envision today

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January 21, 2013

Dr. Andrew Rawicz
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Re: ENSC 440 Project Proposal for NaviCane: Navigation-Assisting White Cane

Dear Dr. Rawicz,

Enclosed with this letter is our *Proposal for NaviCane: Navigation-Assisting White Cane* for our Engineering Science 440 Capstone Project class. The objective of this project is to design and implement an intuitive device that will provide increased mobility for those that are visually impaired.

In this document, we have outlined an overview of our project's design, features, and implementations. In addition, it will provide information regarding our sources of information, a tentative projected budget and proposed funding, our team overview and organization, as well as information detailing our tentative development schedule and milestones. We will also explore other alternatives in the market today and compare how our product is able to improve upon and replace features existing in multiple standalone devices.

Envision Today is composed of a four-member team of senior engineering students whose knowledge and expertise allows for an effective delivery in products featuring hardware and software solutions. The team, Vincent Guan, Edwin Leong, Raymond Li, and Darren Tong, has a background in systems and computing engineering. If you have any questions or concerns regarding our proposal, please feel free to contact Raymond Li via email at rla41@sfu.ca.

Sincerely,

Vincent Guan
CEO
Envision Today

Enclosure: *Proposal for NaviCane: Navigation-Assisting White Cane*

Proposal for NaviCane: Navigation-Assisting White Cane

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Submitted to:

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Executive Summary

"It is not miserable to be blind; it is miserable to be incapable of enduring blindness."
- John Milton

In a world driven by technology, many people have the luxury of enjoying the aspects of travelling to new places and experiencing new things. A trip to the mountain peaks is only a bus ride away. The journey to the oceanside requires no more than a simple commute. However, not everyone is as lucky.

Imagine one day that the world is dark and unclear. No amount of light is able to illuminate your desired path. With every step you take, there is a sense of uncertainty. Uncertain of whatever dangers or obstacles may lie ahead. This is the reality that the visually impaired face each and every single day. The World Health Organization (WHO) estimates that 285 million people worldwide are visually impaired, equating to roughly 4% of the entire human population [3].

We at Envision Today aim to enhance the quality of life of the visually impaired with the NaviCane: Navigation-Assisting White Cane. The NaviCane is essentially an integration between an ordinary white cane and pre-existing Global Positioning System (GPS) devices. Along with navigational capabilities, the NaviCane also features obstacle detections in front of and above the user. This will ensure that any user (regardless of their degree of vision impairment) may be able to comfortably and confidently travel. By utilizing our software application in conjunction with the NaviCane, the user is able to input any desired destination into the device. In the real world, the NaviCane operates similarly to an ordinary white cane so the learning curve is rather low; this provides the user with an easier transition period from their ordinary white cane to our device. We foresee the NaviCane being able to guide the user to venture out of their comfort zone and into unfamiliar territories. Since our product provides functionalities of a GPS navigational device within a regular white cane, it becomes more cost-effective, lighter in weight, and more user-friendly when compared to existing solutions on the market.

The business model of this product begins at the helm of the direct sales model. Through visually impaired organizations, we start with demonstrations of the product. After numerous demonstrations in different organizations, we will change to the intermediary business model. In due time, these organizations will become the middlemen for our product as we will allow them to promote and sell our product through their established online and retail establishments.

Envision Today is composed of four talented and passionate senior engineering students. Within four months, we will develop and implement an enhanced tool, the NaviCane, for the visually impaired. The estimated required funding for the entirety of this product is currently budgeted at $470, for which we were granted $500 from the Engineering Science Student Endowment Fund. Increased funding will definitely help to enhance our product with additional functionalities.

