ENSC 305W/440W Grading Rubric for Post-Mortem

Criteria	Details	Marks
Introduction/Background	Introduces basic purpose of the project. Includes clear background and motivation for the project.	5 **/05%**
Body of the Document	Provides a high-level description of main functions and project modules. Outlines materials, costs, and schedule (both estimated and actual).	13 **/15%**
Problems/Challenges	Outlines major technical challenges encountered. Explains how these were resolved. Details any major changes in scope and design.	5 **/05%**
Group Dynamics	Includes a discussion of how the team was organized, any problems that arose, and how they were resolved	5 **/05%**
Individual Learning/Work-load Distribution Chart	Includes a one-page, individually written reflection upon what was learned from the project, both technically and interpersonally (each team member writes a page about their learning experience). **The workload distribution chart outlines major technical, administrative, and support tasks and indicates who participated significantly in those tasks.**	25 **/25%**
Conclusion/References	Summarizes outcome and evaluates the project. Includes discussion of future plans, if any (or explains why project will be abandoned).	10 **/10%**
Meeting Agendas/Minutes	Includes an appendix that provides all the meeting agendas and minutes produced by the team over the course of the semester. (NB. Neatness does not count here.)	0 **/20%**
Presentation/Organization	Document looks like the work of a professional. Ideas follow in a logical manner. Layout and design is attractive.	5 **/05%**
Format Issues	Includes title page, table of contents, list of figures and tables, and references. Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted.	4 **/05%**
Correctness/Style	Correct spelling, grammar, and punctuation. Style is clear, concise, and coherent.	4 **/05%**
Comments	Overall, good document. You lost the majority of your marks because you did not include the appendix with the meeting agendas/minutes.	76

Unipark-1000

An Easy to Install Vehicle Parking Sensor

ENSC440 Post-Mortem

Title/Name	Signature	Date
Author/Chief Executive Officer Kenny Lam		
Chief Financial Officer Edmund Mo		
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Chief Operations Office Will Zhang		

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1 Introduction

Unipark-1000 is an ultrasonic parking assist system that is designed for easy installation. The conventional ultrasonic parking assist system requires the user to drill holes and run wires through the front and back bumper of the vehicle for installation, Unipark-1000 is designed to eliminate all the installation steps that would normally require a mechanic to perform. The goal of this project was to investigate the feasibility of such a design. We developed a proof of concept build by Nov 29, 2013 and tested it according to the system test plan laid out in our design specification document. The prototype was proven to be an acceptable parking assist system with an easy setup requirement.

1.1 Scope

This post-mortem document provides the high-level description of our product and outlines materials and costs for the project. It also discusses the challenges encountered during the architectural and system design phases of the Unipark-1000 and explains how these were resolved. The post-mortem introduces the team dynamics and illustrates both technical and interpersonal knowledge gained for each team member. This document summarizes outcome and evaluates the project and includes the future plans if we decide to continue development on the project.

1.2 Intended Audience

The intended audience is the members of SABZ Incorporated and also the shareholders.

2 Description of main functions

Unipark-1000 consists of three physical parts, two sensor modules and a display module. The two sensor modules are physically and functionally identical. One sensor is installed at the front bumper and the other at the rear bumper of the automobile. The display module is located on the dashboard of the automobile where it will be visible to the user. Figure 1 below illustrates the physical setup.

