March 28th, 2019
Dr. Craig Scratchley
School of Engineering Science
Simon Fraser University
British Columbia, V5A 1S6

RE: ENSC 405W/440 FoodSavr Proposal

Dear Dr. Scratchley,

The attached document contains a proposal for our capstone project, the FoodSavr. Our goal for this project is to help people minimize the amount of food that gets wasted on a daily basis. FoodSavr is an autonomous robotic system that easily allows a user to keep track of what food they have in their home.

This document aims to outline the scope of the project, a market analysis of similar products, the costs involved, and a project schedule. This proposal will also include a description of each team member and their roles in the project. Our team's goal is to show that this is a product that is unique and has the potential to be a must-have product for consumers.

Our team at Savr Robotics comprises of four engineering students: Liam O'Shaughnessy, Jay Zhao, Zavier Aguila, and Vivian Pan. I would like to thank you in advance for taking the time to review this proposal. If there are any raised concerns or questions, feel free to contact me at loshaugh@sfu.ca.

Sincerely,

Liam O'Shaughnessy
Chief Executive Officer
Savr Robotics

Project Proposal

Smart Food Storage Device

Team 6:

Liam O'Shaughnessy

Jay Zhao

Vivian Pan

Zavier Aguila

Executive Summary:

With a growing sense of global responsibility, consumers are now looking at their lifestyles and finding ways, small and large, to lessen their negative impact and increase their positive impact on the world.

FoodSavr is an automated food tracking device that aims to address these growing concerns while saving money for the consumer. It will make use of robotics and image processing to aid the user in dealing with their grocery-bought items. From the moment foodstuff arrives on your counter, it will track the item along with its expiration date and amount to help with inventory management. It will prevent redundant purchases and food spoilage by providing an accessible, easy-to-use inventory list to reference during their next trip to the supermarket. It will also provide appropriate notifications when an item nears its expiration and will suggest ways to use it up.

Over the span of 8 months, the team's goal is to produce an engineering prototype of the FoodSavr. The project has four major milestones: Requirements Specification, Design Specification, Proof of Concept demonstration, and the Engineering Prototype completion. The first three milestones are scheduled for completion within the first four months of the project. This leaves the last four months for improving on the design and adding extra features. The FoodSavr will be taking images of the food item and using software to extract the expiry date and barcode. This allows the system to keep an online profile of what food the user has in their home. Benefits to the user include reducing their food waste and cost of groceries.

Over the last century, Smart Homes have surfaced as a new normal to the average consumer. In Canada alone, revenues in 2019 amounted to 1.2 billion with an expected growth of 15.9%. This growth shows people's interest in smart home products and that people are looking for the next big thing to improve their lives. The FoodSavr intends to fill that role. There is no real market competition for what the FoodSavr can do. One of the bigger food tracking systems in the market, MyFitnessPal focusses more on a user's daily intake of food and the nutritional benefits. In contrast, the FoodSavr tracks your current food stock and automates the process.

Our team two computer and two system engineers have expertise in both the world of software and robotics. The overall skill and determination of the team at Savr Robotics will let the ambitious goals for the FoodSavr become a reality.

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Glossary

API	Application Programming Interface
Firebase	Google's server solution
FoodSavr	Product Name
LED	Light Emitting Diode

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1. Introduction/Background

In recent times, consumers have enjoyed a surge in the variety and availability of various food products. Seasonal fruits and vegetables have now been a year-round staple, ever available in the produce aisle of the local grocery. Big-box retailers encourage consumers to buy large number of products with discounted prices.

With the arrival of the luxury of abundance and choices comes with its pitfall- waste, specifically food waste. The Food and Agriculture Organization of the United Nations have estimated that ⅓ of all food products are wasted. In North America, about 40% of the total food waste happens with the consumer, while 60% happens between the production and retailing life cycle of the products [1].

An increase in food waste also causes in an increase in harmful gas emissions. Landfills filled with food waste decompose and release methane gas, and they have become one of the largest contributors to greenhouse gases [2].

