Jan 31, 2018

Andrew H. Rawicz
School of Engineering Science
Simon Fraser University
V5A 1S6

Re: ENSC 405W Project Proposal for PharmaSort's Axis prescription pill sorter/dispenser

Dear Dr. Rawicz,

I am writing to you to outline PharmaSort's project proposal. Attached, this document will explain the project idea, intended market, and design processes of our undertaking. Our goal is to create Axis, a type of prescription pill sorting machine that, for personal or pharmaceutical use, can accurately identify many different types of prescription pills from their bottles and sort them accordingly.

This proposal is meant to identify the market need and customer base as well as assess safety concerns and risks involved with our proposed device. It will also touch on possible implementations and design steps, as well as the cost effectiveness of any proposed solutions. Along with this, a project schedule will be outlined with a budget analysis.

PharmaSort features five engineering students: Francis Tran, Hazel Monte de Ramos, Freddy Kooliyath, Mirac Chen, and Ananth Prabhu. All of these students come from the core engineering options offered at SFU, and bring very diverse skill sets to the table.

Please do not hesitate to contact us via our designated contact person, Hazel, for any questions or concerns you may have. You can reach her at hmontede@sfu.ca

Sincerely,

Francis Tran

CEO

PharmaSort

Proposal for the **Axis**: A Prescription Pill Sorter and Dispenser

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Submitted to:
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Dr. Andrew Rawicz: ENSC 440
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Executive Summary

Prescription drug use is inevitably a large factor in the health maintenance of many Canadians, serving as the second highest expenditure in healthcare with a cost of $29 billion in 2013 [1]. Among the age demographic of medication users, seniors rank the highest [1], and adversively can also be prone to the highest risks. Drug noncompliance occurs irrespective of age, but seniors - who tend to suffer from vision and memory impairment- often fail in adhering to their medication with greater likelihood. Whether it be overuse or underuse, or simply failure to read the fine print on labels, consequences are evident- and they can be severe.

The following proposal documents a possible solution to this issue: Axis. Our aim is to minimize the drug noncompliance in seniors and other potentially disadvantaged demographics (such as rural or Aboriginal communities) by proposing a device that can effectively determine and administer the correct pills and dosage at the appropriate day for a single week. This will be accomplished using camera sensors and character recognition API to extract required information from the prescription label. The internal hardware structure will be designed to sort the pills by day, pass any excess medication for that week, and dispense accordingly.

Granted, other solutions exist in the market, but most often, they require manual dispensing through infrastructure such as plastic pill organizers. Accuracy can be compromised if the user is elderly and unable to correctly organize or remember to take the pills. Our device will surpass the rudimentary manual sorting- effectively reducing human error- and rely on the efficiency of electronic solutions to provide a far better option.

Complete design documentation will lay out the functionalities, assembly, and integration plan, which together will yield a final working prototype within the course of 8 months. Meanwhile, the accompanying documents will discuss other risks, scope, and marketing strategies to deal with the competitive and economical consequences that come with launching a product. Current projected expense is an estimate of $468 and is planned to be funded through the ESSEF, Wighton Fund, and our own resources.

With a group of such diverse talent, the PharmaSort team is optimistic that they can challenge the status quo of the pharmaceutical industry and streamline an innovative approach to taking prescription drugs safely and precisely from the comforts of your home.

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Glossary

Term	Definition
API	Application Programming Interface: a set of functions for interfacing with the underlying software system
Drug Noncompliance	The act of a patient failing or refusing to comply to take appropriate medication or treatment
NDC	National Drug Code
ESSS	Engineering Science Student Society
AMD	Age-related Macular Degeneration: Blurring of vision through degeneration of the macula in the eye from age

1 Introduction

According to Statistics Canada, it is expected that the senior population will surpass the number of youths aged 14 and under by 2021, and will grow to a targeted range of 9.9 to 10.9 million by 2036 [2]. It seems evident that a rising demographic would have significant issues that should definitely be considered and looked upon. Many new innovations are being made to target the younger audience, but to us it made greater sense to focus on the older generation by envisioning devices that would solve real issues and improve their overall lifestyle. With a goal and a passion to serve, combined with the creativity that sparked our desire to dream, PharmaSort hopes to deliver the Axis, a device that will prove its worth to society.

Aging is an inevitable process which affects all humans in a variety of ways. With about 40% of people above the age of 65 displaying signs of memory impairment due to their age [3], things that were once so easy- such as taking the correct pill at the correct time of day- suddenly become more difficult. Moreover, with a rise in prescription drug use from 12% among youths to 83% among 65 to 79 year-olds [1], remembering to take medication becomes a real issue. Although professionals are able to correctly diagnose symptoms and dispense the respective pill at the appropriate time, there are many situations in which a professional can not be available immediately, and other factors may inhibit the use of such medications. In such cases, missing the required medication, or ingesting the wrong one, can have adverse consequences.