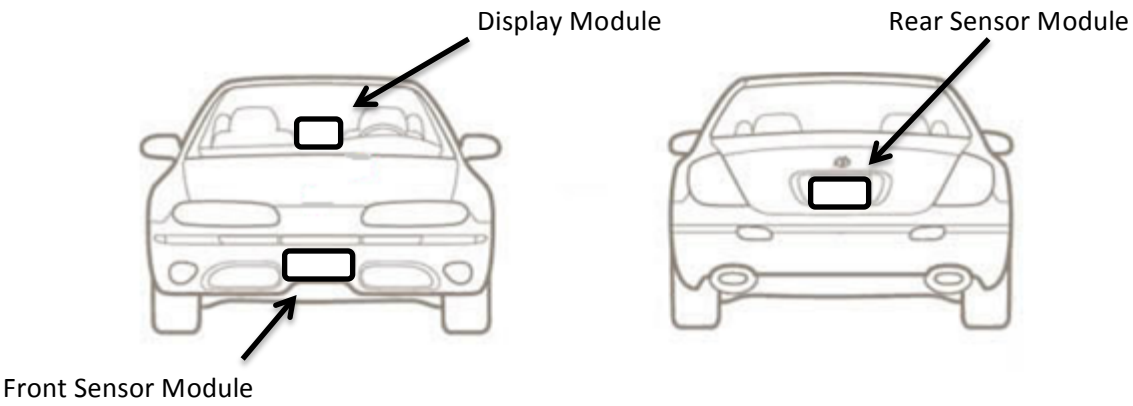

Figure 1: System Overview

The display module will wirelessly collect distance data from the front and back sensor modules and display them for the driver to see. The system has an on/off switch, which means the user must manually activate the parking sensor when they want parking assistance. The display module will refresh the distance data 3 to 4 times per second. The communication between the sensor module and display module are done through a wireless Bluetooth link. The display module has the ability to remotely switch on the two sensor module via radio frequency. This feature along with the Bluetooth communication link allows for zero wiring between the modules; therefore it dramatically reduces the complexity of installation.

The sensor module is equipped with ultrasonic transducers to measure the range of the closest object from the module. There will be memory inside the sensor module to store the collected range data. The sensor module will continuously collect range data and save only the most recent measurements into its internal memory. It will sends distance data to the display module when request to do so.

The display module, which is physically mounted on the car dashboard, has the following functions

- Collects range data from sensor modules
- Displays the distance to the closest object on a digital LED display
- Sounds an audible alarm whose beeping frequency corresponds to obstacle distance
- Remotely power on sensor modules for distance measurements

The block diagram for display module is shown below:

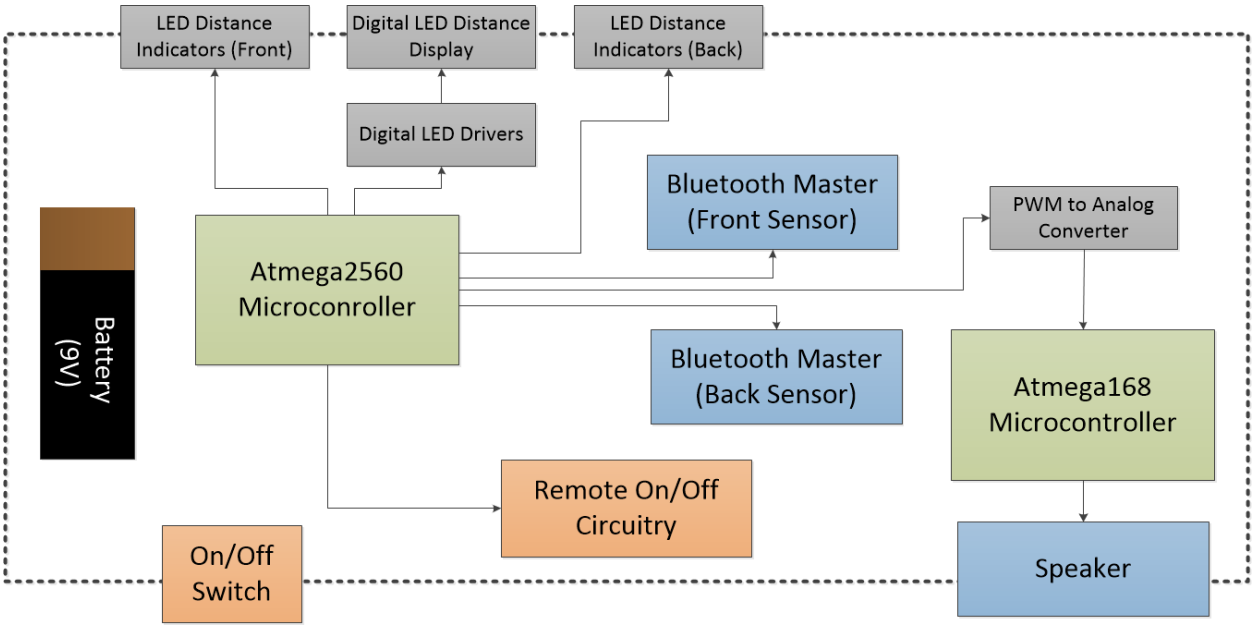

Figure: Display Module Detailed Block Diagram

Sensor module controls the distance measurements and responsible sending the data back to display module. The following diagram indicates the functions:

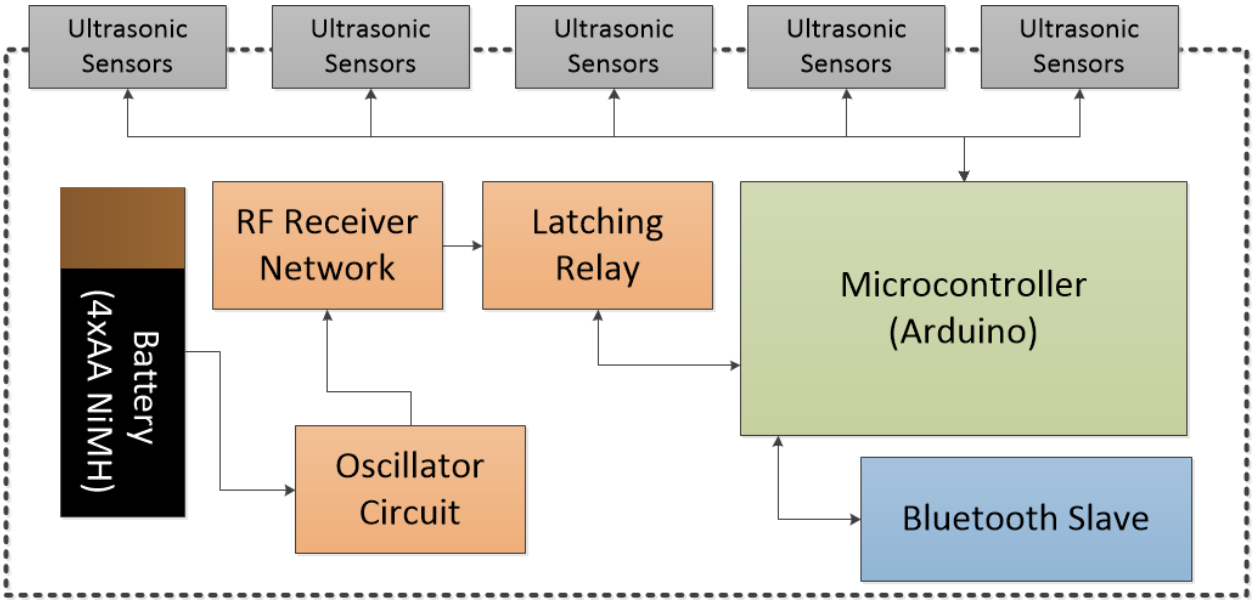

Figure: Sensor Module Block Diagram

2.1 Cost

The following is a summary of the budget for the project:

- Estimate budget	+$750.00
- Total spending on R&D effort	-$777.65
- Budget exceed by	-$27.65

A more in depth analysis would be useful.

Notice that we are only over the budget by $27.65 which is very good. We didn't go over budget by a large amount because we left a lot of room for design problems and rework costs. Some reasons for why we ended up going over budget are

- We had to purchase a more powerful microcontroller with more pins.
- We had to purchase a couple more ultrasonic sensors than initially planned.

Overall, we felt that our spending was under control and budget was pretty accurate.

2.2 Schedule

Figure 2, below, shows the general schedule for the project which we established at the start of the semestor.