The aim of FoodSavr is to address the food waste on the consumer front by addressing the redundant product purchases and the eventual spoilage caused by unused or excessive food products.

There's currently no device on the market which organizes food items effectively and intelligently. We saw this as an opening to create a product which can be integrated into the home to easily catalog our food purchases. The FoodSavr can help consumers keep track of all the items in their fridge and pantry, as well as their expiry dates. The automation system we are creating will minimize user efforts in the cataloging process.

2.Project Overview

2.1 Scope

The scope of our capstone project is to produce an engineering prototype design of FoodSavr for Savr Robotics. Our team will be designing, assembling, and testing the prototype of FoodSavr. This engineering prototype will allow users to place a food item and autonomously scan for the expiry date and barcode information. This information will be recorded to the user's online profile and is accessible on both a web and mobile platform.

The engineering prototype of FoodSavr will contain two main mechanical components. A two-link robotic arm used for maneuvering the camera component to scan food items of different size. A rotation base component used as a turn table to rotate the food item 360 degrees for scanning of different sides.

The FoodSavr engineering prototype will be processing images on a Raspberry Pi computer using Python libraries and the Google Vision API. The processed data will be saved to the free google database system, Firebase, for the engineering prototype phase. This data is used to populate the user online profiles.

2.2 Risks

One of the biggest risks to our FoodSavr system is the inaccessibility to the information placed on the bottom of the food items. For example, if the user places a canned food item with the expiry date information written at the bottom. Our system will not be able to detect this expiry date as the system does not contain any cameras the base. We are relying on the users to place food items with all bar code and expiry date information away from the bottom. When the user fails to do this, our system will not be able to record the necessary information the product promises. However, we will upload an image the product instead.

Another potential risk for the engineering prototype is the timing of our system. The timing of our system depends entirely on the speed of rotation of both the robotic arm and the base system. We understand that users do not want to spend a long time waiting for their items to be scanned. Therefore, our system must perform scanning of each item under a reasonable amount of time. However, for the engineering prototype we are limited to the speed of our controlling and processing units. The timing of our scanning process can be improved for the final product.

2.3 Benefits

The goal of the FoodSavr is to help individual control food waste using the fully autonomous system to keep track of their food inventory. We are targeting the problems of overbuying of food which eventually ends up being wasted. The online inventory profile will allow each user to easily access all the information in their fridge and pantry on their fingertips. The FoodSavr also aims to provide other benefits to its end users as well as its stakeholders. We are controlling the cost of the product to be lower than the future sale price to increase the future potential profit. For the end users, they will receive environmentally friendly device that can help reduce their food waste, reduce their day to day grocery cost

Limitation of Competition

In section 4 Market and Competition, we discuss what is our market and targeting customers, and we can see there is nothing like our product FoodSavr out there in the market. We aim to bring the smart food storage to the dominant of the unexplored market.

Environmentally Friendly

Food waste is always the issue we are facing in the past, using our product will reduce the amount of food waste from household level. Therefore, it will lead to less greenhouse gas emission and less economical wastage.

Easy to Use

Thanks to modern technology, we use image recognition to record the expiry date of the food items specified with bar code. The process will be fully automatic, the only user interact would be putting the food item on the device, and then let the robotic arm to scan the item and upload to the web interface to record your data.

Cost Reduction

On the customer side, using FoodSavr would help with purchase redundant food item, this led to financial saving.

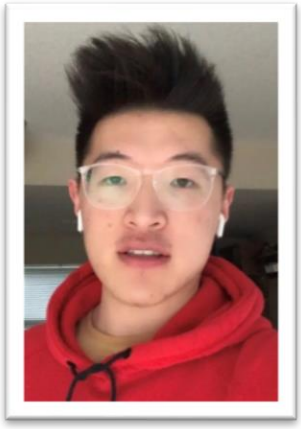
3.Company Overview

Savr Robotic is a new company that provides expertise in global environment friendly smart devices, including FoodSavr robot is a smart food storage device. We cater to bring products can both convenience human life and reduce wastage to protect our eco system.

