GNG2101

Design Project Progress Update

A05 BRC1

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Table 1. Acronyms

Acronym	Definition
BOM	Bill of materials, this is the list of materials needed as well as their costs
BPA	Bisphenol A, a chemical used in the production of plastics
CPVC	Chlorinated polyvinyl chloride, a type of plastic used for similar applications of PVC, just more durable and can survive higher temperature
DFX	Design for X, this is a design philosophy where certain aspects, (X) are paid more attention to during the design process
LCA	Life cycle analysis, this is a form of analysis that covers all impacts of the products throughout its lifetime and before its lifetime.

Table 2. Glossary

Term	Acronym	Definition
Bearing	N/A	A component that facilitates smooth rotation of the cup holder in the final design.
Counterweight rod	N/A	A rod that retracts when not in use, used for smooth movements and balance.
Inertia control mechanism	N/A	A device that controls the speed of movement, especially in the descending motion of the cup holder.
Epoxy	N/A	A strong adhesive to bond materials together
Swivel arm	N/A	Allows the cup holder to rotate between 90 and 180 degrees, making it easier to push out of the way when not in use

1 Introduction

The following document consists of the expected information of deliverable B, C, and D. The outlined tasks of this document include the sustainability report, the design for X, the problem definition, the concept development, the project plan, the detailed design, the BOM, and a project plan update. These topics will give an in-depth look at our project which was to design a cup holder for a client with mobility issues in their arms.

2 Sustainability Report and DFX

2.1 Sustainability report

If our group did not have access to the university facilities, our final product would consist of a latex-free plastic cup purchased from Dollarama. That would be attached to a gooseneck taken off from an adjustable lamp. The cup would then be attached to the gooseneck, and a plastic clamp would be placed at the end that would clamp onto the bedrail. We would sell this product for 60 dollars to make the most amount of profit.

Triple Bottom Line	Positive	Negative
Social	- Constructed from BPA free plastic - Allows people with disabilities to drink from bed	- Targets a very small audience not a lot of buyers
Environmental	- Possibly made from reusable parts (e.g. reading lamp clip+ neck, old cup, etc.…)	- Mostly made of plastic, which emits a lot of CO2 during its fabrication - Latex free plastic used for the cup holder. Latex free plastic is non-biodegradable, recycling plastic is also very inefficient.

Economic	– cost efficient for the company due to utilizing cheaper materials - minimal labour required	- Not accessible to everyone because of the price of the product

Ableware Bedside Beverage Holder

★☆☆☆☆ 1 Review 1 Questions \ 1 Answers

$58.39 Drop-Shipped

Item #: 081121730 | Catalog #: 557190

- Constructed from BPA and latex-free plastic materials, most glasses or cups will fit into the plastic holder, even those with handles
- For frames under 1" in diameter, a plastic reducer is supplied to position on the frame and place the clamp over it
- The adaptive drinking aid assists individuals with restricted upper extremity strength and range of motion while lying in bed or sitting in a wheelchair
- Note that hot beverages should not be placed in the beverage holder as well as a container holding more than 20 oz. of fluid
- The 11" (28 cm) long flexible, chrome-plated gooseneck allows the user to position the cup to a desired, easy-to-access location

https://www.performancehealth.ca/bedside-beverage-holder

(Fig.1.1): Existing Product

Life Cycle Assessment (LCA) of this product:

Goal & Scope: The cup holder will allow people with a limited range of motion to easily and safely drink water in bed. The cup holder will be able to hold a wide range of weights and sizes of cups without any form of failure.

Inventory Analysis: We expect they have a large supply of plastic and chrome-plated goosenecks to keep the cost down. This means supporting manufacturers of goosenecks and producing CO_2 while producing plastic.