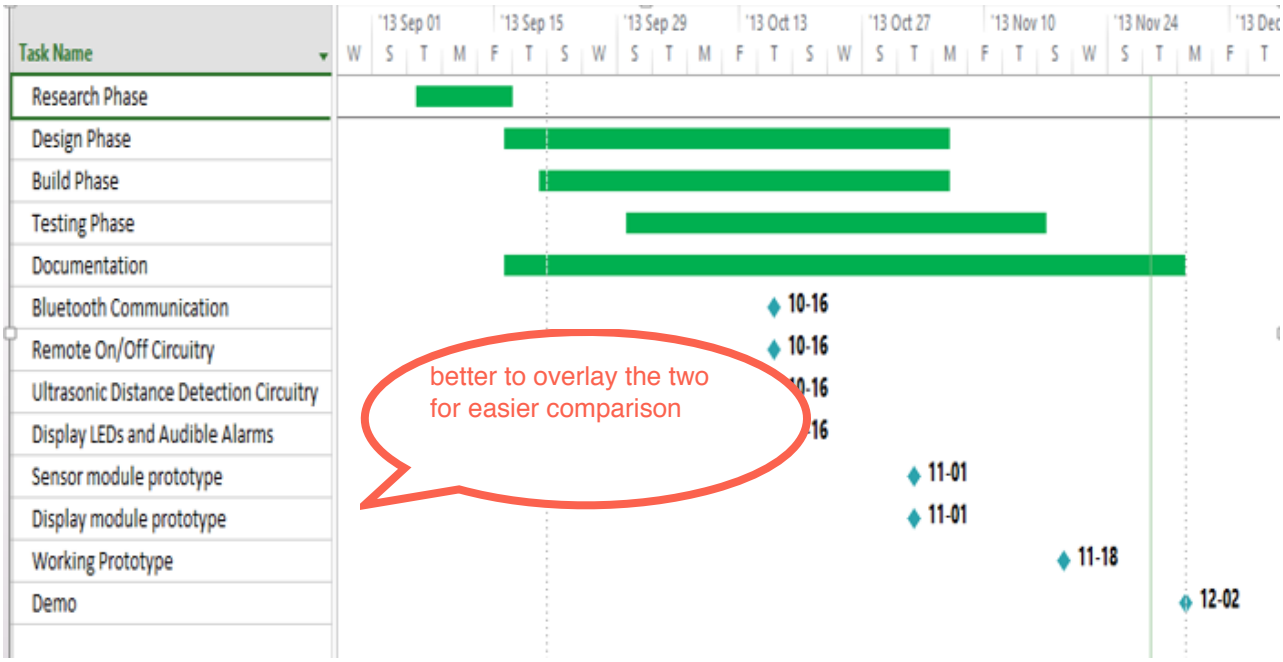

Figure 2: Original Schedule

Figure 3 below, shows the actual schedule that we followed during the semester.