PharmaSort's solution will arrive in the form of the Axis. The Axis is an innovative device capable of sorting the required pills by day, and dispensing at the appropriate time. Bypassing the need of manual user input, this device will take all information required by reading the prescription label, and then dispense accordingly as instructed. This proposition, we view, will greatly minimize human error and increase efficiency, preventing the chances of the individual missing their medication. The basic functionality of the Axis utilizes a camera that will capture the bottle label and use character recognition API to decipher the necessary information. The user then dispenses the pills into the machine, which will sort the exact amount for a week, passing all excess pills through another chute. After the machine is loaded and the information scanned is translate this into usable data, the device will then dispense the medication accordingly.

The following proposal aims to give an in-depth look into the Axis, by examining it's system overview, market and cost, along with a detailed look into the planning required to accomplish the desired goals. A team overview is also included to collectively illustrate the diverse and versatile group of individuals who will be working behind this concept in hopes to transition it into a fully functioning device.

2 System Overview

2.1 Scope and Functionality

The system will take input from a user; more specifically, the user will scan the bottle's label and then pour the respective pills into the device. The system will parse the information found on the tag and with that information, will dispense pills according to the dosage and frequency specified on the tag.

The project harmonizes both a sophisticated software back end with a mainly mechanical hardware front end. Both will be discussed in the contents of this proposal. On the software side, we propose to implement functions that will be able to read image files and identify characters, specifically, printed characters on a prescription bottle. The goal is to be able to parse the information on the label of a prescription tag and identify key words which will govern the order and quantity of dispensation.

The excess pills that are left over will be poured back into the bottle, while the pills that will be administered will be placed into compartments that will be ordered by day. This would allow easy organization while properly administering the right dosage according to the pill bottle instructions.

2.2 Risks

Theoretically for an application such as this, it would only be acceptable and most ideal if the device had minimal risks which do not result in life threatening consequences. Unfortunately due to the nature of the materials we are dealing with, one minor mistake could result in a dangerous situation. The first major risk would be having prescription pills dispensed incorrectly. While we will try our hardest to ensure the software and hardware work smoothly and perfectly in conjunction, even the most seemingly secure systems sometimes have failures due to unforeseeable circumstances. Another problem is ensuring that the dispensing mechanism of the pills flows smoothly. If something were to be lodged into the pipe of the device, it could cause a user to miss one or more doses of medicine.

Obviously, there is only a reasonable amount of verification that a product can undertake to ensure safe usage for the user. That being said, there are several corner cases that must be taken into consideration with this machine.

On the hardware side, one of our main challenges will be to keep the pills intact after the sorting process -- after all,we will try to increase the speed of our machine. Pills stuck in the machine might cause system failures, or even worse - cross contamination for other pills.

The device currently does not check if all the pills in the bottle are homogeneous, because only the label is scanned. This can cause risks when dumping the excess pills, since the system could potentially dump incorrect pills if the mechanical implementation has an inadequate degree of accuracy.

There needs to be careful thought about how a user can make mistakes, for example, forgetting to scan the label and starting the machine, numerous checks are needed to be made in order to present a safe and marketable product.

In terms of prototyping, no large personal risks are involved because none of the pills tested will be consumed. Only minor machine shop risks are apparent when building the machine.

2.3 Benefits

Opposed to the risks discussed above, this proposed device has many benefits and aims to solve several problems. It will directly benefit the elderly, particularly ones that live alone. This demographic may have trouble with handling pill packages (or reading them) due to loss of memory, eyesight or other lack of capacity. In remediating this, we aim to help such people take medication in a precise and timely manner. This will definitely have a profound social impact on the market.

At the most rudimentary level, Axis can serve as an advanced tablet organizer. For seniors who tend to have multiple medications, it can prove to be a hassle to try and organize them in an effective manner. With Axis, tablets and pills can be organized by day for a single week, preventing overuse and underuse of the prescribed medicine.

Secondly, it eliminates a number of errors the user can make by reducing the number of instructions and manual labour (which would all instead be accurately done by the machine). Unlike most dispensers, the user doesn’t have to manually sort the pills themselves, which avoids the common problem of elderly consumers who have vision problems or mobility restrictions. Furthermore, the Axis will be designed in a way to catch possible errors, thus enabling early prevention of mistakes.

Thirdly, the amount of supervision for the consumer would be reduced since once the Axis begins to yield very accurate results, it can service patients as a stand alone service. This enables healthcare providers to focus on other patients whom would require more severe aid.

Fourthly, a product like the Axis will be easily funded by the government given the immense need for a device like this for the elderly. The healthcare system in Canada is very well funded, therefore, the support of the government would increase the acceleration of sales of this product in the market which financial and operation support.

Finally, this device will increase the feasibility of at-home care treatments. Once the accuracy of the machine becomes adequate, the elderly will be able to undergo medical treatments at home because the device would provide the medication in an accurate and effective manner. This would largely reduce the need of attention and space in hospitals/care homes which is becoming increasingly harder to come by with the increasing population of baby boomers and subsequent generations.

