

# **fTeam Deliverable B**

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## 1. Introduction

People all around the world face different types of disabilities which affect their day-to-day tasks. Currently there are existing and developing devices to help people with disabilities to not worry about their limitations and live a 'regular' life. However, there is always room for more improvements and innovations to ease daily tasks. The client is a company of occupational therapist that are looking to facilitate the lives of their clients. Currently, they are looking for an adaptive care tool to mitigate the difficulties of people with mobility limitations. This project will aim to aid people with mobility disabilities, specifically to allow them to take care of toddlers and children. Ideally, the stroller and walker combo will ease the user's life while being as discreet and efficient as possible. The tool will allow the user to navigate and complete their childcare tasks despite their limitations.

This report consists of 6 sections: problem analysis, benchmarking, problem statement, metrics and target specifications, concept development and prototype testing. The Problem analysis section will provide an in-depth analysis of the problem posed by the client. It will present the client needs that were identified during the first client meeting and rank them. Next, the benchmarking section will look at similar products/projects and their users to understand what has worked in the past. This section will focus on taking aspects of other products and fitting them to the client's needs. Afterwards, the metrics and target specifications will provide numerical values and acceptable ranges for the requirement that were identified in the problem analysis. Furthermore, a problem statement will be developed from the information provided in both the problem analysis and benchmarking sections. The problem statement will be extremely useful throughout the design project as it will be a reminder of what the final goal is. With the information and goals from all the previous sections, different sub-concepts will be brainstormed to generate a global concept to use as a plausible solution for the problem at hand. Finally, an evaluation of the final global concept (first prototype) will be completed and analysis of it will be provided.

### B.1 Problem Definition

## 2. Problem Analysis

To achieve a more equitable and inclusive lifestyle it is necessary to first understand the adversities experienced by people with mobility disabilities and/or difficulties, specifically those who tend for children. 2.7 million Canadians over the age of 15 experienced limited mobility or disability, of those some are parents, guardians and/or childcare providers. Facing mobility issues when tending for a child, bring the usual parenthood hardships as well as new obstacle to overcome. However, with the right adaptations and implementations of tools, the struggles surrounding limited mobility can be reduced or ideally be fully mitigated. To finish with a functional and efficient design, we first need to know the usual activities parenthood entails and

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then how the previous may be affected when dealing with mobility issues; once there is an understanding of the problem(s) and adversities, the process of finding a solution can start.

Due to all the previous points, the accessible stroller is going to provide a way to navigate childcare without worrying about their mobility disabilities. It will allow the user to complete all the basic needs and requirements that are present when tending for a toddler.

| USER STATEMENT   | INTERPRETED NEED                                       | ORGANIZATION |
|--|--|--------------|
| “Hoping for a stroller that a parent can use outside and in stores that would benefit their stability, allow for easily slow and stop when needed” | The stroller provides a means for the parents to rest. | Stability    |
| “We’re located in California, so no snow or ice but it should be able to endure rain”  | The stroller operates normally in the rain.            | Durability   |
| “The parents do not go on long walks for long stretches of time”   |  | Mobility     |
| “Families may use be in need of this the system for approximately 2 years before transitioning to a different stroller”                            | System operates as intended over multiple uses .       | Durability   |
| “A lot of the parents do not want to be identified as disabled”  | The design of the walker is discrete.                  | Appearance   |
| “Parents may have limited use of specific parts of their body or fatigue, requiring frequent breaks”   | The stroller provides a means for the parents to rest. | Stability    |
| “Most parents are able to walk to the front of the stroller to take care of their child”   | The parents can easily move around the device.         | Mobility     |
| “It should be comfortable and safe for the child”  | The child is protected and comfortable in the device.  | Safety       |
| “Some parents wanted a brake they could grab and   | The parent can easily access the brake mechanism.      | Mobility     |

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|  |  |            |
|--|--|------------|
| other wanted a brake to push down on”  | The stroller implements an easily accessible hand brake.   |            |
| “Ease of pushing and braking are important... if a small motor helps with this, we are open to the idea” | The device has simplistic technology that is easily operatable.<br><br>Keep the technology simplistic. | Technology |
| “They might want to take long pauses or shorter brakes”  | The stroller can be slowed down and completely stopped from an easily accessible brake.                | Mobility   |
| “They should be able to put their weight on the walker without it having to stop”                        | The parent needs to be able to put their weight on the stroller.                                       | Stability  |
| “The parents don’t want to stand out too much where people start to stare”                               | Design of the walker is discrete.<br><br>The stroller instills pride/normalcy in the parents.          | Appearance |
| “We don’t want the technology aspect to be too much for the parents”                                     | The device is easy to use.<br><br>Keep the technology simplistic.                                      | Technology |
| “Parents want to be able to easily navigate the device above curbs and hills”                            | The device allows easy navigation over curbs and hills.  | Mobility   |
| “It should have storage space for bottles and a diaper bag”  |  | Technology |