Impact Assessment: We can reference the completed LCA for the gooseneck manufacturing and include the kg of CO_2 emissions in our report. When considering plastic manufacturing we can get a report from the manufacturer of the raw plastic pellets and note the kg of CO_2 output of their production. Lastly, we can record the kg of CO_2 produced by the melting and injection moulding of the plastic in house while creating the rail connector and cup holder.

Interpretation: Covering the goal and scope, inventory analysis, and impact assessment, we can see how the goal and scope is reasonable for this kind of product, as well as how the inventory includes all materials necessary for the creation of the product, and lastly the impact of obtaining and manufacturing all these materials.

2.2 Design for X

1- Design for Safety:

The product must be safe to use, handle, and install. Additionally, the product should not fail on the user affecting their safety. This is important as the user may be disproportionally affected by any unsafe design.

2- Design for Usability:

Product must be intuitive and simple to use. The client should not be required to perform any painful or out of range movements when adjusting the position of the cup holder and straw to reach them. This is especially important because the client has limit range of motion due to their disabilities.

3- Design for Reliability:

The product must reliably and consistently work, this is important as the client and prospective future clients may not be able to fix or clean up any sort of failure that may occur in this product.

4- Design for Installability:

The product should be very easy to install with clear instructions and minimal confusion. The product should also be convenient in the sense of only needing one kind of tool to set it up. This is important because the user may have a limited range of motion and not be able to follow complicated installing instructions.

5- Design for Weight:

This product should be as light as possible while still being sturdy enough to hold the weight of the cup. This is because the client needs to easily push the product out of the way before adjusting or going to sleep and may not have the strength if it is too heavy.

3 Problem Definition, Concept Development, and Project Plan

3.1 Problem definition

Design and build a device that attaches to a bed rail and enables a way to access a cup independently while lying down. It must require limited arm strength and mobility for the cup holder to be adjusted. It must be sturdy and accommodate different cup sizes. It must be safe and easy to maintain.

3.2 Concept development

Option 1: This prototype concept consists of a c-clamp that attaches to the head of the bed frame. Attached to the c-clamp is a triangular joint that has an obtuse angle. Attached to the joint is a ball and socket joint gear that allows the counterweight rod to retract when the cupholder is not in use. The counterweight rod will come down when our client pulls the string attached to the rod. When no downwards force is being applied the rod will retract back to its original position because of the counterweight that will be attached to the rod. To control the movement of the we can add an inertia control mechanism which will control the speed that the rod descends at.

(Fig. 3.1): Attaches to the wall

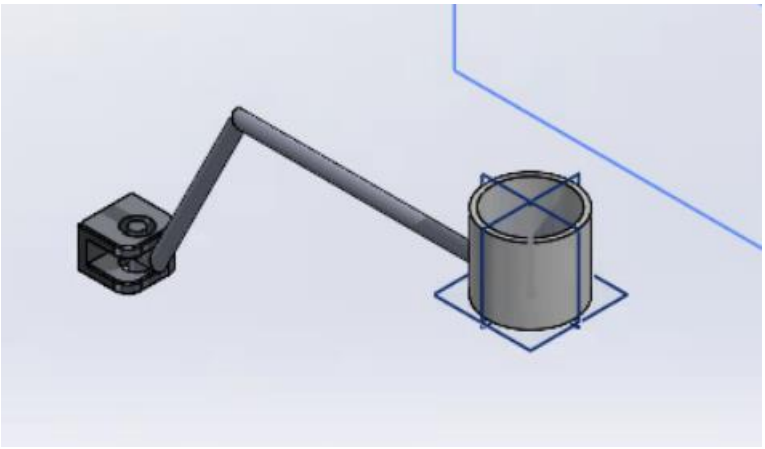
(Fig. 3.2): Attaches to wrist

Option 2: This prototype concept consists of a c-clamp that attaches to side of the bed frame. Attached to that is another moveable rod that can spin 270 degrees and be tucked behind the bed frame when not in use.