Liam O'Shaughnessy - Chief Executive Officer

Liam is a senior computer engineering student with an interest in firmware and software application development. He has experience working with the Linux kernel, embedded systems, and deep learning. He has worked for both small companies like Gumstix and larger corporations such as ICBC. Some of his projects in industry include: NVIDIA Jetson TX2 computer on module development, u-boot bootloader development, and debugging hardware modules. His experience in this area will help the team on the software and system integration components of the project.

Jay Zhao - Chief Operating Officer



Jay is a 6th year Systems Engineering student with interest in Hardware design and smart embedded system development. He has worked as a Firmware developer and a Hardware developer each 8 months at Gumstix Inc. Where he learned Linux develop environment Yocto as an embedded image of the varies of COM(SOC). Also, he used Egle to design a customer-based circuit board which takes from scratch to production, wrote test job to verify the functionality. He gained solid understanding of a product development life cycle and teamwork. He will bring in embedded hardware knowledge to the team.

Vivian Pan - Chief Product Officer

Vivian is a senior year Systems Engineering student with experience with working on integrating multi-level designs. She has experience working the Fuel Cell, Machine Vision, and the Automotive industry through her co-op and internships. Her experience in these industries will bring insight on how to integrate the different levels of systems together and provide knowledge on achieving the best product for the company.

Zavier Aguila - Chief Technology Officer

Zavier is a Computer Engineering Student with expertise in Digital design and software development. He has worked as a Software Engineer in a team that develops underwater Sonar devices, a Validation Engineer working with RAID Controller chips, as well as a member of a research team whose main efforts are focused on an FPGA-based open-source RISCV processor. He has experience in the interfacing of software and hardware to form a cohesive working product.

4. Market and Competition

4.1 Market

Over the last century, Smart Homes have surfaced as a stable trend. In Canada alone, it has a 2019 revenue of 1.2 billion with an expected growth of 15.9%. More so, the Smart Appliances Market have the largest share of the total revenue and is estimated to be a *314 million* market with a projected growth of *30.7%* for 2019 [3]. It is clearly an increasing market that can support new ventures and new products and return a sizeable profit.