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| Interpreted Need  | Organization | Ranking (numerical) | Explanation   |
|---|--------------|---------------------|---|
| The stroller allows the parents to rest                         | Stability    | 1                   | The parent is comfortable.  |
| The stroller operates normally in the rain                      | Durability   | 4                   | Geographic placement.   |
| System operates as intended after multiple uses                 | Durability   | 2                   | Usage over a long period of time.                                       |
| The design of the walker is discrete                            | Appearance   | 3                   | Functionality is important over appearances.                            |
| The parents can easily move around the device.                  | Mobility     | 3                   | The child is always being watched by the parent.                        |
| The child is protected and comfortable in the device            | Safety       | 1                   | The safety of the child should be always ensured                        |
| The parent can brake easily                                     | Safety       | 1                   | Control over the system   |
| The device has simplistic technology that is easily operatable  | Technology   | 5                   | If the user can use the device properly                                 |
| Keep the technology simplistic                                  | Technology   | 5                   | If the user can use the device properly                                 |
| The device allows easy navigation over curbs and hills.         | Mobility     | 1                   | Device should be able to tackle terrain wherever the use of this device |
| The stroller can be slowed down and completely stopped          | Mobility     | 1                   | System control.   |
| The parent needs to be able to put their weight on the stroller | Stability    | 1                   | The stroller can support the weight of the child and the parent.        |
| Design of the walker is discrete                                | Appearance   | 3                   | Stroller instills normalcy in the user                                  |
| The device is easy to use                                       | Ease of Use  | 1                   | Ensures fundamental accessibility                                       |

Numerical ranking from 1 to 5, 1 being the most important and 5 the least.

### 3. Benchmarking

#### Stroller:

Strolling Stones – In the fall of 2022 the *Strolling Stones*, a past GNG 2101 design group proposed “A safety-oriented stroller design with the capacity to support a much higher load than the average stroller”. Their walker-stroller concept was “designed with accessibility in mind to respond to the missing market for parents with mobility challenges, and to empower parents with disabilities” (Strolling Stones – Accessible Stroller, 2022). Good reviews: during client meeting 1, the client expressed their appreciation for the simplicity of this design. Bad reviews: during client meeting 2, the client was disappointed by the lack of a braking system.

UPPAbaby RIDGE All-Terrain jogging stroller – The all-terrain jogging stroller from UPPAbaby is “built for performance, the all-terrain RIDGE jogger goes more places, at all paces.” (UPPAbaby, 2022). This compact and durable jogging stroller features: A weather canopy, disc hand braking, adjustable handlebars, large and robust tires and compact foldability. Good reviews: This product received a rating of 4.5/5 on Strollberry.com. One parent was appreciative of the amount of storage space, comfortable seat and overall durability of the stroller. Bad reviews: One parent on Strollberry.com claimed that the stroller was bulky and cumbersome on uneven terrain.

Baby Jogger City Select LUX stroller – The 2017 all-terrain City Select LUX stroller from Baby Jogger provides active families with a compact, lightweight and braking stroller for on the go. This jogging stroller “is perfect for growing, active families and now folds 30% smaller and comes with all-wheel suspension plus a decelerating hand brake” (Bed Bath and Beyond, 2023). Good Reviews: This product received a rating of 4/5 stars on the Bed Bath and Beyond website. One parent complemented the braking system, adjustable handlebar, amount of storage space, and foldability of the stroller. Bad Reviews: One parent was unhappy that all add-ons had to be purchased separately (eg. Cup holder, parent console, child tray...).

|                                  | <i>Strolling Stones</i>                             | <i>UPPAbaby RIDGE</i>                               | <i>City Select LUX</i>   |
|----------------------------------|---|---|--|
| Cost                             | N/A   | \$949.99  | \$929  |
| Weight Capacity                  | N/A   | 55 lbs  | 45 lbs   |
| Is it weather resistant          | Yes, has weather resistant canopy over the stroller | Yes, has weather resistant canopy over the stroller | Yes, has weather resistant canopy over the stroller                        |
| Does it feature a braking system | No  | Yes, features disc hand braking                     | Yes, features hand operated parking brake and hand brake for speed control |
| Is it compact                    | No  | folded size 18.5” L x 26” W x 36.5” H               | 42.5” L x 23.6 W x 44.8” H   |

Table 1. Stroller Benchmarking

Walker:

Strolling Stones – In the fall of 2022 the *Strolling Stones*, a past GNG 2101 design group proposed “A safety-oriented stroller design with the capacity to support a much higher load than the average stroller”. Their walker-stroller concept was “designed with accessibility in mind to respond to the missing market for parents with mobility challenges, and to empower parents with disabilities” (Strolling Stones – Accessible Stroller, 2022). Good reviews: during client meeting 1, the client expressed their appreciation for the simplicity of this design. Bad reviews: during client meeting 2, the client was disappointed by the lack of a braking system.

