Project Deliverable M: **Final Design Report**
GNG 2101 – Intro. to Product Dev. and Mgmt. for Engineers

Faculty of Engineering – University of Ottawa

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Abstract

This report will discuss how our company, Steady Co, found an effective solution to an issue within the disabled community. We will first summarize the meetings that we had with the client and discuss how the feedback affected our work plan. Then, define the problem, come up with a solution and have it be validated by our client. We will also look at other competitors and why we have an advantage over them.

Introduction

The World Health Organization (WHO) released a report that claimed “Musculoskeletal conditions are the second largest contributor to disability worldwide” [1]. The article defined Musculoskeletal conditions as any of the 150 conditions that affect muscles, bones, joints, and any of their tissues. In 2018, the Arthritis Foundation released a report that defined arthritis as a phrase that refers to joint pains and diseases, with more than 100 types . Because arthritis is hard to determine, and can sometimes be confusing to doctors, there are 54 official have arthritis. However, recent studies suggest that 91 million Americans may have arthritis [2].

More than 1% of the population suffer from Rheumatism arthritis, damages to the lining between the finger bones, and some limited wrist movement range [3]. Other diseases cause limited wrist movement. According to Statistics Canada, 1 in 100 people were diagnosed with arthritis in 2008, with approximately one in three senior males, and one in two senior females reporting arthritis that year [4]. These statistics are only meant to increase.

People with these conditions face difficulties in day-to-day activities. Take our Saint Vincent Hospital patient for example. She faces issues every day trying to eat by herself. She is in constant need of assistance when it comes to eating. She is in need of a product that will help her eat independently and with ease.

This report will explore how our product found a unique solution to help people with disabilities use utensils properly, and most importantly, independently. We will discuss what the problem really is, what our solution is, why is it an effective solution, and what is to come.

Empathy and Problem Definition

Client Statement and Need Specification

The team was able to meet our client on May 25th, 2018. The client informed us, that due to her disability and her weak arm strength, she was unable to use normal utensils during meals. The client was prone to spill food because of joint problems, and had trouble rotating her wrist because of arthritis. Also, her disability does not allow her to reach items of food that are too far on her plate. Furthermore, she is unable to open her hand, which prohibits her from holding large objects. As the interview continues, we learn that the government does not subsides patient feeding, which means that finding help to eat would be costly.

Problem Statements

We developed two need statements that fit the two products we are producing. The first need statement is for the spoon, and it states the following: design a stabilizing utensil that is lightweight and low cost to help client eat independently. The second need statement is for the plate, and it states the following: design a rimmed plate with a rotating and locking mechanism, and rugged texture that provides a frictional surface. More information about the two products will be discussed in detail later.

Benchmarking

Lifeware and Gyenno are two companies that already produce utensils for people with disabilities. Their design uses sensing methods and damping motors to keep the bowl of the spoon in place. While the technology used to make this design is fascinating and complex, it is too expensive on the market. A spoon could have a price range of 150-200 CAD, and the government does not subsidise assistive feeding. Fortunately, our company found a cheap, and easy to make solution that could give users 50% of our competitors product functionality for 10% if the price.

Prototype, Testing & Customer Validation

In this section, we will discuss the prototypes and ideas we generated to solve the problem statement, and how the customer feedback affected the course of action of developing the product.

Ideate and designs

Further analysis of the client's need statement helped us look at the problem through two distinct lenses. We needed a product that can stabilize, but also stab and help reach food that is too far. Therefore, we divided the tasks into two parts. A spoon will help provide rotational stability, and a plate will help reach items beyond the patient's reach, and stab food more efficiently. Bellow is a table that displays all of our previous design ideas (From deliverable B):

