

April 6th, 2021



Dr. Craig Scratchley  
School of Engineering Science  
Simon Fraser University  
Burnaby, BC, V5A 1S6

Re: ENSC 405 Proposal for *EZSpice*

Dear Dr. Scratchley,

This document outlines the proposal for our product *EZSpice*, an intelligent machine for the kitchen. *EZSpice* will dispense the desired spice with precise quantity for the consumer while they are cooking, which enables voice control and touch screen control.

This document also outlines our project scope and purpose, highlights the risks and benefits, as well as how we intend to deal with these risks. It also provides an overview of competitive products and our target market. Lastly, it lists out our cost considerations and a brief introduction of each team member. This document also shows the basic timeline of deliverables from Proof-of-Concept to Final Product.

Our team consists of 6 senior SFU engineering students with huge enthusiasm in our product (in alphabetical order of Last name): Minh Dinh, Yuxiang Huang, Jiaxi Lin, Xing Shen, Vi Thai, and Lingchong Weng. We plan to meet consistently and hold each other accountable for this project, and are confident with what we will produce.

Thank you for reviewing this proposal document and future documents. If you have any questions or concerns, please contact us through GitLab or contact Minh Dinh, our Chief Communications Officer, via [qdin@sfu.ca](mailto:qdin@sfu.ca).

Sincerely,

A handwritten signature in black ink, appearing to read "Jiaxi Lin". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Jiaxi Lin  
CEO  
Peppermint Inc.

# PEPPERMONT

## Proposal for *EZSpice*

<b>Team members</b>	Minh Dinh	CCO
(Names are listed in the alphabetical order of the last name)	Yuxiang Huang	CTO
	Jiaxi Lin	CEO
	Jayden Shen	CFO
	Vi Thai	COO
	Higgins Weng	CPO
<b>Submitted to</b>	Dr. Craig Scratchley	ENSC 405W
	Dr. Andrew Rawicz	ENSC 440
	School of Engineering Science Simon Fraser University	
<b>Contact</b>	Minh Dinh	
	qdinh@sfu.ca	

# Executive Summary

Cooking spices are crucial and necessary in our daily life. Without various spices, chefs as well as home cooks are unable to create multiple delicious dishes. However, storing and looking for different types of spices in our kitchen is a headache, especially for those that are not frequently used. Currently, there are not many intelligent products to solve this issue on the market, so our company decided to explore this potential business area.

Our company, Peppermint Inc. consists of 6 highly motivated and enthusiastic Engineering students from SFU who have interests in different areas and industrial experiences. We would like to deliver superior value to our clients through our intelligent cooking spice dispensing machine, EZSpice.

EZSpice contains a powerful processor which can perform speech recognition on the spice name and the numeric quantity. It can also be woken up with one simple greeting sentence as those popular smart home products such as Amazon Alexa, Google Assistant. Once it receives the voice command from the user, the system will control the device's special quantifier via multiple stepper motors. Finally, the machine will dispense the spice with the desired amount that you need.

In recent years, the market for smart home appliances has a huge potential as it is on the rising trend. Nowadays, consumers are more willing to pay more for the convenience and luxury that the technology provides. In 2018, it was reported to have a revenue of 2.28 million U.S. dollars in Canada and is expected to have a growth of 66% in next 5 years [1].

With confidence in the market, we have implemented EZSpice with an overall development cost, including the proof of concept and the final prototype, to be around \$370. This cost will be brought down once multiple subcomponents, especially the electronic and mechanical parts of our machine are put on the production line. Our goal is to deliver our PoC at the end of April, and ultimately leads into our prototype at ENSC 440. In between these two timestamps, our company will continue work on optimizing the design of EZSpice in order to make it more efficient and intelligent.

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# 1.Introduction

As the culture of cuisine spreads around the world, many families have a lot of spices in their kitchen. These spices may not only be limited to local dish spices, but also others that come from other countries in order for them to make different styles of foods. However, with the increasing amounts of spices in their kitchen, it becomes a real problem for home cooks to find the correct one. For beginners that are not experienced in cooking, using the correct quantity of spices is also a big trouble.