2.4 Proposed Design

We propose a design that features hardware working in conjunction with software to identify and sort prescription pills in an efficient and timely manner. On the software side, we aim to connect to Wi-Fi (or a 3G/4G network in the event of unavailable internet access in aforementioned rural areas and technologically unequipped residences), and use Google's Cloud Vision text recognition API to parse the necessary information from the labels. This will provide instruction to a mangOH microcontroller which will appropriately manipulate the mechanical portion of the system on how and when to dispense and sort each prescription pill.

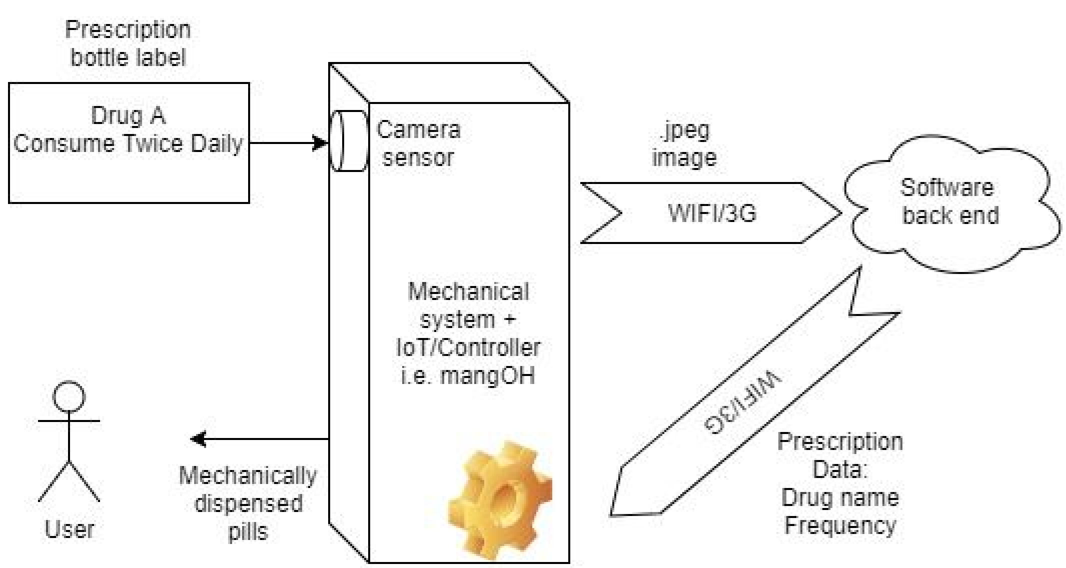

Figure 1: High level system diagram

2.4.1 The Hardware

The final proposed design would have the entire system housed inside a spherical combination of pentagons. This allows the device to minimize damages to the internal structure if the device were to be knocked over. The structure of the pentagons arranged in a sphere will transfer the impact forces uniformly throughout the structure to minimize shock damage to the system.

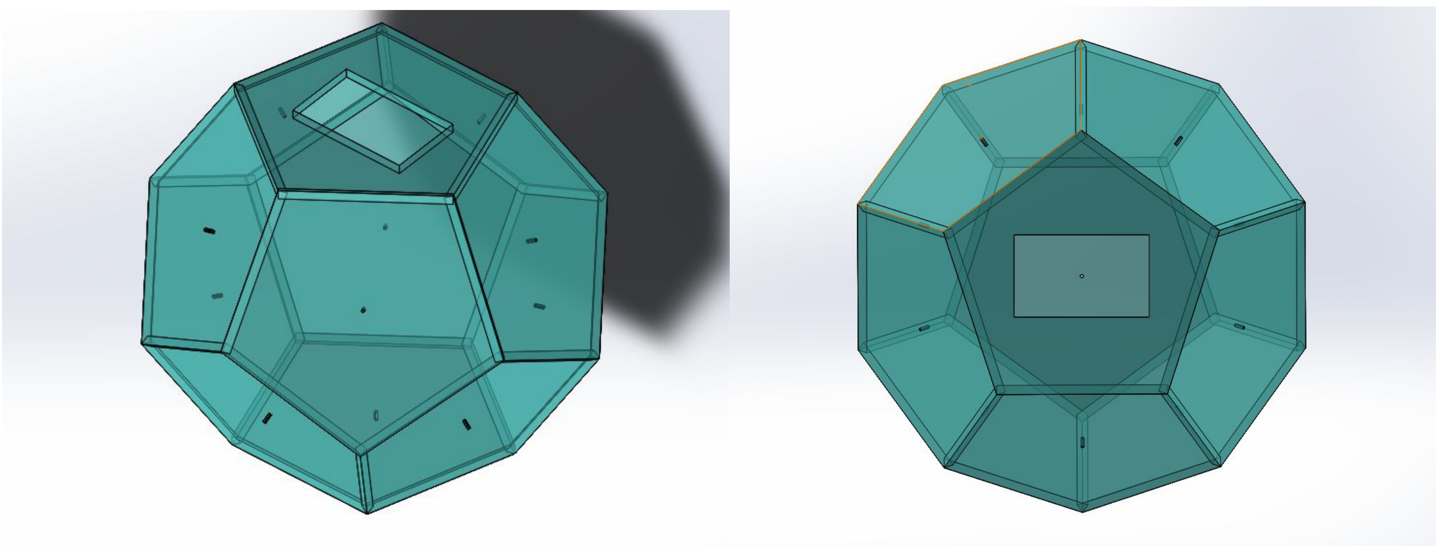

Figure 2.1: Pentagonal structure of the Axis

The pills will enter the device through a rectangular hopper that narrows down to a square. This prevents the pills from being crushed by distributing the forces gradually when being fed into the sorting operation.

