April 1st, 2023

Dr. Mike Hegedus
School of Engineering Science
Simon Fraser University
8888 University Dr, Burnaby, BC V5A 1S6

Re: Final Proposal for SpicePro

Dear Dr. Hegedus,

Attached in this document is Z4D Solutions's final proposal for SpicePro, an automated spice dispensing system. SpicePro caters towards restaurants who are seeking unique alternatives to spice-preparation and a way to increase overall efficiency in a fast paced-kitchen. Alongside product performance, Z4D Solutions also prioritizes product ease-of-usability and promises to deliver a device that is intuitive to understand and easy to use.

This proposal explores topics that provide a high-level understanding of the product, its marketability, associated risks/benefits, and a projected timeline of development. Moreover, financial considerations/limitations of SpicePro will be examined with a realistic estimate of future costs that will be incurred by the company.

Company 10 is composed of six brilliant senior engineering students, primarily majoring in systems and computer engineering programs at SFU. For any questions and inquiries regarding this project, please feel free to contact Arminder Kaur at aka139@sfu.ca.

Regards,

Arminder Kaur
Executive Summary

ENSC 405W

Final Proposal

SpicePro

April 1, 2023

Company 10:

Amon Sidhu - (Head of Finance) - (301340025)

Zoltan Gonsalves - (Requirements Specialist) - (301354689)

Daniel Keum - (Software Lead) - (301335490)

Arminder Kaur - (Head of Communications) - (301404918)

Aadpratap Singh - (Hardware Lead) - (301384709)

Armaan Bandali - (Project Lead) - (301322810)

Executive Summary

Behind the closed doors of restaurants, there are always activities involving prepping ingredients before or after open business hours. Our company aims to alleviate the time consuming issue and provide a way to speed up prep time - helping chefs perform more tasks ahead of time so that the kitchen operation is more streamlined.

The spice dispenser is designed to be both convenient and functional. SpicePro, our prototype, will be made from durable materials such as wood and also easy to clean. Our product includes multiple spice containers for storing different spices and each having a maximum capacity of 750 mL for storage capability. Furthermore, there is an intuitive touch screen to select and configure desired spice quantities.

To reach high levels of accuracy, SpicePro utilizes a rotary drum dispenser mechanism along with a weight sensor. From the spice container, a steady flow of spices flows through the rotary drum which dispenses into a spice bowl. Every 25 milliseconds, the weight sensor tracks the current weight of the spice dispensed into the bowl and updates how much more spice is needed until the desired quantity is reached - creating a feedback loop. To dispense from different spice containers, our product uses a mechanical multiplexer to switch between spices.

Our company, Z4D, is formed from 6 SFU engineering students with experience in a variety of domains from electronics to software. The goal for SpicePro's prototype is to complete by August 10, 2023 and our team plans to continually work together towards this goal. We believe that SpicePro can help our clients to create delicious, perfectly seasoned dishes with ease.

List of Figures

List of Tables

Table of Contents

1 Introduction

The idea for SpicePro came about when members of Z4D Solutions discussed the necessity of efficient spice preparation in commercial kitchens. Given that handling spice is inevitably a major component of most recipes, it may call for manual measurement and portioning which can significantly hold back a kitchen's efficiency during peak restaurant hours. Therefore, Z4D Solutions is pursuing development of SpicePro, a product that can take care of spice measurement/dispensing effectively and automatically in order to alleviate any spice-preparation difficulties.