While in the current market, there exists a very limited number of devices that could help solving these spice issues. Thus, our company Peppermint Inc. has come up with this idea, EZSpice, to crack this difficulty. To achieve the goal, EZSpice will be designed to process users' voice commands and deliver the spice with the requested quantity.

With a simple greeting sentence “Hey EZSpice” or touching the screen, our intelligent spice dispensing machine will start serving you. With the voice commands from users, EZSpice will deliver the correct spice with the requested quantity. Given enough time of development, we believe that EZSpice will provide a convenient and affordable spice dispensing machine to the market.

The purpose of this proposal is to provide an overview of our product and prototype, and it will be stated in section 2. In the first half of section 3, The risks and benefits of our product will be outlined. In the second half of section 3, we will provide a market analysis and the potential competition against our product. In section 4, the cost of each component in our prototype will be listed and the required funding will be roughly estimated according to the cost analysis. Last but not least, we will provide a Gantt Chart to lay out our project scheduling in section 5.

## 1.1 Background

Intelligent household appliances are becoming more and more popular in society as the technological field grows each day. There is an increasing demand in the field of cooking appliances, while not a huge supply related to the area of cooking spice. Our company seized this opportunity to implement a type of machine to make access to spice powders easier if individuals store large numbers of it.

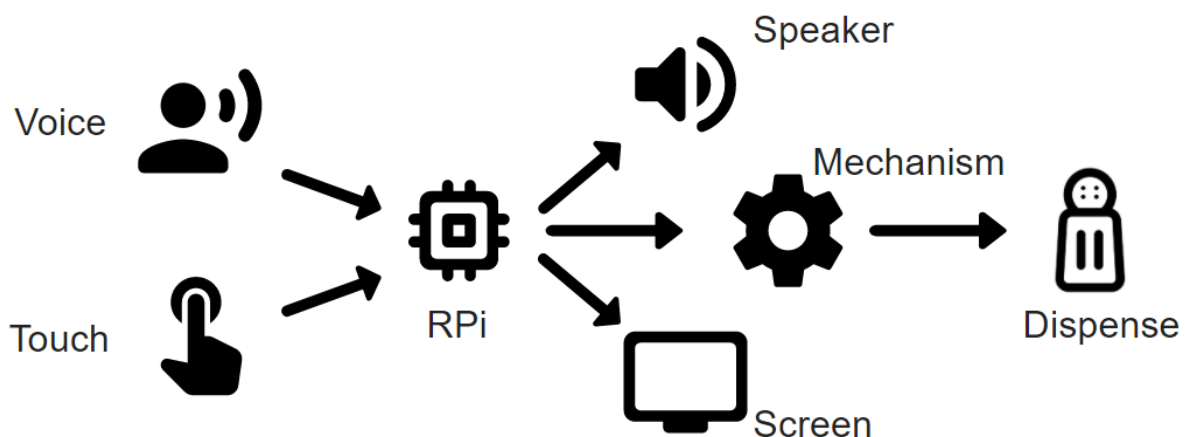
## 2. Scope

The EZSpice is a smart device that helps users categorize and store up to 8 types of powdered spices and dispense them on command. The device is able to either listen to users voice commands or receive users input via the front touch screen to get the correct spice with the correct amount. Furthermore, the device can remember the combination of spices as recipes for later use.