(Fig. 3.3): Rotation at 0 degrees

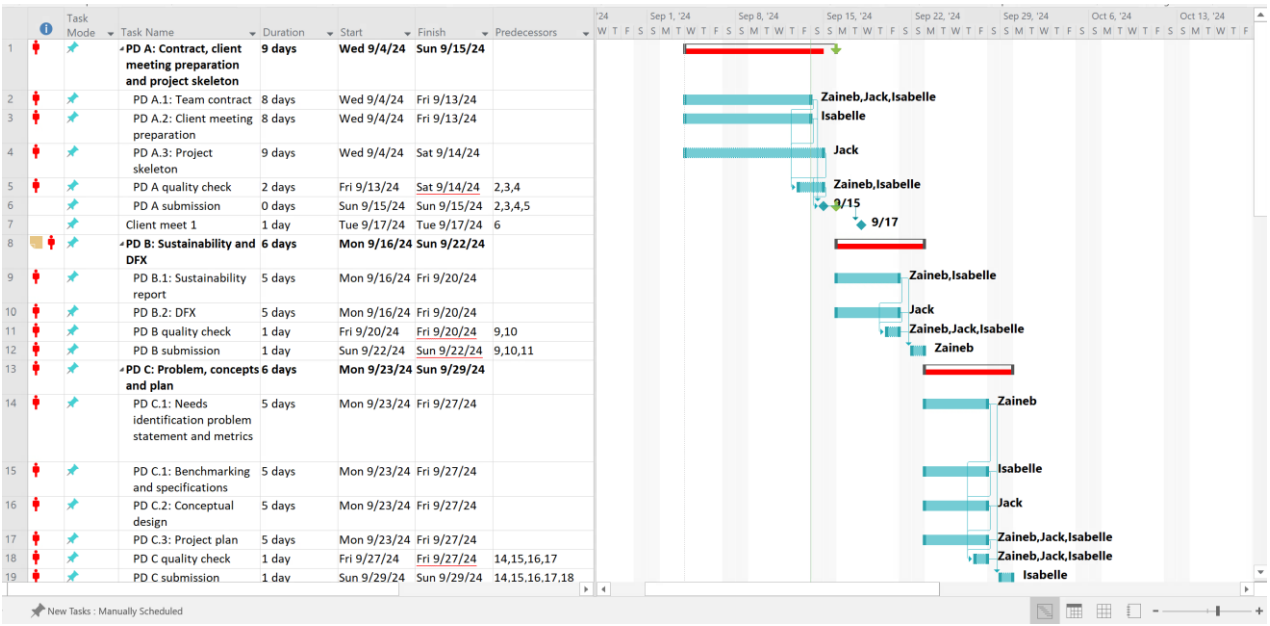
(Fig. 3.4): Rotation at 270 degrees

Option 3: This prototype concept consists of a c-clamp that attaches to the bed rail and can be pushed out of the way when not in use, this will be rigid and will move with a hinge attached to the clamp on the bed rail. The arm will be able to swivel somewhere between 90 and 180 degrees and will be against the wall when not in use. The cup will be positioned close enough to use a straw.

