Design Project 4 – Device for Accessible Charging

PHOLOW Charging Case

ENGINEER 1P13 – Integrated Cornerstone Design Projects in Engineering

Tutorial T03

Team Mon-45

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Submitted: April 10th, 2024

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The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

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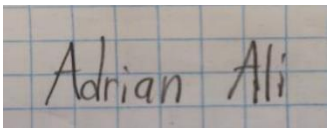
Adrian Ali 400504055



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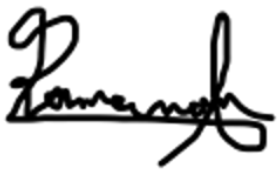
Aarudra Ramanan 400518109



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Executive Summary

While there have been many advancements to improve accessibility for wheelchair users, many problems persist. Our project was centered on addressing a specific issue: outlet reach for wheelchair users. Being that most outlets are located either too high or too low, we designed a device that attached directly to the wheelchair and allowed for wireless phone charging [1].

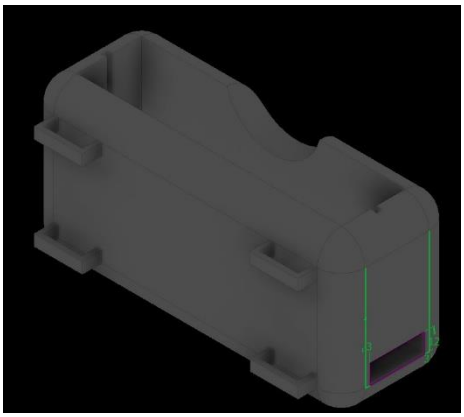

Figure 1. Final Prototype

Our solution attaches to the wheelchair handle—on the client's dominant side—using adjustable straps. As seen in *Figure 1*, there is a slot for the phone and the wireless charger, allowing the phone to charge immediately after being placed in the holder. The slits on the side prevent overheating by allowing for proper air flow; the angled covers block elements from getting into the box. This prototype serves not only as a phone charger, but also as a storage compartment for the client's phone—being that they usually place it on their foot holder or holds it [1].

This design solves the client's issue in a seamless way, allowing them to live their life without going out of their way to find accommodation for this issue; rather than attempting to change existing systems, our approach focused on finding a solution that could be used anywhere, anytime. The benefit of this design is that it provides the client with a convenient and portable solution, for an issue they experience every day [1].

In the future, this design would be modified to be more versatile in its use: to be used both as a charging station and as storage. This would be done by modifying the model to be smaller—to allow for more compartments or pockets. Ideally, we would use carbon fiber for the design as it would have better structural properties and remain lightweight [1].

Background Information

Our client suffers from a birth defect called spina bifida. Spina bifida occurs when the neural tube fails to fully close during fetus development in the womb. This condition can result various challenges: learning disabilities, issues with controlling the bowel and bladder, joint and muscle irregularities, and much more. For our client, spina bifida has led to paralysis in the lower body and limited mobility in the upper body. To address these mobility limitations, the client relies on a wheelchair for local movement, but this solution presents different issues [1].

In indoor environments, our client struggles with finding accessible power outlets due to the loss in physical height and impaired upper limb mobility. In outdoor environments, regular environmental stressors cause issues in wheelchair hardware as the client's geographical location experiences both warm and freezing temperatures. Furthermore, the client suffers from an allergy to latex which must be considered when designing instruments with which the client will make physical contact. The client expressed they experienced a lack of convenient space when carrying objects around, as the wheelchair has very little built in storage functionality [1].

Problem Framing

The client expressed discomfort with both storing and charging their phone while outside of their house. Our research revealed that most individuals with limited mobility experience such problems. For this reason, through the development of our device, we aimed to fix this problem by creating a design that simultaneously secures the placement of a user's phone and charges it.

For our design's objectives and constraints, we collectively decided to accomplish the following with our design:

1. Temperature controlled: The main electronic components that our design is meant to hold (power bank and phone) are both prone to overheating. Given that the client may experience discomfort with touching and moving around hot objects, it is important for our design to be well insulated; in such a manner that touching the case from the outside does not transfer any of the heat from the internal components.
2. Convenient: The design needs to be convenient to use; eliminate an existing problem rather than create more difficulty. For the context of our design, we define convenience to be a state in which our design positively impacts and improves the client's workflow—our design had to be easy to use and helpful.
3. Portable: A requirement for this design was to somehow integrate it into the client's wheelchair—therefore the design should be portable, lightweight, and small enough not to obstruct the wheelchair's path.
4. Aesthetically Customizable: The client expressed an innate desire to customize items they own. For this reason, we decided to focus on giving our item the ability to be modified and customized to the user's liking. This entails having large empty space for stickers, paint, and general decor.
5. Durable: Given that the case would be attached to the client's wheelchair—and would be subject to a lot of vibration—it would need to be durable. Especially the design is meant to hold and secure a user's phone, it is of utmost importance for our design to not only be able to handle extreme weights, but also last a significantly long time.
6. Cost: Given that the goal of this project is to create a realistic design that is usable by our target consumers in their life, we put a constraint on the cost of our design.