In order to achieve the proposed functionalities above, EZSpice consists of the following features:

- A small but high quality microphone and clear speaker to interact with the users
- A touch screen as an alternative way to give command to the device
- A software program that is integrated with Mozilla’s DeepSpeech [2], one of the best offline voice recognition software, to decipher user’s voice commands
- A dispense mechanism with that is controlled by an accurate stepper motor to dispense correct amount of spices
- A microSD card to store users’ recipe

Figure 2.1 provides a high level overview of the EZSpice’s functionality



**Figure 2.1:** EZSpice System Overview

Peppermint Inc. plans to administer 3 main deliverables in our Proof of Concept (PoC) design of the EZSpice, which are the followings:

- Design and 3D print 2 sets of containers and dispensing mechanisms for 2 different spices
- Finish the voice recognition program that will be run on the PoC’s main system
- Use the main system to control the dispensing motors and get the correct spice

The small scale of the current PoC is to focus more on demonstrating the capabilities of the voice recognition software running in the system controlling the dispensing motor. For our

final prototype, Peppermint Inc. will implement the rest of the following features that are not covered in the PoC:

- Scale up and 3D print 8 dispensing mechanisms for 8 different spices
- Integrate the touch screen into the system
- Design and implement the touch screen's graphical user interface
- Implement the recipe feature
- Assemble every part of the system and enclose them with a plastic frame

## **3. Product Justification**

### **3.1 Risks**

Based on our design, we do not foresee any obvious health or safety hazards caused by our product. Moreover, we did not encounter any safety issues during the product testing stage not just as designers but also as end users. While some potential failures may happen when the user is using the device under certain conditions. Factors that potentially cause failures are described below.

#### **Issues with Coarse Spices**

Our spice dispenser was originally designed for fine-grained spices such as salt, sugar and chicken powder. The EZSpice dispenser may not work as expected with coarse-grained spices. The spice quantifier does not work perfectly with coarse-grained spices since they do not fully occupy the quantifier volume, which causes inaccurate dispensing. Worst case is that coarse spices are stuck in the dispensing valve and cause dispensing failure.

#### **Inaccurate Speech Recognition**

Due to the biased acoustic pre-trained model, the speech recognition accuracy will be affected by the accent of users. The speech recognition model works preferably with American accent. Users with other accents may get less accurate speech recognition results. Alternatively, users can still request the dispensing by controlling via the 3.5' touch screen, which hardly fails with proper use. Another factor that may cause recognition failure is the noise of the working environment. If the user is using our product under an environment with loud background noise, the speech recognition may not work as expected.

#### **Mechanical Issues**

The dispensers are driven by stepper motors, whose issues could lead to dispensing failure. Stepper motors could be worn due to overloading. Worn stepper motor might further cause angle misalignment, which would affect the dispensing accuracy. On the other hand, the valves of quantifiers might wear without enough lubrication. Worn valves will have bigger gaps between components and therefore spice can fall into the gaps. Spice stuck in the gap of the dispensing valve may increase rotation friction and end up adding more load to the stepper motor.



### **Effect of Moist Spices**

If the powdered spices get moist, they will later form into a clump. Spice clumps will not be able to fall into the spice quantifier and therefore cause dispensing failure. Under this situation, users need to manually break the spice clump and make them friable.

### **Circuit Overheat**

As a spice dispenser, users will most likely place our EZSpice machine near the cooking area in the kitchen, especially near the stove, which may cause a high temperature working environment. Our machine is designed to work properly under such temperature but not for an extremely long period. Multiple electronic components are highly embedded inside our machine and they may overheat and burn, especially when the machine has been turned on and placed near the cooking area with high temperature for a long time.

## **3.2 Benefits**

By developing our product EZSpice, we aim to make cooking faster and easier. EZSpice dispenses the desired spice with precise quantity for the consumer. Besides the core functions like spice organization and quantification, customers will gain convenience by using some add-on functions such as recipe memorization. Here we list out some primary benefits that customers will get by using our product.

### **Spice Organization**

Not every household has an abundant space for storing multiple spices in their kitchens. EZSpice can help in such circumstances since it gathers different spices in one single machine, classifies them and gives you the exact spice that you need . Hence, users can save their time on looking up spices from all the spice containers by giving simple voice commands or touchscreen input to our EZSpice.

### **Spice Quantification**

One important and useful feature of our EZSpice is spice dispensing. Users are able to dispense spices precisely up to one-fourth teaspoon with our product. It could be very helpful for people on a diet or home cook starter.