LIVINGbasics Four Wheel Walker Rollator – The Four-Wheel Rollator from LIVINGbasics provides reliable support and comfort for those in need of a walker indoors and outdoors. This system features deluxe loop locks for safety, a padded seat and backrest, adjustable handles, and compact sizing for easy storage. Good review: This product was rated 4.5/5 stars on Amazon.ca. Many of the reviews complemented the sturdiness of the walker, and the ease of braking. Bad Reviews: Of the 477 ratings many of the customers were frustrated by the lack of assembly instructions, complexity of the components, and difficulty turning due to lack of wheel rotation (I.e. Left to Right).

U-STEP 2 Neuro-reverse Braking System Walker – This advanced walker from *Just Walkers* was designed to suit those with mobility and neurological conditions. This compact and maneuverable walker features a double-handle braking system that “is easy to use and puts you in complete control” (Just Walkers, 2023), and a setting to control rolling resistance, allowing users to slow the speed of the walker to a pace that suits them. Good Reviews: This product was rated 4.3/5 stars on Amazon.ca. Some positive reviews complemented the foldability of the system, sturdiness, and ease of braking. Bad Reviews: Some customers claimed that the walker was too bulky, wheels didn’t roll smoothly, and price being too steep.

|                                  | <i>Strolling Stones</i> | <i>LIVINGbasics Rollator</i> | <i>U-STEP 2</i>                      |
|----------------------------------|-------------------------|------------------------------|--------------------------------------|
| Cost                             | N/A                     | \$149.99                     | \$605.00                             |
| Weight Capacity                  | N/A                     | 300 lbs                      | 375 lbs                              |
| Is it weather resistant          | Yes                     | Yes                          | Yes                                  |
| Does it feature a braking system | No                      | Yes, deluxe loop locks       | Yes, squeeze and release hand brakes |
| Is it compact                    | No                      | 27” x 22” x 36”              | 42” x 23” x 10”                      |
| Ability to step over curbs       | No                      | No                           | Yes                                  |

Table 2. Walker Benchmarking



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Metrics

| Interpreted Need   | Metric                          |
|--|---------------------------------|
| The stroller provides a means for the parent to rest                                   | Weight (lbs)                    |
| System operates as intended over multiple uses   | # uses / lifetime               |
| The design of the walker is discrete   | Size inches x inches            |
| The parent can easily move around the device   | Device size inches x inches     |
| The child is protected and comfortable in the device                                   | Seat size inches x inches       |
| The parent can easily access the braking mechanism                                     | Time to grab brake: Seconds (s) |
| The stroller implements an easily accessible hand brake                                | Time to grab brake: Seconds (s) |
| The stroller operates normally in the rain   | # uses / rainy day              |
| The stroller can be slowed down and completely stopped from an easily accessible brake | Braking distance (m)            |
| The parent should be able to put their weight on the stroller / walker                 | Weight (lbs)                    |
| The device allows easy navigation over curbs and hills                                 | Curb height (m)                 |

Table 3. Metrics

#### 4. Target Specifications

Target specifications are based after a customer’s needs and metrics are identified. This consists of 4 different concepts which are preparing the list of metrics, collecting information for competitive benchmarking, setting acceptable marginal and ideal target values as well as reflecting on the process and results. These specifications are met explaining the why factor and will be revisited in the future for verification.

| Characteristic     | Unit   | Prefer      | Relation | Target value            |
|--------------------|--------|-------------|----------|-------------------------|
| <u>Width</u>       | Inches | lower/equal | ≥        | 20-27                   |
| <u>Length</u>      | Inches | Lower       | >        | 43-52                   |
| <u>Item weight</u> | kg     | Higher      | <        | 22                      |
| <u>Max Weight</u>  | Pounds | Lower       | >        | 50                      |
| <u>Max height</u>  | Feet   | Lower       | >        | 3                       |
| <u>Storage</u>     | Kg     | equal       | =        | 20                      |
| <u>Breaks</u>      | N      | Higher      | <        | Depending on the weight |
| <u>Cost</u>        | \$     | Lower       | >        | 50-1600                 |
| <u>Curb height</u> | Inches | Higher      | <        | 6-18                    |

Table 4. Target Specifications

#### 5. Problem Statement

After analyzing our customer's needs and benchmarking, we have decided on this problem statement:

Parents who have mobility, stability or endurance concerns find it difficult to navigate different terrains with a stroller while being supported. An adaptive stroller is required to provide support and ease of navigation for the parent.

## B.2 Concept Development

### 6. Concept Development

Based on our problem statement, we have decided to develop final prototype concepts for each subsystem, as well as the entire assembled system required to solve the problem. When considering how to divide into subsystems, we considered the following questions “what are the primary features of the system”, “can any of these primary features be combined to make a larger subsystem” and “can these subsystems grasp the features we want to include in enough detail”. In answering these questions, we were able to divide out concept into 4 main subsystems.

