510 INNOVATIONS

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

January 18, 2010

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

RE: ENSC 440 Enhanced Recycling Bin System

Dear Dr. Rawicz,

Enclosed in this document is the proposal for our ENSC 440/305 Project. Our objective is to design an "Enhanced Recycling Bin" System that automatically detects and separates recyclables that are thrown in to the bin.

This proposal includes a description of our proposed product and outlines possible solutions according to our market and currently available solutions. In addition, our expected budget, possible sources of funding, timeline scheduling, and team organization are explained.

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
Chief Executive Officer
510 Innovations

Enclosure: Proposal for Enhanced Recycling Bin System

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

Executive Summary.

We all want to live in a world that is vibrant, clean, and sustainable. We move into the 21st century with an evolving society, better technology, and stronger leadership.

510 Innovations is looking to provide the world with real solutions on environmental issues. Through innovation and new technologies, our engineers are constantly thinking of ways to achieve a more sustainable lifestyle.

The number of landfills is increasing and although awareness on a greener perspective is spreading, recyclables are still making their way into these landfills. 510 Innovations is proposing the Green Bin, a system that will ensure a significant decrease of recyclables diverted into landfills. We strongly believe the technology and the know-how to accomplish this exists today; there is a growing potential with RFID technology which will be paramount in the development of the Green Bin.

A comprehensive timeline of the next four months will outline the progress of the project. The projected cost of a production Green Bin will be well under $1500 while the current budget allows for $1820 devoted to development. Many sources of funding have been considered, primarily from the Engineering Science Student Society (ESSS) and board members of 510 Innovations. A working production prototype is the goal that 510 Innovations will achieve in the coming months.

There is only one earth, and society can no longer wait for these issues to get any worse. At 510 Innovations, we believe that planning for the future in conjunction with the use of new developing technologies, we can create a greener, more sustainable tomorrow.

510 INNOVATIONS

SEE green . THINK green . DO green .

January 18, 2010
Revision 1.3

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

ENSC 440/305

Table of Content

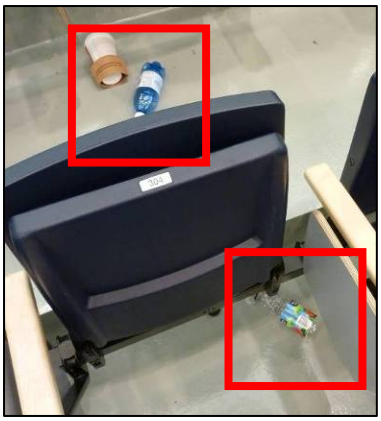
Introduction

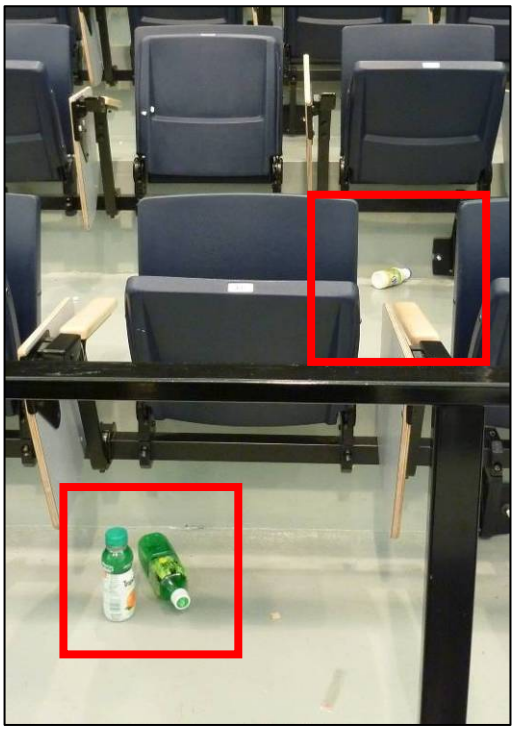
With issues such as global warming and sustainability becoming increasingly evident, as individuals and together as a society it is important to be as environmentally conscious as possible.

As a Vancouver based company, 510 Innovations resides in one of the world's most green and liveable cities. We realize the impact one can still have in a young city, economically and environmentally. It is strongly believed that society is still within its time to shift towards a greener future and we are determined to provide a means to that. At 510 Innovations, its employees are focused on combining creative thinking and new technology to achieve greener solutions.

The Problems.

Lack of Motivation to Recycle.
First and foremost, there is a lack of motivation to recycle, whether because recycle bins are confusing or just simply not appealing enough to entice users. A tour within a typical university lecture hall at the end of the day yielded 20 to 30 bottles and cans, simply left behind. The average student is more educated about the necessity of recycling, and Simon Fraser University already supplies its students with numerous conveniently placed recycling bins. Therefore, it is expected that individuals in other high volume locations are even less likely to recycle.





