwards as shown in Figure 2, we observe the same results.

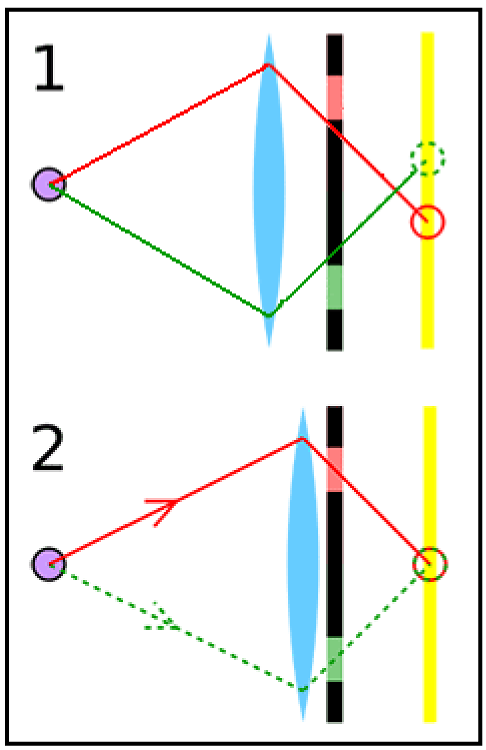



**Figure 1** – Lens shifts its position [1]

However, today's auto focus systems have a variety of problems. They require every lens to have a built-in motor. As a result, lens sizes are larger and the price increases. In order to reduce its size and price, some optics manufacturers design the lens so that it has less glass and a smaller maximum aperture, which results in a smaller size and lower price for the same level of image quality. Also, lens motors need communication pins to make the connection between the lens and camera, so that the camera's processor is able to send signals to the motor, and tell it how much to rotate the focal glass to achieve an in-focus image.

To improve the auto focus system's performance, we introduce a new concept. Our system is designed to shift the image sensor forwards and backwards instead of moving the lens. Figure 2 demonstrates shifting the sensor forward to meet the focal point.

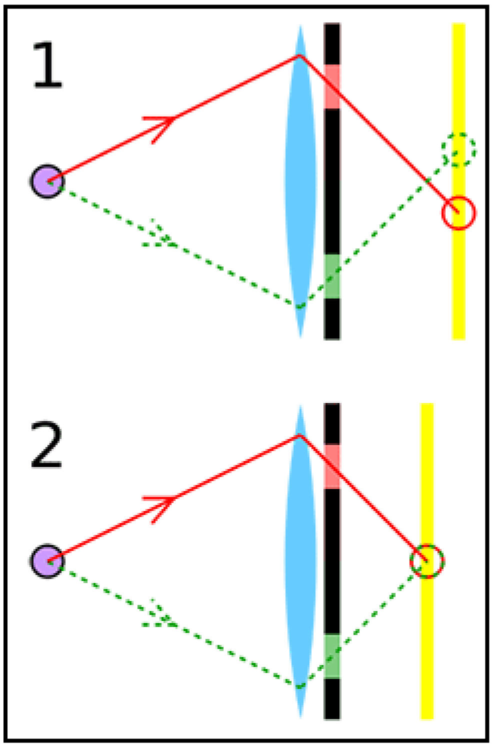



**Figure 2** – Sensor shifts its position [1]

The advantages of the shifting the image sensor instead of the lens are numerous. Lenses manufactured in the future will be smaller without sacrificing image quality. The lens will not require a motor and focal glass, and it will be cheaper to manufacturer. Today, there are many professional photographers and photography enthusiasts that possess a large amount of high quality manual focus lenses such as Leica M and Carl Zeiss screw lenses. By snapping on the cameras that have this system, any manual focus lens can benefit from our auto focus mechanism too.

# System Overview

The innovative auto focus technique is achieved by having an image sensor shifting system, which allows the sensor to slide inside the camera to catch the focus point of the image. There are three main components will be built into the camera, the mechanical shifting system, micro-processor and image sensor. In other words, the image sensor will be moved by a mechanical shifting system to a desired location under the control of the micro-processor. The following flow chart shows how the camera will react when a user want to take a picture.