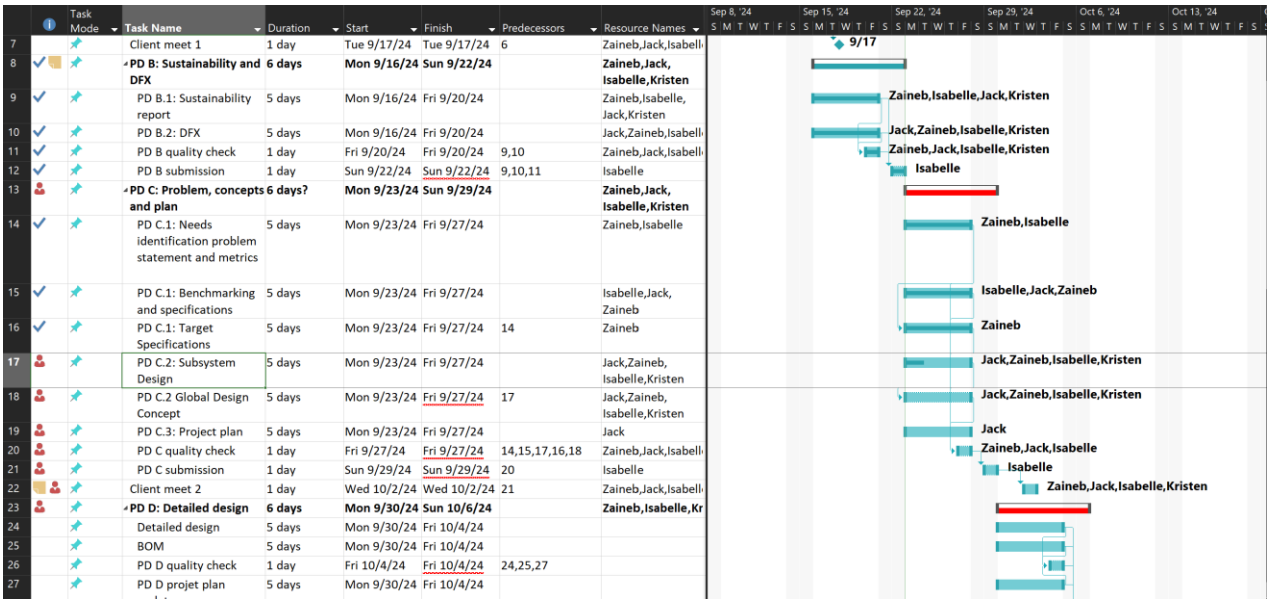


(Fig. 3.5): CAD model of our final prototype

Project plan:



	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**PD A: Contract, client meeting preparation and project skeleton**	**9 days**	**Wed 9/4/24**	**Sun 9/15/24**	
2		PD A.1: Team contract	8 days	Wed 9/4/24	Fri 9/13/24	
3		PD A.2: Client meeting preparation	8 days	Wed 9/4/24	Fri 9/13/24	
4		PD A.3: Project skeleton	9 days	Wed 9/4/24	Sat 9/14/24	
5		PD A quality check	2 days	Fri 9/13/24	Sat 9/14/24	2,3,4
6		PD A submission	0 days	Sun 9/15/24	Sun 9/15/24	2,3,4,5
7		Client meet 1	1 day	Tue 9/17/24	Tue 9/17/24	6
8		**PD B: Sustainability and DFX**	**6 days**	**Mon 9/16/24**	**Sun 9/22/24**	
9		PD B.1: Sustainability report	5 days	Mon 9/16/24	Fri 9/20/24	
10		PD B.2: DFX	5 days	Mon 9/16/24	Fri 9/20/24	
11		PD B quality check	1 day	Fri 9/20/24	Fri 9/20/24	9,10
12		PD B submission	1 day	Sun 9/22/24	Sun 9/22/24	9,10,11
13		**PD C: Problem, concepts and plan**	**6 days**	**Mon 9/23/24**	**Sun 9/29/24**	
14		PD C.1: Needs identification problem statement and metrics	5 days	Mon 9/23/24	Fri 9/27/24	
15		PD C.1: Benchmarking and specifications	5 days	Mon 9/23/24	Fri 9/27/24	
16		PD C.2: Conceptual design	5 days	Mon 9/23/24	Fri 9/27/24	
17		PD C.3: Project plan	5 days	Mon 9/23/24	Fri 9/27/24	
18		PD C quality check	1 day	Fri 9/27/24	Fri 9/27/24	14,15,16,17
19		PD C submission	1 day	Sun 9/29/24	Sun 9/29/24	14,15,16,17,18



