GNG 2101[D]
Project Deliverable C:
Detailed Design and BOM

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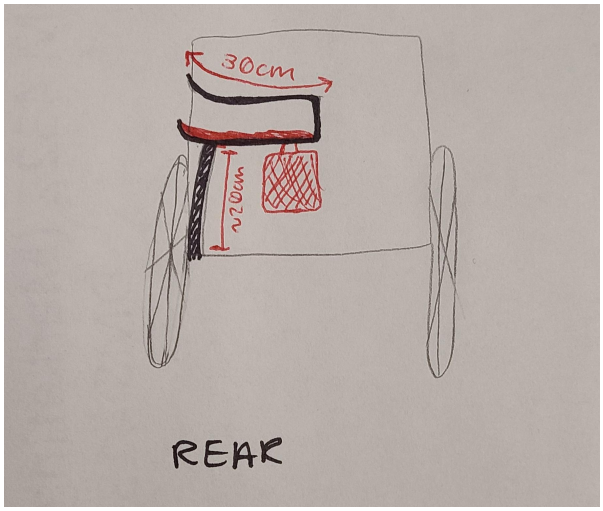
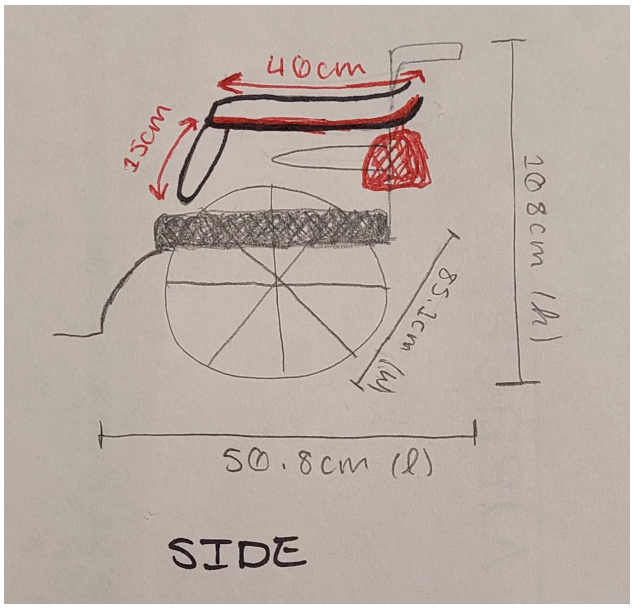
1.0 Introduction

In this deliverable, Group 3.2 will be creating a detailed design and a proposed bill of materials. The second client meet was conducted, resulting in additional feedback on the proposed design from Deliverable B. As a result, a new iteration of the proposed design was created. Additionally, initial conception for the pulley mechanism has been created using CAD. The resources, quantities, and cost to create prototypes are detailed in the new bill of materials.

2.0 Detailed Design

The detailed design was created based on client feedback after the second client meet. The revised detailed design includes a revised mounting system and a shorter travel distance at the rear of the rail. These modifications allow for the armrest to remain usable, and for the bag to have less travel distance when the bag is stowed away at the rear of the chair.





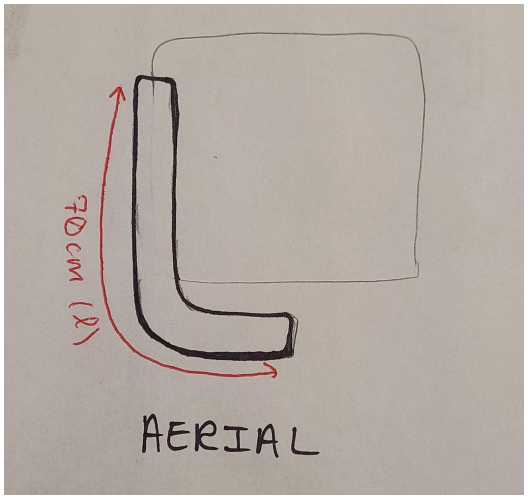


Figure 1 - Third View of The Detailed Design

The tube will be made out of PVC or aluminum; this will be finalized upon further testing and iteration. The bag will travel along the pipe through a slit and its movement will be supported by bearings. The pulley cord will allow the client to access or stow the bag through a curtain-like mechanism. The mechanism will be mounted to the frame of the chair, so as to preserve the armrest usability.

