GNG 2101[D]

Project Deliverable B:

Problem Definition, Concept Development and Project Plan

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GNG 2101 D3.2
January 20, 2023

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1.0 Introduction

In this deliverable, Group 3.2 will be defining the problem definition using the tools that we learned in class. We will also be going through the concept development process to find a potential solution. Finally, we will be creating a plan to complete our prototypes in time for design day.

2.0 Problem Definition

2.1 Client Needs

After the first client meet, the client specified a variety of needs relating to ease of use, mobility, mounting requirements, and weight requirements. These needs were developed by recognizing that her current solution was not enough to meet her needs.

- The transfer device must be easily controllable.
- The bag and device must not block the legs.
- The device must help the client to be more independent.
- The bag must go on the back of the chair.
- The bag must be secure.
- The mechanism must be fast and have readily available access.
- The bag must support a decent amount of weight (day-to-day items such as a water bottle, wallet, light jacket, etc.)
- The mechanism must not interfere with electric controls.
- The bag must not swing while mounted to the chair.

2.2 Client Problems

After the first client meet, it was also apparent that the client's current solution of hanging her bag had a variety of problems. Namely, the knapsack was not easily accessible to her, and accessing her bac each time was incredibly time consuming.

- The knapsack bag hangs from its straps on the rear of the chair on the push handles; it is not independently accessible while sitting in wheelchair.
- Ease of access is complex. Getting items from the bag requires transferring oneself from the wheelchair into another chair and retrieving items from the rear of the wheelchair.
- Getting items from the bag is time consuming; transferring chairs is time consuming.
- Independence is difficult; the client must either transfer themselves into another chair (which is time consuming) or ask someone to help them.

2.3 Problem Statement

The client requires a reliable, easily accessible, and secure wheelchair bag transfer solution which can be used on a day-to-day basis on a mechanical or power wheelchair. The goal of this transfer solution is to have personal belongings be readily accessible without bending, twisting, or reaching for them to help preserve the client's independence.

2.4 Benchmarking

Selection Criteria	**Weight**	**Wheelchair Side Organizer** 	**Wheelchair Underneath Storage Carrier** 	**Wheelchair Backpack** 
Purchase Price	0.1	$20.99 CAD **9 (0.9)**	$23.99 CAD **8 (0.8)**	$79.99 CAD **2 (0.2)**
Hanging Mechanism	0.05	Hangs from left armrest **8 (0.4)**	Hangs underneath the chair **3 (0.15)**	Hangs on the back of the chair **0 (0)**
Accessibility (Does it require twisting, bending, reaching?)	0.6	Requires no twisting/bending, may require minimal reaching. Requires zipper operation. **7 (4.2)**	Requires twisting/bending/reaching, especially bending. **1 (0.6)**	Requires twisting/bending/reaching, especially reaching. Requires zipper operation. **0 (0)**
Security	0.05	Not secure; many objects visible. Bag can be seen at all times. **8 (0.25)**	No physical security, but harder to steal from because it requires a thief to go under the client to steal **7 (0.35)**	Objects not visible if bag is zipped up. However, bag is exposed and cannot be seen at all times. **3 (0.15)**
Sturdiness	0.05	Cannot hold large amounts of weight; only small items **4 (2)**	Four points of contact, but fabric bottom may sag. **8 (0.4)**	Very sturdy; purpose-built. **10 (0.5)**
Size	0.15	31.75 x 17.75 cm **4 (0.6)**	35 x 31 x 16 cm **6 (0.9)**	30.5 x 20.3 x 45.7 cm **9 (1.35)**
Total Score		40 – **8.35**	33 – **3.2**	24 – **2.2**

Metrics are rated 1 – 10, 1 being the worst and 10 the best. These metrics were derived from the initial client meet; the client placed emphasis on certain metrics (e.g. accessibility) and less emphasis on other metrics (i.e. purchase price.)

2.5 List of metrics

The list of metrics includes metrics which are critical to the practical use of the prototype. These include size, weight, motion, ease of use, and complexity.

- Size: The device should not excide the footprint of the chair so the client can still fit through doorways and hallways.
- Weight: The device should be light enough to not upset the balance or change the centre of gravity of the chair.
- Motion: The device should stay clear of any electronic controls.
- Ease of use: The controls should be intuitive and easy to operate.
- Complexity: A simple solution will result in lower manufacturing costs and lower risk points for failure.

