510 INNOVATIONS

Simon Fraser University
Burnaby, BC V5A 1S6
DBL1@sfu.ca
604.767.6108

April 28, 2010

Andrew Rawicz
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

RE: ENSC 440 Post-Mortem for the Enhanced Recycling Bin System

Dear Dr. Rawicz,

Enclosed in this document is the post-mortem for our ENSC 440/305 Project. Our objective is to design a "Green Bin" System that automatically detects and separates recyclables that are disposed in to the bin.

During the past 4 months, 510 Innovations have brought the Green Bin from idea to functioning proof-of-concept. This report describes the system's current capabilities, crucial changes that were made, and the further modifications required to bring it to the market. The budget and timeline are reviewed to see how close we were to our original predictions. Finally, each member of 510 Innovations will also detail their technical and interpersonal experiences.

510 Innovations is comprised of five innovative and dedicated engineers – Scott Hsieh, Michael Kume, Fritz Lapastora, Jeremy Lau and David Leung. If you have any questions or concerns regarding the attached document, please feel free to contact David at 604-767-6108 or DBL1@sfu.ca.

Sincerely,

David Leung

David Leung
Chief Executive Officer
510 Innovations

Enclosure: Post-Mortem for the Enhanced Recycling Bin System

510 INNOVATIONS

SEE green . THINK green . DO green .

April 28, 2010
Revision 1.5

Post-Mortem for an
Enhanced Recycling Bin System

Project Team:

CEO – David Leung
CME – Jeremy Lau
CEE – Scott Hsieh
CFO – Michael Kume
CIO – Fritz Lapastora

Contact:

David Leung
604.767.6108
DBL1@sfu.ca

Submitted to:

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

Abstract

The Green Bin System was successfully completed by the members of 510 Innovations. There were a few deviations from the functional specifications, including the incompletion of the pressure sensor. This document specifies the changes that were made to our original specifications, the reason why the pressure sensor was not completed, and additional components that were included in the Green Bin System to further improve our product. In addition, our future plans for this project, the spending budget and milestone timelines are explained. Lastly, the personal experience reports of the members of 510 Innovations are included.

Table of Contents

Abstract ..... **i**
Table of Contents ..... **ii**
List of Figures ..... **iii**
List of Tables ..... **iv**
Glossary ..... **v**

1. Introduction **1**

2. Current State of the Device **2**
2.1 Overall System 2
2.2 Test Chamber and Identification Components 3
2.3 Power Unit 3

3. Deviation of Device **4**
3.1 Overall System 4
3.2 Test Chamber and Identification Components 5
3.3 Power Unit 6

4. Future Plans **7**
4.1 Overall System 7
4.2 Test Chamber and Identification Components 7
4.3 Sorting Chute and Storage Cells 8
4.4 Power Unit 9
4.5 Production Model Features 9

5. Budget Review **10**
5.1 Budget Overview. 10
5.2 Purchased Items and Costs 10
5.3 Discussion of Funds 11

6. Timeline Review **12**
6.1 Project Timeline 12

7. Inter-Personal and Technical Experiences **14**
David Leung 14
Scott Hsieh 15
Jeremy Lau 17
Michael Kume 19
Fritz Lapastora 20

8. Conclusion **21**
8.1 Final Thoughts 21

List of Figures

Figure 2.1 – System Overview 2
Figure 3.1 – Current Interface Design 4
Figure 3.2 – Original RFID Configuration 5
Figure 3.3 – Current RFID Configuration.......... 5
Figure 3.4 – Sufficient Lighting.......... 6
Figure 3.5 – Insufficient Lighting 6
Figure 6.1 – Speculated Implementation Timeline 12
Figure 6.2 – Actual Implementation Timeline 13

List of Tables

Table 5.1 – Original Estimated Costs 10
Table 5.2 – Current Total Costs 10
Table 5.2 – Current Total Costs, continued 11

Glossary

Bin	Refers to the 'Green Bin' product.
BFO	Beat Frequency Oscillator – used for metal detection.
Cell	The storage compartment for the recyclables and garbage.
Chamber	The section of the Green Bin that houses the identification sensors and sorting mechanism.
Garbage	Objects that may be found within a garbage can that are not recyclable. An object that is not a glass container, plastic container, or aluminum container. This includes garbage that is misplaced in recycling bins.
IR	Infrared
LiPO	Lithium Polymer
NiCd	Nickel Cadmium
NiMH	Nickel-Metal Hydride
Object	Refers to any expected recyclable or common garbage placed in the bin.
Orifice	Refers to the mouth of the bin where object will be placed.
Refuse	Mixture of recyclables and garbage; any inputs of the Green Bin.
Scanning Chamber	The upper portion of the system. It houses both the test chamber and sorting mechanisms.
SLA	Sealed Lead Acid
Test Chamber	The housing which encapsulates all four chosen sensor types.
Typical User	People with a minimum height of 80 centimetres, aged 4 and above.

1. Introduction

The members of 510 Innovations sought to create a complete product, which would not only be beneficial to society, but held the potential to spark a business. The Green Bin accomplishes this. It acts as a standalone system which has a direct impact on the environment, while motivating its users to tune into sustainable technologies. In addition, 510 Innovations has identified a sizeable market for the Green Bin. The following outlines the development process that took place during the past 4 months.

2. Current State of the Device

Throughout the duration of this course, the Green Bin's various component designs have always been retained. The system overview is presented in figure 2.1.