Introduction

Recyclables Discarded into Garbage Bins.
An occurring problem seen in Vancouver and in practically every major city in the world is the amount of recyclables still finding ways into landfills despite recycling programs provided by their municipality. In particular, the plastic bottles, the glass bottles, and the aluminum cans that can be returned to a recycling depot for a deposit are still being thrown away into the common garbage bin.

Garbage Found in Recycling Bins.
Finally, common non-recyclable garbage often finds its way into recycling bins. Not only does this hinder the recycling process, but may potentially damage the machines involved. Clearly, the typical user may not be able to differentiate garbage from recyclable items. Likewise, the objects found in a typical recycle bin are mixed and unsorted.

Engineers at 510 Innovations believe a solution to this problem to be the cornerstone towards a greener future and are currently developing a system to meet this expectation.

Radio – Frequency Identification: An Emerging Technology

The earliest evidence of such technology dates back to the mid 1940's during World War II, where it was used in applications such as covert listening devices and aircraft transponders. Its true form came to be in 1973 when Mario Cardullo patented a passive radio transponder with memory.

Today, research into RFID technology is steadily increasing as are its applications in many industries. From aerospace to health care to pharmaceutical, RFID technology is finding ways to improve efficiency and effectiveness. What is of particular interest is how it is paving a new and bold path in the packaging industry.

Currently, most packaged products found at the average grocery store are tagged with Universal Product Code (UPC), which is used primarily to track trading items sold in North American retail. What is of particular interest is how this tagging system is used by beverage companies on plastic bottles, glass bottles, and aluminum cans as packaging. In the year 1999, the Auto ID Centre was formed as a non-profit consortium to develop a system to succeed the current system. This led to the creation of the Electronic Product Code (EPC) which uses RFID technology. The idea is to increase efficiency through its advantages such as 1) it does not require line of sight, 2) can track in real-time, and 3) has data storage capability. Wal-Mart, P&G, and Coca Cola are some of the big companies that are currently investing in this new system.

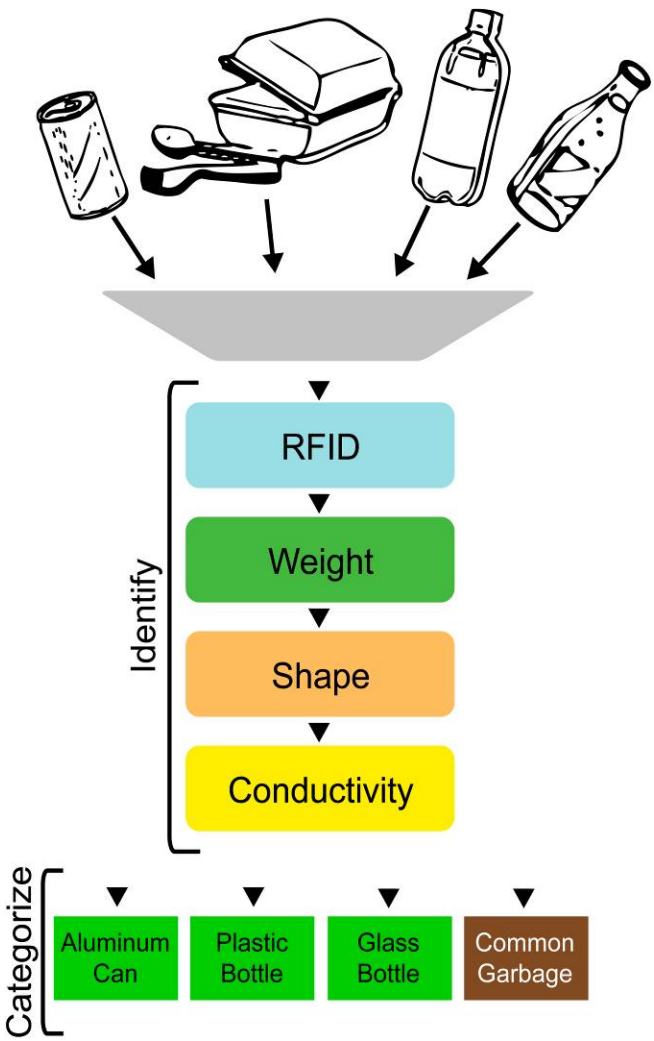
510 Innovations is hoping to take advantage of such as system primarily through its aforementioned first and third advantages. More information into this matter is explained in later in the design section. For now, a case study is presented for in depth look into RFID technology and its current applications.

Case 1 - RFID Enabled Vending Machine Dispenses Bottled Water.