1.2 Background

SpicePro will feature an interactive touch-screen that will give users the ability to dispense a spice or combination of spices by volume or weight with a high degree of accuracy. Moreover, the user will also have the ability to save a custom preset of a spice mix combination with individual spice ratios which can be reused later. This is particularly important for restaurants where recipes call for a certain spice-blend with specific ratios that the user can simply dispense from SpicePro given that they saved it beforehand. The final product will allow users to hold up to 9 spices in 9 individual, 750 milliliter containers. An optimistic 3D model of SpicePro and its internals can be seen below in Figure 1.
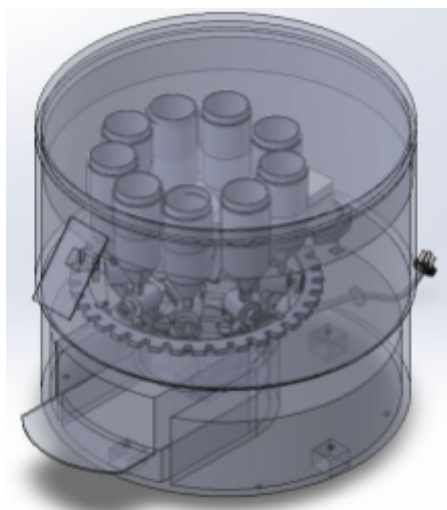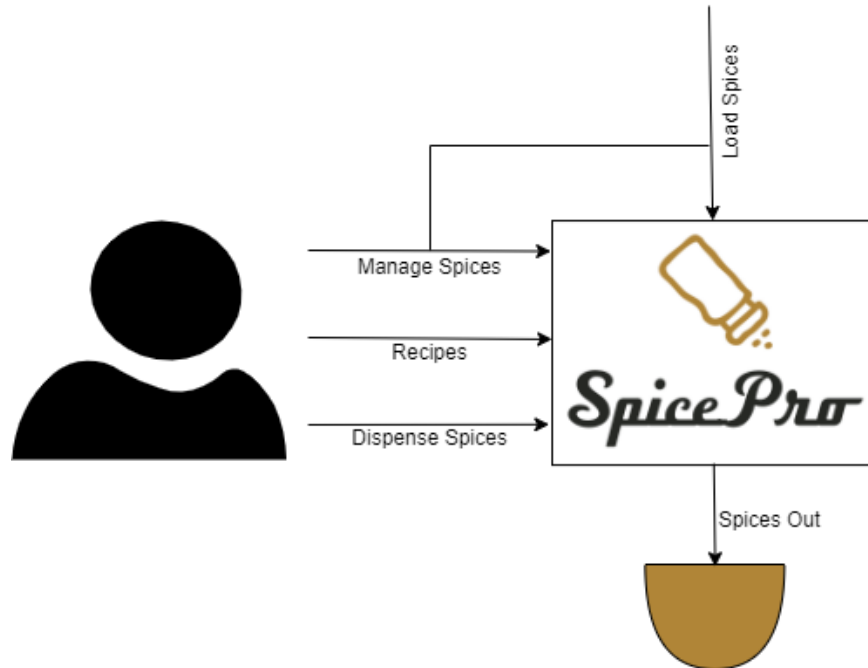
Figure 1: 3D model of SpicePro

Figure 2. SpicePro general workflow and main functionality

A high-level working flow diagram of SpicePro can be visualized by Figure 2. Users manage spice and physically load the system, then can save recipes and dispense the loaded spices automatically.

SpicePro is composed of hardware, software and mechanical design parameters. The hardware of SpicePro is concerned with the electrical components, wiring and the overall power supply/consumption. Software will be written on an Arduino Mega board in order to facilitate the motion of electrical motors and to provide an interactive and intuitive display on the user touch-screen when powered on. The mechanical components of the device include the mechanical multiplexing design and set-up, dispensing mechanism design and the overall support structure and organization of internals. It is imperative that these three design parameters function in unity without any major problems in order to enable a successful electro-mechanical system in SpicePro.

The design of SpicePro will also focus on the safety of the user by designing the exterior to be seamless and free of any exposed internals. The software written on the touch screen will have in-built warnings, feed-back alerts, safety notifications, emergency-stops and other such elements that will enhance the safety of the user. Most importantly, the spice being inserted into SpicePro will not interact with any non food-safe materials during dispensing or storage.

The overall design and development of SpicePro will be conducted with careful consideration towards engineering design and safety standards in Canada.

2 Scope

The scope of this project is centered around achieving specific performance criteria that was determined to be essential by members of Z4D Solutions and from feedback received by various restaurant staff and Dr. Mike Hegedus. A compilation of these expectations are given below:

- Avoidance of cross-contamination
- Sound from system must not be unreasonably loud
- Must be food-safe
- Must be easy to clean
- Must dispense spices with a high level of accuracy
- Must dispense a variety of spices
- Must be able to store spices lasting up to a day
- Must be fit for a fast paced environment
- Must be an affordable and worthwhile investment for an average restaurant
- Must be easy for the user to operate
- Must allow the user to set spice presets
- Must allow the user to dispense spice in bulk
- Must not be bulky and/or heavy system

In order to design SpicePro with the parameters listed above, an extensive requirement and design specification list was formulated. Furthermore, the development of SpicePro can be condensed into five main design milestones. These include: accurate dispensing mechanism, functioning user-interface, overall structure and safety, design synthesis and cost.