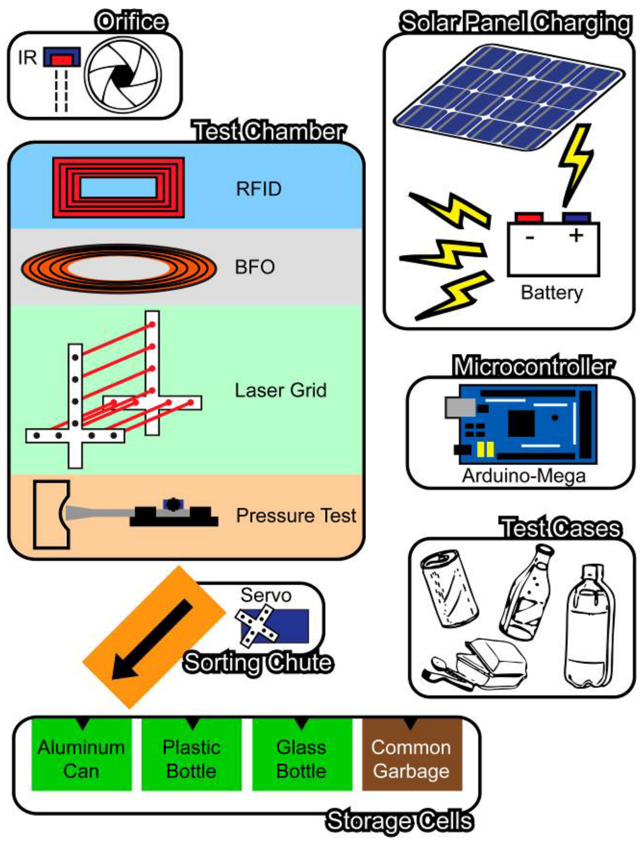


Figure 2.1 – System Overview

2.1 Overall System

Mechanics, Interface and Storage

- **Mechanics**
  All 4 mechanical actuators, pertaining to the trap door, orifice, coin dispenser and sorting chute, are working as expected.

- **Interface**
  The interface has been completely redesigned. It is presented in the subsequent section: 3. Deviation of Device.

- **Storage**
  Currently, the frame rests atop a small plastic container. It has been divided into 4 divisions and is suitable for our proof-of-concept model.

2. Current State of Device

2.2 Test Chamber and Identification Components

RFID

Operating at 125kHz, the RFID detector is fully functional. With a sufficient power supply, it is capable of detecting both large and medium sized RFID tags (small sized RFID tags have a success rate of 50%).

BFO

The BFO, metal detector, is working efficiently, capable of differentiating aluminum cans from other refuse with a success rate of 90%. Electrolytic fluids have been shown to interfere with the detector. Investigation is to be continued on this.

Laser Grid

Originally, the laser grid was not expected to yield useful results. However, the laser grid is able to identify most of our test cases during the testing.

Pressure Test

Unfortunately the pressure test has not been deemed ready for integration to the rest of the system. The theory was sound, as we were able to differentiate glass and plastic by measuring the rate of rotational velocity. However, the success rate was only about 25%, due to the processing speed of the microcontroller.

2.3 Power Unit

Battery and Solar Panels

Originally designed to be a bonus feature to our project, this portion of the project is currently incomplete. The solar panel is capable of absorbing sunlight and charging a battery, however, the output is not consistent enough for stable operation of the microcontroller.

3. Deviation of Device

The constructed proof-of-concept model does not deviate far from what was designed. Extra features were added, and testing revealed minor changes that were required.

3.1 Overall System

Interface

The current interface design is given in figure 3.1:

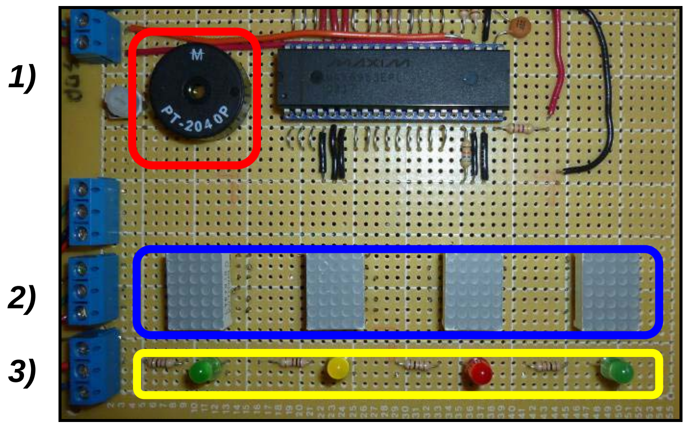


Figure 3.1 – Current Interface Design

- ***1) Microphone***
  An additional feature is the inclusion of a microphone, which will be programmed to play a variety of tunes to enhance the user experience.

- ***2) Capacity Indicators***
  Originally, the capacity indicators were each represented by a single LED. Currently, it utilizes four **5x7** LED grids. Resembling a bin shaped outline, each indicator shows the capacity at intervals of: **16.7%.** In addition, these four grids can be used to display words and designs.

- ***3) Selection System (Reverse-Biased LED Buttons)***
  In previous designs of the Green Bin, there was no user interaction beyond simply placing the refuse in the orifice. This successfully caters to our target audience, consumers which are not motivated to recycle. However, we realized that environmentally-conscious users may wish to play an active role in the recycling process, and implemented a four button selection system.