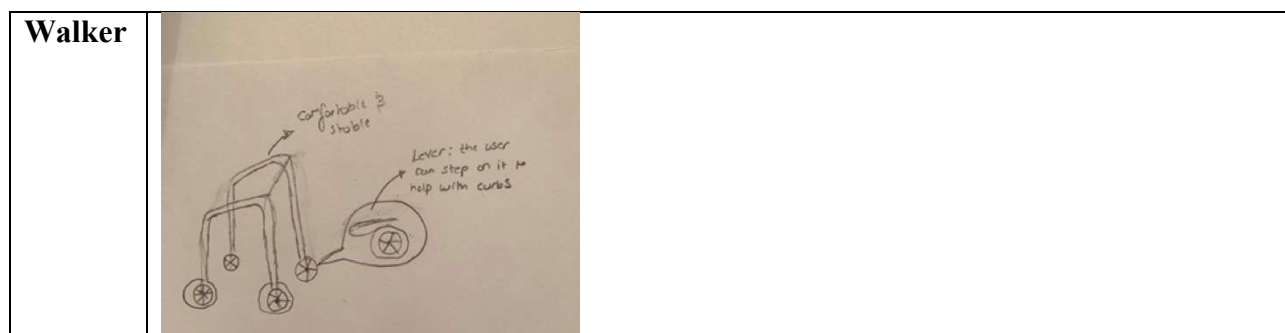
In the walker subsystem, we will highlight any ideas that may pertain to the walker in assistance to the parent. As the parent is a main user of this system, it is important to highlight any features that will be included in the walker to assist them in using this product. In this subsystem, ideas regarding a seat, possible storage, and insight as to how the walker will be attached should be included.

Following, in the stroller subsystem, we will detail any ideas that may pertain to the stroller component. The child being transported in the stroller is the second main user of this system, so it is important that we highlight any features that may improve their experience as well. In this subsystem, ideas regarding child safety, the construction of the stroller, possible storage and connection aspects should be included.


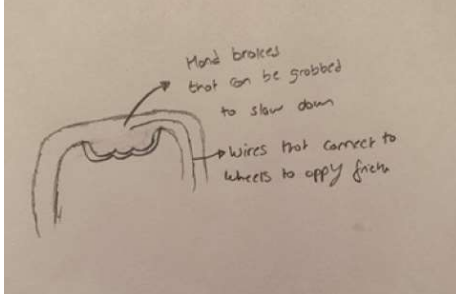
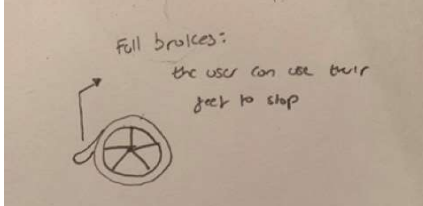
In the slowing brakes subsystem, we will detail how a set of brakes will be able to slow the movement of the stroller without causing it to come to a complete stop. These brakes will allow parents to slow the speed of the system over rough terrain or when feeling the need to slow down. This section should touch on what kind of brakes will be used and how the brakes will be activated.

Finally, in the full brakes subsystem, we will highlight features of a braking system that will allow parents to full stop the movement of the system. This feature will allow parents to stop suddenly if in emergency, or to stop if in need of a break.

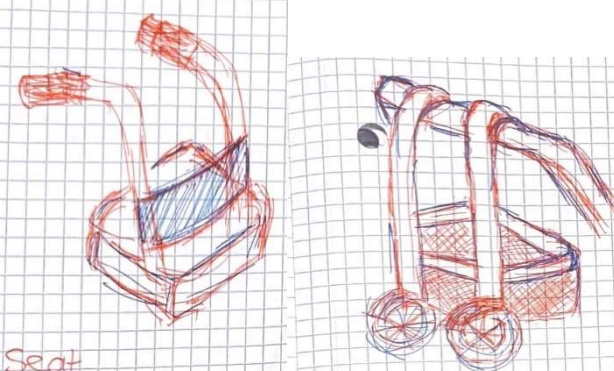
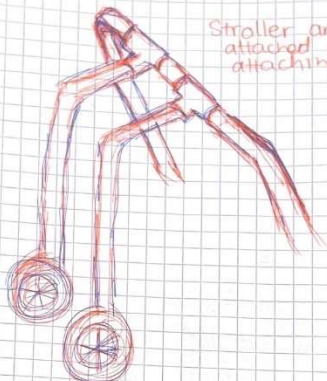
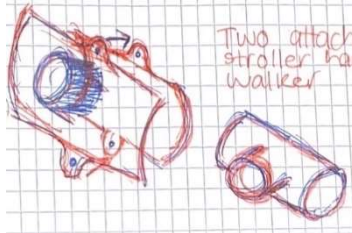
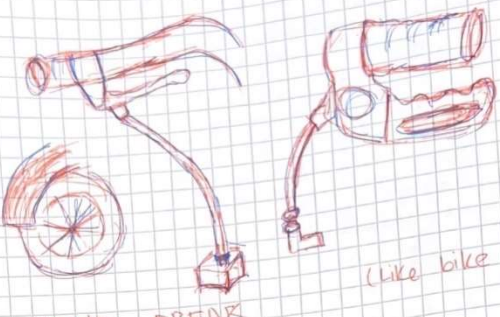
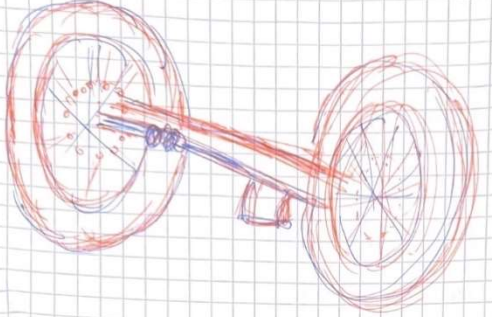
#### Concept 1: Deborah