These milestones govern a path for Z4D Solutions to ensure that there is acceptable progress during the development of SpicePro and that major design challenges are being met. A detailed timeline of the project's timeline will be provided in section 7 of this document.

3 Product Justification

3.1 Risks

With a high standard of cleaning required for kitchens, the primary concern is ensuring SpicePro meets these standards. Users will have to consider 3 components for regular cleaning when using the system: spice container, touch screen and spice bowl. Cross contaminations should be avoided at all times by ensuring that the spice container and spice bowl is always clean. To migates this potential issue, our company encourages users to flush the spice container with water and dispense into the spice bowl. Regular hygienic standards must also be met on the touch screen. Since chefs deal with food, there may be food residue left on the screen after usage which may decrease touch sensitivity. To resolve this issue, users should regularly wipe the screen.

The device relies on the user being responsible for handling and maintaining the device. Users should not tamper with the device and only interact with SpicePro through the 3 components. Some risks include not following the requirement specification and filling in the spice container with spices not suitable for the spice dispenser. Or not correctly following the instructions on the touch screen. To ensure none of these are issues, there will be a user manual and intuitive interface for guidance. Like any electronic device, automatic spice dispensers can malfunction, which may lead to incorrect measurements or the dispensing of the wrong spice. SpicePro requires yearly maintenance to avoid any issue related to electronics.

3.2 Benefits

3.2.1 Greater flexibility mixing spices in needed proportions

SpicePro can dispense spices by volume or weight accurately. Using these features, users can mix combinations of spices to desired proportions and even scale for higher serving sizes. Bulk spice dispensing is encouraged as it will further help with common tasks like organizing spice or having quick access to spice mixtures - a stress free task as SpicePro deals with it. To have uniform distribution of spices within the spice bowl, users can use a lid to cover the spice bowl and shake the spice bowl.

3.2.2 Time saved for prepping spices

SpicePro will be more convenient for preparing spices in bulk and increase time efficiency when adding to a routine ingredient preparation. Users can easily input their desired spice measurements and while the spice dispensing is in progress, use that same time to prep for other ingredients.

3.2.3 Additional organizational structure for spice containers

Instead of the common spice rack used in kitchens to hold spices, SpicePro has the same advantages of storing spices in one location. Less potential mess and hassle with cleaning up spice bottles. The best place to keep your seasonings and spices is in a pantry or cabinet that maintains a cool temperature and is protected from direct sunlight and moisture.

4. Market

4.1 Research Rationale

Z4D Solutions spoke to two restaurants in particular and got some feedback concerning SpicePro. Restaurant "Village Curry and Spice" stated that SpicePro can be utilized as a learning tool for novice chefs and give them a sense of how much spice to use. They were also enthralled with the concept of spice presets, which will directly assist these novice chefs who are learning new recipes. Staff from "Browns Social House" stated that SpicePro will be able to reduce

confusion and commotion in a busy restaurant where measuring spice during peak hours can get hectic. The restaurants were also enthusiastic about this product for the fact that SpicePro can serve as a storage space for 9 spices in total with a large capacity.

The feedback from the staff and management of high-end restaurants makes it quite evident that SpicePro has a high potential in the restaurant business as it can not only make the cooking much more easier and efficient, but it can also reduce the prep time and thereby, reducing the staff required and hence, cut down costs. The presence of SpicePro in the kitchen can enhance and elevate the cooking experience, therefore, the expanding restaurant business will escalate the market for SpicePro.

Figure 3 below, shows the expanding billion dollar restaurant business in Canada,with a revenue of US$41.7bn in 2022 [1]. The growth and the investment in this business has led to a lot of advancements in the infrastructure of the restaurants, their dining, especially, their kitchen and the cooking practices. New cooking tools that make cooking easy in the fast-paced environment find their place easily in the high-end kitchen.