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Glossary

API	Application Programming Interface
CGDB	Canadian Guide Dogs for the Blind
CNIB	Canadian National Institute for the Blind
ESSEF	Engineering Student Society Endowment Fund
GPS	Global Positioning System
HW	Hardware
PCB	Printed Circuit Board
SW	Software

1. Introduction

According to a survey conducted by Statistics Canada in 2006, 31.9% of participants that were surveyed indicated they require the use of a white cane for mobility. Currently, the visually impaired have several options for mobility aid: human guides, white canes, guide dogs, and electronic travel aids. Only white canes and electronic travel aids promote independence for the visually impaired.

The objective of the NaviCane: Navigation-Assisting White Cane is to enhance the safe travel of the visually impaired user. Our device allows the user to travel independently to unfamiliar places and sites. The device will receive an input from the user through our software application in order to determine the destinations that need to be reached. Our software application communicates with the NaviCane to determine the GPS coordinates of the desired destinations. In order to safely guide the user, multiple routes will be determined and added to the NaviCane. By simply following the routing data that the device contains, one can easily arrive at the desired destinations. Furthermore, the addition of ultrasonic sensors allow the NaviCane to detect obstacles ahead. This optimizes the time required for the user to prepare for such obstacles instead of sensing with a regular white cane. The device will provide feedback to the user to warn them of obstacles that may pose a threat.

The marketable advantage of our product does not pertain only to the visually impaired. In fact, other disabled individuals or the elderly may choose to use our product as well. For example, a simple modification in the structure of our design can turn our white cane into a regular stability cane. Although the necessity for detecting obstacles would be no longer needed, the GPS guidance system can still be useful. The GPS guidance system will prevent the user from becoming lost and provide an efficient method for the user to find their route again.

This proposal will document the overview of our product, design considerations to be implemented, potential risks and benefits from existing solutions, scheduled planning for our workload, and allocation of funding.

2. System Overview

The project design consists of two systems, one is the software application through the user's computer and the other is our hardware device, NaviCane. Figures 2-1 and 2-2 demonstrate the basic functions of the cane. The user inputs the desired destinations through the software application, which will in turn be transmitted to the device via USB interface. The device guides the user with corresponding directions through each path to reach the final destination. The device will be comprised of two ultrasonic sensors to detect for obstacles in front and above the user. Using the output signal of the ultrasonic sensors, the device will alert the user with information about the distance and size of the obstacles.