  By selecting one of the four classifications, the user's intuition contributes to the identification process. This does not bypass the testing process, but adds additional points to the chosen category. If multiple categories are chosen, no additional points are added and testing continues as previously designed.

3. Deviation of Device

3.2 Test Chamber and Identification Components.

RFID

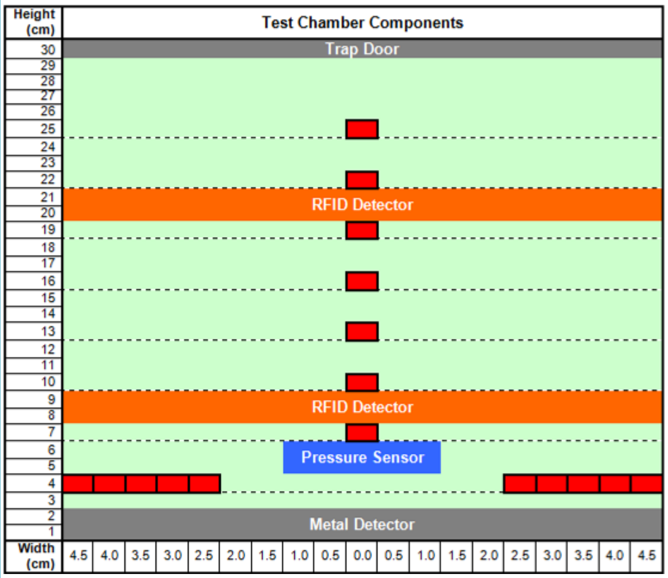


Figure 3.2 – Original RFID Configuration

***Original:* Dual Receiver Design**

The original design is shown in figure 3.2. Two RFID receivers were mounted on the outside of the test chamber, and placed so that their effective range would encompass the entire chamber.

They would be activated once the orifice door was closed and effectively prevent users from tampering with the scanning process.

However, the lower receiver caused interference with the BFO metal detector, and the tag may be on an angle that cannot be detected.

***Current:* Single Receiver Design**

The current design is shown in figure 3.3. Utilizing a single RFID receiver, it is toggled on when the orifice is open and turned off when it closes. The scanning is performed as the refuse is inserted into the test chamber.

This method increases the chance of the RFID tag being read, and is effectively outside the range of the BFO metal detector, preventing interference from occurring.

The detriments of using this design are negligible.

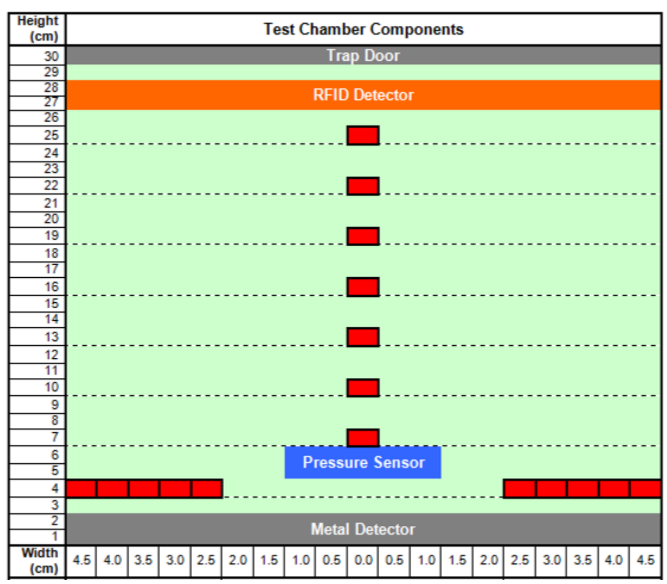


Figure 3.3 – Current RFID Configuration

3. Deviation of Device

3.3 Power Unit

Battery and Solar Panels

Modified Iteration B Circuit

While the previous design could adequately charge a battery and utilize the battery to power the system, it could not switch intuitively. The original Iteration B circuit has been modified for '*Smart*' functionality. The modified circuit has 2 modes.

When there is a sufficient light source to supply the solar panels:

- The solar panels charge the battery
- The system is simultaneously powered by the panels

When the light source is insufficient:

- The system is powered by the charged battery

This '*Smart*' switching function is shown in figures 3.4 and 3.5 below:

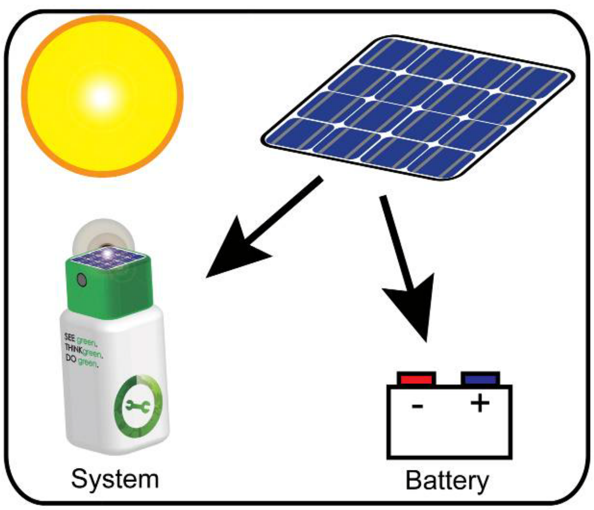


Figure 3.4 – Sufficient Lighting

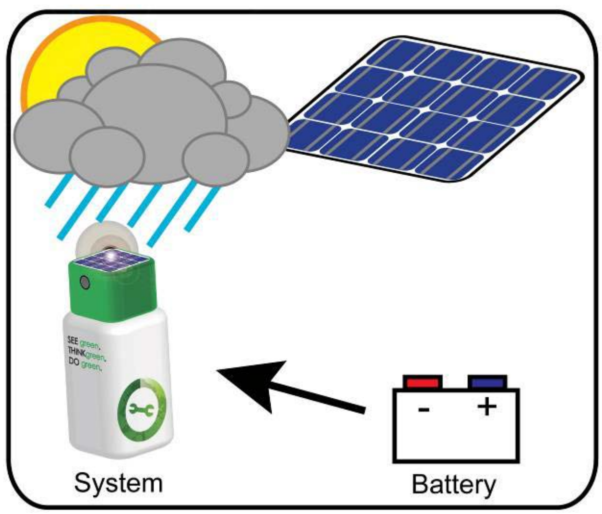


Figure 3.5 – Insufficient Lighting

4. Future Plans

The current Green Bin system was developed specifically to act as a proof-of-concept model. As such, not only are modifications expected, but several components have been designed to be capable of scaling up in terms of functionality and resolution.

4.1 Overall System

Enclosure, Built-in Library, and Electronics

- ***Fully Enclosed Weather-Resistant Casing***
  All components will be encapsulated in a protective outer casing made of UV resistant material. The case itself and all access panels shall be waterproof.

- ***Expand Acceptable Recyclables Library***
  More test cases will be added, and the library of shape profiles, rigidity characteristics, and RFID tags will be increased.

- ***Customized Printed Circuit Board (PCB)***
  A PCB will be designed to include all electronics components; for production.

4.2 Test Chamber and Identification Components.

Laser Grid

- ***Increase Grid Size***
  The original cross-shaped grid will be scaled up, utilizing more laser diodes, and will resemble a large rectangle. This will provide increased resolution, allowing the lasers to detect the varying widths and contours of the refuse and also to determine if the refuse is symmetrical or not.

- ***Deformation Testing Algorithm***
  The height and width test can be performed once before the pressure test, creating a temporary snapshot, and a second time afterwards. Writing an algorithm to compare the two images will allow the grid to observe if permanent deformations are made. Plastic recyclables tend to return to their original shape after pressure is removed. This allows further differentiation of plastic bottles from aluminum cans and garbage.

- ***Modification Methodology***
  The Charlieplexer and multiplexer designs were chosen for the proof-of-concept Green Bin because they allow this scalability.

4. Future Plans

Pressure Test

- ***Utilize Superior Customized Parts***
  The system can be rebuilt with superior motors, gear boxes, and rack and pinions. Unlike the current screw, the teeth will match up in parallel, and the inclusion of a gear box with a higher ratio will lower the power requirements. This will allow the component to operate more efficiently and smoothly. The optical encoder may also be replaced with a sliding potentiometer or other alternative measuring device.

- ***Continued Rigidity Testing***
  Further testing, observing the way in which materials bend and the resistance they provide, will increase the library of rigidity characteristics.

4.3 Sorting Chute and Storage Cells.

Sorting Chute

- ***Implement Sorting Functionality into Test Chamber***
  As the components surrounding the test chamber are lightweight, a servo motor can be used to reposition the test chamber above the correct cell before opening the trap door. Removal of the sorting chute will decrease the system's height.

Storage Cells

- ***Increase Cell Size and Proper Divisions***
  The cells will be made larger to house a greater amount of recyclables and garbage. Research will be conducted to appropriately size each of the 4 cells according to the expected amount of refuse from each category the Green Bin will receive.

- ***Wireless Capacity Indicator Signal***
  When a cell is full, a wireless signal will be sent to notify the operator. A similar signal transmission method will be used to indicate if an error occurred.

4. Future Plans

4.4 Power Unit

Battery and Solar Panels

- ***Increase Battery Capacity***
  A larger battery will be used to ensure power for the speculated amount of use.

- ***Increase Solar Panel Size / Surface Area / Efficiency***
  This will be done through the addition of more cells and solar panel defrosters.

- ***Eliminate Dependence on AC Plug-in Power (Pressure Test)***
  Once the pressure test component is optimized, the power requirements will be lowered and will no longer depend on AC Plug-in Power to operate. The power unit must be modified to deliver the power required to perform its test. The AC plug-in feature will remain as an alternative backup source for all further models.

4.5 Production Model Features

The future modifications listed above are the most pertinent ones to develop the proof-of-concept model into a model which is presentable to investors. As the Green Bin was intended to eventually become a complete product, many features pertaining to the production model were listed in the ***Functional Specifications for an Enhanced Recycling Bin System***. That document details changes that still need to be made until the Green Bin is ready for mass production.

Likewise, in order to form a business around the Green Bin, there are many milestones to be accomplished on the business side. Such tasks include the preparation of a business plan and the acquiring of design patents.

5. Budget Review

5.1 Budget Overview.

The original estimated costs for the Green Bin project were outlined in table 5.1 below.

