GNG2101 Deliverable C

Detailed Design and BOM

Introduction to Product Development and Management

GNG 2101

May 28th, 2023

Group Z13

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Abstract

The main objective of this deliverable is to showcase the detailed design we came up with based on previous design concepts and client feedback. Subsequently, we evaluated its feasibility and outlined our approach to achieving our goal of creating the product. Additionally, we created a comprehensive bill of materials (BOM) for our final prototype. Throughout the deliverable, we demonstrated that our detailed design has the potential of satisfying all the client needs while being within budget and realistic for the team to manufacture.

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Introduction

In our previous deliverable, we came up with different concepts for our product. Once we presented the concepts to the client, we received valuable feedback. Our group got insight into how our client feels about our current designs, and we also received suggestions about changes we could make. In this deliverable, we will focus on the details of our second client meeting, the changes made to the design presented in deliverable B, skill sets and missing skills, realistic timelines and detailed bill of materials (BOM) for our final prototype.

Client Feedback

From the client meeting, we showed each of our designs to Travis, as well as our two main concepts. Nicky's boyfriend Steven was there to ensure that we had more opinions on our concepts.

a. Concept 1.

   The cup doesn't have a handle, so they liked the idea that it can be versatile. They weren't sure if the cup would be secure enough and if it had the desired usability.

b. Concept 2.

   They liked the idea of the cup, but were worried that it would take too much time to install. Steven was concerned that Nicky wouldn't be able to use it since they don't have staff in often enough to fix it or install it if the cup accidentally falls out or needs to be replaced.

c. Concept 3.

Travis liked this idea, and believes that if there was a rotating element, it could be rotated under the tray when not in use. They were concerned about the location of the cup when attempting to drink. They have custom straws that Vicky must use, and the straw may not be long enough. Having a longer straw would not work, as it will require too much suction force.

d. Concept 4.

   Was Travis' favourite out of the first 4 concepts. He likes that it sits on the tray and is simple to install. Steven was concerned that it could still be knocked over and suggested increasing the height of the sides.

e. Concept 5.

   Travis stated that it will be the easiest to set up and doubts that it will be pushed out of place it hit. Steven mentioned that there may not be enough space under the tray for it to work. A smaller clamp would allow for more space, since the clamp could only go in about 1 inch before interacting with Nicki's legs. The mechanism that attaches the tray to the wheelchair may also pose as an obstruction preventing proper use of this concept.

f. Final Concept 1.

   Our client likes the idea of a screw mechanism and thinks it's the best way to attach the cup holder. He likes that the cup can't be hit by Nicki since it's under the tray. Unfortunately, he doesn't think it's the proper solution for her case since it would put the cup too far away, making it hard for Nicki to drink out of the straw (due to the suction force required). Also, since the cup sits on the side of the

tray, it makes the wheelchair wider and this is not desirable since it would make it hard to go through a doorway.

g. Final Concept 2.

Travis really liked this idea and stated that it was something that he thought would work well. He was enthusiastic while talking about it and did not raise any objections surrounding its design or functionality.

Detailed Design of the Concept

There are three main subsystems in our final design: the cup holder, the clamp, and the thumb screw. The cup holder subsystem consists of a custom 3D printed cup holder with an integral slot to allow the clamp to be slid into the cup holder. The cup holder is secured to the clamp by a magnet, as this allows for a strong enough connection between parts while also making the cup holders easily interchangeable.