S2C Global Systems and Fort Wayne, Ind., systems integrator and contract manufacturer Northern Apex have co-developed an RFID-enabled vending machine able to dispense bottles of water. A built-in RFID antenna and interrogator automatically read each bottle's passive 13.56 MHz RFID tag which is affixed at the bottom of each bottle. A customer can purchase bottles of water with the use of a credit card, where the RFID reader will document the transaction at the point of purchase. When a customer returns with an empty bottle, the system then correlates the scanned RFID tag with the purchasing transaction, either processing a deposit refund to the customer's credit card, or providing a credit toward the purchase of a refilled bottle. S2C Global Systems has already installed several S2C AquaDuct machines in Canada—one in Surrey, British Columbia, and another in Montreal.

System Overview

Objective. The enhanced bin will have a port that accepts unknown refuse from the user. Once inserted, the refuse is processed in two stages: identification and categorization.



Identify. The composition of the refuse is determined by a series of tests performed by four sensors:

1. **RFID** – detects presence of RFID tag and provides associated information.
2. **Weight** – measures the mass by using piezoelectric scale
3. **Shape** – characterization of the shape using optical sensors
4. **Conductivity** – detects metallic alloy by measuring an electric charge

The combined data set will identify the refuse.

Categorize. Through the use of motors and actuators, the refuse is then placed into one of four separate compartments:

1. Aluminum can
2. Plastic bottle
3. Glass bottle
4. Common garbage

Power Source. The enhanced bin's functionality will be extended through the use of solar panels as a self-sustaining power source. During the day, the solar panels will supply a constant charge to a built in battery. The components used to complete the objectives must work within the constraints of using such a power source.

Casing. A robust case will be created to house both the identifying and sorting mechanism as well as the four containers. This case will be constructed entirely from environmentally friendly materials.

Environmental Benefits

Why would a product such as ours be necessary? Currently an estimated seven million water bottles end up in Metro Vancouver landfills each year. And only 13 percent of recyclable bottles produced are actually recycled. By simplifying the return process of recyclables and increasing the incentive for people to recycle, the recycling rate can be gradually increased.

Even a small decrease in the amount of recyclables that end up in landfills can make a big difference for the benefit of the environment. Recycling 10kg of plastic bottles eliminates 3.3kg of carbon emissions from the atmosphere. And recycling 10kg of aluminum cans eliminates 37kg of carbon emissions from the atmosphere. And with plans to expand currently existing Metro Vancouver landfills in addition to proposals of shipping waste to the United States, further efforts must be made now to decrease the amount of garbage that we produce, something our proposed product can help accomplish.

Social Impact

It is important to demonstrate as a society the commitment to making the planet a better place for future generations. Moving towards an environmentally sustainable economy is a monumental challenge, but cities at the leading this shift will reap tangible and long-term benefits in terms of green jobs, improved health, and prosperity.

Vancouver is already considered as one of world's most liveable cities, however it is not nearly as close to being environmentally sustainable as it should be. As of 2009, Mayor Gregor Robertson spearheaded the Greenest City Action Plan, a social project aimed to launch Vancouver at the top of worlds greenest city by 2020. This plan entails ten major goals to inspire a greener economy, build greener communities, and improve human health. One of these goals is the Zero Waste Challenge.

The Zero Waste Challenge is ambitiously targeted to reduce solid waste per capita by 40% by the year 2020. A set of priorities have been set in order to achieve the challenge, which includes the necessity to improve the recycling program. The issue is that many recyclable containers are still finding its way into landfills, an issue 510 Innovations strongly believe can solve.

Not if, but when this goal is realized will citizens see the impact it will have on society. 510 Innovations' enhanced bin hopes to be a stepping stone towards the goals set by the Greenest City Action Plan. Cleaner, healthier communities also mean wealthier communities. Not only beneficial to the environment, the 'Green Bin' also hopes to inspire and motivate society on the issue of recycling. It will promote an effective recycling program so investments in such programs and technology are indeed producing results. And of course, maintaining and improving Vancouver's reputation as one of the world's greenest and liveable cities.

Possible (Existing) Design Solutions

Currently, there are several methods of recycling bottles and cans implemented in the public. To prevent recyclables from ending up in landfills, there must be a greater awareness and an increased incentive to recycle for the general public. Currently, there are several readily available options available to the public. But each has its own flaws and limitations, as explained below.

Conventional Recycling Bin (Manual Sorting)

The Conventional Recycling Bin offers a cheap and easy solution for recycling in public places. However, this recycling bin requires the user to place recyclables into different slots, according to the recyclable's composition material. While the idea is simple, the percentage of people that actually dispose recyclables into corresponding slots is still low. As a result, recyclables often end up in the wrong compartment, and even common waste is thrown into the recycling bin, due to convenience and laziness.