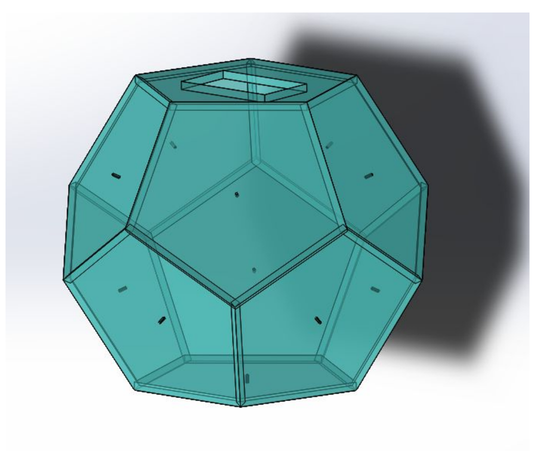

Figure 2.2: View from the side

The first operation would be to separate the pills for sorting one by one to determine what day the patient will have to take and the dosage. This will be implemented through a mechanical motion system that avoids jamming and individualizes the the pills. Each time a pill is loaded, another pill is released. The right side is where a translational motion will be applied which would mechanically perform the process described.

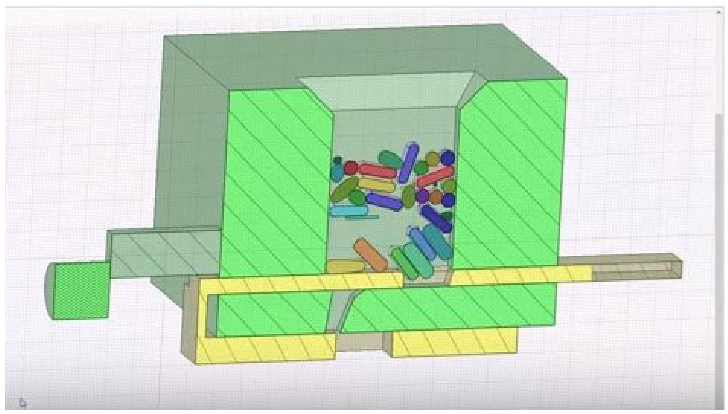

Figure 3: Simulation of dispensing single pills (From Algoryx) [4]

There will be flaps which will control the side that the pills will go down. If there are an excess amount of pills, then the flaps controlled by servo motors will route the pills to their respective destinations. The excess pills tube would lead the pills back to the original bottle which the user will be instructed to place under the dispenser before starting the sorting process.

The pills are sorted by day on a circular surface, which lies at the bottom of the structure. This surface is partitioned into seven sections for each corresponding day of the week, with each section acting as a separate tray. A servo motor will appropriately rotate this surface so that the tray of the current day will be positioned at the user-end, who will then be able to pull the tray out and obtain their medication.

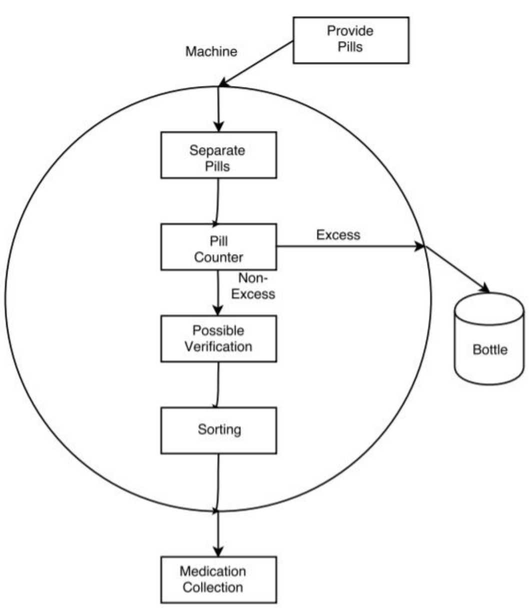

Figure 4: Mechanical flow chart

2.4.2 The Software

In terms of software, the over-encompassing function is to create a method that is able to identify characters on the bottle label. The first step is to obtain two or more different angle shots of the label on the target prescription pill bottle. This is due to the fact that the label is adhesively attached onto the curved surface of the logo, making a profile photo difficult to obtain. The photos will be sent to a photo stitching API which will combine the photos into 1 final image. After the final image is obtained, the system will use Google Cloud Vision API to generate text from the input image. From this data, the system can parse the necessary details such as prescription liabilities and frequency of consumption. This functionality will be implemented using a Python script running on PharmaSort servers to connect to Google's Cloud Vision API and synthesized using an Arduino or mangOH microcontroller.