### **Recipe Memorization**

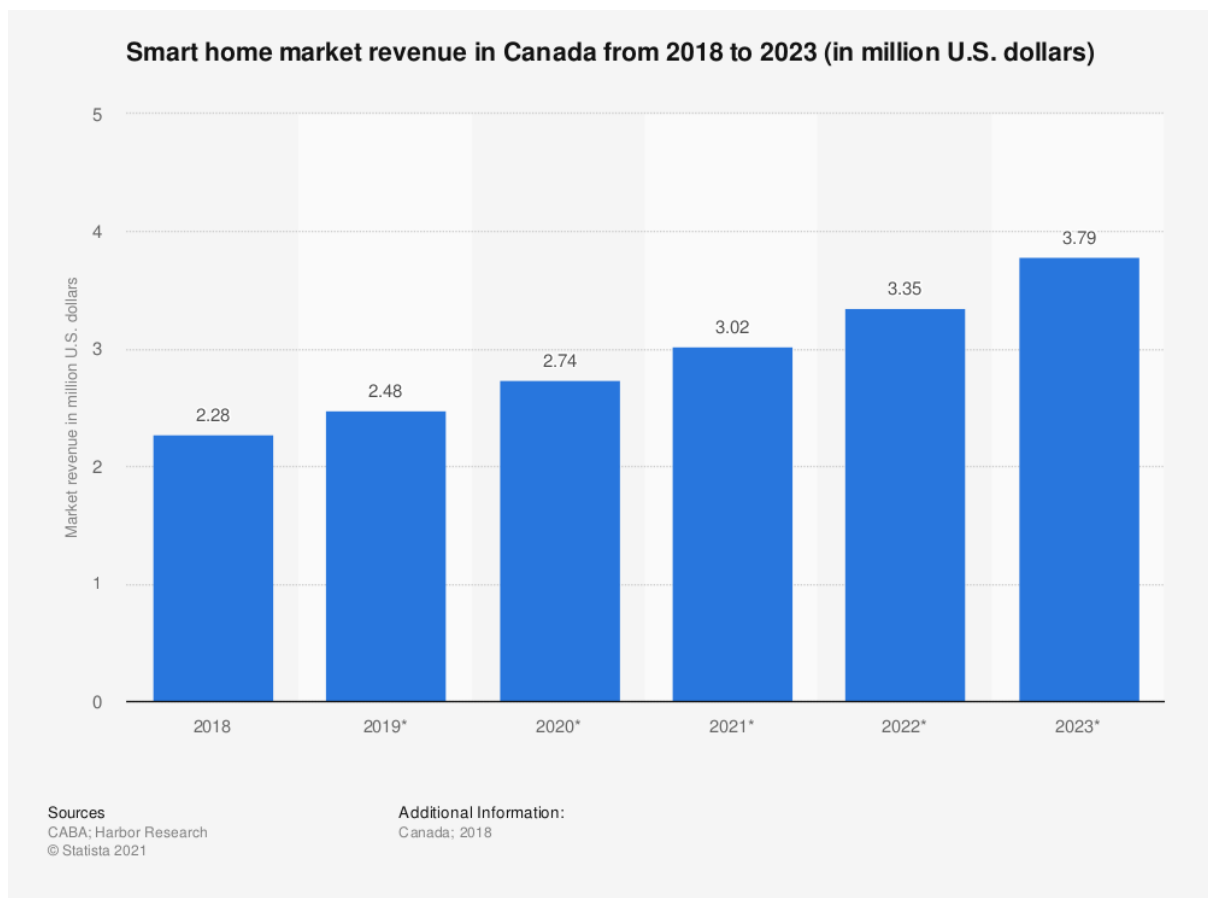
Moreover, clients can make use of the designed “Recipe” function of our machine which remembers the recipe of various dishes that the client has cooked frequently. In this case, consumers no longer require to control EZSpice to dispense each spice of the dish one by one. This function saves the time of preparing spices for the same dish repeatedly and also makes the diet well-regulated.