RecycleTech Reverse Vending Machine

This particular recycling bin automatically sorts recyclables according to material. In addition, aluminum cans are compressed with a built-in compressor, and plastic bottles are shredded to save space. The limitation of this device is that it requires the bottles and cans to be completely empty and requires the user to place the containers in a particular position for it to be detectable by the machine. And as a result, this machine is not practical in the real world environment

EnviroBank Reverse Vending Machine

This system distinguishes different types of recyclables by scanning the barcode on the bottles and cans. Through use of the UPC database, it determines the composition material of the placed object. The downside for this system is that the placement of the barcode is different for most recyclables; hence, the machine needs to scan the entire container each time. As a result, this is a very slow process and the recyclable cannot be crushed before recycled. Furthermore, the machine is unable to handle non-recyclables. If a non-recyclable object is placed inside the machine, the placed object is returned, forcing the user to take back the waste and dispose it properly into a garbage can. Lastly, the machine requires a 240V power source, limiting the locations that this machine can be used.

Proposed Design Solutions

Enhanced Bin. At 510 Innovations, we propose an enhanced recycling bin that automatically differentiates glass, plastic, and aluminum containers and common trash found in current recycling bins and sort each type according to material. This high tech recycling bin will make recycling in public places easier by reducing the disposing process of recyclables into one simple step. In addition, we have a great potential to attract public attention, due to the novelty and easiness of use of our product. As a result, we can generate a greater awareness and educate the general public in the importance of recycling.

Differentiation – RFID Technology. While automatic recycling bins have already been developed, the main differentiator for our product from the competitors will be the adoption of RFID tags on all recyclables. The RFID tags will act as the main distinguisher for different types of materials. As RFID slowly becomes the standard to replace UPC barcodes, 510 Innovations is following the trend of the future and setting a new standard for the recycling process. RFID enables faster process as it can be detected in a wider range of proximity rather than barcodes, which requires direct scanning of the code sequence. Using other sensor types such as weight, conductivity and shape profiling in parallel with RFID, our system offers a more flexible and accurate detection method with possibilities of detecting bottles from common garbage. In addition, low power RFID modules and other sensor types consume far less power in comparison to the barcode scanners and compressor combination. This enables our product to be powered with rechargeable batteries and solar cells and function as a self-sustaining system. Doing so will allow our product to be used outdoors and in places without any source of external power.

The main challenges that need to be overcome during the development and completion of this project are limited time and budget. Due to the variety of color, shape, size and design of recyclables, majority of our time will be spent on testing and improving of profile sensors so that they can detect most recyclable containers currently available to the general public. Therefore, the majority of our budget will also be used to acquire or build different types of sensors and determine which ones are the most accurate for our purpose.

The implementation of RFIDs into consumer goods is not just limited to recyclable cans and bottles. For example, by adding RFID tags on to consumer electronic enables recycling plants to determine the exact way to disassemble and recycle the device by simply reading the tag. In addition, with a better RFID reader that can detect multiple RFID tags, one can read and sort multiple recyclables simultaneously.

The potential in using RFIDs to determine the proper disposing and recycling of consumer goods are limitless. Due to time and budget constraints, the disposal of plastic, glass and aluminum containers, and the creation of greater public awareness for the proper recycling of reusable materials will be the focus of 510 Innovations.