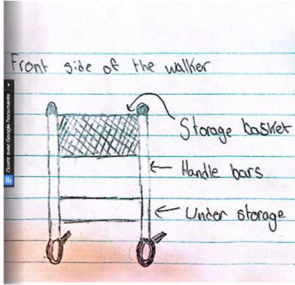
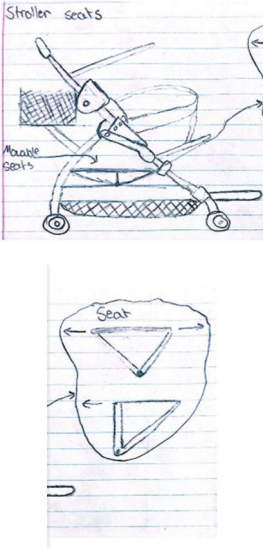
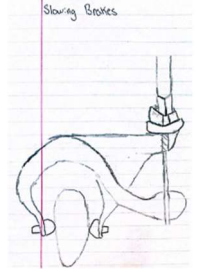

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|                              |  |  |
|------------------------------|--|--|
| <p><b>Stroller</b></p>       |   |  |
| <p><b>Slowing Brakes</b></p> |   |  |
| <p><b>Full Brakes</b></p>    |  |  |

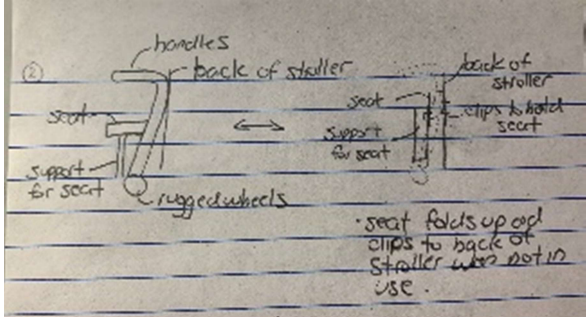
Concept 2: Natalia

|                              |  |   |
|------------------------------|--|---|
| <p><b>Walker</b></p>         |  <p>Seat</p>  | <p>Storage attached to Walker between walker and stroller</p>   |
| <p><b>Stroller</b></p>       |  <p>Stroller and walker attached with T-tube attaching device</p>        |  <p>Two attachable tubes for stroller handle to attach walker</p> |
| <p><b>Slowing Brakes</b></p> |  <p>HAND BREAK (like bike break)</p>                                    |   |
| <p><b>Full Brakes</b></p>    |  <p>STEP BREAK</p> <p>When stepped on, the wheels are fully stopped</p> |   |

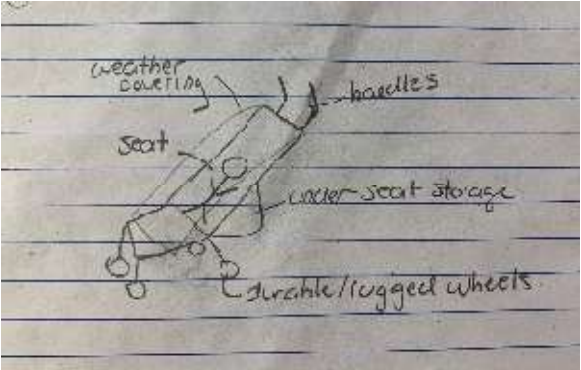
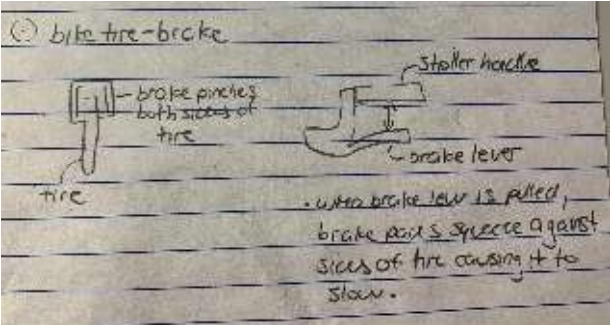
**Concept 3: Rejgar**

| Walker  | Stroller  | Slowing brakes   | Full brakes  |
|---|---|--|--|
| <p>Front side of the walker</p>  | <p>Stroller seats</p>  | <p>Slowing Brakes</p>  | <p>Full brakes</p>  |