2.6 Target Specifications

Target specifications allow us to create a best-case scenario for the prototype. Ideally, the prototype will fall within the target specifications in order to allow for more practical use.

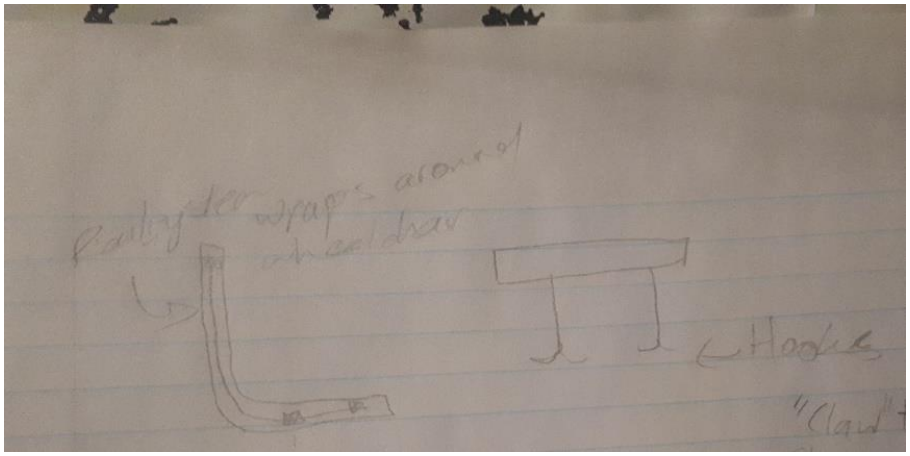
- Size
  - Ideal: ~ 60 in x 30 in x 10 in
    - More compact, less chance to hit or damage something.
  - Acceptable: <80 in x 36 in
    - (Smaller than the average doorframe), including wheelchair.
- Weight:
  - Ideal: ~20lbs
    - Enough to carry some groceries and a couple other items
  - Acceptable: ~15lbs
    - Some items may be heavier than this amount but is approximate weight of a laptop and 3 textbooks.
- Motion:
  - Ideal: Within 20 cm of the controls, must be on the left armrest.
    - Enough room for error not to cause damage.
  - Acceptable: within 15 cm of controls
    - Higher chance of error, but still allows for sufficient error room.
- Ease of Use:
  - Ideal: Very easy
    - Should be operable totally independently.
  - Acceptable: Useable with little difficulty and users require no facilitator training to operate the device.
    - Not enough difficulty to cause damage to the user or frustration with the product.
- Complexity:
  - Ideal: As simple as possible (10 or less moving parts) Less electronics.
    - Cheaper, less points for failure
  - Acceptable: 25 moving parts.
    - More points of failure but may be more user friendly.

3.0 Concept development

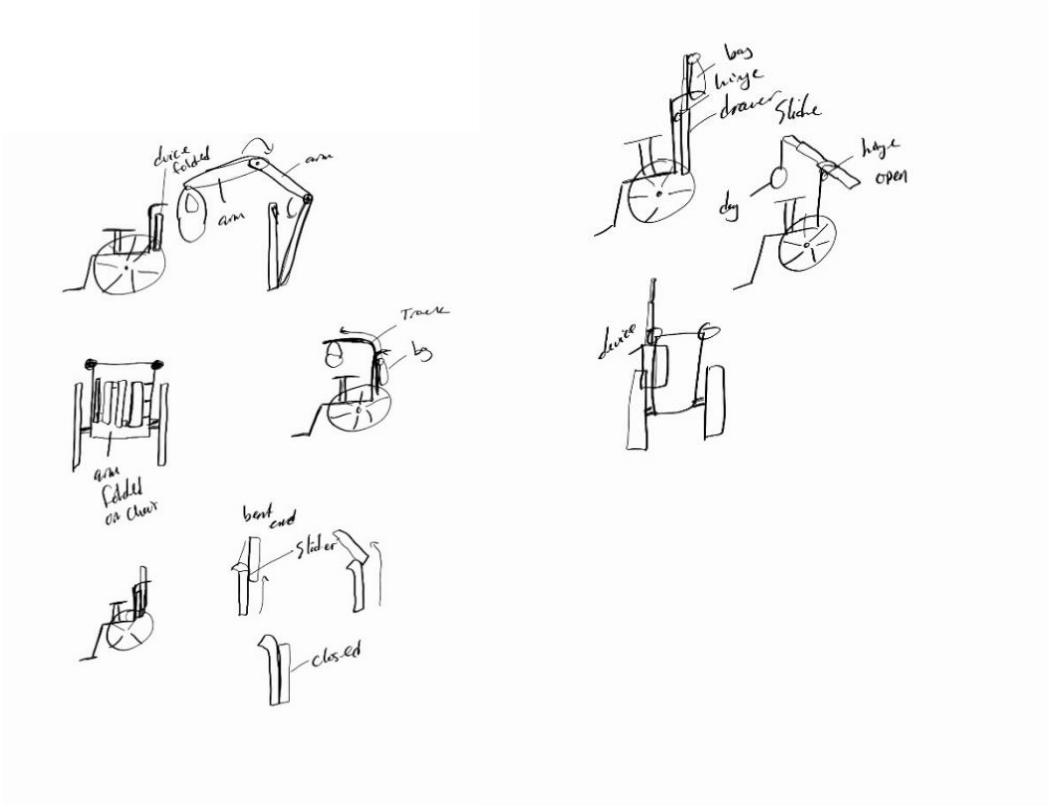
Many concepts were developed during the ideation and brainstorming stage. After considering the prioritised metrics, we combined the best of each prototype to create a final prototype concept.