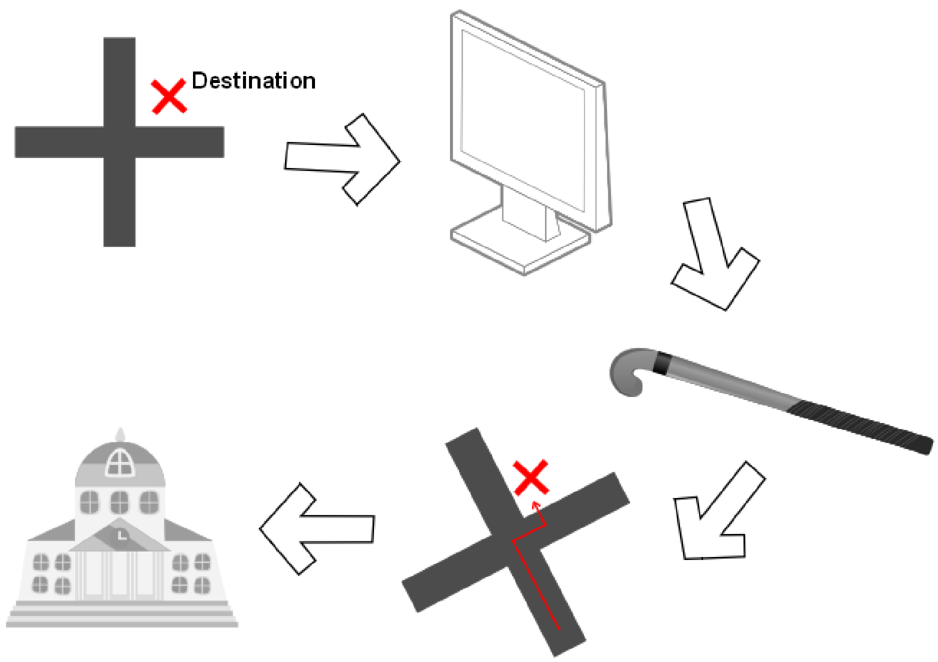

Figure 2-1: Top-level Block Diagram

A simple switch enables the user to turn off the GPS functionality while still providing feedback for obstacles. This allows the user to use the cane for indoors without having any interferences which provides a more safer environment. The device will be powered by a wirelessly rechargeable lithium-ion battery. The wireless recharging will be accomplished by an inductive charging mat supporting the QI standard.

Figure 2-2 below shows the system block diagram for the NaviCane.

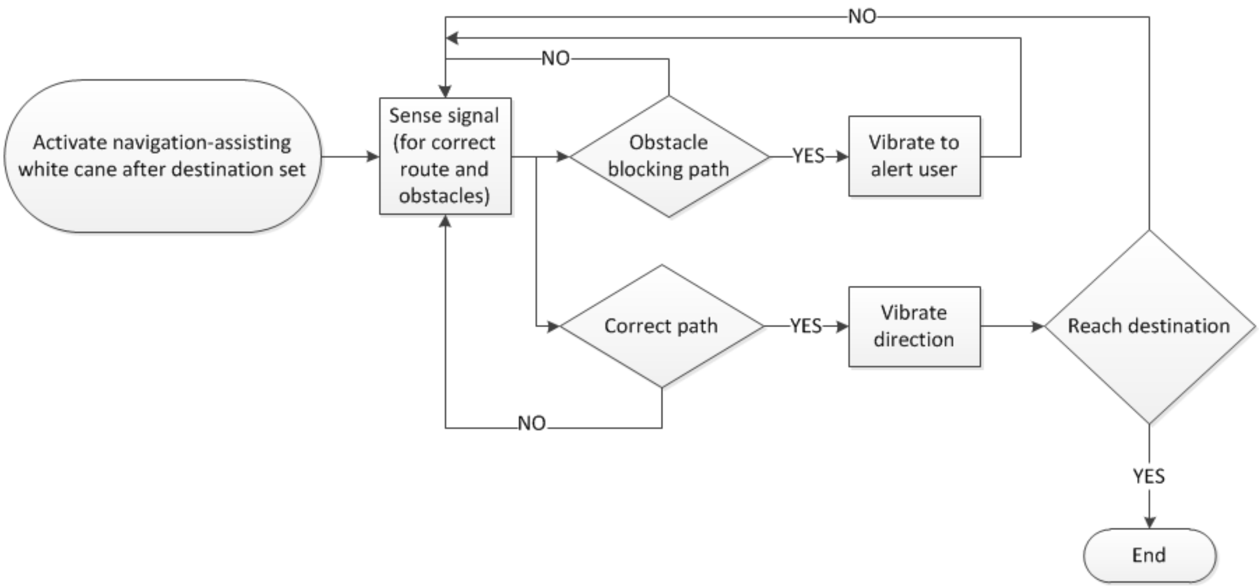

Figure 2-2: System Block Diagram for NaviCane

3. Existing Solutions

Currently, there are several options for the visually impaired if they wanted to purchase existing mobility aids. The complexity of mobility aids for the visually impaired can range from very basic to advanced. However, one important factor that must be considered is the ability to allow the users to discern their surroundings. Simply guiding the user is only sound theoretically. Since environments and surroundings do change, the user must be allowed to adapt to these changes rather abruptly.

3.1 Guide Dogs

Guide dogs are professionally trained animals in order to provide independence and safe mobility for its user. Abilities of guide dogs include the understanding of basic verbal commands, to safely guiding the user through traffic, and protecting the user from potential risks and dangers. One distinct advantage with a guide dog is its ability to determine safety. The dog's live reflexes triumphs over current detection algorithm. Without a doubt, guide dogs do provide genuine human-to-animal interaction and even act as pets during its afterhours.