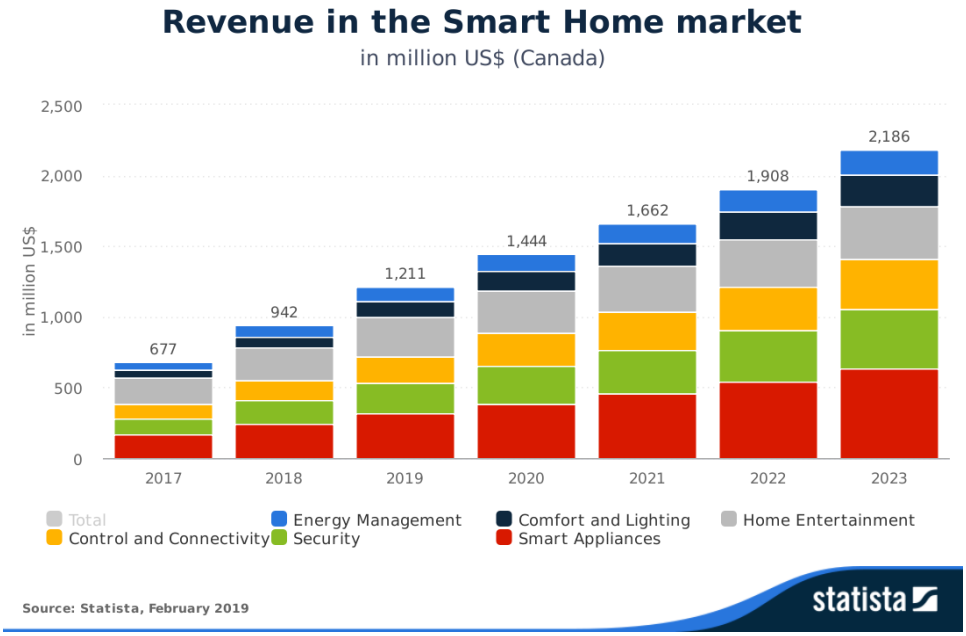


Figure 4.1.1 Smart Home Market Revenue

In Canada, Amazon and Google's smart home assistant, Alexa and Google Home, respectively, have been adopted by a growing percentage of households. In a span of a year (2019), the adoption rate has risen from 10.5% to 15.7%, a tremendous growth bringing the number of adopters to 5.8 million in 2019 [4]. This growth shows people's interest in transforming their home to a smarter ecosystem by buying and installing smart home products.

It can be easily seen from the market size and its projected growth that the market has high profitability. But because of the market's high revenue potential and having gone through its initial growth phase, the market is now highly saturated with products that cover a range of services that constantly overlap. This could prove to be difficult for newer products to penetrate.

In order to enter and establish yourself in a saturated market, a firm can opt to create a new submarket, that is to uncover unfilled needs in the existing market. FoodSavr aims to address overlapping issues in Food Tracking and Smart Storage.

4.2 Competition

Our device falls under a food tracking category, a large portion of this market overlaps with the health and nutrition monitoring market. They offer services and products to track food consumption, calorie and nutrient breakdown and provide an overview of the user's dietary profile. Since these services offer many similar traits as the FoodSavr, it was important to the team that the possible competition was analyzed and discussed. Understanding what our competitors may lack, FoodSavr can improve on their shortcomings.

MyFitnessPal (MFP) is one of the largest food tracking systems, it is mainly focused on its smartphone app where you can track your daily intake of food through either manually input or more usually use a barcode to expedite the process [5]. The app is hugely popular with over 19.1 million unique users. Despite this, the focus of MyFitnessPal is different from FoodSavr. MFP focuses on tracking individual meal and displaying their nutritional information. FoodSavr focuses on tracking current food stock with a focus on automation. With this consideration, MFP has the most comprehensive list of food products, easily beating out the readily available databases and would be a great partner to FoodSavr.

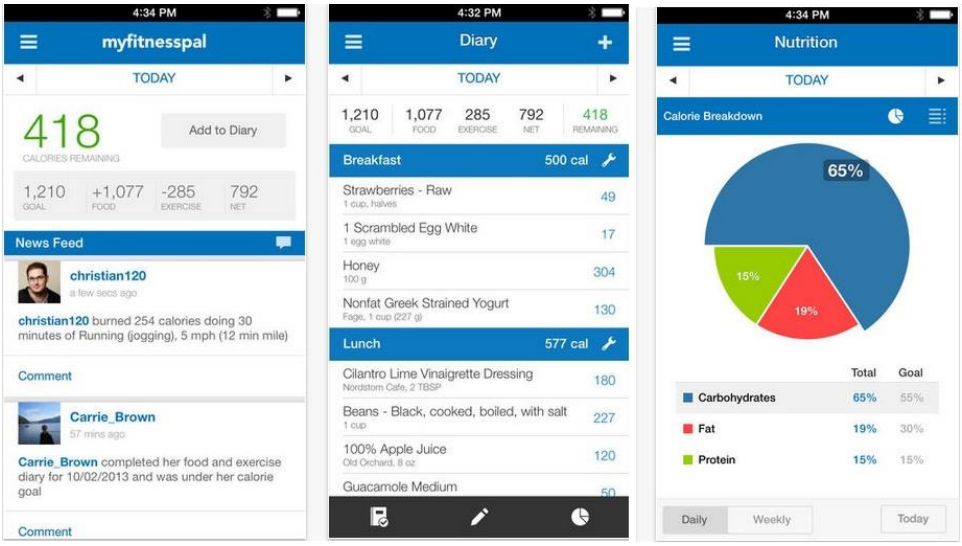


Figure 4.2.1 MyFitnessPal App

GeniCan(USD 150) focuses on building a shopping list by tracking the products you throw away. It clips on to any trash can, and the user can scan the barcode while disposing a product or use voice commands to add the item to an accessible shopping list. FoodSavr on the other hand, wants to provide a list that tracks the current amount of foodstuff at any given time, to reduce situations where a user might discover that they don't have enough of the ingredient right before they start cooking.