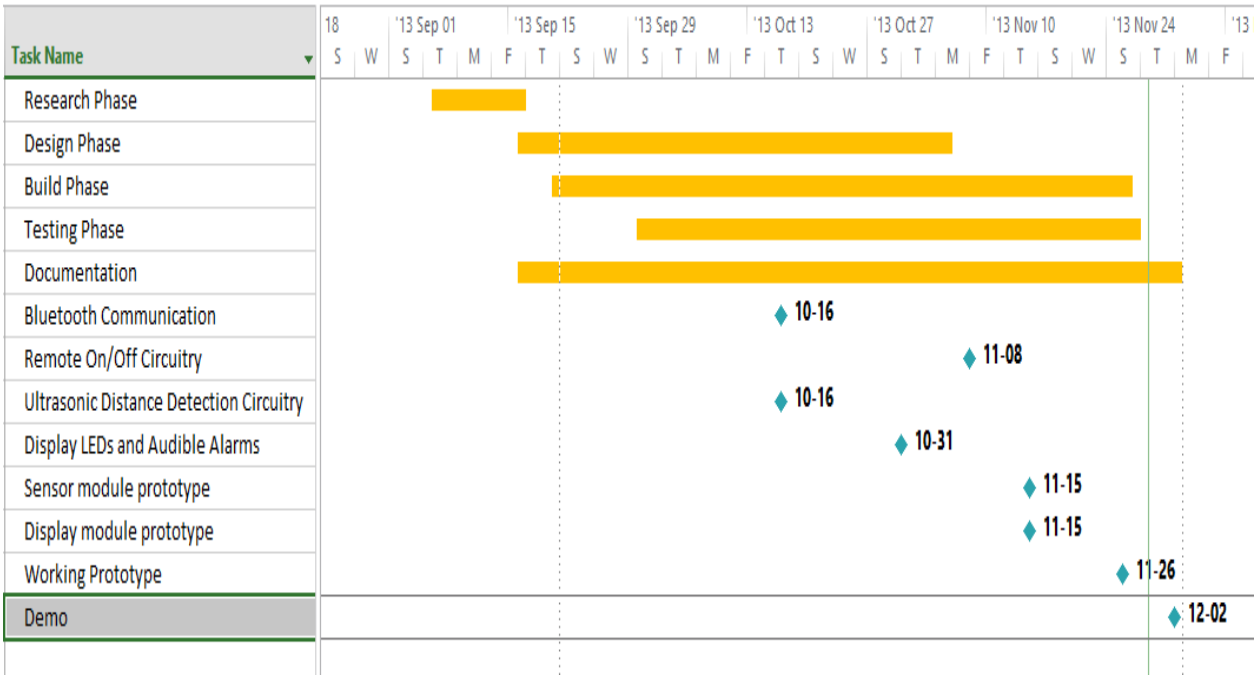

Figure 3: Actual Schedule

As you can see from the above figures, our schedule is delayed. We planned to have each separate parts done by Oct 16th. However, The Remote On/Off Circuitry and Display LEDs and Audible Alarms were delayed by a couple of weeks. This is due to unexpected design issues. The receiver circuit in the remote on/off circuitry drew too much current and we had to find a design an oscillator circuit to control power consumption through periodically power cycling the receiver circuit. The display module was delay due to problems with trying to get the microcontroller to play sound and display numbers at the same time. We ended up resolving the issue by using a second microcontroller.

Number and label the table.

3 Challenges

The following table outlines all our design problems and challenges we faced in no particular order.

Problem	Status	Solutions
Sensor modules were not powering on	Fixed	Turn out we were missing antenna wires. Solution was to just solder them onto the circuit

Problem	Status	Solutions
Loose wiring or wrong wiring	Fixed	Double checking the circuits against the datasheets
Bad solder joints	Fixed	Visual inspection of solder joints
Unstable Bluetooth communications	Fixed	Largely due to loose wiring
Failure of microcontroller to play sound and display digits at the same time	Fixed	Redesigned the circuit using two microcontrollers
Sensor module was using too much power	Fixed	Implemented a oscillator circuit design to power cycle the sensor module to reduce power consumption

Asides from these problems, we felt that the design process went quite smoothly. The following table shows a list of problem discovered with our design which still needs to be resolved. We included proposed solutions to these problems.

Problem	Status	Solutions
Audio Alarm beeps only for back sensor	Not Fixed	Implement the alarm for front as well. The way it should function is when two object gets close to the car from both side, the alarm will sound for the object which is closer to the car. The main program code can be edited to allow for this using a simple if else statement.
Location of the Sensors need to be changed for the purpose of making the device compatible on variety of cars	Not Fixed	Lots of cars don't have free space on the top or bottom of their rear license plate but all of them have free space on their sides. We may need to consider placing the sensors on the sides of the license plate to make our device compatible with more cars. Alternatively, we could reduce the size of the ultrasonic sensor, so it would not stick out too much

Problem	Status	Solutions
Reduce the System start up time	Not Fixed	It takes 38 seconds from the moment the user turns the device on until the display module shows the values. We need to reduce that time to less than 10 seconds. We can reduce the time by modifying the library to allow for the simultaneous connection for back and front sensors. Also, we can tweak the connection delay time to eliminate waiting time.
Use Color LED for different distances	Not Fixed	Instead of using red LED for all 5 bars, we need to use red LED for closer distances and Green LED for farther distances
Dead spots	Not Fixed	During testing we notice there were some unexpected dead spots in our coverage. Further testing is required to determine exactly where they are and why they exist. A propose solution can only be derived when we have a better understanding of the problems.
Measurement values sometimes spike to low or high values.	Not Fixed	Redesign the wirings to reduce the electrical noise. Inspect the build for loose wirings and bad solder joints. Put decoupling capacitor on power lines.
No power button	Not Fixed	We need to implement it for beta build
9V battery operation	Not Fixed	We need to implement it for beta build

4 Future Work

The following is a list of the future work we still have to do with our project.

Task	Details
Bluetooth Communication	• Reduce Master/Slave linkage time to improve responsiveness of the system.
Range Detection	• Improve detection algorithm to be able to locate object (rough estimate) on a 2D plane.

Task	Details
Range display Unit	• Employ various colors LED light for better conveying distance data to user. • Revise display module design to allow displaying range data from both front and back sensors. • Incorporate adjustable volume control on the audible alarm in display module.
Remote on/off switching Unit	• Increase clock frequency on the Remote on/off switching unit to improve responsiveness of the system.
Module Casing	• Redesign sensor module casing to reduce complexity of the installation steps. • Improve display module casing to allow better mounting solution on car vehicle dashboard.
Sensor Module Battery Life	• Eliminate unnecessary current draw from while energizing the relay coil.
PCB design for Display module	• Create custom PCB for display module to improve shock/vibration resistance, and reduce the form factor.
PCB design for Sensor	• Redesign PCB layout with multi-layer tracks to allow more compact design of PCB.
Complete test plan for prototype and final product	• Complete remaining test plan requirements once prototype and final product is ready.
Better test method for object detection	• Devise test method to improve measurement accuracy. (e.g. employ better measurement equipments)
Patenting Sensor/Display Module Design	• Consult law firm for patenting procedure and detail. • Complete any necessary paperwork.
Planning For Mass Production	• Analyse steps need to be taken to move prototype to mass production
Cost Analysis of Prototype	• Finalize prototype design and create expense report for the prototype.
Market Research	• Determine Pricing of the product and our targeted customer.
Sustainability Consideration	• Achieve a relatively long product life-time through design. • Providing repairing/replacing services to customer to avoid product going to landfill.