However, the projected cost of raising a regular dog is approximately $700 per month [2]. This includes food, care, and veterinary costs. Over a long period of time, it would sum to quite a large investment. Although guide dogs are promoted for their independence, the reliance of an animal slightly contradicts the fact that guide dogs encourages independence. Furthermore, the Canadian Guide Dogs for the Blind (CGDB) organization states the cost of providing a guide dog to a user is in excess of $35,000 [4]. Realistically, it would be very difficult and expensive to provide guide dogs for every visually impaired person. An additional concern about guide dogs is its inability to let users understand their surroundings accurately.

Figure 3-1: A Typical Guide Dog [7]

3.2 White Cane

A white cane is an essential tool for people with vision loss. It allows the users to detect their surroundings for obstacles and dangers, as well as checking the change in walking surfaces. Its history dates back to the times after World War I. Introduced for nearly a century, the white cane has proven to be withstand the test of time in assisting the visually impaired. The success and prevalence of the white cane is one of the main reasons why we decided to incorporate it into our design. There are many variety of white canes on the market, but an average cost is only $40.

Despite its success, no product is without flaw. One concern raised with the white cane is its basic functionalities. A sweeping technique is applied by the white cane users in order to perceive obstacles and dangers in the front of them. However, it is unable to detect obstacles and hazard hanging above the users. This is one reason we decided to add ultrasonic sensors in our design to detect overhanging objects above the users. Another disadvantage of the primitive white cane is its inability to guide the user. With no communication between the user and the cane, the potential of this product diminishes greatly.

Figure 3-2: An Ordinary White Cane [9]

3.3 Electronic Travel Aids

A product of our technological advances is the electronic travel aid for the visually impaired. These devices operate similarly to the GPS devices in cars or on our smartphones. Using GPS coordinates, they provide directions to the user to reach their destination. Using Bluetooth technology and satellite radio signals, the GPS receivers will determine the corresponding location from its network. Electronic travel aids usually provide communication to the user through audio and speech recognition. The electronic travel aids provide an independent way for users to navigate, albeit the technology is still advancing. This is another factor we decided to incorporate into our design, thus leading to a GPS device within our product.

A typical electronic travel aid, such as the renowned Trekker Breeze, can cost up to $700. With such an expensive device, proper care must be maintained to prolong the longevity of these devices. One flaw we noticed with electronic travel aids is its lack of physical interaction with the ever-changing environment. The device is unable to detect any outstanding obstacles along its proposed route to the destination. What if there was construction along the path? Without an ability to physically determine if the proposed route is applicable, the potential of these devices diminishes similarly to the white cane. In addition, carrying this device is not usually discreet and may generate unwanted attention or possible theft.

Figure 3-3: A Typical GPS Device Designed for the Blind [8]

4. Proposed Design Solution

The major design goals behind this project are reliability, subtlety and affordability. The reasoning behind these goals are not only so the product can achieve financial success, but also so that we can ensure that we are making a real impact on the lives of as much of our consumer base as possible.

The reliability of our product is likely one of the most important features this product should hope to achieve. If the device cannot function within a large realm of possible environments and for a reasonably long amount of time, then our device will not be adoptable by the community at large. To this end, the GPS module is likely to be the most costly and important module on the product. We must ensure that the GPS module is accurate enough for walking traffic and able to work through many adverse environments that a consumer is likely to encounter. Since we must be able to guide a visually impaired person through what is likely to be a busy and crowded city street, the device must be correctly calibrated to ensure a highly accurate guidance to each potential intersection. Adverse working conditions such as rainy weather and tall buildings must also be tested for. The GPS module being used will feature an embedded antenna that will provide for quick navigation updates and good reception in even the most crowded urban areas. The power supply is also an important factor in this regard. We are also ensuring that the power load from our device is as low as possible. In order to achieve this, we are taking steps to allow the regular usage of our device to draw the least amount possible. These steps include allowing the user to determine when to toggle the direction guiding on and off, using low power solutions for the direction guiding, and running as few computations through the onboard device as possible.