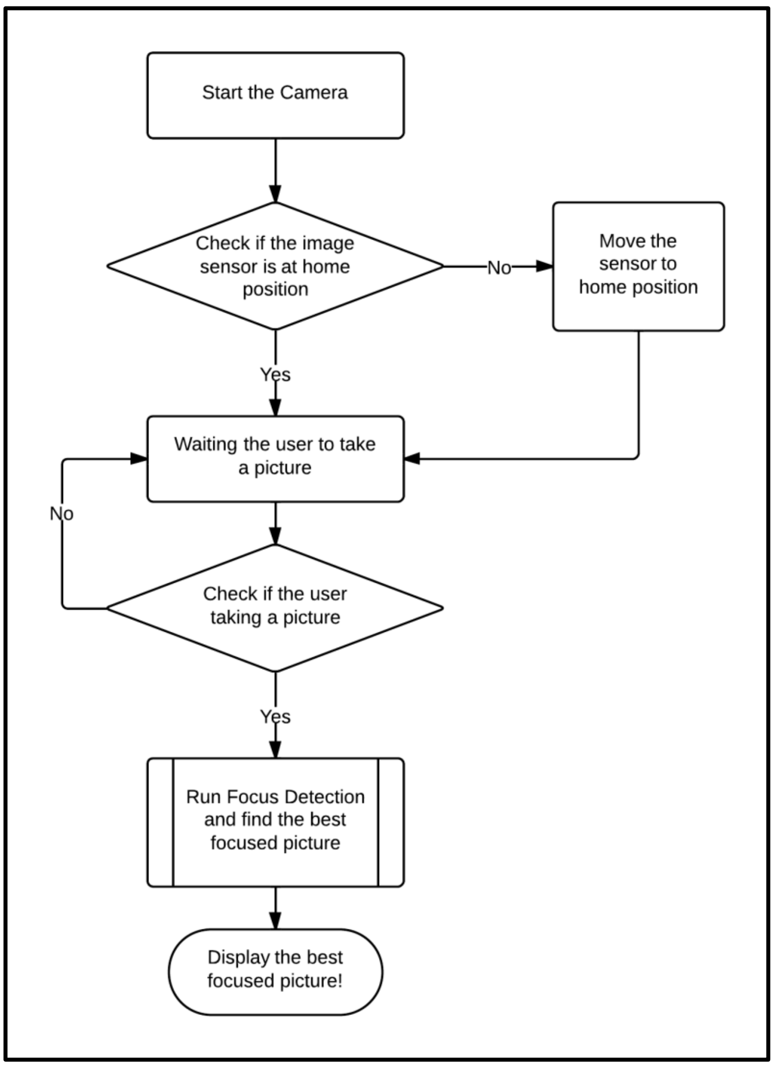



**Figure 3** - System Flow Chart

# Proposed Design Solution

The following flow chart shows how our designed system works to find out the best location for the image sensor and perform auto focusing. The image will be divided into 9 equal parts, and only the objects in the center parts will be considered as desired focus objects. To do this can significantly reduce the time needed for image processing.