**Concept 4: Ginger**

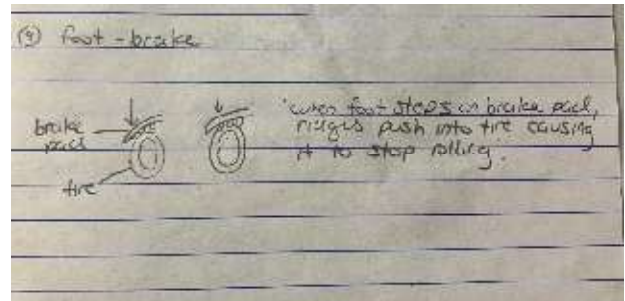
| Walker |  |
|--------|--|
|        |  |

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|                       |   |
|-----------------------|---|
| <p>Stroller</p>       |  <p>A hand-drawn sketch of a stroller on lined paper. The sketch is a side view of a four-wheeled stroller. Labels with arrows point to various parts: 'weather covering' at the top, 'seat' in the middle, 'handle' at the back, 'under seat storage' below the seat, and 'durable/tugged wheels' at the bottom. The drawing is simple and illustrative.</p>   |
| <p>Slowing Brakes</p> |  <p>A hand-drawn diagram of a 'bite tire-brake' mechanism on lined paper. The title is '(c) bite tire-brake'. On the left, a cross-section of a tire is shown with two vertical lines representing brake pads. A label 'tire' points to the bottom of the tire. A label 'brake pinches both sides of tire' points to the pads. On the right, a side view of the mechanism is shown. A 'stroller handle' is at the top, connected to a 'brake lever'. Below the lever, a note reads: 'when brake lever is pulled, brake pads squeeze against sides of tire causing it to slow.' The drawing is a simple technical sketch.</p> |

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Full Brakes





## 7. Concept Evaluations

There are many benefits to conducting formal and informal evaluations of our concepts. We were able to discover the limitations and relative strengths of our concepts. To evaluate our proposed concepts, we held several informal discussions to enumerate the advantages and disadvantages of each concept. For example, Deborah’s concept provided a mechanism for navigating but did not provide a seating subsystem, which we interpreted to be a client need.

### Decision Matrices

Guided by the Three Absolute Indices proposed by David G. Ullman, we created a decision matrix to guide our concept evaluation process. The selection criteria were also created based on the metrics and target specifications agreed upon earlier.

| Selection Criteria   | Concept Options   |                   |                  |                  |
|--|-------------------|-------------------|------------------|------------------|
|  | Deborah’s Concept | Natalia’s Concept | Rejgar’s Concept | Ginger’s Concept |
| Feasibility  | 4                 | 6                 | 5                | 6                |
| Manufacturing Time<br>(Higher number = less time required) | 7                 | 5                 | 6                | 8                |
| Degree to which it meets customer’s needs                  | 5                 | 3                 | 7                | 5                |
| Cohesion of subsystems                                     | 6                 | 9                 | 7                | 8                |
| <b>Total</b>   | <b>22</b>         | <b>23</b>         | <b>25</b>        | <b>27</b>        |

Table 5. Decision Matrix

We then proceeded to use a weighted matrix. We unanimously agreed on the weights for each selection criteria.

| Selection Criteria   | Weights | Concept Options   |                   |                  |                  |
|--|---------|-------------------|-------------------|------------------|------------------|
|  |         | Deborah’s Concept | Natalia’s Concept | Rejgar’s Concept | Ginger’s Concept |
| Feasibility  | 0.3     | 4                 | 6                 | 5                | 6                |
| Manufacturing Time<br>(Higher number = less time required) | 0.1     | 7                 | 5                 | 6                | 8                |
| Degree to which it   | 0.4     | 5                 | 3                 | 7                | 5                |

|                        |     |             |             |             |             |
|------------------------|-----|-------------|-------------|-------------|-------------|
| meets customer's needs |     |             |             |             |             |
| Cohesion of subsystems | 0.2 | 6           | 9           | 7           | 8           |
| <b>Total</b>           |     | <b>2.88</b> | <b>2.88</b> | <b>3.85</b> | <b>4.36</b> |

Table 5. Weighted Decision Matrix

### Evaluation Results

After group discussions and leveraging evaluation tools like the decision matrix, we can derive the advantages and disadvantages of each proposed concept. For example, Deborah's concept addresses the client's need for the stroller to be easily navigable, but it does not address the need for storage. On the other hand, Rejgar's concept provides a solution for the storage needs of the clients but does not address navigation. Each concept has different advantages and disadvantages. It is important to note the cohesion of subsystems in Natalia's concept scored highly in our decision matrix. There is, on average, a two-point difference between the total scores in the decision matrix. This implies that the proposed concepts all have similar viability for the final global concept.