5 Group Dynamics

Some short sentences here. Consider editing.

SABZ Incorporated is small research company consisting of fou e are based at the SFU Campus in Burnaby, BC. The company was established in August 2015. Kenny Lam is the CEO of the company. Edmond Mo and Hamidreza Haghshenas are the CFO and CTO respectively. Will Zhang is the COO. During this three-month work, we have encountered problems in each phase of our design. We solved them together and delivered our product successfully.

We separated the project into different parts and each of us was individually responsible for that part. Kenny was working on Bluetooth Communication Protocol. Edmond worked on the ultrasonic distance detection circuitry. Hamid took care of the display LEDs and Audible Alarm and Will was responsible for remote ON/OFF circuitry. After finishing this, we integrated each part and worked together to make the whole product. We communicated our work progress to each other and had design discussions during our weekly engineering meetings. We also had group work sessions where we would got together to work on the project. We encourage each other to ask for help and support when needed and to voice concerns over proposed designs.

6 Individual Learning

Here we individually describe our responsibilities and learning experiences during the project.

6.1 Kenny Lam – Chief Executive Officer

At Sabz, I served as the project lead, a co-author and editor for project documents, and a design engineer. As the project lead, I was responsible for the following duties

- Organizing and leading team meetings and discussions
- Preparing the project schedule and identifying action items
- Delegating action items evenly to all team members and following up on the actions
- Providing consultation on designs and troubleshooting problems

As a design engineer, I designed, built, and tested the Bluetooth Communication and the tone generator circuit. For the Bluetooth communication, I sourced the Bluetooth modules used and coded the software library and custom functions which are used by the sensor and display module programs to

wirelessly send distance data. I also put together a crude design concept for the casing. As Co-author of project documents, I put into writing all my design details. As editor, I worked on compiling the write ups from all team members and integrating the parts together into one cohesive document. This involved a lot of formatting, editing and proofreading of the documents.

Of all my tasks, I think keeping after people and making sure tasks were done was the lease enjoyable part of the job. I felt like a jerk whenever I had to tell people to finish their work even though I tried to do it as nice as possible. The design work was easy and fun. I felt our team meetings were quite productive and everyone walked away knowing what needed to be done and by when. I think, as a team, we probably should have worked more earlier on so that we weren't so crammed in the last month. At one point, we thought we were ahead and eased up on the gas pedal. This was a mistake. I also made the mistake of underestimating the amount of work it took the put all the electronics into the case and get it to work. I am very grateful for my team mates rising to the occasion and helping me with this portion. Without their aid, a working prototype would not have been possible. Making the prototype took many more hours than expected because we ran into problems such as bad solder joints, missing wires, loose connections, and some mechanical problems. The work here was intensive and involved creating custom PCBs for the sensor module, mounting all the components onto the case, wiring the boards and components together, inspection and testing of the prototype. Working on this part as a team made the work a lot easier and more enjoyable. I almost feel that had this been our philosophy from the beginning, we could have accomplished more.

6.2 Edmond Mo – Chief Financial Officer

From the past three months, I have learnt that it can be tricky to work in a team where each one of us possesses different skills and talents. Works must be carefully divided across each member according to individual skill, and conflict must be dealt swiftly before it escalates. Overall, I think we have performed better than I anticipated in terms of group dynamic and technical.

From what I have observed from the team members, conflicts seems to arise when one member fail to complete his assigned task on schedule. Reason for missing the schedule could be the lack of knowledge in that area. However, our group was able to quickly resolve the issue by giving the team member a helping hand to solve the issue. I feel like not only we resolve the conflict, but increased the sense of teamwork.

I did learn a few new things during the development of the Unipark-1000. I have self-taught myself to use PCB design software and making the physical PCB on a copper board. I am quite satisfied with the produced PCB given that I have no prior experience in this area.