2.1 Client Feedback

The client gave lots of useful feedback and recommendations during the second client meet. They suggested the backpack sit in the middle of the chair to allow the weight to be more balanced and the track could be off centered to allow more distance so the bag would not drag on the ground. It was also recommended that the product sit on the arm rest, however at another point in the client meet it was brought up that the armrests are flimsy making it a less than ideal spot for mounting, in addition the product can't interfere with the motion of the armrests. One of the clients would prefer a powered product as some of the other users may be unable to bring the bag forward using the pulley alone. One of the clients suggested using aluminum instead of PVC piping to make it stronger; the aluminum may also be able to take on the desired shape easier than the PVC. The product itself shouldn't weigh more than ten to fifteen pounds to prevent the chair from flipping. However, it is safe to assume the bag could be emptied before the user leaves the chair. In addition there are tip prevention wheels on the back of the chair. It is necessary for the product to be very reliable with a simplistic option being best. The client also reminded the group to be aware of people and objects around the chair the device could interfere with.

2.2 Detailed Concept Design

To illustrate the design of the wheelchair backpack transfer device in detail, the project team developed a visual representation of the overall concept and defined each subsystem in detail, including how each subsystem is linked to each other. Detailed versions of the assets can be found by following the links provided for the assets in the BOM.

Regarding the overall concept visual diagram, the picture is detailed in *Figure 1*. After market research and analysis, the size of wheelchairs used by most people with disabilities is: rear seat-to-floor height 42cm, wheel diameter 85cm, seat width 45cm, so the current team's size design is based on this data. In general, in order to achieve the goal of transferring the backpack from the back of the wheelchair to an accessible position for the client , the device designed by our team will be mounted on the wheelchair frame and a track system for guiding the luggage that will be moved by the pulley machinery. At the same time, there will not be an effect on the normal use of the wheelchair, for example, it will not cause a shift in the center of gravity of the wheelchair, ensuring the availability of armrests, etc.

The whole device can be roughly broken down into the following subsystems:

Slide rail:

The slide rail will be made of a section of pipe with a ~90 degree bend, a slit cut below the pipe exists, the slit serves to guide the track type movement of the backpack firmware. The inside of the pipe is hollow

and we choose to place pulley sets at the front and back ends and string the pulleys together with a traction rope. Considering the need for durability and lightness, the first choice of materials for the pipe is aluminum or PVC (to be fully decided during the prototyping stage.)

Clamping structure:

Considering how the device transfers the backpack from the user's back to the wheelchair, a clamping mechanism is involved that holds the backpack securely and allows it to be lifted and transferred. The clamping mechanism should be adjustable to accommodate backpacks of different sizes and should have a locking mechanism to hold the backpack in place during the transfer. The design of the team would be similar to the adjustable clamps in coil flipbooks. As the point of contact between the equipment and the backpack, a hard plastic is our first choice considering cleaning and maintenance.

Pulley Set:

The pulley set is the key to ensure the movement of the backpack. The single pulley is driven by two bearings to rotate and fixed by two pieces of metal, the purpose of using bearings greatly reduces the pulling force when the client controls the movement and makes the movement smoother. The two pulleys will be located at the two ends of the slide, and the pulleys will be held in place by a traction rope. The client will pull the traction rope at the front exit of the slide rail and the pulleys will roll.