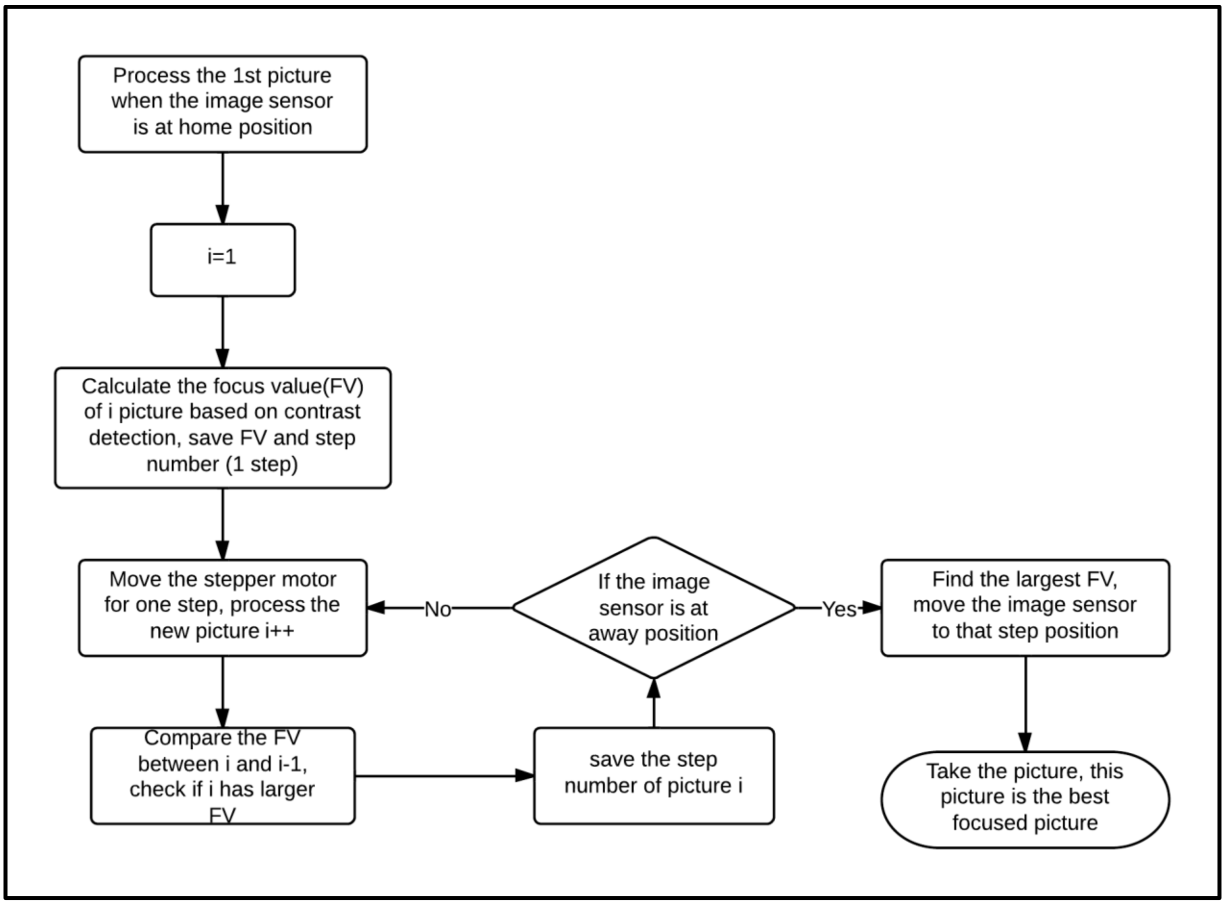



**Figure 4** - Focus Detection Flow Chart

## Focus Detection Selection

Two auto-focus detection algorithms are used in modern cameras: phase detection and contrast detection.  Phase detection requires extra hardware support to adjust the sensor for correct focus [2]. Contrast detection measures the intensity difference between adjacent pixels on the image for each frame, and figures out which frame is the most in-focus.  We have decided to use contrast detection, because it can be done without using an internal mirror, and is simpler than phase-detection.

## Image Sensor Selection

CCD and CMOS image sensor are the most popular in current camera industry. CCD sensors have better image quality, but the cost and power consumption are relatively higher than CMOS sensor. CMOS sensors with build in processor are applied to mobile devices and webcams, and CMOS chips can be fabricated on any standard silicon production line. As the result, CMOS tend to be extremely inexpensive compared to CCD sensors. Our design is intended to introduce a new concept of image focusing technique, so the image quality is not the most important aspect to be considered for the prototype. Low cost CMOS sensors are definitely the best choice at this time. [3]

## Mechanical Shifting System Selection

Many actuators are available to provide a means of linear motion, for example hydraulic, pneumatic, piezoelectric, telescoping and electro-mechanical actuators. To perform at short distances, high speed and precision motion, the electro-mechanical actuators are the best option. A lead screw can translate a stepper motor into linear motion to offer accurate movement with high speed. More important, the lead screw and motor combination are a self-locking mechanism, which can stabilize the image sensor while receiving image data.

# Financial Planning

## Cost Breakdown

The following table outlines an initial estimate of the costs associated with this project:

| Equipment List | Quantity | Estimated Unit Cost |
|---|---|---|
| Image Sensors | 2 – 3 | $50 |
| Microcontroller | 1 | $100 |
| Motor | 1 – 2 | $50 |
| Supplies for mounting fixture | ~ | $50 |
| Lenses | 1 – 2 | $50 |
| Power Supply | 1 | $20 |
| | | |
| **Total Cost** | | **$320** |

**Table 1** – Initial budget estimation

The values listed are approximations based on preliminary research, and do not account for potential shipping and duty fees. At the project progresses, this table will be updated to reflect more accurate values. At this time, however, we feel that the above table represents a realistic look at the expenditures for this project.