3.1 Final Prototype Concepts

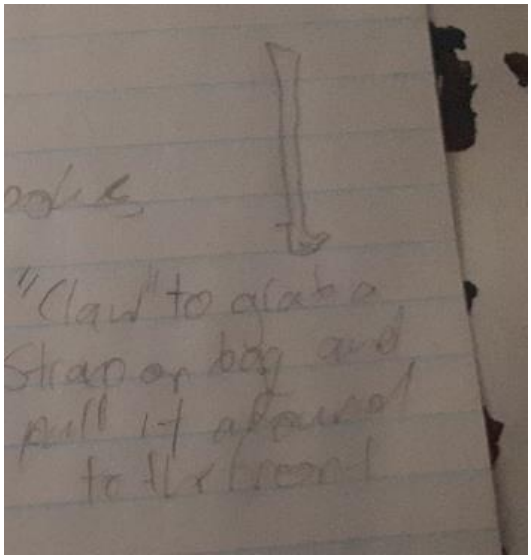
- Movement device
    - Track system: the bag will move along a track



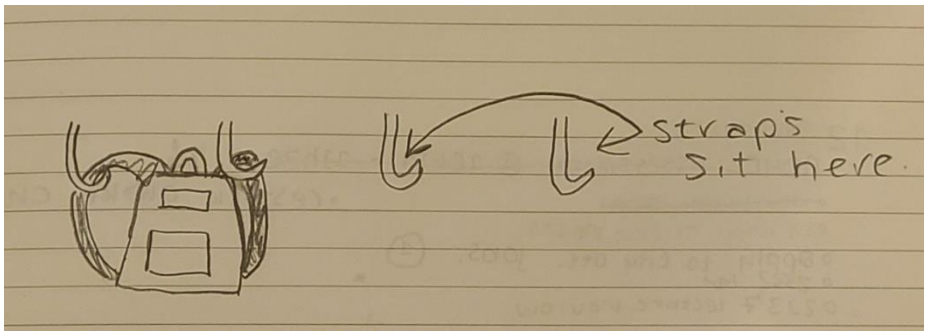
    - Electric\mechanical arm: the bag will be moved with a swinging arm



- Controls
    - Claw: to grab the bag and pull it forward to the back/front.



    - Could have a cord that the operator pulls to get the bag.
    - Hooking system to secure the bag.



3.2 Analysis

Each subcomponent was analyzed to create the best feasible solution. These subcomponents include an arm, mechanical gears, and a track system.

- Arm:
    - Arm has been done before.
        - Terra didn't favour this solution.
    - Could swing into people.
    - Must be electric.
- Mechanical Gears:
    - Would require no power to operate, only a client-operated crank.
    - Many points of failure. If the wheelchair goes over a bump, a gear could become misaligned or fall out.
    - Hard to repair.

- Track System:
    - Would be simple.
    - Could be either electric or mechanical.
    - Could be used fast.