Proposed Design Solutions

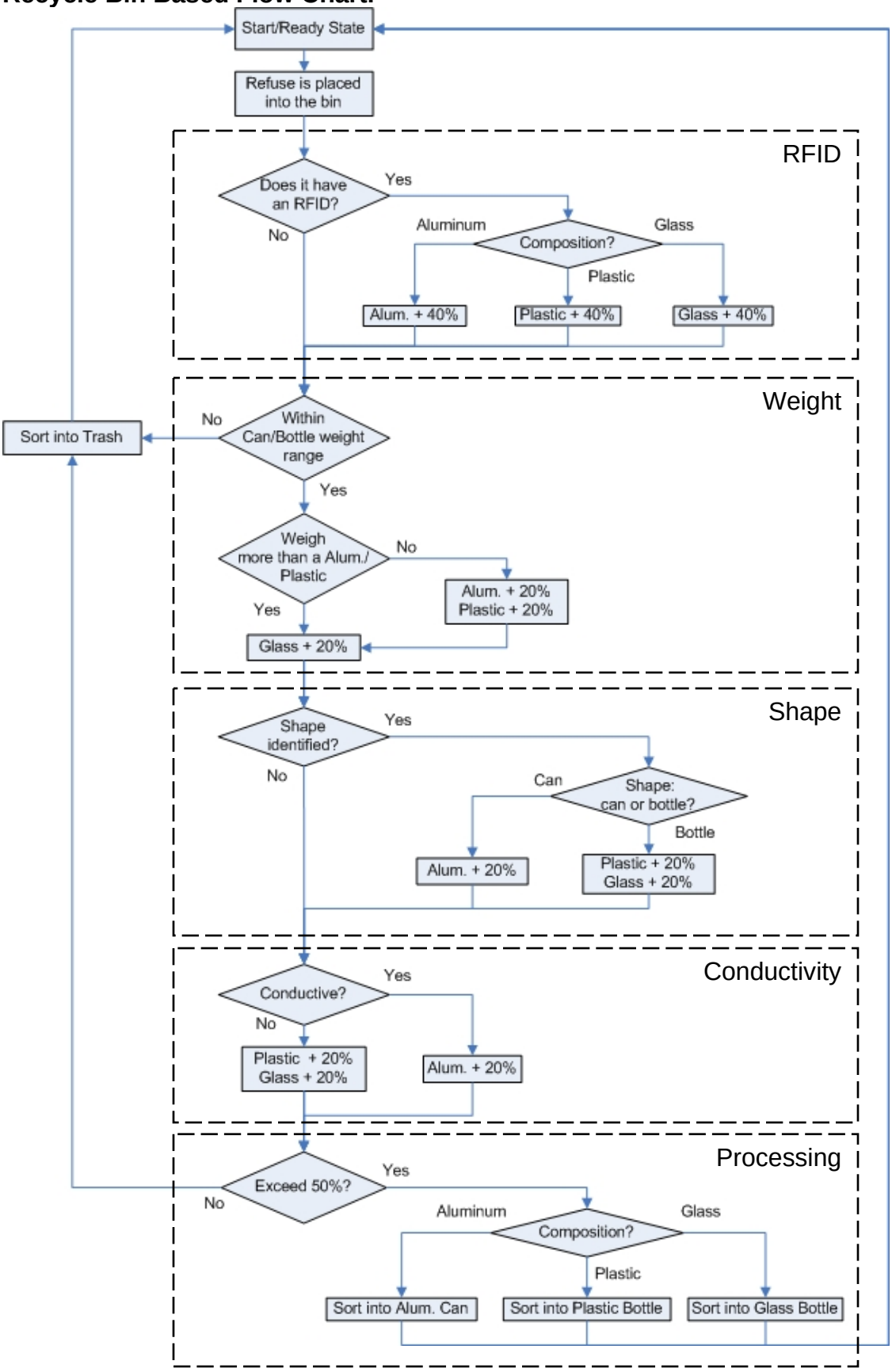
There are two possible flow charts that the software may follow.

Recycling Bin Flow Chart. The first flow chart determines the composition by utilizing all the tests. Each sensor speculates what the object may be, then combines the results and performs an action based on the majority. As the information provided by the RFID is the most definitive, it is makes up 40% of the majority, while the other tests contribute 20% each. This will simulate a recycling bin as it will accept all recyclables. However there may be garbage that mimics a recyclable object's shape, conductivity and mass. This cannot properly filter those objects out, so it will act as an adequate replacement for recycling bins.