Below is an in depth system diagram focusing on the software aspect of the system:

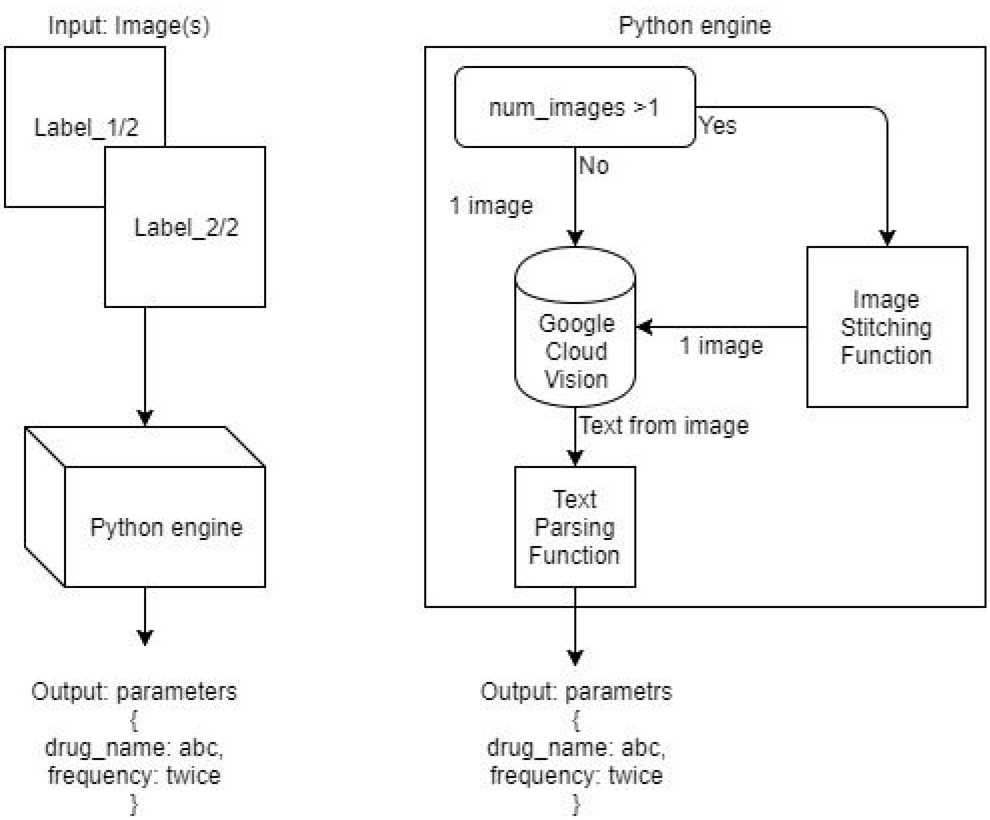

Figure 5: System software flow chart

3 Marketing and Analysis

3.1 Current Need

According to an article in the National Center for Biotechnology, it is estimated that a range of 40% to 75% of drug noncompliance exists within the elderly community [5], with age related health issues being one of those reasons.

Age-related Macular Degeneration (AMD) associated with age, currently stands as the number one reason for vision loss in Canada [6], and since prescription labels can often have small print, it can be significantly challenging for an older individual to correctly decipher the instructions or identify the medication itself. In terms of memory related issues, about 40% of those above the age of 65 demonstrate some form of memory loss [7], and about 7.6% among the age 75 and above sustain memory disabilities [8]. Challenges in being able to recall if a pill was taken, can lead to overuse or underuse of medication, and with most seniors taking multiple pills in a single day, this can become increasingly problematic.

Moreover, a study involving participants aged 70 and older showed that among the 95% that experienced problems taking their medication, a few of those problems included reading and understanding instructions and simply taking the medication [9].

Additionally, since the system boasts a 3G/4G SIM slot, a data connection is feasible for rural Aboriginal, or otherwise remote areas. This could help administer medications to populations which do not have a readily available pharmacist to assist in dispensing. In these cases, the label of the medicine can even be updated via reprint and sticking on the bottle. The pharmaceutical resources available to rural and Aboriginal communities is definitely lacking, according to studies [10].

Analyzing this background information, and assessing the problems of medication adherence, our primary market focus will be the elderly, particularly those who live alone and require prescription medicine frequently (though we do perceive that there is a potential market among other demographics). As well, we expect that the senior population in Canada will continue to grow, seeing as their numbers have substantially increased in the past years [2]. Table 1 shows how the demographic has seen an incline from 2000 to 2010, which is sure evidence to us that the Axis will be marketable.

