



# EVA Control System

Post Mortem

**Project Team:** Adam Franklin  
Alex Girtonea  
Bryon Long  
Alex Lung  
Mark Ma  
Mahyar Yousefi

**Contact:** Adam Franklin  
[contact@eva-controls.com](mailto:contact@eva-controls.com)

**Submitted to:** Dr. Andrew Rawicz – ENSC 440  
Steve Whitmore – ENSC 305  
School of Engineering Science  
Simon Fraser University

**Date:** December 14, 2012



# Table of Contents

---

<b>Table of Contents.....</b>	<b>2</b>
<b>Introduction.....</b>	<b>2</b>
<b>Current State of System .....</b>	<b>3</b>
<b>Deviation from the Original Design .....</b>	<b>3</b>
<b>Future Improvements .....</b>	<b>5</b>
<b>Budgetary and Time Constraints .....</b>	<b>6</b>
<b>Interpersonal Technical Experiences .....</b>	<b>7</b>
<b>Adam Franklin – Chief Executive Officer (CEO) .....</b>	<b>8</b>
<b>Alex Girtonea – Chief Marketing Officer (CMO).....</b>	<b>9</b>
<b>Bryon Long – Chief Design Officer (CDO) .....</b>	<b>9</b>
<b>Alex Lung – Chief Finance Officer (CFO).....</b>	<b>11</b>
<b>Mark Ma – Chief Technical Officer (CTO).....</b>	<b>12</b>
<b>Mahyar Yousefi – Chief Operating Officer (COO).....</b>	<b>12</b>
<b>Conclusion .....</b>	<b>13</b>

## Introduction

---

Our team has been together for the past thirteen weeks and has worked on a voice controlled home automation system. We are aware that patients or individuals with disabilities often have trouble maneuvering light switches, for instance, either in hospitals or at home. Therefore, our innovative system is mainly focused to bring convenience to individuals with disabilities. In order to achieve this goal, our team consisting of six engineering students -- Adam Franklin, Alex Girtonea, Bryon Long, Alex Lung, Mark Ma and Mahyar Yourself, had to work hard throughout the term. For this project we designed three different parts: first, voice recognition that was designed through individual voice commands; second, web based implementation; and third, automatically controlled light levels based on harvested daylight. According to the user's commands, the microcontroller (MCU) determines which device needs to be controlled, what function needs to be executed, and if the command is valid. From these commands, the MCU is able to regulate a wide range of preexisting infrared (IR) devices. Designing the system with IR compatibility will allow this technology to be easily integrated into homes with existing home automation controls. Under high motivation to find a way to provide more comfort living life for individuals with disability, the team derived this idea from a dream to the actual prototype with high competitive marketing environment.

## Current State of System

---

The system is currently capable of manipulation of the light through voice recognition and web base system. The web base system enables the user to be able to switch between automation mode and user-control mode as well as turn on and off the light. In order to prevent unnecessary conflict of the system and simplicity for the user, the voice recognition is implemented to only enable the user to turn on and off of the light. Although there are still much can be improved to make the system achieve a user-friendly environment. The EVA control team believed this proof-of-concept device is a complete prototype of the intended system.

## Deviation from the Original Design

---

Throughout the development of the EVA Control System we encountered various problems and considerations which required significant system changes and deviation from our initial design. While a few of these deviations and changes were compromises



that limited us from achieving our initial goals, the majority were actually improvements upon the original design.

## System Design

Our initial design for the system used electrical relays hardwired to the controller for turning light switches on and off, which after preliminary research is primitive by today's industry standards. We realized that various companies have already designed and marketed light switches that can be controlled wirelessly through infrared (IR), radio frequency (RF), or a number of different wireless protocols. With this new information we changed the scope of our project to be more of a universal controller for the existing products already on the market rather than an isolated control system. This change in scope led us to implementing IR and RF transmitters through the central control unit. In the end, even though we could only get the IR transmitter to function properly we believe that it provided a well enough representation of the functionality of the system for a proof-of-concept prototype.

## User Interface

Initially we had planned to implement the user interface exclusively through an iPhone application. However, we determined that an application might be more a complicated platform than our system required. Thus, we changed to a web page based interface that users could access through any internet enabled device. This deviation not only provided us with the required functionality of the user interface we were looking for, it also made our system more user friendly and accessible.