## Funding

At this time, we have applied for funding from the Engineering Science Student Endowment Fund (ESSEF). In the coming weeks, we will be applying for the Wighton Fund, conditional on our project meeting the set eligibility requirements for this fund. In addition, we may also seek funding from faculty members who show interest in our project. In the event that we are unable to raise the amount of funds needed for our project, we will likely divvy up the cost between the four group members.

# Marketability

Motus Technology will bring a number of benefits to end-users using a camera with our mechanism. Photographers spend thousands of dollars on lenses alone, since they have to buy different lenses for different features. Currently, if someone wants to get an auto focus lens, it will cost even more. In today's market, the price difference between auto focus lens and manual focus lens is on the order of several hundred dollars for same focal length lenses and same camera brand. With our auto-focus implementation, photographers can perform auto-focusing with a manual lens, which means that they don't have to spend more money on lenses that offer auto-focus. Furthermore, companies can lower their costs of production on auto-focus lenses by not incorporating more complex tasks like auto-focusing. Therefore, our implementation will benefit both the manufacturers and end-users.

# Sustainability

One of Motus's goals is to promote sustainability and have a restorative effect on the environment. What this means to us is to not only mitigate damage to the environment, but to take proactive measures in all stages of development and provide a better world to live in. In order to do this, we look at two key areas: Manufacturing, and social capital. We will take into consideration social, economic and ecological sustainability in all aspects of our prototype's design and manufacturing process. When selecting the parts for our prototype, we will also be assessing the recyclability of the components and evaluating whether they can be considered technical nutrients and re-used for future projects. We also consider social capital in all areas of the project's lifecycle. We will be constantly evaluating how the choices we make throughout the design development process can have a positive effect on the lives of others, and society as a whole.

One area in which we can make a large impact is in the manufacturing of lenses and lens adapters. With our prototype, we can eliminate the need for some components used to drive the motor in the lens attachments, including the motor itself. By eliminating these components from the design of lenses, we reduce the amount of mass waste created by the disposal of the lens attachments, and lens adapters. We will be evaluating other ways that we can cut down on waste throughout the project's lifecycle.