Market size of the full service restaurant sector in Canada from 2012 to 2021, with a forecast for 2022 (in billion U.S. dollars)

Source
IBISWorld
© Statista 2022

Additional Information:
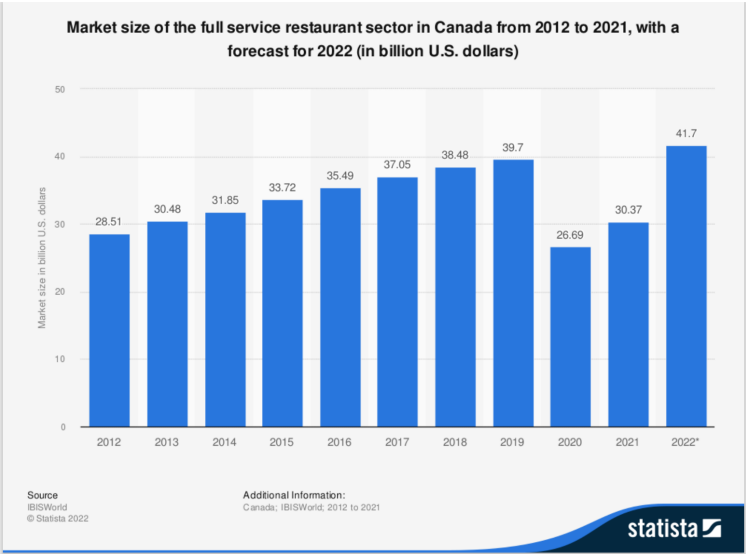Canada; IBISWorld; 2012 to 2021

statista

Figure 3. Market size of full service restaurant sector in Canada [1]

Figure 4 below, shows the expanding spice and culinary herbs market in Canada. The revenue in this sector amounts to US$1.03bn in 2023 and is expected to grow annually by 5.87% [2]. With this increase in demand of the spices, and people's love for the spice mixes, restaurants focus highly on the spices being used, and are very particular of which spices go in a particular mix and in what proportion/amount, and this prep for different recipes takes a good amount of

the prep time and labor as well to measure different spices with different measuring devices such as a weighing scale, measuring cup etc., and these spices are measured to a high precision. With SpicePro in a restaurant kitchen, it will not only save them labor and time to do the measuring and mixing, but will also increase the efficiency eliminating human error.
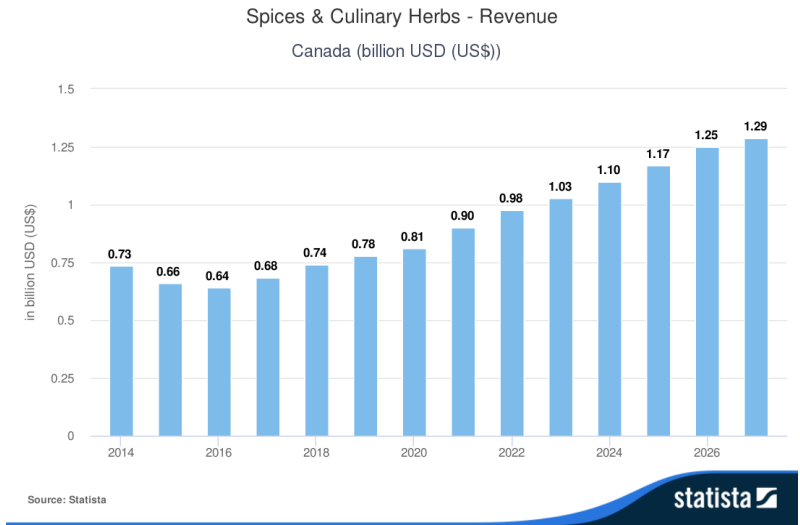

Figure 4. Revenue for Spices and Culinary Herbs in Canadian Market [2]

Hence, the introduction of SpicePro to a restaurant kitchen will make cooking a lot faster and handy and it will likely have a boosting demand in the billion-dollar restaurant and spice industry.

4.2 Competition

4.2.1 TasteTro

It is one our biggest competitors in the field of automatic spice dispensing. TasteTro (Figure 5) acts as a spice blender with about 20 spice pods providing the user with a blend of the required spices as per the desired recipe [3]. TasteTro aims to serve a target market of hobbying cooks and people who wish to make their desired recipes at home.

SpicePro goes beyond the scope of TasteTro serving a completely different target market, SpicePro with its large containers and high-dispensing speed is built to work in a high-paced

environment, hence it is targeting a market of professional kitchens and high-end restaurants. It dwells on the principle of reducing prep-time and quality enhancement.

Figure 5. TasteTro product image [4]

4.2.2 Automated Spice Dispenser

Falling in line with TasteTro, Automated Spice Dispenser (Figure 6) aims to target a market of hobbyist chefs and home cooks aspiring to make their life simpler and trying to make the perfect recipe. Although not in the market it uses refillable buckets to store spices that are smaller in size and designed for small time use, unlike SpicePro designed for a larger audience and bigger servings [5].