## Wireless Communication

After the previously mentioned change in scope, we had intended to implement both IR and RF control through the central control unit to provide wireless communication. This goal however, was never realized since we were only able to get the IR transmitter working, mainly because we were unable to interface with the INSTEON SwitchLinc RF switch due to its proprietary protocol. Despite this shortcoming we still feel that the realized system represents the comprehensive proof-of-concept we intended at the outset of this project.

## Future Improvements

---

A crucial philosophy that we at EVA Controls believe is to give users home automation through a smooth integration scheme with their current household devices. While the current system does capture the idea for smooth integration, there are certain aspects where we can improve our product. Future improvements on increasing communication options, additional voice commands, and even the aesthetic look of our product will increase EVA Control's viability in the market as an effective budget home automation system. Two additional future goals that EVA Controls will seek are to add a confirmation response from EVA and as well as expanding our product compatibility to more than just lighting controls. The implementation of these improvements will most definitely make EVA Controls an active competitor in the home automation market.

### Communication Options

The current wireless technology that EVA Controls is utilizing in the system to send instructions to corresponding devices is Infrared. Naturally, it is not realistic to assume all current household devices are done using Infrared technology. So it becomes beneficial for EVA Controls to increase the number of communication options. Developing X10 and RF compatibility will allow for easier integration of our product for more users. This will reduce the need to replace current working household devices as users will be able to choose the version of EVA Controls that is most suitable for them.

### Additional Voice Commands

Increasing the number of available voice commands will allow the user to have more control with their home automation. EVA Controls will have to upgrade the voice recognition module in the future to provide for more possible voice commands. The introduction of these new voice commands will continue to be simple words so that users will be able to easily memorize.

### EVA Voice Interaction

Adding a human effect to EVA Controls will make for a more satisfying experience for the user to interact with their home automation system. We will look into implementing this feature in the future to make our product to be both easier and friendlier to use. This feature will consume a lot of time and resources to create but should make EVA Controls a strong contender in the market.



## Product Compatibility

Although EVA Controls currently demonstrates the ability to act as a home automation lighting system, we intend for EVA Controls to branch out to control other household devices as well. Actions such as opening the curtains, turning on the TV, or setting an alarm clock should be viable with EVA Controls in the future. We will look into integrating common household devices with EVA Controls to allow users more control over their home either through voice control or web based interaction.

## Budgetary and Time Constraints

	Unit Price	Quantity	Subtotal
Arduino Mega2560	\$62.23	1	\$62.23
Arduino Ethernet Shield w/o POE REV3	\$47.42	1	\$47.42
Lutron IR Dimmer	\$42.54	1	\$42.54
INSTEON RF Switch	\$86.22	1	\$86.22
Philips Dimmable LED Bulb	\$22.37	1	\$22.37
Various Electrical Components	\$40.16		\$40.16
Mounting Platform	\$8.05	1	\$8.05
RF Transmitter	\$44.42	1	\$44.42
IR LED (751-1204-ND)	\$1.20	5	\$6.00
Photodiode (751-1002-ND)	\$2.31	3	\$6.93
Light to Frequency Converter (TSL235R-LF)	\$4.70	3	\$14.10
PCB	\$42.53	1	\$50.53
Voice recognition Chip LD3320	\$30.72	1	\$30.72
Display LEDs (5/PK)	\$3.30	1	\$3.30
PC Header Pins	\$1.90	2	\$3.80
NPN Transistors (10/PK)	\$3.15	1	\$3.15
Case Material	\$18.65		\$18.65
<b>Total Expenses</b>			<b>\$482.59</b>
<b>Total Financing</b>			<b>\$500.00</b>
			<b>\$17.41</b>
<b>Original Budget</b>			<b>\$595.00</b>