	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
7		Client meet 1	1 day	Tue 9/17/24	Tue 9/17/24	6	Zaineb,Jack,Isabell
8		**PD B: Sustainability and DFX**	**6 days**	**Mon 9/16/24**	**Sun 9/22/24**		**Zaineb,Jack, Isabelle,Kristen**
9		PD B.1: Sustainability report	5 days	Mon 9/16/24	Fri 9/20/24		Zaineb,Isabelle, Jack,Kristen
10		PD B.2: DFX	5 days	Mon 9/16/24	Fri 9/20/24		Jack,Zaineb,Isabell
11		PD B quality check	1 day	Fri 9/20/24	Fri 9/20/24	9,10	Zaineb,Jack,Isabell
12		PD B submission	1 day	Sun 9/22/24	Sun 9/22/24	9,10,11	Isabelle
13		**PD C: Problem, concepts and plan**	**6 days?**	**Mon 9/23/24**	**Sun 9/29/24**		**Zaineb,Jack, Isabelle,Kristen**
14		PD C.1: Needs identification problem statement and metrics	5 days	Mon 9/23/24	Fri 9/27/24		Zaineb,Isabelle
15		PD C.1: Benchmarking and specifications	5 days	Mon 9/23/24	Fri 9/27/24		Isabelle,Jack, Zaineb
16		PD C.1: Target Specifications	5 days	Mon 9/23/24	Fri 9/27/24	14	Zaineb
17		PD C.2: Subsystem Design	5 days	Mon 9/23/24	Fri 9/27/24		Jack,Zaineb, Isabelle,Kristen
18		PD C.2 Global Design Concept	5 days	Mon 9/23/24	Fri 9/27/24	17	Jack,Zaineb, Isabelle,Kristen
19		PD C.3: Project plan	5 days	Mon 9/23/24	Fri 9/27/24		Jack
20		PD C quality check	1 day	Fri 9/27/24	Fri 9/27/24	14,15,17,16,18	Zaineb,Jack,Isabell
21		PD C submission	1 day	Sun 9/29/24	Sun 9/29/24	20	Isabelle
22		Client meet 2	1 day	Wed 10/2/24	Wed 10/2/24	21	Zaineb,Jack,Isabell
23		**PD D: Detailed design**	**6 days**	**Mon 9/30/24**	**Sun 10/6/24**		**Zaineb,Isabelle,Kr**
24		Detailed design	5 days	Mon 9/30/24	Fri 10/4/24		
25		BOM	5 days	Mon 9/30/24	Fri 10/4/24		
26		PD D quality check	1 day	Fri 10/4/24	Fri 10/4/24	24,25,27	
27		PD D projet plan	5 days	Mon 9/30/24	Fri 10/4/24		

4 Detailed Design and BOM

4.1 Detailed design

This detailed design is based off the feedback we received from our clients during our second client presentation: The primary feedback provided to us from the client is that the action of pulling on any part of the product is not a viable way for the product to function, this rules out any kind of mechanism in which the client is not in reach, as the pulling motion of getting it closer is off the table. The other primary feedback from the meeting is that the product cannot be mounted to the headboard, the client made it clear that the cup holder was to be mounted to the bed rail, and that mounting the cup holder to the headboard is not a viable option for the final product. The primary changes to be made to the product are to have a mechanism that mounts to the bed rail, and to remove any form of pulling from the design, it is important that moving forward, we both take these considerations into account and that we must account for the reasons behind these restrictions, to keep designing with the client's interests in mind.