Component	QTY	Equipment / Part	Cost
Microcontroller	XX	Microcontroller and Development Kit	100.00
Solar Panel Charging	XX	3.7v 6000mAh Lithium-Polymer Battery	150.00
	XX	Monocrystalline High Efficiency Solar Panel	120.00
Framework	XX	Device Housing/Casing Material and Various Hardware	650.00
Test Chamber	XX	Various Sensors and RFID Development Kit	200.00
Sorting Mechanisms	XX	Actuators and Motors	350.00
MISC. Parts	XX	Miscellaneous Electronic Components	250.00
Total			**$1,820.00**

Table 5.1 – Original Estimated Costs

5.2 Purchased Items and Costs

The current purchased items and total costs are presented in table 5.2 below:

Component	QTY	Equipment / Part	Cost
Sorting Mechanisms	1	HS-625MG Servo	
	1	HS-645MG Servo	
	2	3/8" Bore Clamping Hub	
	2	Servo Hub (Hitec)	
	2	3/8" Bore, Precision Ball Bearing (Flanged)	
	2	48" Standard Extension	
	2	32 Tooth, 32 Pitch Hub	
	1	64 Tooth, 32 Pitch Hub	
	1	48 Tooth, 32 Pitch Hub	275.69
	48	Socket Head Machine Cap Screw (8-32 x 5/8”)	
	6	Bushing (3/8” x 7.50”)	
	1	Precision Shaft (3/8” x 8”)	47.60
Trap Door	1	3/8 Aluminum Rod	9.50
Orifice	1	Round Brass Tube	1.69
Laser Grid	13	Laser Diodes	
	13	Photo Resistors	50.96
Pressure Test	2	½ Inch Wire Rope Clip Mounts	
	1	U-Bolt Zink Clamp	5.92
	1	Threaded 6-inch Sleeve Anchor	3.80
	1	48P Pinion 34T	6.78
	20	Screws and Nuts	5.13
	1	Metal Gear (22 teeth)	6.67
	100	Lock Nuts, Screws, Nuts, Threaded Rods	53.67

Table 5.2 – Current Total Costs

5. Budget Review

Component	QTY	Equipment / Part	Cost
Framework	2	Acrylic Sheets (12in x 24in) + adhesive solvent	39.32
	250	Washers, Nuts, Screws	26.92
	10	L-Brackets and Mounts	
	1	Keyhole Saw	13.75
Solar Panel Charging	25	Polycrystalline Solar Cells	350.00
Storage	8	Plastic Containers (Varying dimensions)	103.00
BFO & RFID	1	BFO & RFID Antenna Coil Wiring + associated parts	31.19
RFID	3	Seeedstudio 125KHz RFID Module	
	20	Parallax 125KHz RFID Tag - 50mm Disc	
Microcontroller	1	DFRobot DFRduino ATMega1280 USB Microcontroller	
MISC. Parts	1	Lynxmotion Steel Socket Head Screws - 5/8" x 4-40 (100)	
	1	Lynxmotion Steel 4-40 Nuts w/Nylon Lock -1/4" (100)	
	1	Lynxmotion Steel Socket Head Screws - 5/8" x 5-40 (100)	
	1	Interlink Electronics 1.5 Square FSR	197.83
	2	Small PCB	5.38
	2	Copper PCB Sheets (12in x 12in)	33.40
	1	2-Pin mini connector	
	1	Terminal Block DT-126VP	8.01
	1	DREM194 CUTT	
	1	Electrical Tape	
	3	UNI-Rod Steel Rod	
	2	Flush Fit PVC Piping	34.34
	1	Crazy Glue and stationary	3.36
Total			**$1313.91**

Table 5.2 – Current Total Costs, continued

5.3 Discussion of Funds

- **Engineering Science Student Endowment Fund**
  Our team applied to the ESSEF and received **$675.00** to fund our project.

- **Wighton Engineering Development Fund**
  A full-fledged report and application have been proposed to Dr. Andrew Rawicz and Steve Whitmore. It is currently under consideration.

- **Estimated Costs vs Actual Costs**
  Originally, our team estimated a cost of **$1,820.00** to complete our project. Upon further evaluation, we realized that it was beyond the requirements of this course to build the Device Housing/Casing. This effectively removes **$650.00** from our original speculation, resulting in an estimation of **$1170.00**. As such, at a cost of **$1313.19**, we believe we operated well within our original estimation.

6. Timeline Review

6.1 Project Timeline

The original speculated timeline is provided in figure 6.1.