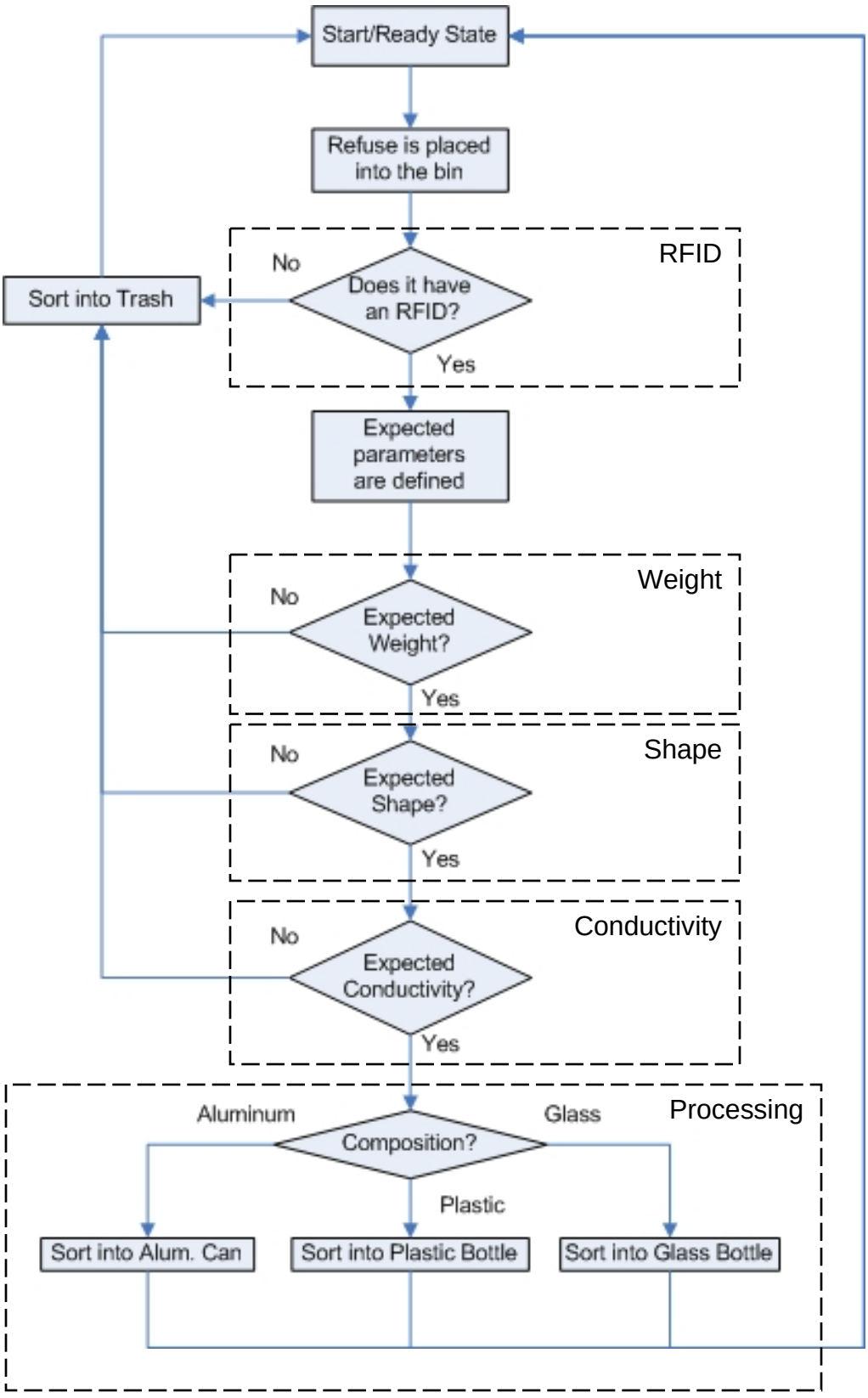
Garbage Bin Flow Chart. The second flow chart determines the composition by strictly relying on the information provided by the RFID. The RFID provides the system with expected parameters and the object is discarded as trash if any of the tests fail. This will simulate a garbage bin, because it can accept all types of refuse, including those that may mimic a recyclable object's shape, conductivity and mass. While this will reject a few recyclables, it is capable of filtering out all the non-recyclables without exception. Thus, this will act as an adequate replacement for both garbage bins and recycling bins.

The respective charts are provided on the following two pages.

Recycle Bin Based Flow Chart.



Garbage Bin Based Flow Chart.



Budget and Funding

Budget Overview. The estimated cost for the project is outlined in the table below.

Microcontroller and Development Kit	$100
3.7v 6000mAh Lithium-Polymer Battery	$150
Monocrystalline High Efficiency Solar Panel	$120
Device Housing/Casing Material and Various Hardware	$650
Various Sensors and RFID Development Kit	$200
Actuators and Motors	$350
Miscellaneous Electronic Components	$250
Estimated Total Cost	**$1,820**

Estimated Cost of Project. Device housing and casing material is the most expensive component of the project. However, this cost can be lowered by looking into the use of different material types. The RFID reader/tags and the other sensors will be tested to see whether or not they can be used to determine the material properties of the object placed into the machine. Whether or not each sensor will be used in the final design of the product will be dependent on performance and accuracy. All costs and estimates are inclusive of tax and shipping fees.

Budget and Funding

Sources of Funding. There are several sources of funding that 510 Innovations will take advantage of. It is notable that this project performs an objective that is aids the environment and manages waste through recycling. As such, this project meets the requirements for certain grants and scholarships

The Engineering Science Student Endowment Fund (ESSEF). The ESSEF is a pool of funds set aside to provide students with funding for projects that are entrepreneurial, competition-based, or course-related. 510 Innovations has presented to the board which governs the funding, and is currently awaiting notification of the amount granted for this project.

Brian Grant Award. The following states the requirements for this award:

> *"The Ministry of Environment, the Recycling Council of British Columbia (RCBC) and the British Columbia Chapter of Solid Waste Association of North America (BC Chapter SWANA). The Brian Grant Award is for $1,500. Students eligible for the award are those who are pursuing a degree, certificate or diploma in environmental science, engineering, or other suitable major related to the field of solid waste management, industry product stewardship/extended producer responsibility and recycling."*

The students within 510 Innovations will submit an entry for this grant.