	2000		2010	
	Males	Females	Males	Females
65 to 69	549,849	592,079	712,574	756,351
70 to 74	458,800	546,223	519,504	585,046
75 to 79	334,483	470,538	412,120	500,247
80 to 84	184,298	311,022	283,842	404,310
90 and older	32,319	96,045	59,374	158,762
Total Number	**1,648,478**	**2,203,481**	**2,138,036**	**2,681,565**

Table 1: The numbers of senior citizens in Canada [11]

Although adherence to pharmaceutical drugs is not entirely related to age associated issues, as personal opinions and decisions of the individual play a large role, if a device can be marketed to prevent the age aspect, there is at least fewer factors at play. As such, we see a real demand for the Axis, as it becomes a solution to a very real problem.

3.2 The Competition

Currently, there are other competitors that we would need to consider in the market. Their own strengths and weaknesses are examples to us on how we should consider designing our own product. The following are listed below:

3.2.1 Hospital Dispensers

In order for hospitals to deliver medication to their patients, nurses must pick them up from a special machine made for medication dispensation. To do this, the nurse must find the name of the patient and punch in the required quantity required. Despite prescription pills coming preorganized, our goal remains to minimize the mistakes of human error. In this context the higher the redundancy means an increase in safety which is most important to us.

3.2.2 Blister Packaging

Blister Packaging is a current competitor that involves combining all the daily medications into plastic pockets that are sealed. This offers an effective and cheap way to distribute medication that avoids mixing up different medications on different days and taking the right dosage [12][13]. These packages are robotically made through a very fast packaging process that seals the pockets, where each pocket is labeled by the day of the week so the consumer has to just pop the package to get the medications. Although efficient and clean, a drawback is that most of the packaging is often very hard to open. This results in risk of dropping and losing pills. Our device aims to provide a similar efficient and organized method to distribute prescription pills without the need for dexterity to open tightly sealed packages. Additionally, Axis affords an at-home solution to dosage regulation and organization, while Blister Packaging most certainly doesn't. This means that a change of dosage can render an existing blister package unusable. Meanwhile, Axis allows for adaptation via updated medication labels.

3.2.3 Pill Counters at the Pharmacy

One of the main functions of pharmacies is to provide a regulated amount of medication to people who have a prescription. To ensure they always dispense the authorized amount of drug, pharmacies have devices that can determine the number of pills in a prescription bottle. An example of this is the DRX-500s Cloud Automatic Pill Counter from Torbal [14]. This device connects to the Torbal server via internet, and retrieves the most up to date information about the particular drug based on user input and weighing. In contrast, the device we propose will provide similar functionality in terms of sorting pills, but will be available for home use, and will be more of an economic choice for our customers.

4 Cost Considerations

Typically, devices affiliated with medical uses will need to have a high degree of accuracy, which calls for an increased investment in making sure that the operations are refined.

Some of this cost can be offset from the consumer with government funding and subsidies. Below in Table 2, you can find a conglomeration of materials we think will be necessary and their associated costs.

	Estimated cost per unit	Total Cost
Servo motors (~4)	$15	$60
3D Printing (SFU)	$0.03/gram and $1/hour	$50
Stepper Motor (1.7A ~3)	$20	$60
Sensors (Including a camera)	$150~200	$200
SIM card subscription (data)	$10-20/month (free if you have Wi-Fi)	$20
Overall + Contingency cost (20%)		$468

Table 2: Costs of materials

Overall, it does not seem like this undertaking will be very costly. With possible investment from Sierra Wireless and through personal resources, we hope to have a working prototype ready for less than $500.

We have contacted the Engineering Science Student Society (ESSS) about the student endowment fund. They have currently put us on “to be determined” status pending on our project proposal. We also will soon look into applying for the Wighton fund mentioned by Steve Whitmore during lectures. The remainder of the costs will be self funded.

5 Project Time Schedule

As done above, we divide the project into two main categories: hardware and software. By the end of the first two weeks of February, we hope to have a firm grasp on Google's Vision API and how to utilize it. It would also be ideal to have done research about the parts required for building the physical prototype. The goal by the end of February is to have all the necessary components, both software and hardware, conglomerated and working. This leaves the entire month of March for building and testing. Finally, in April, we will conduct all remaining integration and ensure a smoothly functioning proof of concept.

For the second semester of the project, under the administration of ENSC 440, the team will work to develop a refined, professionally displayable version of Axis.

5.1 Milestones

There are several moments during this semester for which we would like to set goals. Below is a table detailing rough bi weekly goals for this and the following semester.

Mid February	End of February	Mid March	End of March	Mid April
Researched necessary parts; Character recognition API figured out	Ordered parts; Familiarized with mangOH; Develop algorithm for categorization of pills	Software integrated with mangOH; Plan on how to build the prototype	Proof of concept under construction; Testing	Demonstration

Table 3: Projected milestones - Term 1

Mid May	End of May	Mid June	End of June	End of June
Finish hardware design	Finish testing and improving pill feeding/sorting mechanism	Implemented excess pill removal, pill counting mechanism	Implemented bottle scanning station	E/F design completion

Table 4: Projected milestones - Term 2

For a more detailed timeline of goals, please refer to the Gantt chart in Appendix

6 Team Overview

Ananth Prabhu

Ananth is a fourth year computer engineering student. Passionate about software development and writing (both code *and* everything else!), Ananth hopes to create innovative solutions for the issues of the world. From his past co-op experiences, Ananth has learnt much about project management and also software topics such as databases, web development, APIs, and other relevant technical skills.