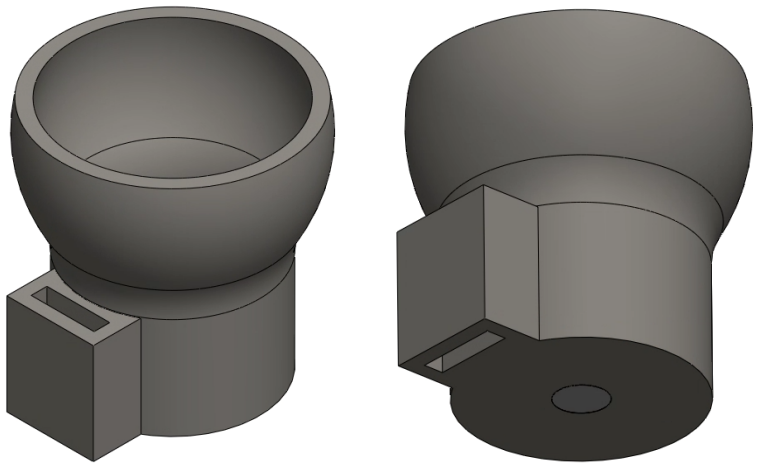

Figure 1. Cup Holder Subsystem (Magnet Shown in Second Picture)

The clamp subsystem consists of three machined flat bars of steel that are slotted and welded together to ensure a rugged and sturdy clamp. A 5/16” - 18 hex nut is welded to the bottom of the clamp to allow the thumb screw to thread through the clamp, which tightens the cup holder to the wheelchair tray. A thin piece of rubber is also glued to the bottom face of the top clamp arm to add friction between the tray and the cup holder.

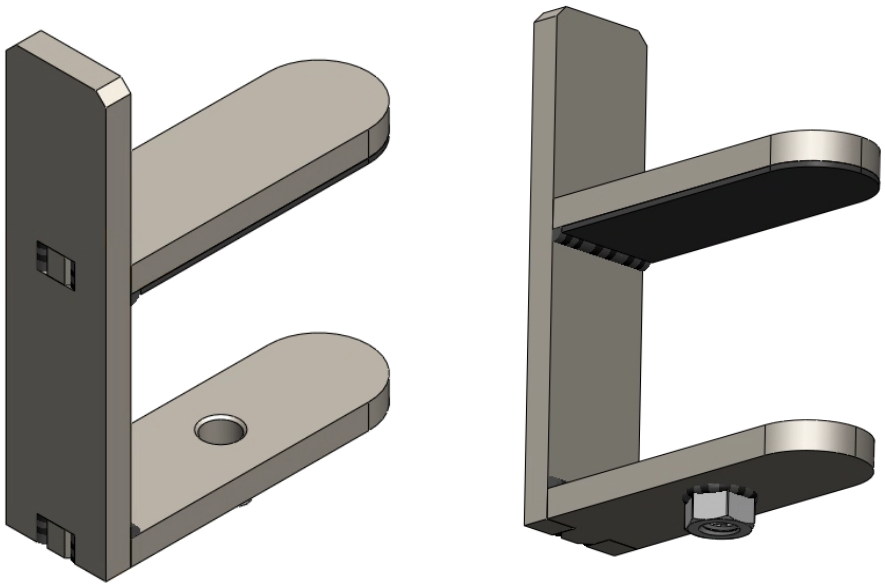

Figure 2. Clamp Subsystem

The thumb screw subsystem consists of two parts; a 5/16” - 18 steel thumb screw and a threaded rubber tip. The thumb screw is threaded through the nut of the clamp until the tip is protruding. The rubber tip then screws onto the end of the thumb screw. This ensures there is enough grip between the tray and the entire clamp to prevent the cup holder from moving if it is knocked.