Figure 4.2.2 Genican

Out-of-milk (Free) is a smartphone app that is similar to Genican in that it is often used to scan items to add them to a shopping list. It has a focus on the budget and monetary aspect of grocery shopping, allowing users to track their food budget and break it down to even more specific fields such as cleaning supply, baking, and produce to provide an overview of the user's spending. Similar to the Genican comparison, FoodSavr focuses on other aspects of the process. FoodSavr tracks current amounts rather than building a reminder system of items that have ran out.

Looking at the different competitor to FoodSavr it can easily be seen that there are no direct competitors to the product, and it can stand to make its own market by improving and iterating on the products currently available on the market.

5.Project Planning

This project spans the course of two, 4-month segments that include a series of documentation, design review meetings, and presentations. The first segment of this project will mainly be focussed on the initial design and requirements specification. At the end of the first segment there will be a proof-of-concept demonstration of the FoodSavr. The second segment will include design optimizations and adding extra functionality to the product. This section outlines the team's plan to keep the project on schedule and manage our time effectively.

Figure 5.1 describes the main tasks and milestones for the project, the start and end date of each task, as well as the team member(s) responsible for the task. These tasks are illustrated within a Gantt chat showed in Figure 5.2.

TASK NAME	START DATE	END DATE	START ON DAY	WORK DAYS	TEAM MEMBER
FoodSavr Project					
Brainstorm Ideas	1/7	1/20	0	14	All
Software Requirements	1/21	2/1	14	12	Liam, Zavier
Hardware Requirements	1/21	2/1	14	12	Jay
System Requirements	1/21	2/1	14	12	All
Mechanical Requirements	1/21	2/1	14	12	Vivian
Requirements Specification Document	1/21	2/7	14	18	All
Order Parts	2/1	2/4	25	4	Jay
Expiry Date Detection Development	1/31	3/1	24	30	Liam
Barcode Detection Development	1/31	3/1	24	30	Zavier
Base Design	2/15	3/10	39	24	Vivian, Jay
Arm Design	2/15	3/10	39	24	Vivian
Design Specification Document	3/1	3/14	53	14	All
User Interface Brainstorming	2/15	2/20	39	6	All
User Interface Design Appendix	2/20	3/1	44	10	All
Arm Construction	3/20	3/31	72	12	Jay
Base Printing	3/25	3/31	77	7	Vivian
System Software Development	3/20	4/1	72	13	Vivian, Liam
Website Development	3/27	4/5	79	10	Zavier, Liam
Software Testing	4/1	4/5	84	5	Zavier, Liam
Mechanical Testing	4/1	4/5	84	5	Vivian, Jay
System Testing	4/5	4/10	88	6	All
Beta Phase Planning Document	4/25	5/7	108	13	All
Expiry Date Detection Generalization	5/1	6/1	114	32	Liam
Barcode Detection Improve Database	5/1	6/1	114	32	Zavier
Automating Scan Procedure	5/10	5/20	123	11	Vivian
Website Improve GUI	6/1	6/20	145	20	Zavier, Liam
User Acceptance Testing	7/1	7/15	175	15	All
Requirements Specified	2/7	2/7	31	1	All
Design Specified	3/14	3/14	66	1	All
Proof of Concept	4/15	4/15	98	1	All
Engineering Demo	8/15	8/15	220	1	All

Figure 5.1 - List of Tasks and Milestones

5.1 Milestones

There are four major milestones in our project that span both the first and second segment. The first segment's milestones include: Requirements Specified, Design Specified, and the Proof of Concept presentation. This section will describe the main processes for each milestone. Each team member will be involved for every milestone, while individual tasks are assigned to one or two team members. Tasks are assigned based on team members experience and preference.