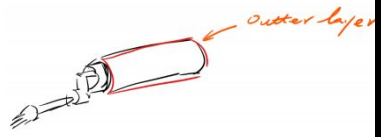
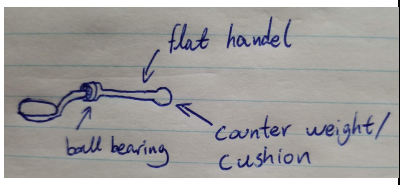
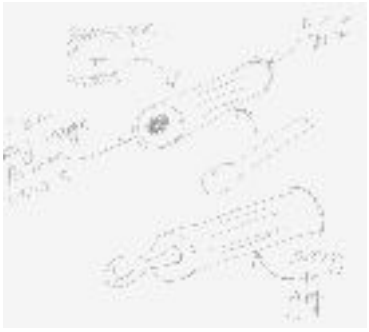
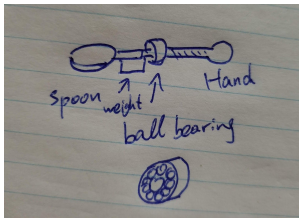
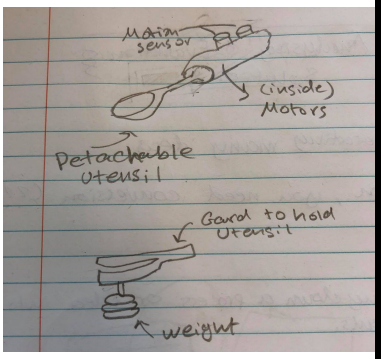
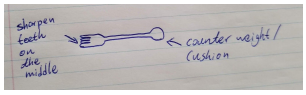
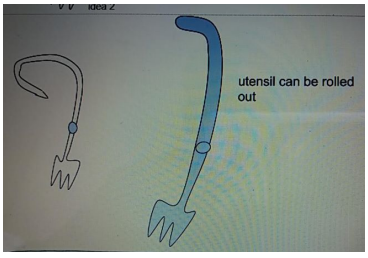
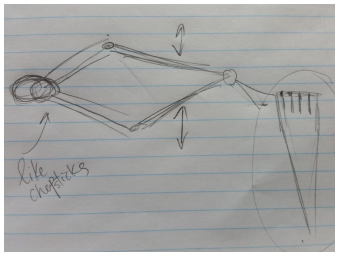
Initial design concepts	Brainstorm	Final designs
		
		
		
		

Table 1: Sketches and Ideas to Solve the Problem

As one can see, the designs we ideated are simple and lacking in electronic components. This will greatly cut down on cost and manufacturing time, giving our company a greater advantage than our competitors.

Figure 1 and Figure 2 show the finalized sketch of the prototypes we will make. At first, we thought the plate will be any plate with ridges to help patients pierce their food better. The ridges provide a counter force for when the user tries to stab the food, thus reducing the pressure needed to penetrate items. The design of the plate was improved and will be later discussed.

The design of the spoon was simple. It consisted of three parts. The bowl of the spoon was attached to a ball bearing which is attached to the handle of the spoon. The ball bearing will give rotational stability to the bowl of the spoon to keep it in place when weight is added to it.

Figure 1: Sketch of the Plate

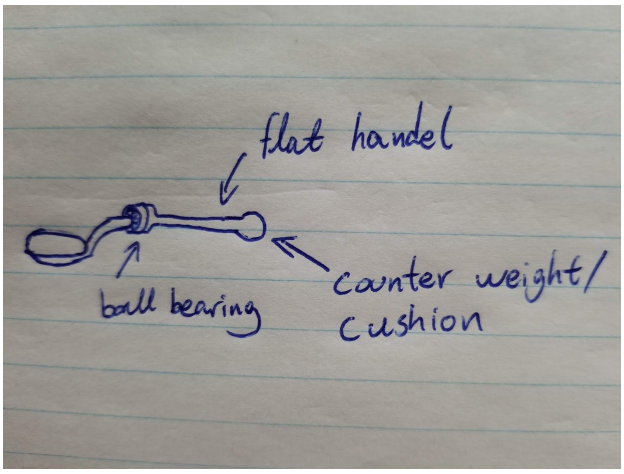


Figure 2: Sketch of the Spoon

Client Feedback

The patient seemed impressed by our solution, but remarks were made. Firstly, our client showed a concern at the ball at the end of the utensil. This was mainly due to her inability to open her hand and hold large objects. The solution to the issue was simple: remove the ball at the end of the handle. Secondly, we discovered our original client used an attachable rim for her plate for rotational purposes which allowed her to access her food. This gave the group more insight on how to develop a rotating mechanism to solve our problem statement.

Prototype

We implemented our first spoon prototype after our meeting with the customer. The prototype is a 3D printed spoon with simple mechanism using ball bearing for the spoon head rotates freely, as mentioned before. We used another ball bearing as weight to make sure the spoon head is always facing up. A design of the plate was also made so that it could rotate. A sticky pad below one side of the edge would stop this rotation when force is applied. Ridges on the plate top will help to hold food in place. Figures 3 and 4 below are screenshots of the Tinkercad models. The dark blue part of figure 4 represents the friction surface that will stop the plate from rotating, while the red part represents the rotating mechanism.