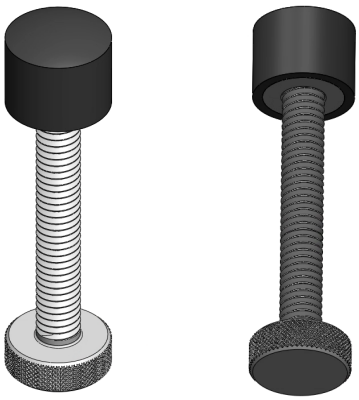

Figure 3. Thumb Screw Subsystem

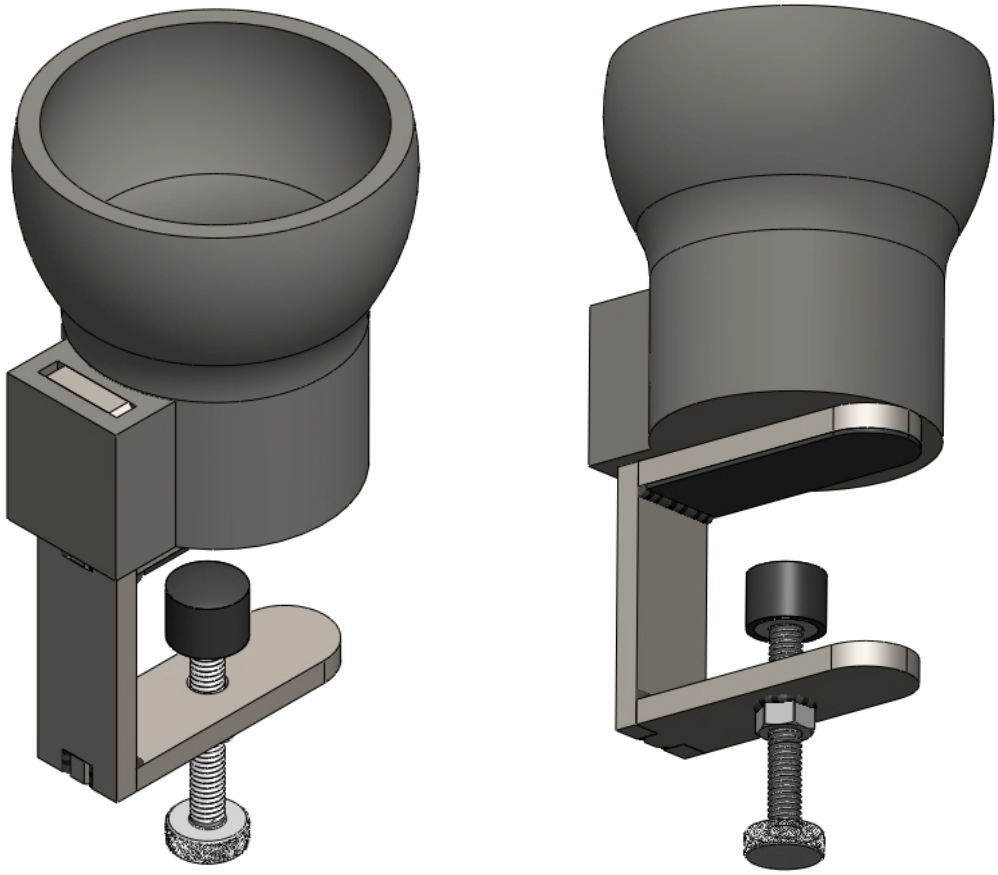

Figure 4. Entire Assembly

Skills Required

The skills listed below are necessary for the completion of the product. The check mark represents a team member having this skill, while an “X” represents all team members missing this skill:

- SolidWorks ✅
- 3D printing ✅
- Welding ❌
- Lathe ✅

- Mill/drill press ✅
- Online shopping ✅

As a team, we have all skills necessary to complete the project except for welding. In order to have the skills necessary to weld, at least one team member must receive the appropriate training and obtain the welding certifications. If no training and certification is available on the university's campus during the term, we will have to ask a trained staff member of the workshop to carry out the welding with the help of our instructions. The welding required for our product is minimal and should not require extensive effort from the staff or the team members and should be easily achievable.

Time Constraints

The estimated time that it will take to implement and fully complete the manufacturing of our design will be approximately 8 hours in total. This includes around 2 hours for the machining welding, and assembly of the clamp subsystem, and 5-6 hours for the 3D printed component. For the 3D printed component, members of the team must be present for the first 30 minutes of the print to ensure it is printing the part correctly. However, due to the long printing times, the printers can be left alone for the remainder of the print, and be picked up after completion.

The amount of free time that each member has varies. Sunday is the only day that MakerSpace is open, so a team member must be free to 3D print on that day. Justin and Francois are busy on Sundays, so the other three team members who have time on Sunday can go set up and print the necessary components. Brunsfield is open most days of the week and the machined pieces do not have to be completed all at once, so members can go and do as much of the work as they can during their free time, and depending on their skill levels. No team members have

their welding certification, so they must get help from a Brunsfield worker, which will narrow down the time slots that we can work on the project. Not all team members have to be available at the same time for each design process.