## Hand-free Operation

With our powerful and useful voice control service, customers can give commands to EZSpice without touching the screen in case their hands are dirty or they want to carry on other cooking steps simultaneously.

### 3.3 Market Analysis

In recent years, the innovations in IoT and Smart Home Technology is observed to be on the rising trend. As shown in Figure 3.1, the smart home market revenue in Canada was reported to be 2.28 million U.S. dollars in 2018 and is expected to rise up to 3.79 millions U.S. dollars by 2023.



**Figure 3.1:** Canada smart home market revenue from 2018-2023 [1]

This economic trend is possible because the consumers now are more receptive to the idea of spending a bit more for the convenience that technology brings to the table. Kitchen appliances also see the same trend as there are Samsung's line of smart fridges, the Family Hub [3]; or GE Appliances' smart ovens [4]. Our company Peppermint sees this as an opportunity to tap into this rising market. With EZSpice, the users can effortlessly request a combination of spices with the desired amounts just by talking to the device while they can simultaneously focus on the less tedious aspects of cooking.

### 3.4 Competition

There are a few existing products that have similar ideas as ours, providing users with spices based on requests. Unfortunately, those products or prototypes still require hard control with either touch screen or push button. When people are cooking, it's hard to keep their hands clean. This will be a problem when users touch the screen or push button with their already unclean hands. As a consequence, these inconveniences will increase the difficulty of cleaning the machine and potential risk of short circuits.

On the contrary, EZSpice uses voice control as the main input method, which will significantly reduce the chances that users need to touch the panel to get the desired spices. EZSpice utilizes voice operating systems. Users can completely choose the type and amount of one or more seasonings through voice commands. Also compared with other seasoning dispensing machine designs, EZSpice's multi-dispensing feature is another highlight. In the current market, single dispensing after each selection is widely used in every dispensing machine design. However, to make the systems more efficient and the life more easier, EZSpice is designed to dispense multi-seasoning at the same time after receiving a sequence of spices input.

### Tastetro



**Figure 3.2:** Products of TasteTro

Tastetro will be the main rival of EZSpice in the market. With the more attractive and variety options of spices and handy Tastetro mobile app, Tastetro leaves very tiny improvement room for its competitors. However, TasteTro users still have to wash their hands before using the device. And in this case, EZSpice uses voice control to solve this problem. Only dispensing one spice at one time can be another improvement from us than Tastetro. EZSpice, which can dispense multi-spices at the same time as long as they get the input spices sequences, is more efficient than the Tastetro.

## 4. Finances

### 4.1 Cost Analysis

The table below shows the breakdown cost for each component of the EZSpice prototype. All the prices of the table entries are listed in the currency of Canadian Dollar.

Function	Components	Quantity	Per Price (\$/Unit)	Subtotal (\$)
3D printing components (Bottles, funnels, qualifiers, holders)	Voxelab Standard Photopolymer Resin 500ml for LCD 405nm UV-Curing	2	21.33	42.66
Dispensing Driving Mechanism	Stepper Motors with Motor driver (5pairs/pack)	1	17.99	35.98
	USB Omnidirectional Computer Microphone 360° Portable Conference Desktop Speakerphone Echo Cancellation	1	28.99	28.99
	MCP23017 IO Expansion Board I2C Interface Expands 16 I/O Pins	2	11.85	23.70
Extra	Raspberry Pi package (Raspberry Pi, sd card, power adapter, Raspberry pi case, sd card reader, hdmi cable, linear power switch, heat sinks, fan)	1	109.99	109.99
Total		-	-	241.32