Subtlety is a measure based upon the idea that a user of our device should draw no more attention to themselves than they would otherwise. If the device comes off as too garish, too impractical or attention-drawing, the product risks failing despite its usefulness. This comes into play in multiple areas of our design. When it comes to charging the device, we are looking into a wireless charging solution so that the user would not have to worry about finding a plug or USB cable to power the device. The device will simply be placed on the wireless charging mat when not in use. Similarly, we are looking into bluetooth connectivity when potentially interfacing with either a PC or a smartphone. The method of direction guiding is also an important impact on subtlety. We are investigating the possibilities of vibration based feedback and sound based guidance through earpieces with regards to subtleness and market preference. Another important feature is that we must stay within expected size, weight, and bounds of canes that are abundant and popular in the marketplace. It is also a possibility of merely creating an attachment for existing canes in order to increase usability, affordability, or adoption rates. To these ends, we are looking into performing a focus group with our target consumer base in order to determine the bounds of these aforementioned features.

As with most products in the marketplace today, affordability is a definite priority as we look into the features and hardware of the device. The more affordable the device, the deeper the penetration into the market and the more likely the chance of success for the device as a whole. However, affordability most of the time comes at the expense of the other two design goals. Our approach is to first create a device with the basic functionality described and to then look into ways of keeping that functionality while decreasing the manufacturing cost of the device. Aspects we suspect costs are to be saved include the physical cane itself, the microcontroller, the charging method, the potential need for a mapping license, wires and other miscellany.

5. Sources of Information

To research and analyze our design problem, we gathered resources from the internet, which included component specification sheets for various hardware accessories (such as the GPS module, ultrasonic distance sensors, etc.). Other research involved utilizing the Application Programming Interfaces (API) necessary for the navigational routes. This research will provide us with the building blocks to building a working prototype.

The main sources of information regarding the user interface will come from the scheduled communications and meetings between the Canadian National Institute for the Blind (CNIB) and the Eye of the Dragon focus groups. The Eye of the Dragon is a local dragon boating team containing team members with varying degrees of vision impairment [6]. These focus group meetings will provide us with additional information about the lifestyles of the visually impaired and about their experiences with modern technology. The social workers at the CNIB can provide us with their daily interaction with the visually impaired, which will help us create a better understanding on the needs of each individual. This will help us improve our device and its user interface in order to ensure that we will be able their improve their quality of life to the very best of our capabilities.

Additionally, the teaching assistants will help us with their technical knowledge on the components we will be using to build our device. Specifically, their expertise in designing mechanical structures may prove to be invaluable when we are in the further development stages. It is necessary to consult with a teaching assistant with a background in mechanical engineering when we finalize our mechanical structural design of the NaviCane.

6. Budget and Funding

6.1 Budget

Table 1 below outlines a tentative budget for the NaviCane. The costs below are estimated from reputable resellers. We have also researched alternative components (and secondary sources/suppliers) that can be purchased at the estimated cost to provide for contingencies in the prices of specific components. The miscellaneous cost also acts as the contingency fund for any additional components that may be needed during development. Each component has been carefully selected to balance the performance to cost ratio. They have also been selected based on their ease of programming in order to minimize the development cycle.