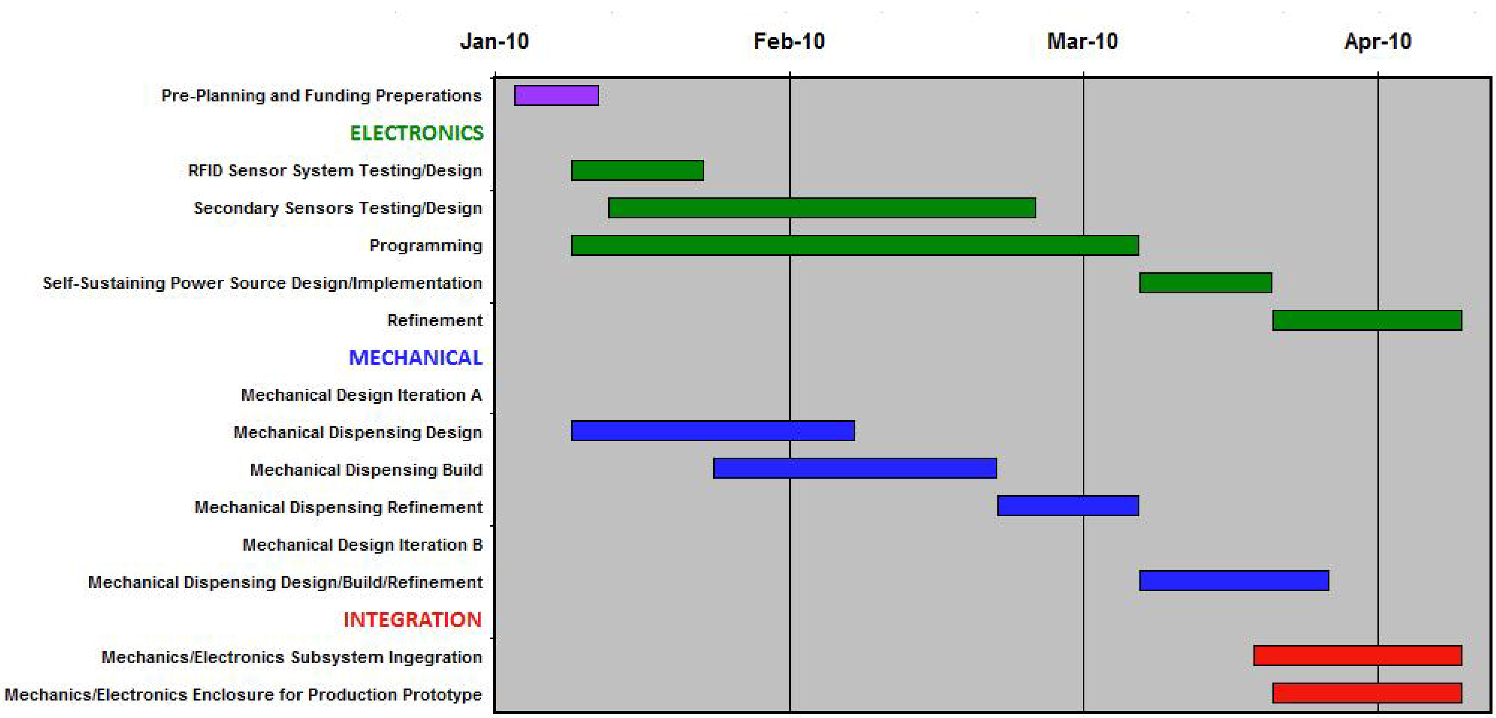


Figure 6.1 – Speculated Implementation Timeline

6. Timeline Review

The actual timeline which was implemented during the course of this project is presented in figure 6.2 below:

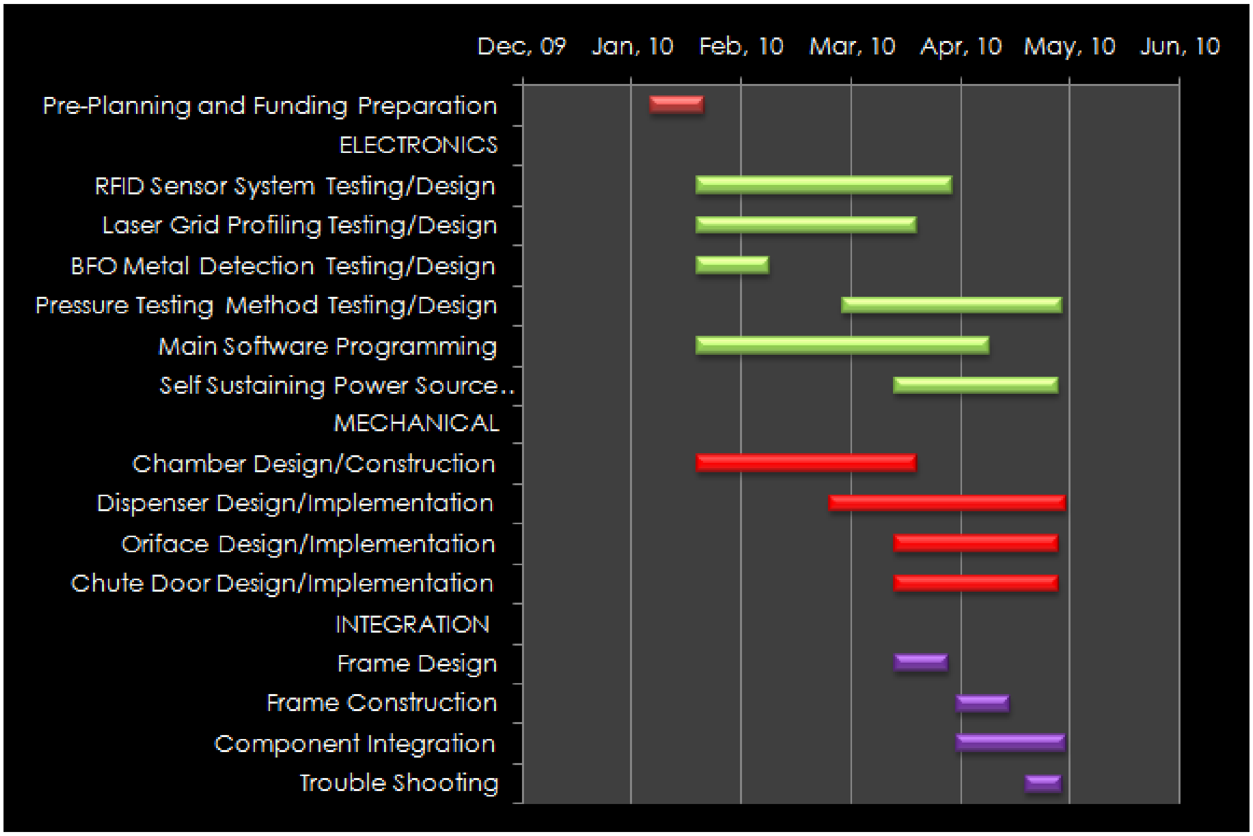


Figure 6.2 – Actual Implementation Timeline

- Scanning method development began early in the project with most of it completed by mid March. Main software programming was developed continuously throughout the project.
- Mechanical design and fabrication began in March. The end of electronic development coincides with the start of mechanical development. Some mechanical design in dependent on chamber design.
- Final hardware and software integration occurred within in last month. With all components finally being constructed, unit testing and troubleshooting is performed.