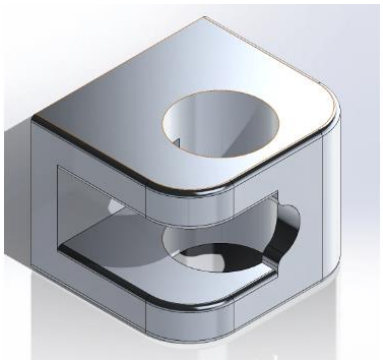
Design Concept:

After presenting the client with design concepts, option 1 and option 2 and taking into account the feedback that was provided we developed our final design concept, option 3 (Fig.). This product will be directly mounted on the bed rail using a c-clamp to replace the see-saw-like design we had initially constructed for the headboard. We will use bearings to ensure that the rod can be pushed or pulled away/close to you. We will focus on the straw to ensure it can easily elongate or collapse and can be bent to a specific angle to allow steady flow of fluid.

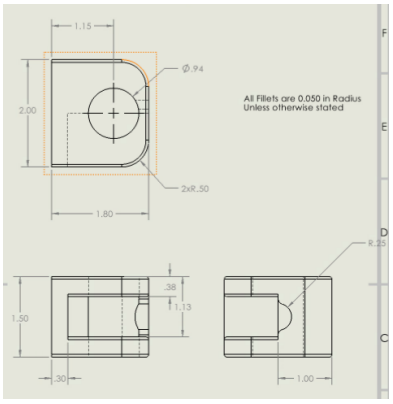
Subsystem Summary and Visual Representation:

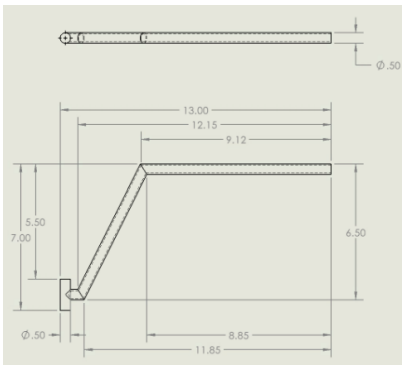
- Subsystem 1 is the clamp- we will use a C-clamp that will be welded to a hinge.
- Subsystem 2 is the hinge- the aluminum hinge will be attached to the CPVC rod
- Subsystem 3 is the rod- the hollow aluminum rod will be short, its purpose is for the cup holder to move away and closer to the client, clearing the bed rail. This rod will be attached to the cup holder by an appropriate epoxy.
- Subsystem 4 is the cupholder- The cupholder will be made by splitting a cup in half, saving the bottom portion and wrapping it in rubber or silicon for the client's safety.

(Fig.4.1.): Subsystem 1: C-clamp

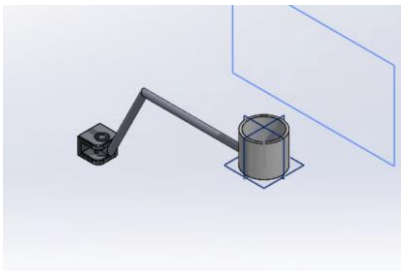


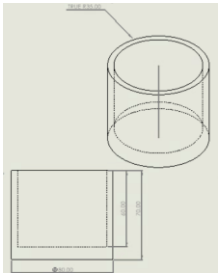
(Fig. 4.2): Subsystem 2: Hinge





(Fig.4.3.): Subsystem 3: Rod





(Fig.4.4.): Subsystem 4: Cup Holder

4.2 BOM

Item	Price	Quantity/Specs	Website
J-B Weld 50139 Plastic Bondre	$15.29	25ml, 3770 PSI tensile strength	https://www.amazon.ca/Weld-50139-Plastic-Adhesive-Syringe/dp/B01IBOK7FE/ref=asc_df_B01IBOK7FE/?tag=googleshopc0c-20&linkCode=df0&hvadid=706759050949&hvpos=&hvnetw=g&hvrand=130311