**Table 4.1:** Proof-of-Concept material costs

Function	Components	Quantity	Per Price (\$/Unit)	Subtotal (\$)
3D printing components (Bottles, funnels, qualifiers, holders)	Voxelab Standard Photopolymer Resin 500ml for LCD 405nm UV-Curing	6	21.33	127.98
Dispensing Driving Mechanism	Stepper Motors with Motor driver (5pairs/pack)	2	17.99	35.98
	3.5 inch Touch Screen TFT LCD for Raspberry Pi 480x320 Pixel XPT2046 Controller SPI Interface	1	33.99	33.99
	USB Omnidirectional Computer Microphone 360° Portable Conference Desktop Speakerphone Echo Cancellation	1	28.99	28.99
	MCP23017 IO Expansion Board I2C Interface Expands 16 I/O Pins	2	11.85	23.70
Extra	Raspberry Pi package (Raspberry Pi, microSD card, power adapter, Raspberry pi case, sd card reader, hdmi cable, linear power switch, heat sinks, fan)	1	109.99	109.99
Total		-	-	360.63

**Table 4.2:** Functional Prototype's material cost

## 4.2 Funding

To cover for the development expenses of the EZSpice, our team will be applying these sources of funding:

1. The Engineering Science Student Endowment Fund (ESSEF) is a fund provided by the Engineering Science Student Society (ESSS). The fund has a total of 4 categories where our company is interested in both Category B (Entrepreneurial) and Category C (Class). Acquiring the ESSEF should not pose any challenges as the EZSpice meets the requirements for both categories.
2. Wighton Development Funds is a fund administered by Dr. Andrew Rawicz that is given to student projects that benefit society. Our company will be submitting our product's proposal to apply for the fund in our ENSC 440 course.

Lastly, if the funding is insufficient for our development or the fundings is unavailable, each of our team members agree to contribute at most \$70, which should cover all of the material cost.

# 5. Project Planning

Figure 5.1 and Figure 5.2 shows the Gantt Charts for our project timeline for the duration within the ENSC 405W course. The black square brackets represent major categories of the development aspects of EZSpice and the blue bars underneath them are the tasks of such categories. The blue dot represents milestones and key tasks throughout the term.

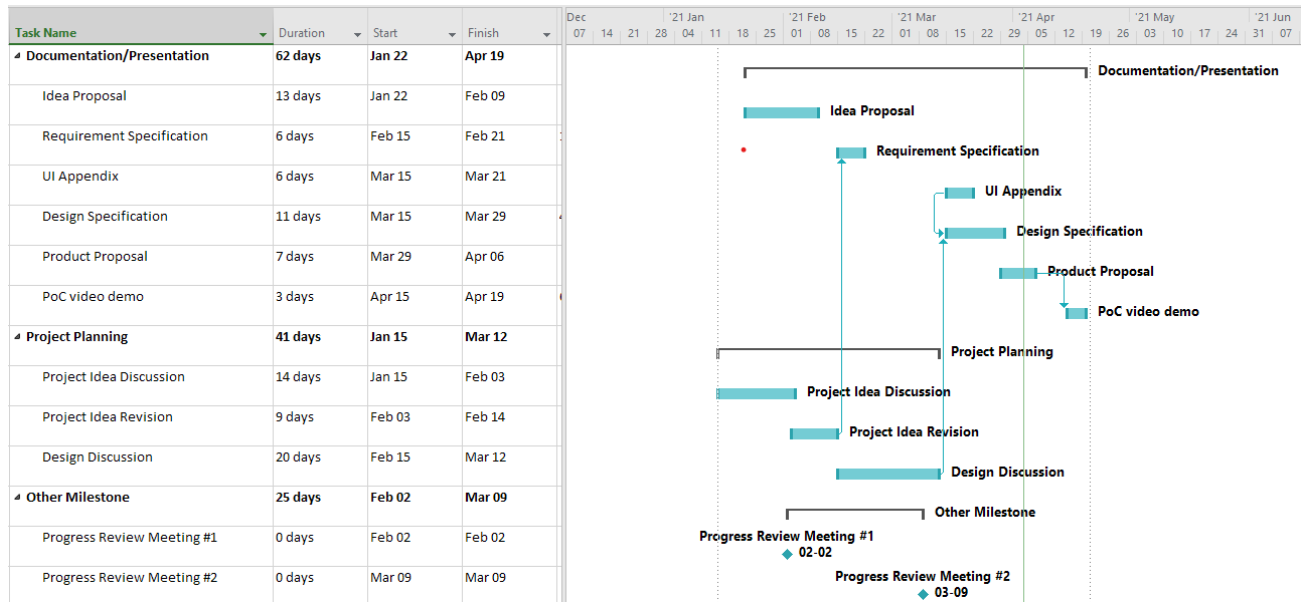


Figure 5.1: Gantt Chart for EZSpice project scheduling (Part 1)