Critical Assumptions

Here are some critical assumptions that may impact our ability to develop our design:

a. Materials and purchased parts might not arrive on time, which will affect the time frame for mechanical assembly.
b. The materials and components we purchase do not work as expected.
c. Materials or purchased items could be damaged or malfunction during the production process.
d. Our print could take too many hours to complete. If it's more hours than the opening hours of the MakerSpace, we might have to ask to extend the opening hours so we can finish our print.
e. We assume that we will receive help from the CEED staff at Brunsenfield center to help us weld our metal pieces.

Bill of Materials

Table 1. Bill of Materials

Item #	Part Name	Description	Quantity	Unit Cost	Extended Cost
1	Hot Rolled 44W Steel Flat Bar	¼" x 1" x 12" metal bar used to make the main body	1	$6	$6
2	3D Printed Cup Holder	The plastic filament used by the school	140.5 g	$0	$0

	(PLA)				
3	Steel Knurled-Head Thumb Screw	Threaded thumb screw used for the clamp system	1	$5.69	$5.69
4	Rubber Bumper	These can be mounted on a threaded stud, in our case it will be mounted on *Item 3*.	1	$5.38	5.38$
5	Disc Magnet	Will be placed on the bottom of cup holder to help secure 3D printed part to the steel	1	$1.62	$1.62
6	Multipurpose paint	Spray paint used to coat our 3d printed part (**Optional**)	1	$12.81	$12.81
7	Rubber Sheet	A rubber grip is attached to the metal piece of the clamp system that will be attached to the tray to add friction.	1	$8.53	$8.53
8	Hex nut	Used for the clamping system, our threaded thumb screw will pass through it (*Item 3*)	1	$0.20	$0.20
				Total:	$40.23

Table 2. Item and Link for Purchase

Item Number	**Links**
1	N/A (price quote from ottawa metal shop)
2	N/A
3	https://www.mcmaster.com/90200A591/
4	https://www.mcmaster.com/9546K43/

5	https://www.mcmaster.com/5862K147/
6	https://www.homedepot.ca/product/rust-oleum-painter-s-touch-2x-ultra-cover-multi-purpose-paint-and-primer-in-flat-black-340-g-aerosol-spray-paint/1000666129
7	https://www.mcmaster.com/1370N14-1370N143/
8	https://www.homedepot.ca/product/paulin-5-16-18-inch-finished-hex-nut-grade-2-oversized-hot-dipped-galvanized-unc/1000142105

Table 3. Parts List

Part #	Part Name	Description
1	Cup Holder	3D printed from PLA
2	Long Clamp Arm	Milled from steel flat bar purchased from Metal Pros Ottawa
3	Upper Clamp Arm	Milled from steel flat bar purchased from Metal Pros Ottawa
4	Lower Clamp Arm	Milled from steel flat bar purchased from Metal Pros Ottawa
5	Steel Knurled-Head Thumb Screw	Purchased through McMaster-Carr
6	Neoprene Bumper	Purchased through McMaster-Carr
7	Rubber Pad	Purchased through McMaster-Carr and cut to dimension
8	Neodymium Magnet	Purchased through McMaster-Carr
9	Steel Hex Nut	Purchased from Home Depot

Conclusion

Based on the feedback received from our client, we further developed our best design concept into a detailed design that can realistically be manufactured. A detailed bill of materials was then created to have documentation on the materials needed, the cost to ensure we are within the budget, and the quantity of items to purchase. Additional things we considered are the skills required to create the product, the functionality constraints, and the time constraints. We determined that our design was feasible to be manufactured, was within budget, and would be achievable within the time frame we were assigned. Now that we have considered everything related to the final design, we can move on and start building our first prototype. If any issues arise during the prototyping phase, our detailed design and BOM must be adjusted to reflect the revised design which must satisfy the client's needs.

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