Table 6-1: Tentative budget outline

Equipment List	**Estimated Unit Cost**
Arduino Uno	$30
One or Two Ultrasonic Sensors (LV-EZ1)	$30 each
One or Two Vibration Motors	$5 each
GPS Module with Embedded Antenna (LS20031)	$60
Magnetometer Breakout Board (HMC5883L)	$15
White Cane or Physical Casing/Mount	$40
Buzzer/Speaker	$5
Battery + Wireless Charger	$30
Printed Circuit Board	$150
Miscellaneous (Cables, Jumper Wires, Taxes, Shipping+Handling)	$70
Total Cost	$470

6.2 Funding

To ensure the success of this project, it is necessary to seek sources of funding in order to complete the development of the NaviCane. Fortunately, after applying and presenting to the Engineering Student Society Endowment Fund, we were granted a fund of $500 to help cover the anticipated costs of development (as outlined in Table 6-1). We believe that this fund is able to cover the entire costs of the project but if in the event that we require additional funding, we are prepared to apply to the Wighton Development fund for assistance. If additional capital is further required, each team member is willing to generate the necessary costs to ensure that the project is completed to perfection.

We may also adjust our bill of materials in order to accommodate for our generated capital funds. This can be accomplished by adjusting some components (such as the GPS module) in order to favour price over performance. In addition, a large portion of the costs is attributed to the necessity of fabricating a printed circuit board. We may be able to lower costs by utilizing only a double layered board (instead of a multi-layered board) and by reducing the overall size of the printed circuit board as indicated by an online price estimator from AP Circuits [1].

7. Schedule

A gantt chart is shown below in Figure 7-1 indicating our expected 4-month development period. Note that documentation is considered a continuous task and it is not indicated in the figures below.

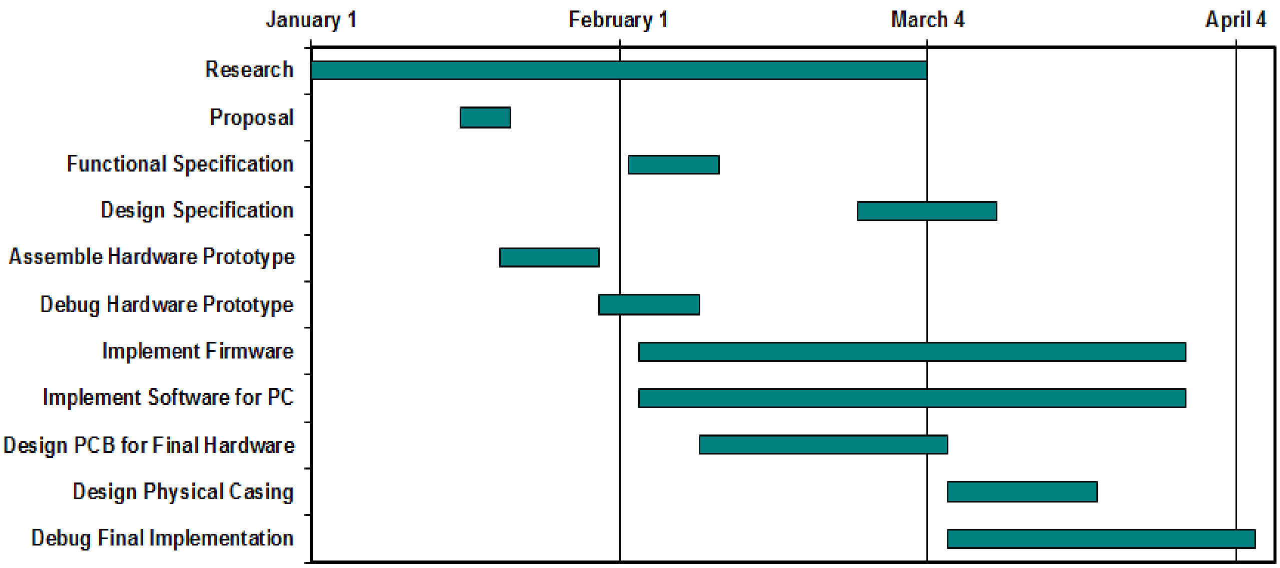

Figure 7-1: NaviCane's Development Schedule

The chart below outlines the key milestones of our project schedule and deadlines.