Freddy Kooliyath

Freddy is a fourth year systems engineering student with a strong foundation in electronics, mechanical engineering, and software development. Through various coursework and in field experience, Freddy has found his passion to be in fields that require the use of many diverse fields such as manufacturing. Through Freddy's electrical lab technician role, he has attained a deep level understanding in electrical equipment and troubleshooting. Furthermore, Freddy has worked as an industrial machine prototyper which required 3D modeling/printing, microelectronics, and software development.

Hazel Monte de Ramos

Hazel is a fifth year systems engineering student eager to venture beyond classroom walls and partake in real world solutions. Her past co-op experience at Cirius Messaging gave her the opportunity to work with API's, utilize software testing tools, and understand the inner workings of a software development company. With a fervour in writing, she has also brought forth numerous documents that provide concise and detailed information. She hopes to collectively bring all these skills and qualities together to showcase the team's PharmaSort device and prove its potential in the real world market.

Francis Tran

Francis is in his fourth year of electronics engineering who despite initial interest in hardware, has become deeply interested in software development and algorithm analysis. He has gained valuable knowledge about image processing and the versatility of Matlab during his co-op with SFU's Biomedical research group. During his time there, he has learned to create Matlab standalone executables and GUIs along with improving algorithm run time.

Mirac Chen

Mirac is a fourth year computer engineering student who has great interest in programming. He is proficient in C++, C, and Python. Mirac has co-op experience in website development as well as software engineering. During his second co-op at Sierra Wireless, he gained knowledge on Windows software GUI design, M2M, IoT application, and so on. Mirac will try to contribute to the team with no spared effort. For the greater good!

7 Conclusion

Age brings challenges, some of which can affect the overall quality of life. When medication becomes routine, and maintenance of one's health suddenly becomes more important, it shouldn't have to be a trial to simply to take one's pills. With the senior population rapidly rising in Canada and many other developed countries, there is a shrinking ratio of caregivers to medical professionals. Seniors reside in the latter portion of their lives, so it would be a welcome addition to not have to balance and manage multiple prescription medications. With vision impairment and memory loss almost inevitable aspects of aging, it is no surprise that so many seniors tend to be drug noncompliant. By reducing the factors that affect this, such as providing a means to compensate for failing eyesight and a fading recollection, we can consequently reduce the likelihood of noncompliance. This, of course, will have a positive effect on not just their health, but their quality of living. Maintaining their medication will give them more time to spend with family, and participate in things they enjoy without needing to worry about the routine of their pills. Additionally, seniors just so happen to be the most pressing demographic in need of Axis. There exist several rural and Aboriginal communities which would also benefit from a device meant to axe drug noncompliance.

Although primarily designed for home use, with further research and investigation, it may be possible to add a degree of complexity to the device. In particular, having a standalone device unreliant on internet connection would be an attractive feature. Furthermore, a machine of this type has a great potential to become a cheap and easy alternative to pill machines at the hospital or pharmacy. With enough innovation and effort, it may be possible to see such a device operational in a hospital environment. While hospital staff and doctors are trying their best to avoid error, there is no harm in redundancy when it comes to safety.

Combining the different skills and talents of each individual in our team, blended with our common goal to bring efficiency and helpfulness to society, PharmaSort hopes to transition the Axis idea to reality.

8 References

[1] Statcan.gc.ca. (2018). *Prescription medication use by Canadians aged 6 to 79*. [online] Available at: http://www.statcan.gc.ca/pub/82-003-x/2014006/article/14032-eng.htm [Accessed 21 Jan. 2018].

[2] Statcan.gc.ca. (2018). *Seniors*. [online] Available at: https://www.statcan.gc.ca/pub/11-402-x/2011000/chap/seniors-aines/seniors-aines-eng.htm [Accessed 21 Jan. 2018].

[3] Small, G. (2018). *What we need to know about age related memory loss*. [online] The National Center for Biotechnology Information. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1123445/ [Accessed 21 Jan. 2018].

[4] How to invent a pill dispenser. (2018). [video] Available at: https://www.youtube.com/watch?v=iwnlcyby1cw [Accessed 25 Jan. 2018].

[5] C, S. (2018). *Medication compliance in the elderly. - PubMed - NCBI*. [online] Ncbi.nlm.nih.gov. Available at: https://www.ncbi.nlm.nih.gov/pubmed/7836347 [Accessed 27 Jan. 2018].

[6] Cnib.ca. (2018). *CNIB - Fast Facts about Vision Loss*. [online] Available at: http://www.cnib.ca/en/about/media/vision-loss/pages/default.aspx [Accessed 27 Jan. 2018].