Figure 6. The Automated Spice Dispenser [5]

SpicePro, just as in case of TasteTro, serves a completely different market, basically setting its crosshairs on high-end restaurants and professional cooks who serve larger portions and require bigger containers and faster dispensing at the same time being reasonably accurate.

4.2.3 Spice mix packages

Instead of automated spice dispensers chefs can choose to simply buy a premade spice mix package, such as Club House (Figure 7). While they do not offer the flexibility of handmade spice blends, retail spice companies offer a wide range of blends that restaurants can adapt to if needed. These packages are carried by most grocery stores and are fairly affordable while offering convenience, but may be more expensive than procuring and mixing the individual ingredients for the blend.

Figure 7. Prepackaged retail spice [6]

5 Project Planning

A gantt chart of the development of the Proof of Concept prototype for SpicePro can be seen in Figure 8. Non-green tasks outline the predicted timeline the company budgeted, while green tasks show the actual timeline of tasks directly under each respective task. Due to shifting requirements, scope, and target market, materials acquisition and project construction were delayed from original expected completion dates. Additionally, rapid prototyping and assembly led to discovery and reworking of the entire mechanical structure, naturally delaying integration of subsystems. Despite delays, the company's diligence in budgeting time for tasks has led to a safe discovery of better design and requirements without impacting project delivery.
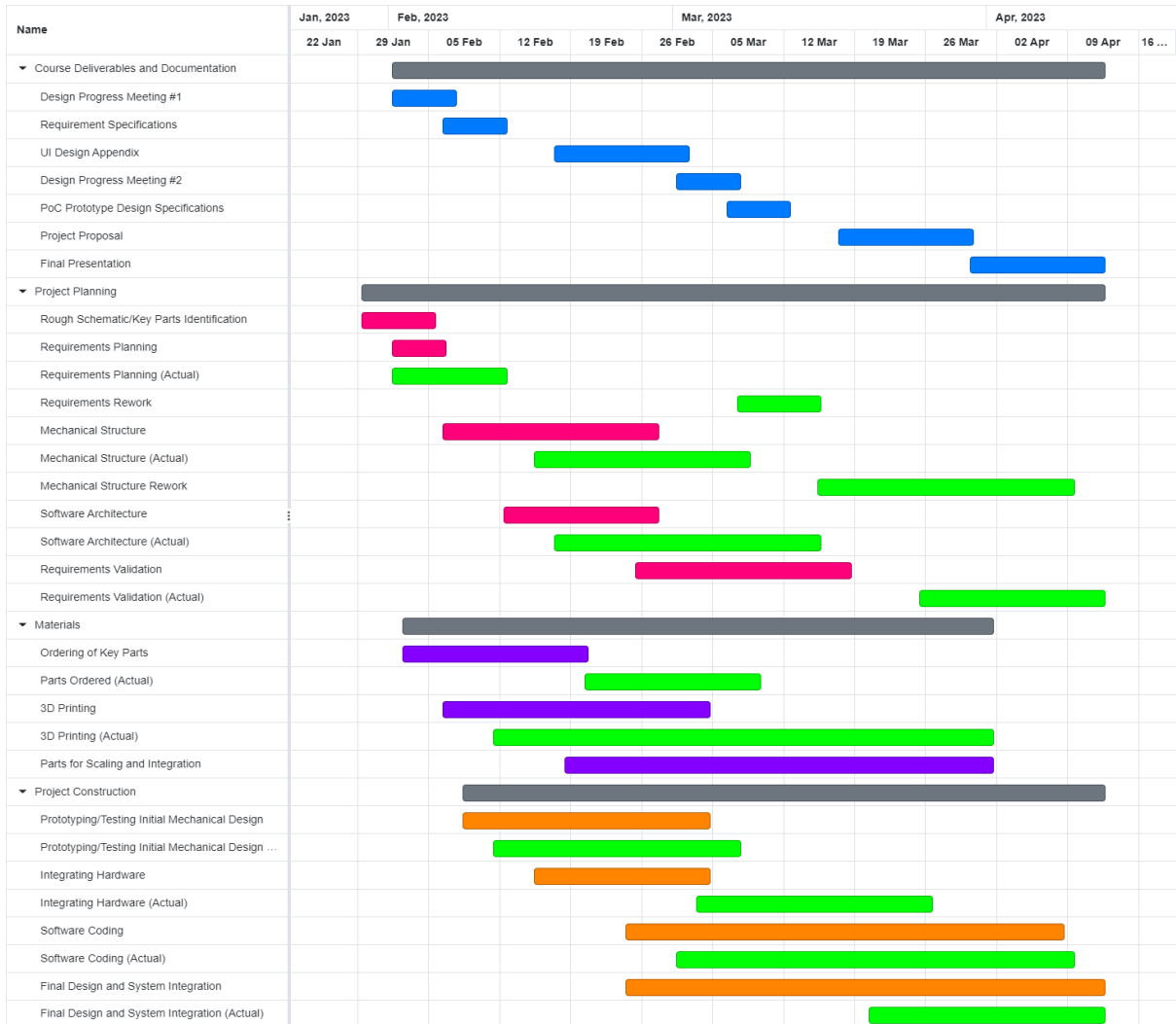
Figure 8. Gantt chart of predicted and actual timelines