Conceptual Design

Ideation:

Function	Means			
Hold Phone Securely	Pocket	Strap	Cup-holder	Phone stand
Charge Phone Safely	Attached portable charger	Separate section that holds charging cable	Outlet extender/Reacher	Wireless charging
Attach to wheelchair	Magnets	Velcro	Buckled with tightener	Hook (metal can be adjusted)

Figure 2 – Morph Chart

To design a solution that incorporated our objectives and worked around our constraints, we created a morph chart—as seen in *Figure 2*. This allowed us to explore potential ideas: a pencil case with a strap and charging cable, a hanging case with a portable charger, and suspended velcro box with wireless charging.

Criteria	Weighting	Pencil Case with Strap		Hanging Case		Hanging Case with support		Suspended ÷ Velcro Box	
		Score	Total	Score	Total	Score	Total	Score	Total
Secures phone	**5**	4	20	5	25	5	25	3	15
Charges Phone	**3**	3	9	5	15	5	15	5	15
Weather Resistant	**4**	3	12	5	20	5	20	5	20
Ease of Access	**4**	5	20	3	12	3	12	3	12
Provides extra storage	**1**	5	5	1	5	1	5	0	0
Durable	**3**	3	9	5	15	5	15	5	15
Customizability	**1**	4	4	5	5	5	5	4	4
Portable	**5**	5	25	5	25	5	25	5	25
Total	-	-	104	-	122	-	122	-	106

Each design yielded different strengths and weaknesses, which we classified by how well each design aligned with our objectives--using the decision matrix from *Figure 3*. The pencil case with a strap, scored well in the 'ease of use' category but suffered in 'charging efficiency' and 'durability'.

Figure 3 – Decision Matrix

The hanging cases both secured the phone well: ensuring security and safety of its contents. They also charged the phone quickly but were slightly harder to use and access. The suspended velcro box was especially durable and weather resistant but at the expense of being harder to use. We decided a hanging case was our best option, as this prototype struck the best balance between portability, durability, weather resistance, security, and customizability. We combined the strap from the hanging case for security, the wireless charger for increased accessibility, the hard case of the velcro box for durability, and the open design of the pencil case for accessibility.

Existing Ideas/Solutions (commercial products):

Figure 4 - NEWDERY Battery Case [1]

There exists no direct competitor to our product, however there are similar products that use different ideas to accomplish a similar task. NEWDERY Battery Case—*in Figure 4*—is a phone case that was designed with a battery inside it to prolong the usage of the device without needing to recharge. Although users do not need to recharge their phones at outlets as often, it significantly increases the weight of the device; which may be especially troublesome for those with reduced mobility. Furthermore, this design does not provide additional storage on the wheelchair, which was one of our major objectives, and is not very user customizable, as it can only be purchased in the color grey.

Design Evaluation:

After testing the first iteration of our product, we noticed many necessary refinements: the phone wasn't easy to take out, weather elements could enter, and high external temperatures could become an issue when charging the phone. We received feedback from IAIs that having a cover would reduce the risk of water infiltrating our device in extreme weather, and that it should be a watertight solution. Thus, we added a clear lid, that is easy for the client to open and take out. To resolve the overheating issue, the IAIs suggested that we create air ventilation holes that keep water out but allow for passive cooling. We added ventilation ducts on the side of our product with inclined ramps to prevent water from entering while dissipating heat. Additionally, a divider was added in to reduce heat transfer from the wireless charger to the phone. To make the phone easier to take out, we increased the divot size on the side.

Final Proposed Design

Figure 5. Finalized Design

The finalized design (Figure 5) incorporates a detachable partition, that is used to separate the phone from the portable charger. This feature mitigated potential heat transfer from the portable charger to the phone. The design also integrates ventilation apertures on either side of the model to facilitate airflow, while having slanted components to prevent water from entering the compartments. Additionally, the design has a detachable lid allowing the client convenient access to their phone. To ensure the accessibility of charging the portable charger, a charging hole has been positioned on one of the sides of the design for easy connection of the charging wire. This way, the client can easily charge their portable charger without having to take it out of the model. To safely secure the design of the wheelchair, a strap-based mounting system has been implemented which prioritizes ease of use and safety.