5.1.1 Requirements Specified

The requirements specification involves looking at the different components of the system and planning what the FoodSavr will do. Tasks involved for this milestone include software, hardware, system, and mechanical requirements. These tasks were scheduled to finish six days before the milestone in order to give time for the final task. The final task for this milestone will be completing the requirements specification document listed in Figure 5.1 above.

5.1.2 Design Specified

The design specification milestone incorporates development work for each component of the FoodSavr. Tasks involved for this milestone include expiry date detection and barcode detection development work. These are both done within software and can be started on immediately without needing to wait for parts to arrive. Other tasks include the base and arm design which have dependencies on the parts and will start later. The final task for this milestone will be completing the design specification document. Due to the inherent dependency on the development work, the design document and development tasks can be done in parallel.

5.1.3 Proof of Concept

The proof of concept milestone includes the physical construction of the arm and base as well as the system level software to have the motors, sensors, and image processing software working together. It will also include tasks for creating a simple web page user interface and testing of all the components. The software and construction tasks are scheduled to be done in parallel by different members of the team. The milestone will conclude with a proof-of-concept demo of the FoodSavr.

5.1.4 Engineering Demo

The engineering demo milestone will be a milestone for the second segment of the project. These tasks include the Beta Phase Planning document which will be another iteration of planning for the second segment. Some projected tasks include further development work in expiry date detection and barcode detection. Other tasks will be the automated scanning procedure which will make the system more autonomous with less user interaction and improving the user interface to make the FoodSavr attractive to the average consumer.