In the end, most important lesson I got from this project is social skill I have developed when working with a team where each member have different level of ability.

6.3 Hamidreza Haghshenas – Chief Technical Officer

In Sabz corporation , my position is Chief Technical Officer and all the tasks regarding to parking sensor project were distributed four ways which I had the responsibility of Design, test and implementing all the parts in Display module. This includes the sections that my group mates worked on and I had to integrate them into display module. At beginning I received the Master Bluetooth modules from my partner for the purpose of data communications between the Sensor modules and Display module. Next Sensor would send the closest distance of back and front sensors in strings format. Next I had to program the Arduino Mega Microcontroller to manipulate the data and do all the conversions in order to get a distance value in cm. In addition I categorized the values in 5 sections, starting from 0 to 50, next from 50 to 100 and so on. For each category I assigned some specific LEDs to turn on; for example if the distance value is between 0 to 50 all 5 LED bars would be on, and as the distance increases by 50 cm one LED would turn of, and lastly for distances greater than 250 cm all LEDs would be off. This feature was developed for both back and front sensors, but for back sensors as we don't have much vision I added more feature, for example audible alarm which would beep faster as distance decreases. Another feature for back sensor was seven segment displays which would allow the user to see the distance of back sensor as they get close to an object; as a result, they know where exactly the object is from the car.

After the design of the display module on bread broad I moved every component into a solderable bread board and test the module to function as expected. This step involved lots of soldering and wiring techniques as display module had lots of components and there was lots of wirings which I had to design it in a way to fit everything in a small box.

Another responsibility that I was involved with was documentation of our design process throughout the semester.

Some courses that aided me with this process were ENSC 225 and ENSC 325 which were mostly involved with circuit design and helped me with integration of components. Also CMPT 128 and ENSC 351helped me with programming aspect of the design , as I was using Arduino software and it was compatible with C language.

6.4 Zi Yue Zhang – Chief Operations Officer

During the past three months, I have learned a lot of knowledge about how to build a successful product. ENSC440/305 is one of the toughest courses I have ever taken in my undergraduate studies. In this course, there is no instructor to teach us and I have to use the knowledge I learned before and implement them into reality and try to build an entire product.

In our company SABZ, my role is Chief Operations Officer. As COO, my responsibility is to organize the tasks we need to do and make sure the company can run smooth. I record the meeting minutes for our every meeting and schedule the time for our next meeting. I also need to communicate with the other members in the company and ensure we are on the right track. Other than that I also have my own task. I am in charge of building the remote ON/OFF circuit. The circuit is used to remotely turn on the sensor module from the display module so that we do not need to run any wires. I used RF technology to perform the communication between the transmitter and receiver. The transmitter was built together with the display module and both will be turned on at the same time and then the transmitter will send the signal to receiver which is on the sensor module side to turn on the sensors. During the process, we found out that the power consumption on the receiver side is too large and since we supply sensor module on AA batteries, we decided to optimize the remote ON/OFF system in order to save power. CFO Edmond and I added one oscillator circuit to perform that. The circuit will oscillate so the power won't be on all the time. By doing that, we save about 60% of the power.

I gained knowledge on electric circuit and also on the BJT. I learned some RF transmitting technology as well. I practised knowledge I learned from ENSC 225 and 325 in this project. Other than the electronics circuit knowledge I learned, I know that scheduling is also very essential part in engineering. By scheduling ahead, I can save more time and make the work easier. Group work is also really important in making a successful product. We all have our specialties and weakness. Besides, there is a lot of work need to be done in this huge project. We can help each other out and split the

work so each of us will have a reasonable work load. At the end of this project, we all learned good team work can avoid much trouble.

The past three month of work is a joyful experience for me. I have learned new knowledge and practised my skills. I want to thank you all my partners and also the faculties that helped us. This project was a challenge for me and I am happy we can finish the project well by the end.

7 Conclusion

This post-mortem was written to summarize and evaluate the project Unipark-1000. It also indicated the challenges we encountered. Moreover, it introduced the future plan to improve our product. All the cost and schedule are also included in this document. Group dynamics and individual learning are discussed as well. To sum up, SABZ did quite well in finishing our design. We may consider commercializing the product. In order to do that, we have to continue working on the prototype. We have to fix some minor errors and improve the design according to the future plan.