SWANA BC Chapter Scholarships. The following states the requirements for these scholarships:

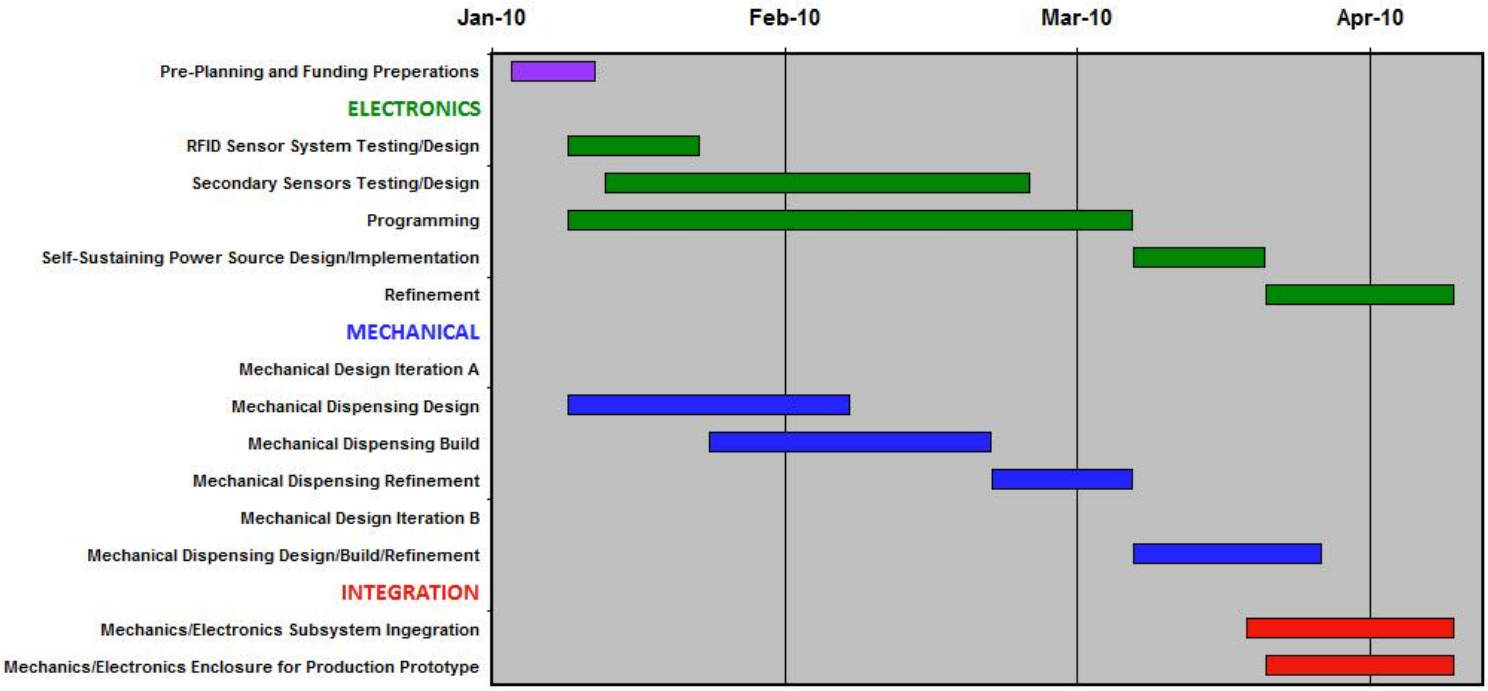
> *"Scholarships available to encourage students studying in disciplines related to solid waste management and environmental protection."*

The students within 510 Innovations will submit entries for this scholarship.

Funding by Students. Finally, a pool of funds will be made up of contributions from each of the five students involved in this project.

Schedule

Timeline. A Gantt chart of the projected design schedule.



Design Methodology. 510 Innovations will utilize an iterative design model as illustrated in the Gantt chart in the above figure. Rigorous testing will be performed on an initial design, testing will be performed, and an improved model will be constructed until the process is satisfactory and the proposed goals are met.

Given the time frame of this project, 510 Innovations believes that an iterative design process is superior to a waterfall model in that smaller goals can be realized in smaller steps making achievements and integration at a later step easily identifiable.

Schedule

***Project Milestones*.** The table below outlines the project milestones in terms of design milestones and documentation milestones over the period from January to April.

				31	Mechanical Iteration B Completion		
				25	Self-Sustaining Power Source Implementation	14	Mechanics/Electronics Enclosure Complete
Design Milestones							
24	RFID Sensor System Completion	28	Secondary Sensor System Test Completion	11	Mechanical Iteration A Completion	14	Mechanics/Electronics Subsystem Integration Complete

January		February		March		April	
	ESSSEF Proposal Funding	8	Functional Specification	8	Design Specification		Group Presentation
18	Project Proposal			22	Written Progress Report		Post-Mortem

Documentation Milestones

Project achievements are shown in the upper echelon and project deliverables are shown in the lower echelon.