Specification	Weight	Arm	Mechanical Gears	Track System	Claw	Cord	Hooks
Size	0.15	4 – **0.6**	4 – **0.6**	4 – **0.6**	4 – **0.6**	7 – **1.05**	10 – **1.5**
Weight	0.10	3 – **0.3**	3 – **0.3**	6 – **0.6**	4 – **0.4**	8 – **0.8**	3 – **0.3**
Motion	0.10	2 – **0.2**	4 – **0.4**	9 – **0.9**	4 – **0.4**	4 – **0.4**	0 - **0**
Ease of Use	0.40	8 – **3.2**	2 – **0.8**	3 – **1.2**	4 – **1.6**	4 – **1.6**	0 - **0**
Complexity	0.25	7 – **1.75**	1 – **0.25**	8 - **4**	5 – **1.25**	7 – **1.75**	9 - **2.25**
Total		24 - **6.05**	14 – **2.35**	30 – **7.3**	21 – **4.25**	30 – **5.6**	22 – **4.05**

Ease of use is the most important specification; if the client is unable to use the product, the product holds no value. Complexity is the second most important as more points of failure may cause the device to fail more frequently (and thus be unreliable) and become expensive to replace. Size is the next most important specification, as it must not interfere with the user's environment or interfere with where they are able to go. Finally, there are weight and motion, with the max load the arm can carry and as well the motion it takes for the device to make it from the back of the wheelchair to the side.

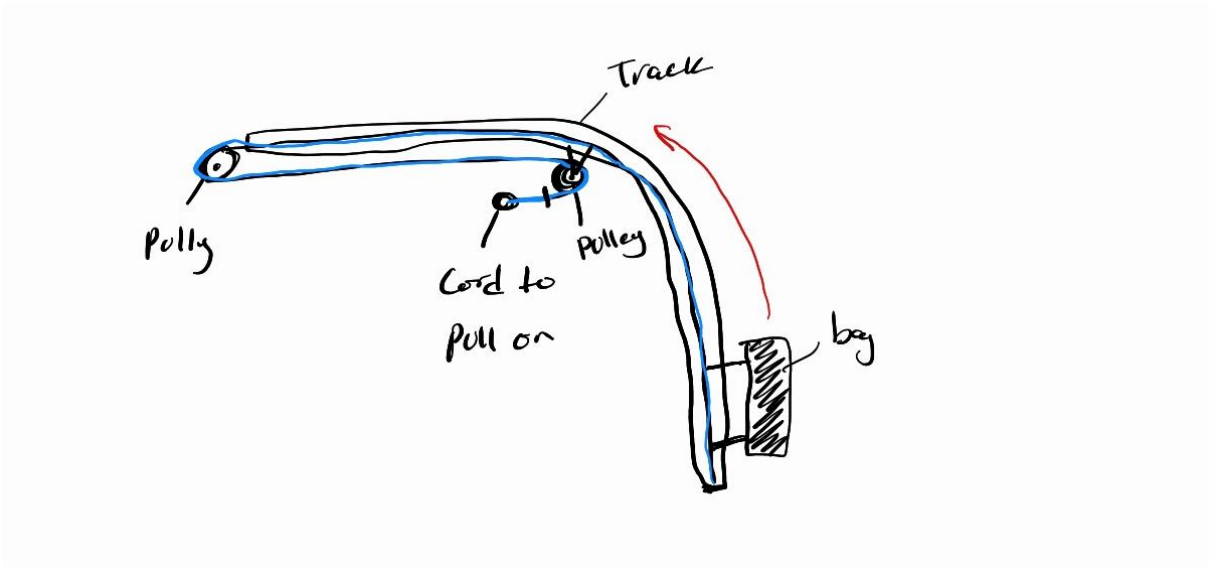
3.3 Selection

The group has decided to use a track system with a cord. As an alternative, the second-best course of action is an arm with a cord.

3.4 Global Design Concept

A track system to guide the bag which will be moved mechanically by a pulley.

3.5 Sketch / Cad



3.6 Explanation

The chosen design modification is a track system that will be moved mechanically by a pulley. Both designs scored highest overall in their subsections as well as in the weight category. A track system will not interfere with the user's ability to get into doorways and the design does not involve any electronics, as per requested by the client. A possible difficulty with this design will involve being able to mount it to a wheelchair with any sort of damage that would void the wheelchair's warranty.

4.0 Project plan (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 problem statement after considering client needs and wants based on the initial interview. Benchmarking was performed to help create a few rough sketches with potential ideas for a final prototype. From these rough sketches, analyses were performed to ideate what an ideal solution might be. Finally, the Wrike was updated with completions and new tasks.