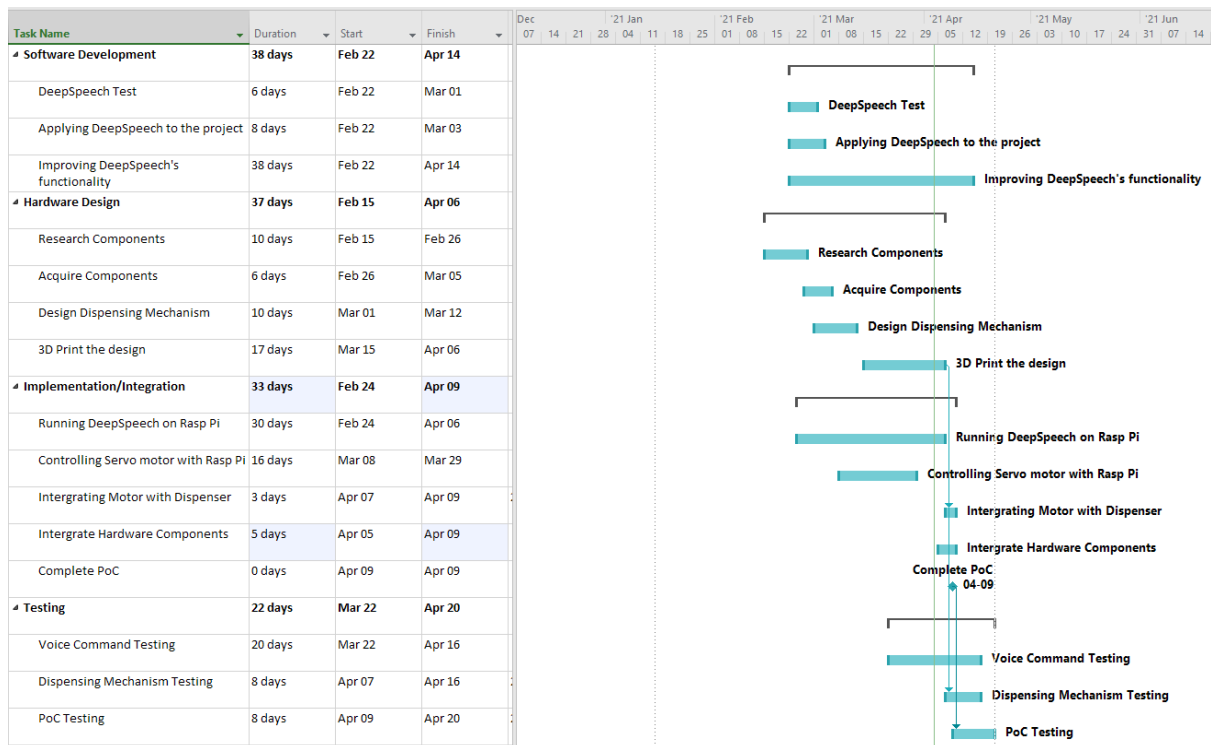


Figure 5.2: Gantt Chart for EZSpice project scheduling (Part 2)

## 6. Company Detail

### Company Overview

Founded on January 11th, 2021, Peppermint Inc. focuses on making easy and intelligent access to multiple cooking spices in the kitchen of households with its nicely integrated machine prototype, EZSpice. With EZSpice, households can get their desired spice powder with specific amounts by just using some simple voice commands as well as via the mounted touch screen.

The logo for Peppermint Inc. features the word "PEPPERMINT" in a bold, black, sans-serif font. A single green leaf icon is positioned between the 'M' and 'I' in "MINT".