Post Mortem

ID	Task Name	Duration	Start	Finish	02 Sep '12		16 Sep '12		30 Sep '12		14 Oct '12		28 Oct '12		11 Nov '12		25 Nov '12		09 Dec '12		23 D						
					W	S	T	M	F	T	S	W	S	T	M	F	T	S	W	S		T	M	F	T	S	W
1	Research	25 days	Thu 06/09/12	Wed 10/10/12																							
2	Actual	47 days	Thu 06/09/12	Fri 09/11/12																							
3	Funding	7 days	Mon 10/09/12	Tue 18/09/12																							
4	Proposal	4 days	Wed 12/09/12	Mon 17/09/12																							
5	Milestone #1 - Proposal Complete	0 days	Tue 18/09/12	Tue 18/09/12																							
6	Functional Specifications	15 days	Tue 18/09/12	Mon 08/10/12																							
7	Actual	14 days	Mon 24/09/12	Thu 11/10/12																							
8	Milestone #2 - Functional Specifications	0 days	Tue 09/10/12	Tue 09/10/12																							
9	Milestone #3 - Oral Progress Report	0 days	Tue 16/10/12	Tue 16/10/12																							
10	Design Specifications	20 days	Tue 25/09/12	Mon 22/10/12																							
11	Actual	16 days	Mon 01/10/12	Mon 22/10/12																							
12	Milestone #4 - Design Specifications	0 days	Tue 23/10/12	Tue 23/10/12																							
13	Hardware/Software Development	31 days	Tue 02/10/12	Tue 13/11/12																							
14	Actual	44 days	Mon 15/10/12	Thu 13/12/12																							
15	Parts Acquisition	5 days	Mon 08/10/12	Fri 12/10/12																							
16	Actual	23 days	Tue 16/10/12	Thu 15/11/12																							
17	Integration	18 days	Fri 26/10/12	Tue 20/11/12																							
18	Testing/Defect Fix	18 days	Fri 02/11/12	Tue 27/11/12																							
19	Verification	15 days	Mon 12/11/12	Fri 30/11/12																							
20	Actual	24 days	Mon 12/11/12	Thu 13/12/12																							
21	Milestone #5 - Written Progress Report	0 days	Fri 09/11/12	Fri 09/11/12																							
22	Documentation	72 days	Tue 04/09/12	Wed 12/12/12																							

## Interpersonal & Technical Experiences

---

### Adam Franklin – Chief Executive Officer (CEO)

The first step taking by our group for this project was actually forming the group. We formed our group using the 305-planning email list. Naturally I had my concerns about forming a group with people I hadn't work with before, but, those concerns were alleviated very shortly after meeting with everyone to start planning our project. At our first meeting in late August, we began discussing possible project ideas. I had the idea of a automated lighting system that automatically adjusted light levels based on incoming daylight, also refereed to as daylight harvesting. Mark had another idea regarding voice recognition hardware, so after some discussion we decided to merge the two ideas and design a voice controlled lighting system. I have never been a big fan of voice control but when it was suggested that we market the system towards people with disabilities to improve living comfort I was completely on board.

My experience with electrical systems and wiring, from my coop position with BC Hydro, lead me to take on the responsibility of designing and building the electrical components of the system. With out initial design these electrical components included electrical relays for On/Off control. This design, however, was short lived after I began researching the current technology being used on the home automation market today. Through this research I became very familiar with the various home automation protocols including, X10, INSTEON, Z-Wave, and ZigBee. The one commonality I noticed between all of these protocols was that they were all wireless, thus I realized that our system must be wireless as well. This required even more research into an area I was unfamiliar with on a technical level. This is where the group dynamics became very helpful for me, I was able to consult with all the members and get their inputs about what they thought was possible or not. These consultations with group members allowed the design and development of the project to progress efficiently.

I believe that the numerous projects reports required for ENSC 305, along with our meetings with the professors and TAs, is what pushed myself and our group to develop a better, more relevant product. Without these reports I feel that we would have just implemented our initial system, which would have resulted in an inferior product. This is why I believe that one of the most valuable concepts that I have taken from ENSC440/305 is that you cant just jump into a project and build the first thing that come to mind, significant research must be done into determining the status of the current market as well as existing products.





Overall I had a great experience working with the five other members of our group over the last four months and I appreciate the fact that I have gotten the chance to work with such great, and intelligent future engineers. Through working with them, I have gotten the chance to learn about various engineering aspects that I previously had little to no valuable knowledge or experience with, such as programming Arduino microcontrollers. Given the opportunity I would gladly work on developing an engineering related product with this group again.