## 8. Final Concept

### Description

After evaluating our concepts, we decided to take a morphological approach to determine our final global concept. We took distinct parts from our individual concepts to create a global concept. We chose this method due to the complementary advantages of our proposed concepts. Using Natalia's mechanism to integrate the various subsystems, we were able to combine the best parts of our concepts to form an ideal one. We chose to incorporate Rejgar's and Ginger's sliding seat features due to their great adherence to our client's needs. For the braking subsystems, we chose Natalia's bicycle-inspired hand brake and ginger's wheel stoppers. Storage was mentioned as a customer need, so our final global design features the storage basket proposed in Rejgar's concept. Finally, to meet the need for navigability, we chose to incorporate Deborah's leaver extension for ease of navigation over curbs.

### Relation to Target Specifications

Our final concept adheres to our target specifications. It meets the characteristics of width, length, max height, and weight because it uses an average stroller that has been approved through safety considerations. This ensures that our system will sustain the weight of an adult

without adding any height to the stroller. To further ensure this weight specification, our final concept includes horizontal bars to promote system stability. It is also within the cost specification because and meets the storage specifications. The final concept has an extra storage basket attached to the walker which can hold the specified weight of items. We will not be able to fully evaluate the degree to which the concept meets the target specifications for the breaks on our device until we prototype it. However, given the weight and height specifications, we project that the target specifications for the breaks will also be met by this final concept.

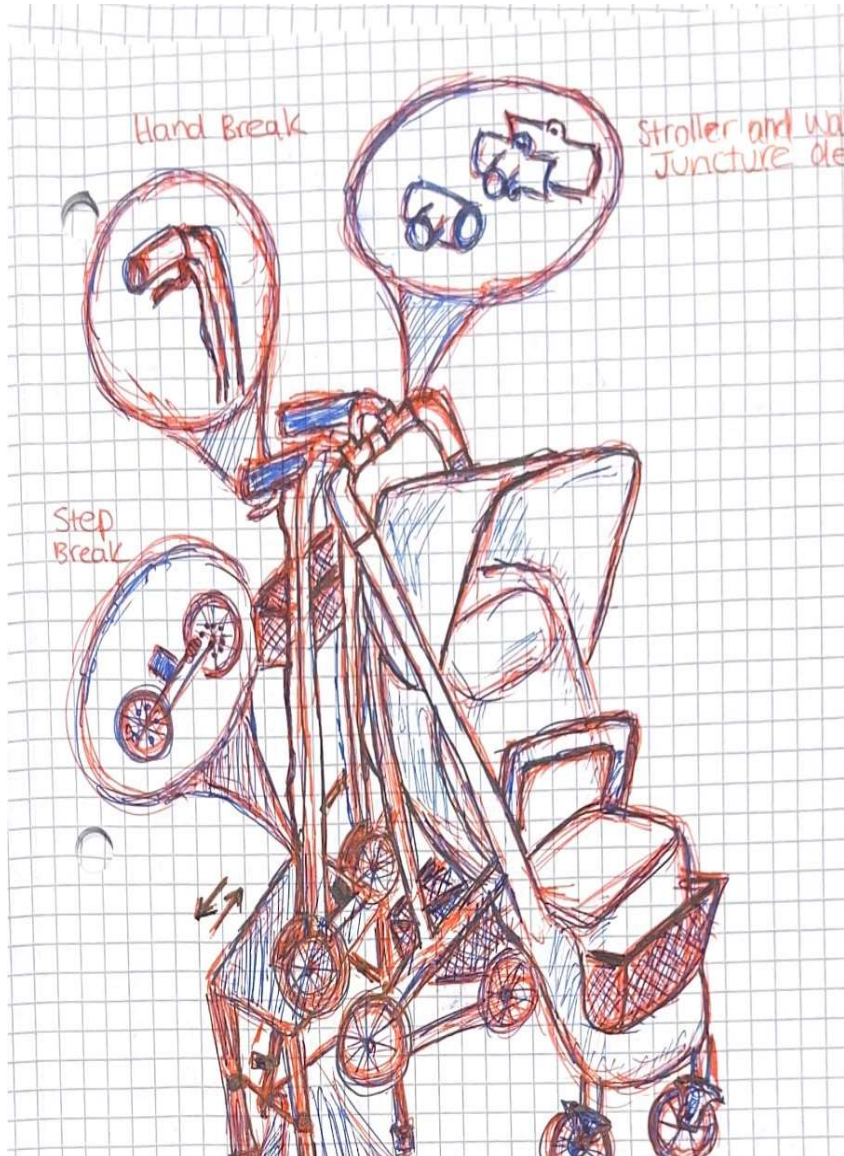
### Evaluation of Final Concept

We understand that there is no “perfect” concept, so it is important to conduct an evaluation of our final concept to find limitations and constraints. This also helps us to address certain disadvantages of our concept for improvements and future iterations. Additionally, it allows us to see what assumptions are being made in our final concept, which is very crucial for prototyping and testing. Analyzing the advantages of our system can help us in our project management because it identifies our unique features and helps direct our focus when prioritizing.