6 Finance

6.1 Cost analysis

The breakdown of each component for SpicePro's prototype is summarized in Table I. Exact costs for purchased components are listed while expected costs for testing, development, and contingencies are also estimated. Additional costs may be incurred when developing SpicePro beyond the Proof of Concept stage.

Table I. Cost breakdown for SpicePro

Component	Description	Price (CAD)
Arduino Mega 2560	Micontroller to control spice dispensing and touch screen	54.99
Adafruit Motor Shield	Used to control the motors	31.95
Stepper Motor	Component needed for the spice dispenser	39.40
Load Cell + Amplifier	Weight sensor to meet spice dispensing accuracy requirement	14.99
7 inch touchscreen	Interface to SpicePro	53.62
RA8875 screen controller	Driver board for touch screen	57.56
Assorted Header kit	Stackable headers for motor driver	20.99
12V 5A Power Supply	Powers up the Arduino	19.99
Lead Screw Assembly	Helps with multiplexing to different spice containers	41.99
Structural support cost	Includes materials needed for encapsulating electronics	80.00
3D-Printing	Necessary custom made components	40.00
	Total Cost	455.48

6.2 Funding

Several sources of funding are available for Engineering students who are currently in the process of completing their Capstone project:

The Wighton Development Fund is administered by Dr. Mike Hegedus. The fund will assist in obtaining additional funding not yet covered. A proposal will have to be submitted and will be evaluated by the fund's committee. We expect this to cover $500 of the overall costs.

Each member of our team has agreed to contribute at most $50 to the material costs. This will provide us with exactly $800 (including the Wighton fund of $500), which should be just enough to successfully construct our prototype.

Z4D Solutions will also apply for the ESSEF fund. This fund, while not guaranteed, can potentially cover all costs for the project after receiving the Wighton fund of $500 thus, not requiring Z4D Solutions members to pay $50 each. The category of the ESSEF fund most suited to our project is Category C, which covers 25% of the total available funding amount. [7]

7 Company Details

Spice Pro was founded Jan 5, 2023. Our company Z4D has a clear goal of revolutionizing the way spices are handled in professional kitchens. Our first prototype, SpicePro, is expected to be completed in August 2023.

Daniel Keum - Software Lead
Daniel is currently a 6th year Computer Engineering student with experience in Firmware development. Previous work experiences at Soldigm will help with validating and verifying design choices. At Z4D, He will be working on the software development for SpicePro that includes controlling the hardware and microcontroller.
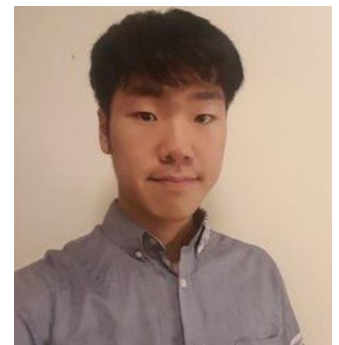
Zoltan Gonsalves - Requirements Specialist

Zoltan is a 5th year Systems Engineering student with a keen interest in mechanical design and robotics. His previous work-experiences and courses have improved his ability to use CAD design softwares such as Solidworks and to conduct numerical analysis using MATLAB. They will primarily be working on the mechanical dispensing mechanisms of SpicePro and ensuring requirements are being met.


Aadpratap Singh - Hardware Lead

Aadpratap Singh is a 5th year Engineering student majoring in systems engineering. His experience with the SCARA robotic arm and hands-on experience with general lab equipment from his co-op at LabTest Certification Inc., should prove to be an asset towards the success of this project. At Z4D Solutions, He will primarily be working on the hardware and ensuring that mechanics and software work in sync with each other.