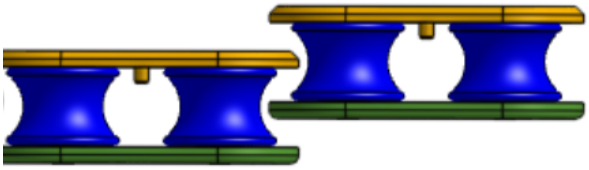


Figure 2 - Initial CAD prototype of the pulley mechanism

Traction rope:

The traction rope will run inside the rail, forming a closed loop by connecting the two pulleys, and the front end of the traction rope will be partially exposed next to the client’s left hand to facilitate the client’s control of the backpack movement.

2.3 List of Skills and Resources

2.3.1 Available Skills and Resources

Groove at the bottom of the slide rail.	Lathe
Assembly of pulley block.	Lathe, mill, weld
Fixed pulley block.	Bolts and nuts.

2.3.2 Missing Skills and Resources

Design of a clamping structure.	3D print
Exposed part of traction rope at the front end of slide rail.	Interview or survey and Testing.
Material selection of traction rope.	Test different materials after assembling the pulley system.

2.4 Time Implementation

In order to use our time effectively and to have a minimum viable product to show on design day, we have decided to split up the project tasks based on our interests and skill sets. A member wants to do most of the pipe manufacturing which they have time to do. Another group member can 3D print needed parts at home, which saves time having to have a group member sit in the makerspace. Another member has agreed to work on a code to control motors using a joystick on an Arduino to conform to the client's preference for electrical operation.

The code will be worked on during reading week, and the machining and 3D printing will be done during the members own time. The group is looking to keep to milestones to make sure that everything stays on track and that critical deadlines are being met. A physical prototype is going to be shown by client meet 3.

2.5 Critical Product Assumptions

Critical product assumptions will be made in order for the project to be built more smoothly. One assumption is that the wheelchair will not flip with the weight of the bag and the product. The group is also under the impression that the wheels will not interfere with the motion of the bag once it is mounted. Another critical assumption the group has made is that the electronic version will not be going outside (will not be made waterproof).

3.0 Bill of Materials

The Bill of Materials details the proposed materials for our prototypes. As well, it details the quantity, price, and source. All together, the current Bill of Materials is expected to be $69.00 CAD.

Part	Price:	Number needed:	Sub total:	Part Link:
Pipe	32.24	1	32.24	https://www.homedepot.ca/product/aqua-dynamic-black-steel-pipe-1-2-inch-x-10-foot/1000126393
Bearings	10.49	1	10.49	https://www.amazon.ca/Miniature-Bearings-Shielded-Bearing-3mm8mm4mm/dp/B0711MRFTY
String	8.58	1	8.58	https://www.homedepot.ca/product/everbilt-5-32-inch-x50-ft-paracord-550-reflective-mixed-colors/1001183706
PLA (3D printers)	0	0	0	
Various nuts and bolts	17.69	1	17.69	https://www.amazon.ca/Washers-Stainless-Industrial-Electronic-Storage/dp/B09Y5RRK26/ref=sr_1_5?keywords=nut+and+bolt+set&qid=1675718040&sr=8-5
			0	
			0	
			0	
		Total:	$69	
Motivation				https://www.amazon.ca/McCaf%C3%A9-Medium-Dark-Ground-Coffee/dp/B08468HMHH/ref=sr_1_6?crid=3AGMIBBYQ9AT4&keywords=coffee&qid=1675718405&sprefix=coffee%2Caps%2C110&sr=8-6

Table 1 - Proposed Bill of Materials

Click here for a link to the spreadsheet.

4.0 Wrike

The Wrike plan was updated to include assignments, milestones, and due dates. Click here for a link to the Wrike.

5.0 Conclusion

In this deliverable, the team created a detailed design based on feedback from client meet 2. This detailed design entails a pulley-rail system, wherein the bag can be pulled forward to access and then backwards to stow. Initial CAD drawings were created to describe the pulley system. An initial Bill of Materials was created, which details proposed materials and their quantities, cost, and sources. The team

will proceed forward with prototyping with special consideration towards skill implementation and knowledge acquisition given time constraints and milestones (i.e., Design Day.) As always, the Wrike was updated to reflect completed tasks and upcoming tasks.