### Meet the members



**Jiaxi Lin**  
[jla477@sfu.ca](mailto:jla477@sfu.ca)  
Chief Executive Officer

Currently in his 4th year as a Computer Engineering student at SFU, Jiaxi is a deep learning enthusiast with interests in mechanical design. He has worked as a research assistant at SFU's Medical Image Analysis Lab (MIAL) for an 8-month period. He is also experienced in front-end web development using VueJS.



**Vi Thai**  
[qvthai@sfu.ca](mailto:qvthai@sfu.ca)  
Chief Operating Officer

Vi is a 4th year Computer Engineering student who is interested in machine learning and embedded software systems. He has worked as Research Assistant at SFU's Synthetic Aperture Radar Laboratory and as a Software Developer at Coast Capital Savings Federal Credit Union. Vi also had experience on embedded systems and network protocols during his internship at Broadcom.





**Lingchong Weng**  
[lwa89@sfu.ca](mailto:lwa89@sfu.ca)  
Chief Product Officer

Higgins is a 4th year Computer Engineering student who has 8 months as Electronic Technician Advisor at Lee's Electronic and another 8 months for the Technical Client Support at BC Genomic Science Center. The primary interest of him is integration of microcontrollers with the electrical circuit and structure design.



**Minh Dinh**  
[qdinh@sfu.ca](mailto:qdinh@sfu.ca)  
Chief Communication Officer

Minh is a 4th year Computer Engineering student whose interests include computer architecture and FPGA programming. He has spent 4 months working as a system verification coop engineer at Microchip and 8 months working as a QA analyst for Gluwa Inc.



**Xing Shen**  
[xsa33@sfu.ca](mailto:xsa33@sfu.ca)  
Chief Financial Officer

Jayden is a 4th Year Electronics Engineering student who is interested in mechanical design. He has spent 4 months working as a market analyst at SPD Bank in China, and he is looking forward to exploring different industries in future career.



**Yuxiang Huang**  
[yuxiangh@sfu.ca](mailto:yuxiangh@sfu.ca)  
Chief Technology Officer

Evan is a 4th year Computer Engineering student who is interested in real-time systems, parallel computation and back-end web technology. He has worked as research assistant in SFU Menrva lab for 4 months and worked as software test developer in DDS wireless for 8 months.

## **7. Conclusion**

The goal of Peppermint Inc. is to apply modern technology to provide convenience for consumers through a smart and affordable dispensing spice machine to the market. In order to accomplish this goal, Peppermint Inc. will use a microprocessor, microphone, speaker to implement the speech recognition system which executes the voice commands from users. The system then uses motors to control the mechanical parts to dispense the spices based on the user's requests.

The team of Peppermint Inc. is excited to develop and propose our practical and convenient product as our Capstone project. In the current market, we have a very limited competition against our product, and we believe that our spices dispensing machine EZSpice not only will be a potential competitive product in the market, but also have a decent influence on changing people's life in the kitchen.

We would like to thank Dr. Craig Scratchley and the rest of the instructor team for the help, support, and instruction on ENSC 405W. We are also looking forward to further cooperation in the rest of this semester and next semester for ENSC 440, working with you and learning from your valuable suggestions and experiences.

## 8. References

[1] Statista, Smart home market revenue in Canada from 2018 to 2023. Accessed on: Apr. 04, 2021. [Online]

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[2] Mozilla, 2017, DeepSpeech. Accessed on: Mar. 20, 2021. [Online]

<https://github.com/mozilla/DeepSpeech>

[3] Samsung, Samsung's smart fridge, Family Hub, product page. Accessed on: Apr. 04, 2021. [Online] <https://www.samsung.com/us/explore/family-hub-refrigerator/overview/>

[4] GE Appliances, GE Appliances' Smart Ovens and Ranges product page. Accessed on : Apr. 04, 2021. [Online]

<https://www.geappliances.com/ge/connected-appliances/ranges-ovens-cooking.htm>