7. Inter-Personal and Technical Experiences

	David Leung **– Chief Executive Officer (CEO)**
	As team leader, I worked primarily on the overall design of the Green Bin and the documentation. I assisted both the electronics/software design pair and mechanical design pair. It was also crucial that I act as a nexus of information and communication. I was the team's representative in all external matters and lead the team meetings.
Technical	As the only course in the engineering program that gives the team free-reign over the design process, I learned that designing from scratch is tedious and difficult. For example, the flow of operations, pressure sensor concept, and Green Bin framework, are all entirely novel entities. As such, it was tough to design them without reference. At times, brainstorming and mental simulations were the only sources of prior testing that could be done before creating such components.
Inter-Personal	During this course, I have learned that while team members may have similar interests and compatible personalities, difficulties may arise when working habits and design methodologies contrast. A defining characteristic is the value one places on work and the value one places on design. Too much design and no work gets done, and work is useless or cannot proceed without design. Communication is crucial to balance the two. As a leader, one's emotions are often tied to the overall tone of the team. However, this works both ways. When conflicts occur, it's important that the leader not be reactive, but be pro-active in changing their own emotions; which effectively shapes the team's.
Business	As our project presents a lucrative business opportunity, I was given the chance to analyze how the Green Bin, and a company built around it, would perform in a simulated market environment. In two previous student-run start-ups, I acted as a secondary advisor to the product's business aspect. This was a good opportunity to finally act as the primary director.
Other	It was an interesting experience for me to be working within a budget and to our own timeline. I also gained plenty of experience in preparing formal documents.

7. Inter-Personal and Technical Experiences

Scott Hsieh – Chief Electrical Engineer (CEE)

With previous experience in microcontroller I was responsible for all software aspect of this particular project. Also, as the only electronics engineer of the team I researched and build majority of the electronic component, sensor system, user interface and integrating/testing the electronic, mechanical and software component of the project to ensure functionality of the project.

Technical

Electronic component I participated in the design and implementation of the laser gird sensor, metal detector, RFID while working on the User Interface such as LED touch sensor, obstruction sensor, display and audio feedback individually on the side.

During the process of electronics development I have gained the skills of researching a concept then take an idea to develop a working prototype onto a fixed platform. Also, with a lot of LEDs and signal to be controlled and sensors to be read I have learn the use of different wiring techniques such as multiplexing, charlieplexing or using specialized ICs to reduce the I/O count for higher efficiency in I/O usage.

Software is a critical component of this project it is required for interfacing, processing and control.

Electronic devices all have different ways of communicating with the microcontroller; for instance RFID does message passing through Serial interface, Display uses I2C interface. I have become familiar in the structure and data types of various buses and writing drivers to send/receive data onto different devices.

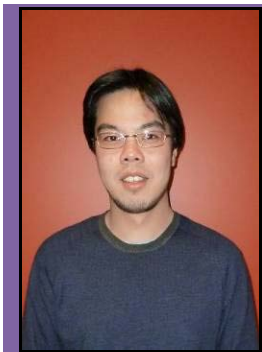
Also, I have learn more about digital/analog signal processing ie. Writing algorithms to detect frequency of LED capacitor discharge or mapping analog input value 0-4V into digital values for presence of metallic objects.

Other than signal processing and interface, another aspect of software is to control hardware both electronics and mechanical. By writing software for motor control, I have learn how to use PWM output to control the speed and angle of rotation for Servo motors, also I have learn how to do signal generations using sine table in software to create 8-bit audio of a piano scale.

7. Inter-Personal and Technical Experiences

	Scott Hsieh – Chief Electrical Engineer (CEE)
Inter-Personal	Personally, I considered the green bin as an ambitious project with a lot of sensors, mechanical components. Therefore, time management is very important to ensure success. Throughout the semester, I have learnt to break my responsibilities into individual milestones and complete these milestones in a given time frame and I was happy because I have achieved that. Overall, our team consists of member with similar personality socially to create a fun, energetic work environment, however, conflicts were introduced due to difference professionally such as some member prefers working early in the day and some prefers working later at night. At some points the groups were divided up and create miscommunications. I find it was important for me to separate work and play and be strict at times to ensure everyone is up to their pace. However, we have weekly meetings to keep each other up to date with the current progress and clear up any miscommunication.
Other	Overall I find this experience to be very valuable, technical experience aside I find the experience to work with the team's dynamic and play off each other's strength and fill in each other's weaknesses is far more important than the technical skill learn in the research and development process.

7. Inter-Personal and Technical Experiences



***Jeremy Lau* – Chief Mechanical Engineer (CME)**

As the Chief Mechanical Engineer, I was responsible for all the mechanical components. Through the use of SolidWorks, an accurate physical model was created for the system and parts were manufactured via laser cutter. I worked in unison with the electrical design team to create a working product.