[7] Alzheimer.ca. (2018). *Normal aging vs dementia | Alzheimer Society of Canada*. [online] Available at: http://www.alzheimer.ca/en/Home/About-dementia/What-is-dementia/Normal-aging-vs-dementia [Accessed 27 Jan. 2018].

[8] Statcan.gc.ca. (2018). *Memory disabilities among Canadians aged 15 years and older, 2012*. [online] Available at: http://www.statcan.gc.ca/pub/89-654-x/89-654-x2015002-eng.htm [Accessed 27 Jan. 2018].

[9] Notenboom, K., Beers, E., van Riet-Nales, D., Egberts, T., Leufkens, H., Jansen, P. and Bouvy, M. (2018). *Practical Problems with Medication Use that Older People Experience: A Qualitative Study*. [online] The National Center for Biotechnology Information. Available at: https://www.ncbi.nlm.nih.gov/ [Accessed 27 Jan. 2018].

[10] Soon, J. and Levine, M. (2018). *Rural pharmacy in Canada: pharmacist training, workforce capacity and research partnerships*. [online] Taylor & Francis Online. Available at: http://www.tandfonline.com/doi/abs/10.3402/ijch.v70i4.17845 [Accessed 27 Jan. 2018].

[11] Statcan.gc.ca. (2018). *Table 28.a Population aged 65 and older, by age group and sex*. [online] Available at: https://www.statcan.gc.ca/pub/11-402-x/2011000/chap/seniors-aines/tbl/tbl0a-eng.htm [Accessed 30 Jan. 2018].

[12] QPharm. (2018). *Packaging Services*. [online] Available at: http://www.qpharm.ca/packaging/ [Accessed 26 Jan. 2018].

[13] Pharmanet.com.br. (2018). *Pharmanet* [online] Available at: http://www.pharmanet.com.br/pdf/blister.pdf [Accessed 26 Jan. 2018].

[14] Torbalscales.com. (2018). *DRX-500sv Cloud : - Torbal Scales*. [online] Available at: http://www.torbalscales.com/drx-500sv-cloud.html [Accessed 27 Jan. 2018].

Appendix

ID	Task Name	Duration	Start	Finish
1	**Project Idea**	**29 days**	**Fri 17-12-22**	**Wed 18-01-3**
2	Brainstorming	17 days	Fri 17-12-22	Mon 18-01-1
3	Research/Planning	29 days	Fri 17-12-22	Wed 18-01-3
4	Finalized Idea	0 days	Wed 18-01-3	Wed 18-01-3
5	**Documentation**	**61 days**	**Mon 18-01-1**	**Mon 18-04-0**
6	Proposal	13 days	Mon 18-01-1	Wed 18-01-3
7	Requirements Specification	15 days	Thu 18-02-01	Wed 18-02-21
8	Design Specifications	25 days	Thu 18-02-22	Wed 18-03-2
9	UI Design Appendix	25 days	Thu 18-02-22	Wed 18-03-2
10	Poster	8 days	Thu 18-03-29	Mon 18-04-0
11	ENSC 405W Completion	0 days	Mon 18-04-0	Mon 18-04-0
12	**Software Design**	**48 days**	**Thu 18-02-01**	**Mon 18-04-0**
13	Panoramic Image Stitching	7 days	Thu 18-02-01	Fri 18-02-09
14	Character Parsing	14 days	Sat 18-02-10	Wed 18-02-2
15	SIM Card Implementation	5 days	Thu 18-03-01	Wed 18-03-07
16	Testing	23 days	Thu 18-03-08	Mon 18-04-0
17	Software Design Completion	0 days	Mon 18-04-0	Mon 18-04-0
18	**Hardware Design**	**62 days**	**Thu 18-03-01**	**Fri 18-05-25**
19	Pill Feeding Mechanism	17 days	Thu 18-03-01	Fri 18-03-23
20	Pill Seperating	16 days	Sat 18-03-24	Fri 18-04-13
21	Daily Compartments	12 days	Sat 18-04-14	Sat 18-04-28
22	Shell	9 days	Sun 18-04-29	Wed 18-05-0
23	Testing	12 days	Thu 18-05-10	Fri 18-05-25
24	Hardware Design Completio	0 days	Fri 18-05-25	Fri 18-05-25
25	**Electronic/Firmware Design**	**51 days**	**Fri 18-04-20**	**Sat 18-06-30**
26	Pill Counting Mechanism	16 days	Fri 18-04-20	Fri 18-05-11
27	Excess Pill Removal	7 days	Sat 18-05-12	Mon 18-05-2
28	Dispensing	9 days	Tue 18-05-22	Fri 18-06-01
29	Pill Bottle Label Scanner	11 days	Sat 18-06-02	Fri 18-06-15
30	Testing	12 days	Sat 18-06-16	Sat 18-06-30
31	E/F Design Completion	0 days	Sat 18-06-30	Sat 18-06-30

Gantt Chart

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