| <b>Advantages</b>   | <b>Disadvantages/Challenges</b>   |
|---|---|
| The attachment mechanism allows parents to use our device with their existing strollers   | We will need to spend some time to design the ideal height and specifications to suit most strollers.   |
| The seating mechanism allows the parent to sit next to their child instead of behind them which makes it easier for them to respond to their child’s needs.                   | The whole adaptive stroller might appear bulky due to the additional features such as the seat  |
| The hand brake for the slow brake subsystem takes inspiration from a bicycle break. The mechanism for this is widely known so this will be advantageous when implementing it. | Requires a lot of cohesion between the various parts we are adding. When manufacturing the various parts, we must ensure that each part always works with the next.                                       |
| This concept builds off the previous year’s attempt which might make manufacturing faster   | Manufacturing time might be a lot depending on how we choose to implement this  |
| There are smaller systems within the subsystems which make it easier to divide tasks and delegate among group members   | The system must support the weight of an adult, this requires strong materials to be used in construction. This might require a bigger budget than we currently have. We must find ways to mitigate this. |
| Most strollers come equipped with Full stop   |   |

subsystems on their wheels, this might help us save time in constructing.

### Final Concept Diagram



### 9. Conclusion

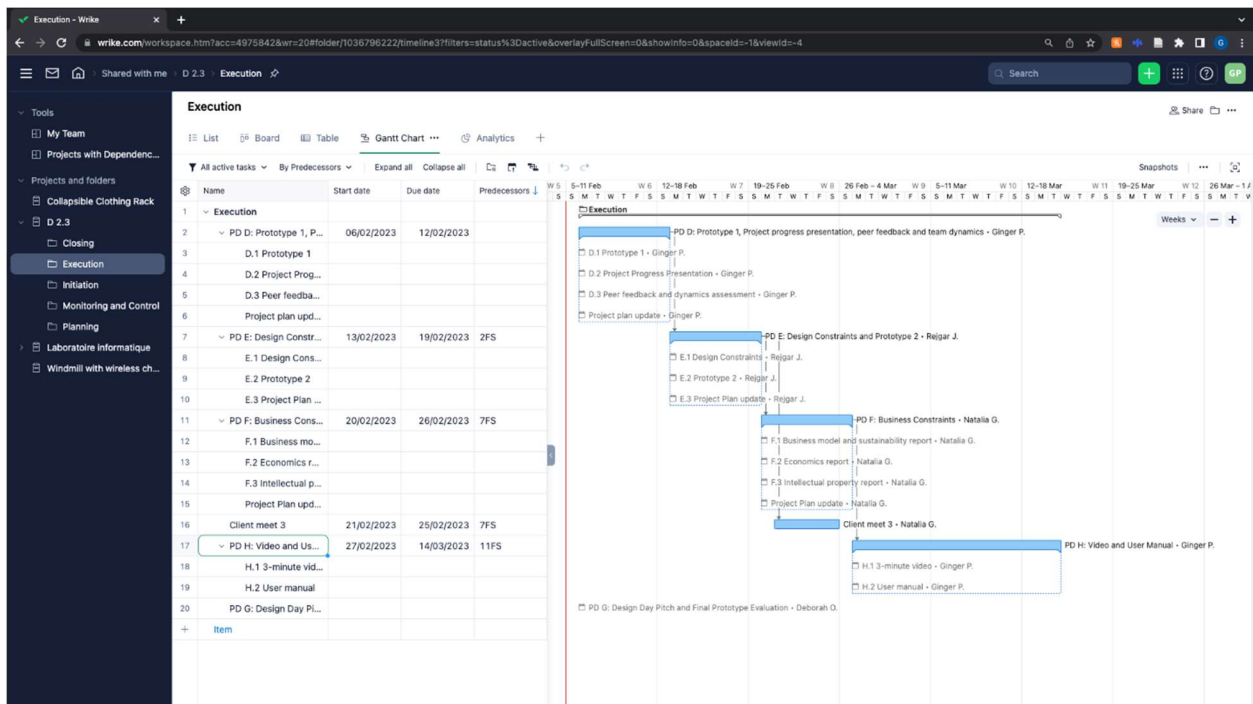
In conclusion, technologies abound to make life easier for people with diverse types of disabilities. As the world advances, so do their needs and desires. We hope to leverage these

## Deliverable B

technologies to develop an adaptive stroller that is conformable and safe for the parents. Strollers are an essential part of parenthood. It is only fair that parents with endurance, mobility, and or stability difficulties also have the right to participate in this fundamental aspect of their child's life. The adaptive stroller we develop should be a source of normalcy for these parents and should adapt to their needs.

Wrike Updated Gantt Chart:

<https://www.wrike.com/workspace.htm?acc=4975842&wr=20#/folder/1036796222/timeline3?viewId=-4>



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