### **Alex Girtonea – Chief Marketing Officer (CMO)**

Having such a diverse group of people to work with made it easy and enjoyable to come up with a viable concept and an interesting project such as EVA Controls. I enjoyed getting the opportunity to dabble in web design, and perfect my programming skills. By each applying our unique skill set, I found it remarkable how diverse the field of Engineering is – computer engineering, electrical engineering, systems engineering, all with their own particular mechanisms.

Seeing Hardware and Software come together has been very rewarding, particularly for a project that can have such meaningful applications. I believe that given more time we would have been able to turn our idea into a truly marketable product.

Also, as a final reflection I would like to advise any future students taking the course that they should not have any Lab intensive courses beside ENSC 440. I took ENSC 325 (Microelectronics II) concurrently, and found it difficult to balance the amount of group work between the two classes. Especially because this is such a rewarding opportunity, ENSC 440 deserves as much attention and dedication as possible.

Nevertheless, this has been a once-in-a-lifetime experience, where I was able to showcase my skills and work with a group of equally hard-working, dedicated people. I had fun developing EVA Controls, and look forward for a future opportunity to work on something similar.



## **Bryon Long – Chief Design Officer (CDO)**

This project has been an exciting experience. Throughout the course of this project, my team and I hit many roadblocks which forced us to deviate from our original goal. We pushed deadlines back and were constantly behind schedule. We were under budget however, which allowed us to experiment with different solutions and expand our project if needed. Even with all these bumps, we managed to pull it off in the end and produced a suitable deliverable. To tackle this project, we as a team decided it would be best to break up into smaller two-man sub teams and so, I teamed up with Alex Lung.

Alex and I were tasked to design and develop the architecture of our product. Because I had previous experience with microcontrollers, I volunteered to research a suitable microcontroller to work with. I had chosen the ATmega2560 from Atmel using Arduino as the prototyping platform since this platform was easy to work with and is easily expandable with many other devices.

When we received our parts, we immediately started setting up the prototyping platform and as expected, it did not require much effort. Progressing into developing our first module, the IR transmitter, we ran into our first issue. The receiving end of the IR transmitter required the signal sent to follow very specific requirements. Due to the specifications of the receiver, we could not easily program the microcontroller to produce the required signal elegantly. And so, we brainstormed several ways of achieving it without having to build any external circuits. Prior to this project, I have worked with other microcontrollers and was familiar with timers, a key feature in most microcontrollers. I developed an algorithm using timers to produce the required signal. The signal produced was correct; however it contained a lot of jitter. I experimented with different algorithms using timers but the end result was the same; an unclean signal. This led me to thinking outside the box; outside the microcontroller to be more specific. I looked into developing an external circuit that would modulate a base signal from the microcontroller to the frequency specified for transmission using a phase-lock loop. This would be the ideal solution but due to the lack of knowledge in this area and time constraints, we were unable to further pursue this solution. Alex Lung had suggested we save ourselves some time and effort by using system delays to generate the required signal. This approach was not an elegant method but it worked. I realized then that as long as things worked, move forward and optimize later because we did not have all the time in the world to perfect every last part of our system. Once the IR transmitter module was completed, Alex and I collaborated with the other members to develop the Daylight Harvesting and Ethernet modules.

All in all, this project has expanded my knowledge in electronics engineering. Not only did I further tune my skills with developing with microcontrollers, I also learned how to transmit signals using IR; something that was new to me. The greatest skill obtained though, I would say, is time and project management. I realized what an important asset this is with any projects. If I could go through this again, the only thing I would change would be to properly plan out the project components and deadlines as this can make or break any projects. By the end, I was satisfied with the outcome and it has inspired me to pursue other self directed projects that utilize the experience gained from this project. I plan to further pursue the phase-lock loop solution to develop a frequency multiplier on my own time.

### **Alex Lung – Chief Finance Officer (CFO)**

This semester has proven to be a very challenging yet exciting semester with the inclusion of ENSC 440/305. Applying my undergraduate knowledge into this project has opened my eyes on what I can accomplish on my own without the normal guidelines in course labs/assignments. The course has also significantly improved my ability to interact with a team as our project required substantial collaboration with the work from other team members. My time management skills have also been refined as I found myself planning carefully to ensure I can commit time to our ENSC 440 project every week. Along with the technical and documentation experience, this course has met and exceeded my expectations on how useful it will become for my future.