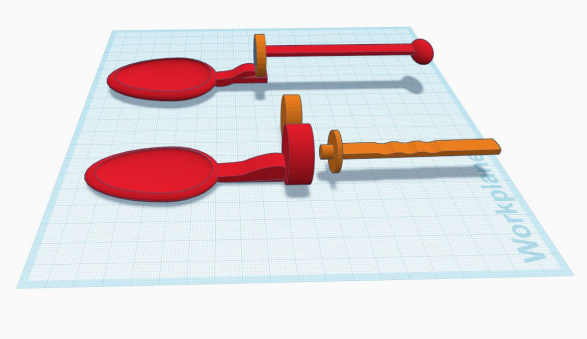


Figure 3: The spoon

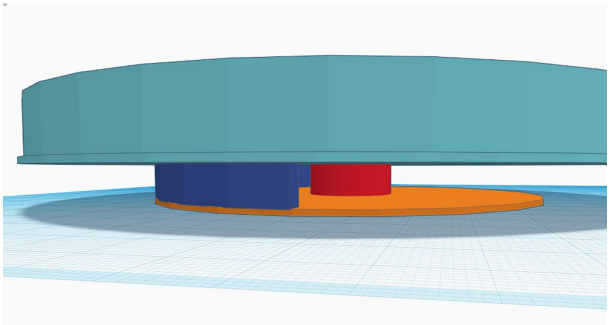


Figure 4: The plate

Client meet

During our last meeting with our client, we gained valuable feedback from the client.The spoon seemed to please our customer but some remarks were made. The customer found that our spoon’s handle was too small and that the length of the handle was too short for its comfort.

Thankfully, these were easy fixes because the handle was 3D printed, and we could easily produce another one. Also, the bowl was too low compared to the position of the handle. This made the client feel nervous that she will spill on herself because the spoon bowl is below the handle. To fix that, we simple redesigned the spoon so that it was aligned with the handle. We also decided to make the bowl of the spoon steeper so that it can contain more food.

Unfortunately, due to time constraints, we were unable to display a functioning prototype of the plate. However, we showed our client the Tinkercad model, and explained the functionality of each part. No comments were made for the plate, except that the client is eager to see how functional the design will be.

Final prototype

We have rectified the details necessary for our spoon. The length of the handle was adjusted, so that the height between the handle and the bowl is reduced.In addition we make a thicker handle. We also think that a steeper bowl would look our prototype like a real spoon.

With the resources available, create a prototype that is close to the final product in terms of functionality.

Final Solution

In this section, we will explore how the end product will be manufactured, how much will the product cost, how much will the company be making, and discuss the business Model of Steady Co.

Project Planning and Feasibility

As mentioned before, our prototypes are made using 3D printers. However, using the 3D filament begs the question of whether it is sanitary to use for the long term. For the final product, the team focused on the following metrics: sanitation, resistance to heat, and washability.

The plate will be made out of ceramic. Plaster mold would be used for more advanced prototype and press mold will be used for massive production when needed. We compared ceramic with other materials such as ABS 3D filament and bamboo filament, and we concluded that ceramic was not only easy to produce with, but it is microwave and washing machine safe.

The spoon will be made out of stainless steel. We are planning to cut a regular stainless steel spoon into two parts and place a standard R4-2RS ball bearing in between them. A cover will be placed around the ball bearing to protect it from dust and dirt. We will use stainless steel because, just like ceramic, it is washable and sanitary.

The company is planning to produce 500 pieces initially to test the market, and samples will be provided to hospitals and senior homes. We hope that by using this outbound marketing approach, we can collect and search for potential clients. We plan on selling 30,000 pieces for the first fiscal year of operation.

Production Cost

Bellow, are tables 2 and 3 which demonstrate the expected Bill of Materials (BOM) for our product. As shown by the Total Extended Cost, the product we are producing is cheap to make. This is gives a great advantage to our business compared with our competitors. As previously mentioned, companies such as Lifeware and Gyenno are selling products at a high price, and the reason might be because they use electronic components in their design. Having that component (i.e an electronic components) will definitely increase the price of a good. Luckily, because we are only using raw materials, we can help solve the problem at a much lower cost.

Table 2 shows the Final Prototype BOM. We are purchasing bulks of raw equipment that will cost the company $18.45. But that is the starting price expense of the company. As time

progresses, we can cut down on supply expense by using equipment from previous purchases. Again, this will greatly cut down on production value, allowing us to produce more spoons and plates at cheaper prices.

Item No.	Part Name	Description	Quantity	Unit Cost	Extended Cost
1	Ball bearing	0.625" R4-2RS	1	$5.00	$5.00
2	Acrylic	1'x 2'x ¼"	1	13.45	13.45
3	Spoon	3D printed	1	0.00	0.00
4	Brim and ridges	3D printed	1	0.00	0.00
					$18.45

Table 2: Final Prototype BOM

Item No.	Part Name	Description	Quantity	Unit Cost	Extended Cost
1	Ball bearing	0.625" R4-2RS	1	$2.02	$2.02
2	Stainless Steel	round bar (0.750)	1"	$7.90/ft ($10.42 CAD)	$0.87 CAD
3	Metal Spoon	Standard tbs	1	$2.00	$2.00
4	Material of plate	Calcined China Clay	1	$3.50	$3.80
					$8.69

Table 3: Production BOM

Business Model

Figure 5 displays our company's business model.