# Team Organization

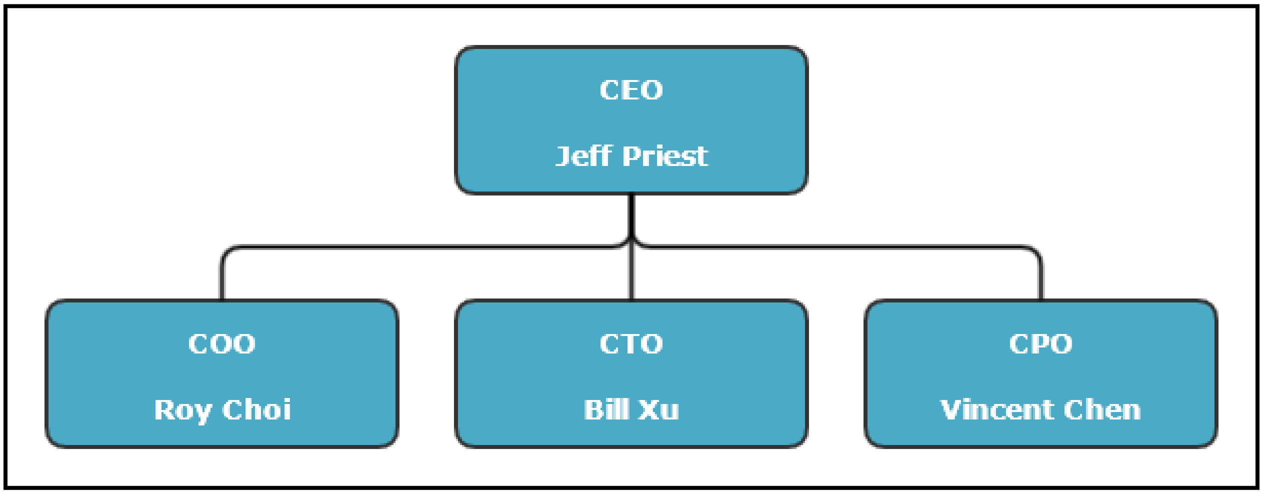



**Figure 5** – Company Hierarchy

Motus consists of four senior Simon Fraser University students in the Enginering Science program. Two of our members are in the Computer Engineering option, and two are in Systems Engineering. Between the four of us, we have over 3 years of industry experience in our respective fields. Our company structure places equal responsibility on each member, and each member is responsible for understanding the project as a whole, as well as the tasks covered by their role in the company. Jeff Priest is our CEO, and his responsibilities include making sure that the internal deadlines and milestones are met, as well as coming up with contingency plans in case deadlines are not met. Roy Choi is the COO, and his responsibilities include keeping track of day-to-day activities such as meeting minutes and scheduling, as well as resolving organizational issues. Bill Xu is the CTO, and he is responsible for researching various technologies appropriate for our project. Vincent Chen is the CPO, and he is tasked with maintaining the product vision and making sure that the end product meets the expected functional requirements set at the beginning of the project.

# Company Profile

## Jeff Priest – Chief Executive Officer (CEO)

Jeff Priest is in his final semester of undergraduate studies at Simon Fraser University. His areas of expertise are in embedded systems and software development. He has past co-op experience at Piccolo Software where he developed dispatch software solutions under the Microsoft .NET Framework for Windows CE devices, and with the Android SDK for consumer tablets. He also provisioned a satellite modem to send positional GPS updates via UDP and SMTP protocols. He has also done research into ARM-based development boards and has implemented a Cortex-M0 soft ARM processor on a Nexys 3 board. In addition, he has overseen projects from conception through to completion and deployment in the field. Jeff's past project experience makes him well suited to oversee the management of Motus.

## Roy Choi – Chief Operating Officer (COO)

Roy Choi is a $5^{th}$ year student in Computer Engineering. He has over eight months of industrial co-op experience, and has experience in multiple languages including C, C++, Objective C, Java, HTML and VHDL. Between writing multiple user manuals for testing in his co-ops and his good time management skills, he is well suited to serve as Motus's Chief Operating Officer.

## Bill Xu – Chief Technology Officer (CTO)

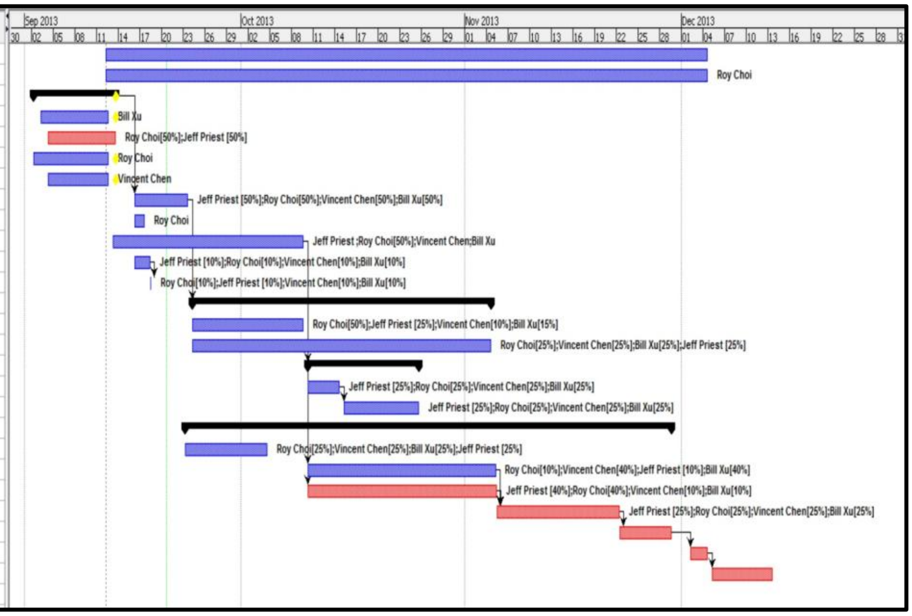
Bill Xu is a $5^{th}$ year student in the Systems Engineering option. He has four months of website developing experience and eight months of product reliability and certification experience. He is comfortable with SolidWorks (CAD) for drafting and 3D modeling, and has an advanced understanding of mechanical design including operating procedure design and mixed production system simulation. He is also knowledgeable in optics technology and photography which makes him a good candidate to serve as Motus's Chief Technology Officer.