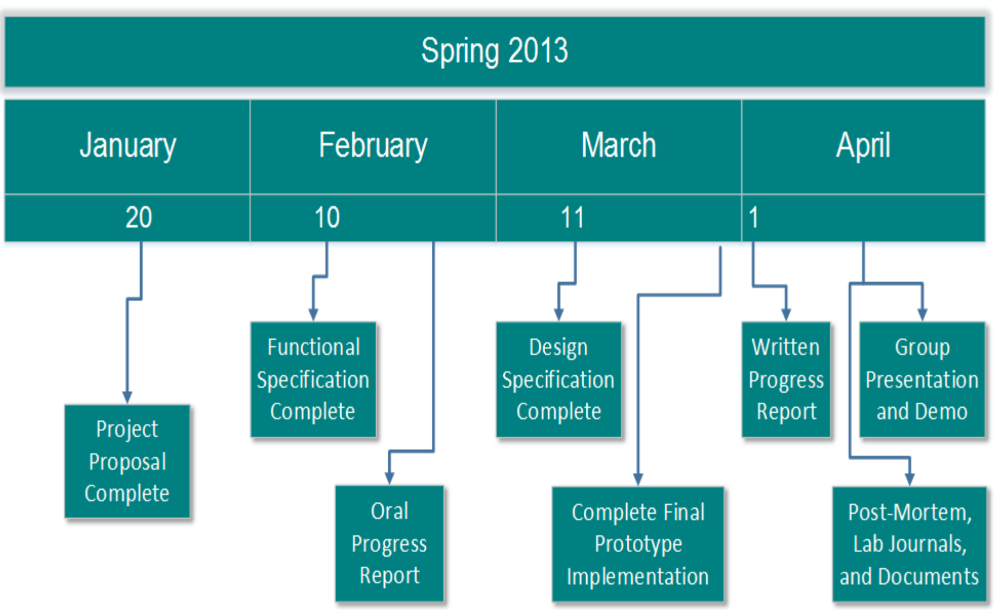

Figure 7-2: Key Milestones

8. Team Organization

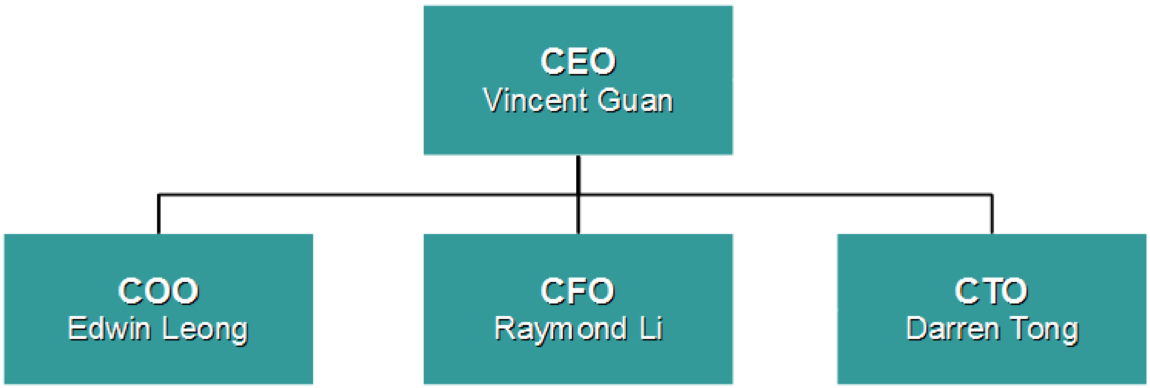

Figure 8-1: Company Hierarchy

Envision Today was the creation of four Simon Fraser engineering undergraduates: Vincent Guan, Edwin Leong, Raymond Li and Darren Tong. Together, these individuals have endeavored to provide solutions for the less traditional or overlooked members of society. Each founder's specific skills and past experience are highlighted in the Company Profile section. Vincent Guan, Chief Executive Officer (CEO), is credited with the initial spark that drove the principles behind the product idea that would be the company's first major project and is active in all roles within the company. Raymond Li, Chief Financial Officer (CFO), is responsible for managing the financial planning, resources, and preparing financial documents. However, he is also an adept hardware design engineer and is not only keen on the latest trends within the industry but playing a large role towards making the hardware ends meet. Darren Tong, Chief Technology Officer (CTO), is in not only in charge of the software development of the product, but also for the liaising with outside resources and prospective partners. Edwin Leong, Chief Operating Officer (COO), is responsible for organization, management, documentation, software development, and software testing.