As the Chief Finance Officer, I took part in maintaining the budget of our project and as well as contributing to the component selections that our project needs. In addition to the financial aspect of our project, I was also tasked to work in the Microcontroller Team. The focus for the Microcontroller team was to ensure that we can send IR signals to a device and create the Daylight Harvesting Unit to detect the lighting environment. Prior to ENSC 440, I had never worked with an Arduino or use IR communication in projects before so these were valuable new experiences for me. We initially planned to implement our project using RF as well, however we underestimated both the time it would take to get IR completely functional and the amount of work required to do RF. Although some of the budget was regrettably spent on RF development, I believe our group as a whole learned a beneficial lesson to do more in-depth research on specific features for future projects.

As a team, I believe we all contributed our significant share of work to make EVA Controls successful for this semester. We were able to work together as a team and help each other when issues came up along the way. From knowing only one member at the beginning of our project, I have come to know four more hard working people just as well. I feel proud that we were able to use our strengths effectively and minimize our

individual weaknesses by engaging as a strong team. Overall, this opportunity has been amazing and I would enjoy working with these members again in the future.

### **Mark Ma – Chief Technical Officer (CTO)**

Since the voice recognition can be used in a variety of applications. I researched prior to the semester and came up with the idea of using LD3320 as the voice recognition processor. Also, I take the responsibility of design and implementing the PCB for the voice recognition part of the project. During the making of this project, much experience was gained on utilizing and personalizing the PCB. Other than basic components like capacitors and resistors, the rest of the components requires to be drawn manually. Although the voice recognition PCB is rather small, it has been a time-consuming process because of the lack of experience. After the PCB has been made, I had assistance from a colleague who assisted in implementing the commands into the microcontroller in the PCB.

### **Mahyar Yousefi – Chief Operating Officer (COO)**

I had a great honor to work with responsible students and I have learnt so much from them. This semester I really exceeded my expectation but not only the achievement of our goal to make a functional prototype (Voice Controlled Home Automation System) but also by achieving this goal under a friendly team work spirit. I am proud that through this project people with disabilities can be served better. I also have learnt by mutual respect, sense of responsibility and understanding of team mates, you can achieve the final goal no matter what.

As a team member of EVA Control, my main responsibility was to focus on the daily operation of the whole company. As a COO, I have always made sure team members were supported by technical issues in case we were faced with any technical difficulty. Our team has designed a three-phase project into voice recognition, web-based and automatically control light levels based on incoming daylight and integrated all phases through microcontroller connection. I and Mark Ma have the responsibility on design and implementation of the voice recognition. So I came up with a schedule to meet the entire write-up deadlines following by actual design and implementation of the voice recognition part. Fortunately, under good team leadership of Adam Franklin we have been updated by each other part at our routine meeting. For this project I have been faced with two major challenges: First voice recognition hardware design, luckily under my partner's previous co-op experience we overcame this challenge with no malfunction problem. Second challenge was the integration part; personally I didn't have any Arduino serial communication background. Again, through my teammates (Alex Lung,



Bryon Long and Alex Girtonea) experience and all researches we have done prior to the integration day we finally overcome this issue too.

Since I have started studying in engineering in SFU, I always had a big dream about taking ENSC 440. There is no doubt that taking ENSC 440 is one of the fundamental courses that made me ready to get more familiar to the actual engineering working industry. By taking this course I have learnt certain facts such as: how to use my own knowledge, persuading on team member, team spirit with a significant influence on the results, performed a wide variety of tasks and constructively conformed to a guideline. All the above achievements had been done under lots of pressure but whenever I have looked back I more realize that "No Pain No Game".

## Conclusion

---

We would like to thank our professors, Dr. Andrew Rawicz and Steve Whitmore, and SFU's School of Engineering for giving us the resources and the opportunity to work on a meaningful, innovative product.

Working on EVA Controls has been a rewarding experience for all those involved, not only in terms of the technical knowledge gained, but also for the team work and the ability to work in a truly professional engineering environment. We have all gained invaluable marketing skills that will undoubtedly help us in our future professional careers.