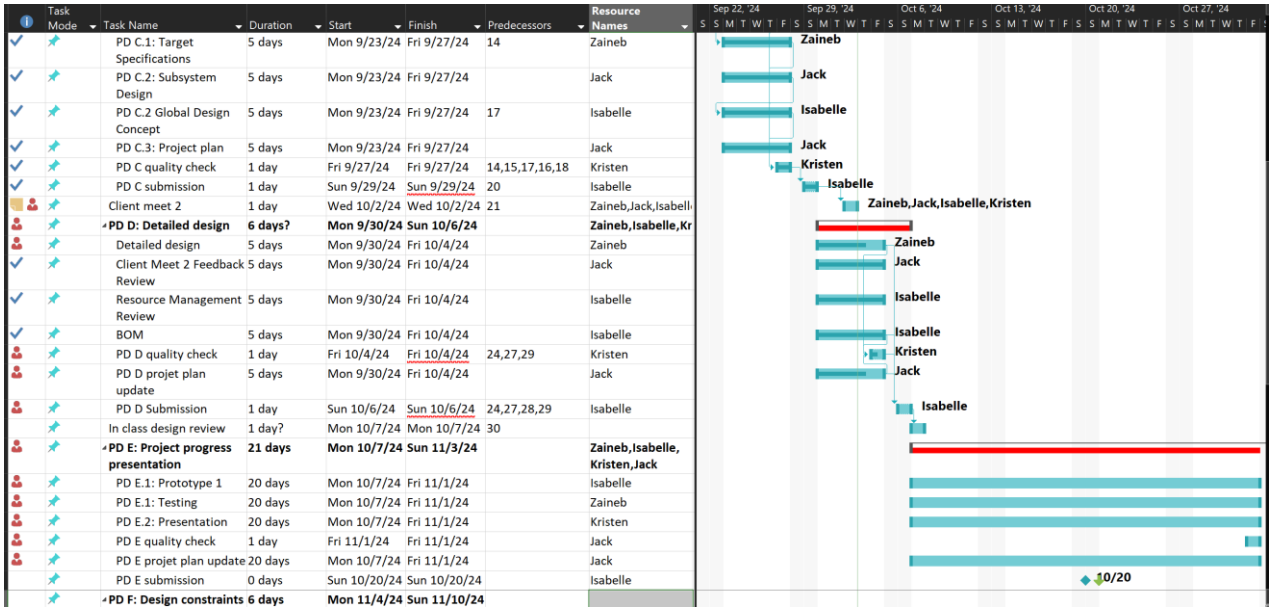
			735263160442 13&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000668&hvtargid=pla-625516023832&mcid=a957c62d98ac37cfa4e2f7ab55e01085&gad_source=1&th=1
Cold Weld Steel Reinforced Epoxy	$11.99	2x28g, Grey, 3000 PSI shear strength	https://www.amazon.ca/Permatex-81374-COLD-COMPOUND-2X28G/dp/B07DYDPDFD/ref=asc_df_B07DYDPDFD/?tag=googleshopc0c-20&linkCode=df0&hvadid=706828597613&hvpos=&hvnetw=g&hvrand=18433224056176346372&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000668&hv

			targid=pla-842425534059&psc=1&mcid=cc532c42064f3a99af332ececd1dbfc8&gad_source=1
CPVC pipe	$4.69	½-in x 5-ft	https://www.canadiantire.ca/en/pdp/bow-cpvc-pipe-1-2-in-x-5-ft-0631903p.html?rq=pvc+pipe
Cupholder	$0 (reused cup)	1	
Aluminium Hinge	Anywhere from $7.81 to $13.20	6” by 24” by 0.020”-0.080” Aluminium sheet metal	https://www.mcmaster.com/products/metals/material~3003-aluminum/corrosion-resistant-3000-series-aluminum-sheets-and-bars/?s=metals+aluminum+3003
Roller Bearings	$3.91x2	2x½-in	https://www.mcmaster.com/products/thrust-

			bearings/roller-bearings~/needle-roller-thrust-bearings/ (Use half inch)
Silicone Cup Sleeves	$9.99	2x, bottom diameter:6cm, top diameter:7cm, blue	https://www.amazon.ca/MECCANIXITY-Resistant-Protective-Anti-Slip-Silicone/dp/B09NM7L97M/ref=asc_df_B09NM7L97M/?tag=googleshopc0c-20&linkCode=df0&hvadid=706840397996&hvpos=&hvnetw=g&hvrand=2469937653980703165&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000668&hvtargid=pla-2259652922538&mcid=e3c05b72919b3173a84c11a319d79bf1&gad_source=1&th=1