Company Profile

Goals and Objectives. 510 Innovations is focused on developing innovative solutions to address existing problems and those that will arise in the future. As such, emphasis is placed on creating products that are compatible with emergent technological trends. This is done by researching which technologies hold the greatest potential and designing products in parallel. This methodology not only contributes and accelerates the progress of the related technology, but gives 510 Innovations the advantage of being the premiere company in development. This also ensures that 510 Innovations will be the leader in the market and increases the longevity of its products.

The most prevalent long term problem that 510 Innovations has identified is the environmental issues that we currently face. Along with rising technological advancements, environmental sustainability is equally important, and thus it is where 510 Innovations draws its name. Visible green light has a wavelength of 510nm, and indicates the company's commitment toward being green.

SEE green. THINK green. DO green.

Vision and Mission Statement. The mission statement, ***'See green. Think green. Do green.'*** describes the attitude and mindset that the company has towards developing solutions.

510 Innovations can ***'See green'*** by generating ideas from observing the current conditions of the environment. During the design process, the company will ***'Think green'*** by choosing production methods that have the smallest carbon impact, and alloys that are recycled or environmentally-friendly. And finally, ***'Do green'*** details the objective of the final product, whether it directly contributes to the preservation of the environment or enhances other sustainable processes.

Team Organization

David Leung – Chief Executive Officer (CEO)

Currently completing his degree in Systems Engineering at Simon Fraser University, David Leung has always held a keen interest in sustainable technologies. As an undergraduate, he has led a team in designing a solar and wind powered house, and aided in the construction of a 7-stage metal detector. Along with other engineering and business students alike, David assisted in the design, manufacturing and marketing of a device which harvested human kinetic motion as a renewable and mobile source of energy. Having acted as both a Chief Information Officer and a Chief Design Engineer in two entrepreneurial start-ups, he hopes to draw from his experiences in leading 510 Innovations.

Jeremy Lau - Chief Mechanical Engineer (CME)

In the final year of a degree in Systems Engineering at Simon Fraser University, Jeremy Lau specializes in electro-mechanical design with a strong emphasis on CAD/CAM. His previous experience as a mechanical design engineer at General Motors of Canada and Team Norco Performance Bikes will prove to be invaluable to 510 Innovations. Having served as the Chief Design Engineer of a green start-up company, he developed the core technologies for a biomechanical energy harvester while honing his business and entrepreneurial skills. His role with 510 Innovations would be to lead and oversee all mechanical design work.

Scott Hsieh – Chief Electrical Engineer (CEE)

A senior Electronic Engineering Major student in Simon Fraser University specializes in digital system and embedded system designs. As the only Electronic Engineering student on the team, Scott Hsieh's role in the project is to design the processing circuits for various sensors and interfacing between the sensors and microcontroller. He also has previous experience in robotics and battery powered devices and wish to learn other aspects of engineering from other members in 510 Innovations.

Team Organization

Michael Kume - Chief Financial Officer (CFO)

A fifth year Systems Engineering Student at Simon Fraser University. Michael's interests include robotics, electro-mechanical design and sustainable technologies. While Michael's field of study is in electro-mechanical engineering, his two previous work experiences have been software based positions at National Research Council and EU-Canada Mobility Program in Romania. Through use knowledge and skills obtained from his studies and work experiences, Michael hopes to be involved in all aspects of work at 510 Innovations,

Fritz Lapastora - Chief Information Officer (CIO)

As fifth year student attending Simon Fraser University, Fritz is on his way to complete his undergraduate degree in the Systems Engineering program. He previously spent eight months with Prism Engineering Ltd, where he worked on many projects that focused on solutions to improve building performance, increase energy efficiency, and implement greener standards. He also promotes a greener lifestyle by recycling at home and by bicycling as his means of transportation.

Conclusion

510 Innovations' goal is to create a product that will simplify the process of disposing recyclables in the general public. With our product, we plan to eliminate the thinking process required by people to properly dispose recyclables with currently available solutions. In addition, we will design our product to be available and functional in any high traffic environment. This is due to the fact that one of the major issues of recycling is that currently available solutions are not highly accessible and as a result, people are forced to dispose recyclables into normal garbage cans. In other words, we will design our product to be self sustaining.

The design and development of our product will be carried out over a four months period, starting in January 2010. The majority of the first half will be the detection of various recyclables, while the second half will consist of integration and testing of our final product. And funding for our project will be provided by the ESSS, private bursaries available for engineering projects based in the field of green/sustainable technologies and lastly, money from our own pockets. Through careful planning and the cooperation and teamwork of the five members of 510 Innovations, we hope to have a working product by the end of April 2010.

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Proposed (Existing) Design Solutions

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Budget and Funding

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