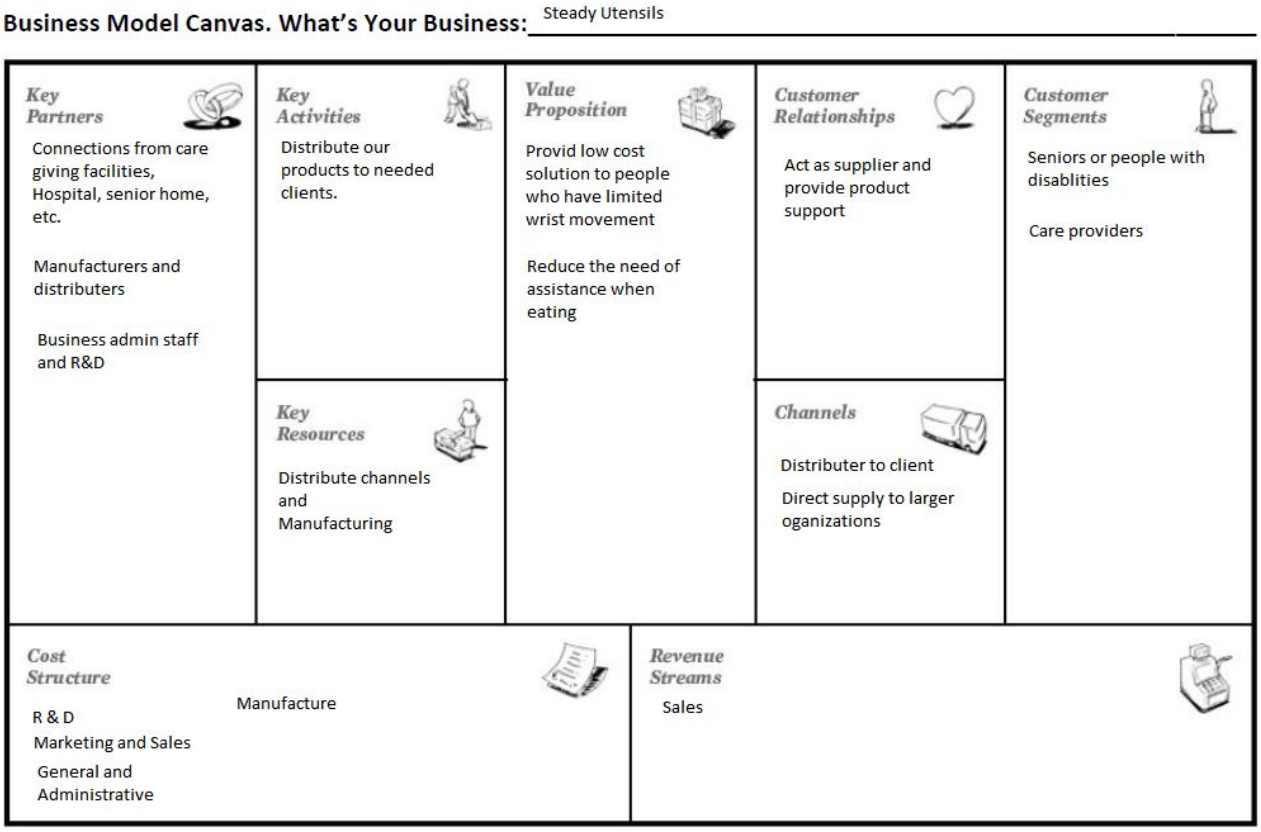


Figure 5: Business Model

Conclusion

We believe that our solution is the best solution for the problem we tackled. Not only have we created a product that works, but a product that satisfies the customers' needs. Our simple design is easy to make, aand the materials ready to make them are cheap.

Reference

[1]"Musculoskeletal conditions", World Health Organization, 2018. [Online]. Available: http://www.who.int/mediacentre/factsheets/musculoskeletal/en/. [Accessed: 02- Jul- 2018].

[2]Arthritis Foundation, "Arthritis By The Numbers", 2018.

[3]G. A, "Overview of epidemiology, pathophysiology, and diagnosis of rheumatoid arthritis. - PubMed - NCBI", Ncbi.nlm.nih.gov, 2018. [Online]. Available: https://www.ncbi.nlm.nih.gov/pubmed/23327517. [Accessed: 28- Jul- 2018].

[4]"Arthritis 2008", Www150.statcan.gc.ca, 2018. [Online]. Available: https://www150.statcan.gc.ca/n1/pub/82-625-x/2010001/article/11097-eng.htm. [Accessed: 28- Jul- 2018].