## Vincent Chen – Chief Product Officer (CPO)

Vincent Chen is a 5th year student in Systems Engineering. He has four months of product design experience and eight months of industrial manufacturing experience. As a member of Motus, he will be responsible for the overall system design, functional testing and reliability modeling for the project. He has knowledge of the engineering design lifecycle and engineering change order (ECO). Vincent's past experience puts him in a good position to serve as Motus's Chief Product Officer.

# Project Timeline

| | Name | Duration | Start |
|---|---|---|---|
| 1 | Keeping Engineering Journal | 60 days? | 9/12/13 8:00 AM |
| 2 | Electronic copy of Meeting M | 60 days? | 9/12/13 8:00 AM |
| 3 | ⊟**Project Item Discussion** | 10 days? | **9/2/13 8:00 AM** |
| 4 | Camera Auto-Focus | 8 days? | 9/3/13 8:00 AM |
| 5 | Automatic Payment Systen | 8 days? | 9/4/13 8:00 AM |
| 6 | Traffic Light Timer | 9 days? | 9/2/13 8:00 AM |
| 7 | Auto-Leveling Wheelchair | 7 days? | 9/4/13 8:00 AM |
| 8 | Project Proposal | 6 days? | 9/16/13 8:00 AM |
| 9 | Project Scheduling | 2 days? | 9/16/13 8:00 AM |
| 10 | Reseach [Camera] | 19 days? | 9/13/13 8:00 AM |
| 11 | Project Fund [ESSEF] | 2.5 days? | 9/16/13 8:00 AM |
| 12 | Company Logo | 0.25 days? | 9/18/13 1:00 PM |
| 13 | ⊟**Design Cocument Prep** | 30 days? | **9/24/13 8:00 AM** |
| 14 | Functional Spec Prep | 12 days? | 9/24/13 8:00 AM |
| 15 | Design Spec Prep | 30 days? | 9/24/13 8:00 AM |
| 16 | ⊟**Progree Report** | 12 days? | **10/10/13 8:00 AM** |
| 17 | Oral Presentation | 3 days? | 10/10/13 8:00 AM |
| 18 | Written Progress report | 9 days? | 10/15/13 8:00 AM |
| 19 | ⊟**Prototype Prep** | 50 days? | **9/23/13 8:00 AM** |
| 20 | Shipping hardware | 10 days? | 9/23/13 8:00 AM |
| 21 | Hardware implementation | 18.125 days? | 10/10/13 8:00 AM |
| 22 | Software Implementation | 18.5 days? | 10/10/13 8:00 AM |
| 23 | Integrating HW and SW | 13 days? | 11/5/13 1:00 PM |
| 24 | Testing fully implemented p | 5.5 days? | 11/22/13 1:00 PM |
| 25 | Prep for presentation | 3 days? | 12/2/13 8:00 AM |
| 26 | Post-Mortem | 7 days? | 12/5/13 8:00 AM |



# Glossary

**DSLR** – Digital Single Lens Reflex camera is a class of digital system cameras. They combine the optics and the mechanisms of a single-lens reflex camera with a digital image sensor.

**MILC** – Mirrorless Interchangeable Lens Cameras are a type of camera that provides interchangeable lens mounts.  This class of cameras do not contain a mirror or optical viewfinder.

**Aperture** – A camera's aperture is a small adjustable opening at the front of the lens that allows a variable amount of light through to the lens.

**Flange Focal Distance** – This distance is measured from the ring mount at the front of the camera to the image sensor near the back of the camera.

**Lens Mount** – A lens mount provides an interface between the camera's mechanical and electrical components, and the components present in the lens attachment.

# References

[1] Cmglee. *Autofocus Phase Detection*. Digital image. *Wikipedia*. Wikimedia Foundation, n.d. Web. 26 Sept. 2013. <http://en.wikipedia.org/wiki/File:Autofocus_phase_detection.svg>.

[2] "Exclusive: Fujifilm's Phase Detection System Explained." *: Digital Photography Review*. N.p., 5 Aug. 2010. Web. 26 Sept. 2013.

[3] *CCD vs. CMOS*. N.p., n.d. Web. 26 Sept. 2013. <http://www.teledynedalsa.com/imaging/knowledge-center/appnotes/ccd-vs-cmos/>.