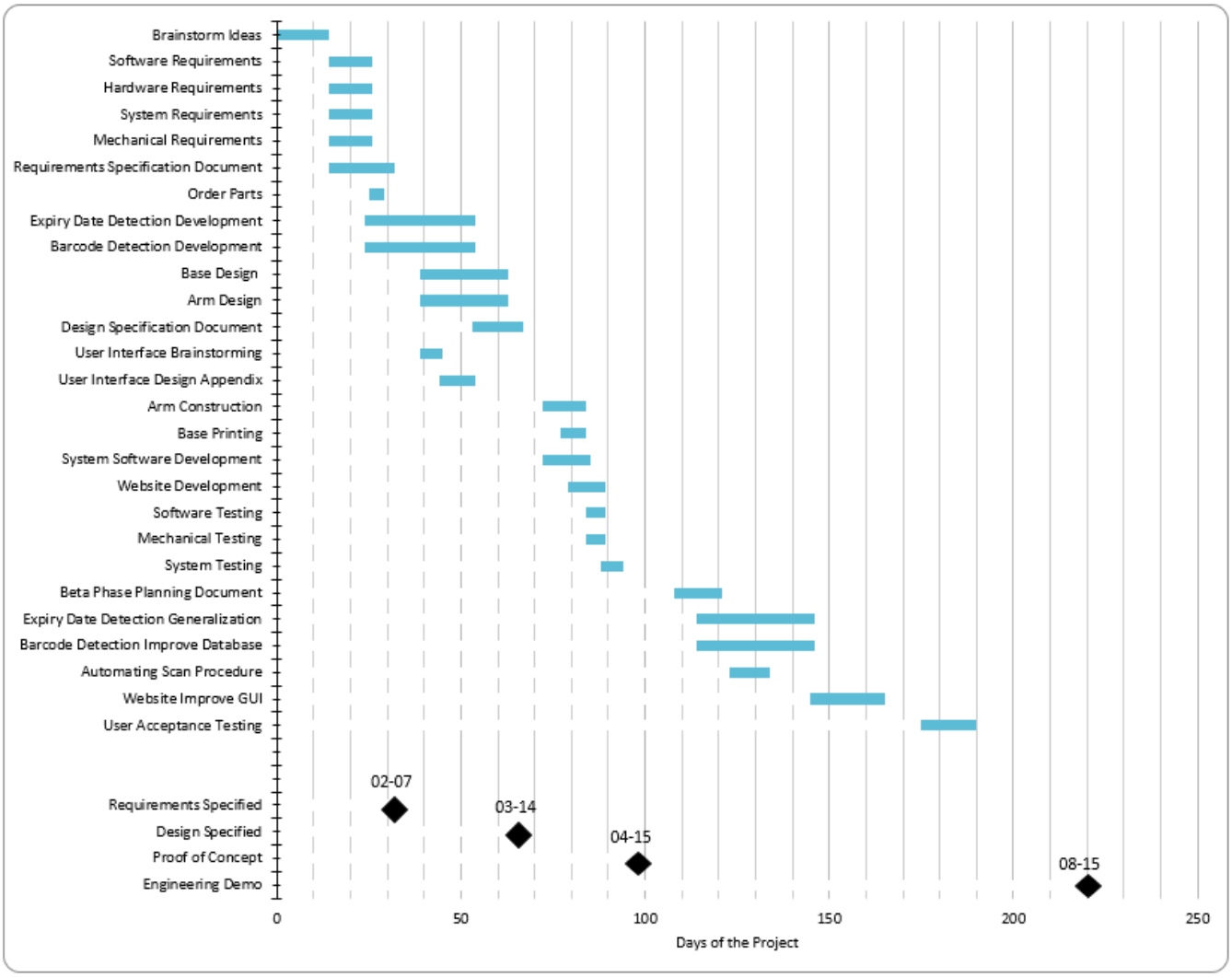


Figure 5.2 - Gantt Chart

6 Finances

6.1 Cost Analysis

The following table shows a cost breakdown for the FoodSavr Proof of Concept

Table 6.1: Proof of Concept Costs Breakdown

	Component	Total Cost
Processing Units	Raspberry Pi	$35
	Arduino Leonardo	$25
	Raspberry Pi WIFI Shield	$50
Sensors	Ultrasonic Sensor x2	$15
	Raspberry Pi Camera	$30
Actuators	Hitec HS-645MG Servo Motor	$40
	Hitec HS-422 Servo Motor x3	$45
Electronics	LEDs	$5
	Prototype Board	$5
	Power Outlet	$10
Mechanical	Custom Design 3D Printing	$100
	Ball bearing	$12
Miscellaneous	Shipping Charges	$50
	Total	**$422**

6.2 Funding Sources

Engineering Science Student Endowment Fund

Our team will be pursuing the Engineering Science Student Endowment Fund (ESSEF) administered by the Engineering Science Student Society for summer 2019 semester [6]. Our project will fall under either Category B (Entrepreneurial).

Wighton Development Fund

The Wighton Development Fund is administered by Dr. Andrew H. Rawicz [7]. The fund is typically awarded to projects benefiting society. Our project will provide a significant benefit towards addressing the issue of food waste through monitoring home's food inventory and expiry date. We will be submitting a funding proposal if not all funding needs are met through the ESSEF.

Additionally, if none of the funding methods mentioned above are successful our team will be contributing $105.5 each towards the final cost of this project.

7 Conclusion

The FoodSavr aims to reduce the amount of food waste produced by everyday consumers through the fully autonomous design which can be easily integrated to our digitalized society. With information readily accessible on our fingertips in the digital age, we aim to provide information about your groceries while you're shopping or on your way home from work worrying about dinner. The minimal user-interactive design of the FoodSavr can be seamlessly integrated into the groceries unloading process.

The food data collected by the FoodSavr allows us to expand the online list to potentially include recipe suggestions, notifications when an item is close to expiring, and even more data driven analytics. As a final product, we hope to allow users to access their online list through a mobile application. Using this mobile application as a virtual grocery shopping assistant, we hope that it will help with our user's busy everyday lives.

Our team is made up of a diverse background of engineers driven to build a product to assist our everyday lives while helping to solve the problem of food waste. We firmly believe that our product will be a user-friendly food tracking assistant device.

8 References

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