C-Clamp	$5.98X2	2x 1-½-in, steel, 750lb clamping strength	https://www.homedepot.ca/product/bessey-cm-series-1-1-2-in-drop-forged-c-clamp-with-1-1-2-in-throat-depth/1000816968
Total	Without HST: $74.96 With HST: $84.70		

4.3 Project plan update



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	PD C.1: Target Specifications	5 days	Mon 9/23/24	Fri 9/27/24	14	Zaineb
	PD C.2: Subsystem Design	5 days	Mon 9/23/24	Fri 9/27/24		Jack
	PD C.2 Global Design Concept	5 days	Mon 9/23/24	Fri 9/27/24	17	Isabelle
	PD C.3: Project plan	5 days	Mon 9/23/24	Fri 9/27/24		Jack
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	PD C submission	1 day	Sun 9/29/24	Sun 9/29/24	20	Isabelle
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	PD D: Detailed design	**6 days?**	**Mon 9/30/24**	**Sun 10/6/24**		**Zaineb,Isabelle,Kr**
	Detailed design	5 days	Mon 9/30/24	Fri 10/4/24		Zaineb
	Client Meet 2 Feedback Review	5 days	Mon 9/30/24	Fri 10/4/24		Jack
	Resource Management Review	5 days	Mon 9/30/24	Fri 10/4/24		Isabelle
	BOM	5 days	Mon 9/30/24	Fri 10/4/24		Isabelle
	PD D quality check	1 day	Fri 10/4/24	Fri 10/4/24	24,27,29	Kristen
	PD D projet plan update	5 days	Mon 9/30/24	Fri 10/4/24		Jack
	PD D Submission	1 day	Sun 10/6/24	Sun 10/6/24	24,27,28,29	Isabelle
	In class design review	1 day?	Mon 10/7/24	Mon 10/7/24	30	
	PD E: Project progress presentation	**21 days**	**Mon 10/7/24**	**Sun 11/3/24**		**Zaineb,Isabelle, Kristen,Jack**
	PD E.1: Prototype 1	20 days	Mon 10/7/24	Fri 11/1/24		Isabelle
	PD E.1: Testing	20 days	Mon 10/7/24	Fri 11/1/24		Zaineb
	PD E.2: Presentation	20 days	Mon 10/7/24	Fri 11/1/24		Kristen
	PD E quality check	1 day	Fri 11/1/24	Fri 11/1/24		Jack
	PD E projet plan update	20 days	Mon 10/7/24	Fri 11/1/24		Jack
	PD E submission	0 days	Sun 10/20/24	Sun 10/20/24		Isabelle
	PD F: Design constraints	**6 days**	**Mon 11/4/24**	**Sun 11/10/24**		

5 Conclusions

Throughout this document, the progress of the bed rail cupholder has been tracked, this has been through the ideation stages, the DFX considered, the visual prototypes, and finally, a detailed design has been compiled. The purpose of this document was to clearly and completely share these stages of the design process and outline the future of the project as it continues development. It has been learned that a client may not fully know what they want, and it is the job of the engineer to design and find the true wants and needs of the client, and what is best for them. The importance of group teamwork and the ability to improvise during client meetings, and to endure after having to restart the process, as well as communicating throughout the process was learned thus far into the project.

6 Bibliography

OpenAi. “ChatGPT.” *Chatgpt.com*, OpenAI, 2024, chatgpt.com.

SolidWorks. “3D CAD Design Software.” *Solidworks.com*, 2018, www.solidworks.com/.