Our team meets twice a week in person to discuss the state of various tasks to be performed and also regularly online to facilitate the progress of our projects. We also facilitate an AGILE software programming approach towards the completion of our projects. Each member is required to keep and maintain an engineering journal.

At Envision Today, we believe in innovation for our products. As this is an early startup company, our team members are dedicated to ensuring the success of the company. They have agreed to provide for the capital needed to ensure the successful delivery of the NaviCane. As a result, they are prepared to work pro bono until a steady profit is earned. After every quarter, each member is to receive 20% of the profits while the remaining 20% will be invested back into the company as capital for continued research and development.

9. Company Profile

Vincent Guan, CEO

Vincent Guan is currently in his fifth year of studies as a systems engineering student at Simon Fraser University. His knowledge is expansive with the variety of courses he has taken such as communication networks, real-time embedded systems, and multimedia communications. His past projects include creating a game called Snake on an Arduino board programmed in C and creating a surveillance system on the Raspberry Pi with C++. Using his vast knowledge, he can provide further insight on the technical aspects of the project that handles with hardware and software.

Edwin Leong, COO

Edwin Leong is currently in his final year of studies as a systems engineering student at Simon Fraser University. His past co-op work experiences include Software Development at SAP Business Object and Hydraulic Modelling at GeoAdvice Engineering. Past projects include various modules for the SAP Enterprise Suite and Sewer and Hydraulic models for the cities of Merritt and Nanaimo. Edwin is keen on developing and utilizing his software development skills and works on a few projects in his spare time.

Raymond Li, CFO

Raymond Li is currently in his final year of studies as a systems engineering student at Simon Fraser University. With past co-op work experiences at Sierra Wireless as a hardware design engineer, he is adept at designing, validating, and troubleshooting various hardware designs. He is very confident in his ability to design successful circuit schematics and printed circuit boards from the prototype stages all the way to manufacturing and release to the market. Past products he has helped bring to the market include state of the art LTE mobile hotspots devices, which are currently being sold by companies such as Rogers, Bell, AT&T, T-Mobile, etc.

Darren Tong, CTO

Darren Tong is currently in his fifth year of studies as a computer engineer at Simon Fraser University. He is a passionate individual for his projects, which corresponds greatly with his traits of determination and persistence. Aside from school, he is an avid sports fan, especially basketball. Music is also another one of his passion. One day, he aspires to be a producer and disc jockey for electronic dance music. Despite possessing an interest in many different fields, he is able to unite all learned skills and techniques to achieve his goals.

10. Conclusion

As our technological reach expands, it is important for us to take a step back and reach out and empower other members of society who may not have the same opportunity to capitalize on our advances. We, at Envision Today, strive to impart the same sense of increasing mobility and freedom that technology gives to the most ablest of us to those who are less fortunate. We will also strive to ensure our product is affordable and discreet in order to facilitate the above goals.

Our proposed device is able to satisfy multiple criteria of different mobility aids for the visually impaired. The design aspects of our product incorporates new and successful methods of mobility aid for people with low vision. Advantages of flexibility and cost-effectiveness clearly distinguishes our product as superior when compared to pre-existing solutions on the market.

Our team is confident that we will be able to meet the specifications and demands of our target consumer and furthermore we are confident that we will be able to meet all of our target design goals indicated by our gantt and milestone charts. With our estimated budget costs already covered by the grant received from ESSEF, we are currently on schedule to deliver a product that satisfies our high standards.

11. References

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