Armaan Bandali - Project Lead

Armaan is a 4th year computer engineering student with a love for software development. He gained valuable experience in programming desktop applications and continuous integration through his 8 month internship with Transoft Solutions in Richmond. With his strong software background in application and embedded development, Armaan will contribute effectively to the low-latency programming required to make SpicePro a success.
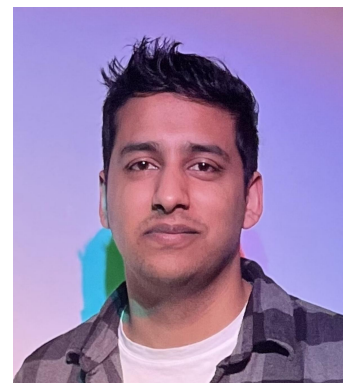
### Arminder Kaur - Head Of Communications

Arminder is a 5th year engineering science student with a major in Systems Engineering. She has a keen interest in robotics, and has hands-on

experience with both software and hardware. She has experience with embedded systems and SCARA robotic arm where hardware and software go hand in hand driving each other. With her previous projects and co-op experience as a Data Quality Analyst, she has attention to detail. At Z4D Solutions, she will mainly be working on hardware and also on designing SpicePro innovatively.

Amon Sidhu - Head of Finance

Amon is a 5th year Computer Engineering student who enjoys programming and takes an interest in the business aspects of product development. He recently completed an eight month co-op term as a QA Analyst at New/Mode and gained valuable experience in software testing. This experience will help him be a valuable asset to the development and testing of SpicePro at Z4D Solutions.
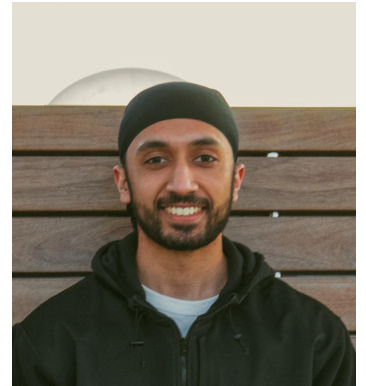
8 Conclusion

In conclusion, automatic spice dispensers can be a valuable addition to any kitchen. They provide convenience, precision, and can even promote better health practices by minimizing the risk of contamination. While there are potential risks associated with their use, these can be mitigated by careful consideration of the costs and potential malfunctions. By taking advantage of the benefits of SpicePro, that is uniquely offered by SpicePro, individuals can enhance their cooking experiences and create delicious, consistent, and healthy meals with ease. So why not consider investing in SpicePro and elevating your cooking game today?

9 References

[1] Statista. (2021, September 22). Market size of the FSR industry in Canada from 2016 to 2020 with a forecast for 2021 to 2025 (in billion U.S. dollars) [Graph]. In Statista. Retrieved April 1, 2023, from https://www.statista.com/statistics/1186289/fsr-industry-market-size-canada/

[2] Statista. (2022, February 24). Spices & Culinary Herbs - Canada: Revenue in the Spices & Culinary Herbs segment amounts to US$335.5m in 2022 [Graph]. In Statista. Retrieved April 1, 2023, from
https://www.statista.com/outlook/cmo/food/sauces-spices/spices-culinary-herbs/canada

[3] "Tastetro Spice System," Uncrate, [Online]. Available:
https://uncrate.com/tastetro-spice-system/. [Accessed: Mar. 30, 2023].

[4] "Spice Cupboard Chaos Solution," TasteTro, [Online]. Available:
https://www.tastetro.com/spice-cupboard-chaos-solution/. [Accessed: Apr. 1, 2023].

[5] R. Gurberg, "Automated Spice Dispenser DEMO," YouTube Video, Aug. 8, 2017,
https://www.youtube.com/watch?v=i3xB1WOZR2Y.

[6] "Cajun Seasoning Blend," Club House, [Online]. Available:
https://www.clubhouse.ca/en-ca/products/seasonings-and-blends/signature-blends/cajun. [Accessed: Apr. 1, 2023].

[7] *ENSC 305W/440W: Funding sources*. [Online]. Available:
http://www2.ensc.sfu.ca/~whitmore/courses/ensc305/funding.html. [Accessed: 01-Apr-2023].