Technical	Through the use of SolidWorks as the primary design tool, I created parts and assemblies of all mechanical components, designing new original designs to mesh with existing motors, servos, and all other electrical components. The majority of the design took place in SolidWorks as it allowed problems to be solved on-the-spot in the program before the parts were created, saving money and most importantly, time. It was important to define the physical and electrical constraints of the system and either design around them or through them. Through the course of the semester, over 300 hours of SolidWorks design took place; physical construction time was minimized with the aid of a CAD/CAM laser cutter which allowed parts to be rapidly produced to exact tolerances. Some of the assemblies I created and produced include the coin dispenser, scanning chamber, trap door, bottle sorter gearbox, and the orifice. As a secondary responsibility, I developed a solar charging system to enable the system to be self-sustaining under the presence of the sun. This proved to be challenging as the system's power requirements could not be stabilized to a level suitable for the power components as faults were discovered outside of our control due to time constraints.
Inter-Personal	Throughout the course, I learned that the communication between the electrical design team and the mechanical design team was crucial as no single stream, electrical nor mechanical, can be completed without a joint collaboration. At times, this created conflicts in design, both mechanical and electrical, in how the marriage of mechanical and electrical needed to come together.

7. Inter-Personal and Technical Experiences

	Jeremy Lau **– Chief Mechanical Engineer (CME)**
Other	Perhaps the most interesting aspect about a restricted four month timeline and a design intensive project is the balance between time and money. Often times, if a problem can be solved by throwing money at it, then it may be prudent as time is more valuable than money in this scenario. This concept poses the question, “Can we fix it by spending more money and is the value of time saved greater than the money spent?”

7. Inter-Personal and Technical Experiences

Michael Kume - Chief Financial Officer (CFO)

In addition to my role as Chief Financial Officer for 510 Innovations, I was responsible for parts of the mechanical design for the Green Bin System.

Technical

My major technical responsibility was to design the pressure sensor used to differentiate glass and plastic bottles placed into the Green Bin System. Due to the fact that all components of the system are dependent on one another, designing the pressure sensor was difficult at times as decisions I made on my own often limited the performance of other parts of the system. As a result, the pressure sensor I designed has gone through numerous redesigning. In addition to the mechanical design of the pressure sensor, I learned to process the acquired information through the use of an optical encoder and Arduino Microcontroller.

Inter-Personal

Personally, I found this project to be both an enjoyable and painful learning experience. Unlike most other engineering course, this project required you to constantly work with your group members. Communication within your team was always required, even for the simplest tasks and parts that you were responsible for individually were generally required by other members of team. And at times, this resulted in tension and disagreement with others.

While there were some problems with team dynamics, I also believe that there were many positives within our project group as well. The level of dedication to the project as well as the push for excellence by all members of this project group is the reason why we were able to complete this project. And through my team members, I have learned more than any of the courses I have taken before. The last four months, I have come to respect and appreciate my team members at a completely different level and I would be happy to work with them again.

7. Inter-Personal and Technical Experiences

Fritz Lapastora - Chief Information Officer (CIO)

Testing Sensory Design & Flow of Operations:

- Develops of sensor methods
- Test chamber construction
- Unit testing and troubleshooting

Technical

From an engineering perspective, I designed and analyzed the BFO metal detector circuit as well as its construction onto circuit board. I assisted in the analysis of the laser bank charlieplexer, design of the photo-resistor bank circuit, and its construction onto circuit board. Also design and analysis of a power switching circuit but later scrapped. I performed all soldering and circuit board design of the logic tower.

I assisted with the test chamber construction which includes integration of all electrical components of system onto chamber and fabrication of BFO and RFID antennas.

I also assisted with RFID system testing, preparation of test cases, overall unit testing and trouble shooting.

From a business perspective, and as everybody else did, I took responsibility of documentation, logistics, and purchasing.

Inter-Personal

On a technical level, I learned a great deal on sensors and the principles behind their operation. Particularly on understanding the RFID system and the Arduino microcontroller, their practicality, potential, and importance of this project and for any future developments.

On a business level, I learned a great deal on team dynamics and overall operations. The difficulty of the project was not the technical aspects, but keeping the team effective and efficient, meeting deadlines, staying on budget, and having clear communication. Emphasis on project management is the one key thing I would take from this experience, making sure procrastination and complacency were kept low and consistency high.

8. Conclusion

Great effort was put into designing each and every component of the Green Bin. The circuitry was tested on breadboards beforehand, and all the mechanical pieces were first simulated through SolidWorks. Likewise, many of our assumptions were well within reason and derived from previous experiences. Employing a 'measure twice, cut once' mandate, all of the manufactured parts did not deviate far from what we designed.

However, there were a few particular components that were altered, because there are no references in existence. Such systems, structures, and configurations are novel and may potentially be patented by 510 Innovations.

8.1 Final Thoughts

Looking back on the past 4 months, as 5 undergraduates soon to enter the working world, there are two important lessons to be learned about being an engineer.

The first, the saying: *"It's easier to talk the talk, than walk the walk"*, holds true. It's much simpler to design something than it is to build it. Likewise, it's easy to underestimate the task at hand.

The second, engineers will tend to be perfectionists. Simulations, tests and redesign are all necessary elements, but hinder development. In the perfect world, an engineer could spend a lifetime perfecting a simple contraption. In the real world, deadlines must be met, and an engineer must learn to cut his/her losses.

Such lessons were taught during this semester, and the members of 510 Innovations will continue to learn them once we graduate.