To make the design, the main container piece and the detachable partition were both 3D printed. The lid was manually shaped using multiple pieces of plastic fused to form one piece. To secure the lid onto the container, two holes were punctured into the lid to allow for the threading of two ribbons, which were then fastened to the container. The 3D printed parts cost $18, the plastic lid cost approximately $2, and the wireless charging bank cost $31.77, which made the total bill of all the materials to be approximately $51.77.

To assess how durable the model was, a weight-bearing test was to make sure the design could support both the phone and the charger without structural compromise—this was done by applying loads of 25kg – 45kg. This evaluation helped to ascertain the design's capacity to withstand different pressures without deformation or structural compromise. In the material selection process, a Granta chart was used to examine Young's Modulus of different materials to determine the most suitable option within our project constraints. The two materials chosen were Carbon Fiber and ABS. While Carbon Fiber had a higher Young's Modulus, we prioritized balancing performance and cost-effectiveness instead. This resulted in our group opting for ABS due to its favourable cost-efficiency and reasonably acceptable Young's Modulus.

The assessment of the design's portability was executed through manual evaluation by our group members to establish the ease of attachment and detachment from a chair. Given the qualitative nature of this testing plan, a scale ranging from 1 to 10 was implemented. The evaluation of this test yielded a score

of 8.25 out of 10 for the ease of attachment and detachment, which gives insight into the expected user experience with the product.

To test how user-friendly the initial design was, we surveyed Design Studio groups on their experience using the model: how easy it was to insert and take out the phone from the compartment. The groups were selected to mitigate any potential bias stemming from personal relationships. However, given the notably low average rating of 4 out of 10, it was evident that adjustments were necessary to facilitate better accessibility. Our group solved this problem by enlarging the slot for phone retrieval. This resulted in a new average rating of 8 out of 10.

The level of aesthetic customization was tested by conducting a survey administered to the same participant groups by querying them on the degree of freedom they perceived in tailoring our design to suit their individual preferences. The results gave us an average rating of 8.5 out of 10 which indicated a high level of aesthetic adaptability inherent in our design. This let our group know that our design created will let the client be creative on how they want to display such a design on the side of their wheelchair.

To establish how good of an insulator ABS is, we evaluated the thermal behaviour of the phone compartment by placing a heated object into the battery compartment. The heated object was generated by putting a phone through a stress test, inducing the overheating. With the phone reaching a temperature of 44 degrees Celsius, it was placed within the phone compartment for 30 minutes to monitor the resultant temperature rise within. Our findings show that in an ambient temperature of 20 degrees Celsius, the highest recorded temperature (within the phone compartment) reached 28 degrees Celsius when subjected to a 44 degrees Celsius load in the battery compartment. This test showed the effectiveness of the insulation of ABS, which influenced us to decide to use ABS as the material of choice.

Conclusion

Looking ahead, if given more time on this project, we would redesign the lid. The lid we created was poorly designed and did not fit well. Moreover, our design has a hole on the side for charging the power bank—this presents a potential risk since water and other elements can get inside at that point. With more

time, we would certainly create either a stopper, or completely rethink the charging for the power bank, in a manner that keeps the internal components of our design safe.

Regarding our testing plan with this project, one of the most significant problems that arose with our earlier prototypes was the size of our design. That is, the model was not big enough to accommodate for a space in which the power bank could be charged. For this reason, we prioritized functionality and submitted a final design that was bigger; however, the problem with the bigger design is that it results in a steep drop for portability which is one of our primary objectives. For this reason, if this project were to be built upon further, it would be best for us to revisit the entire design to not take up as much space on the wheelchair arm. One immediate and obvious solution would be to stack the power bank and phone in a vertical system, which would reduce the amount of space the design takes up across the arm.

The biggest takeaway from this project was the experience we gained from finding a specific problem and devising a method for solving it. If we were to do a similarly structured project in the future, the main thing all of us agree on would be to create prototypes early. A lot of these problems exist in such a form that we, as the designers, managed to oversee. A prime example with this project would be the lack of space within our power bank compartment. If we created prototypes much earlier, we would have found and resolved this issue well before our final design's due date.

Reference List

[1] "P4 Project Module" class notes for ENGINEER 1P13B, Department of Engineering, McMaster University, Winter 2024

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Appendices

Appendix A: Supporting Documents

Objective:	Temperature controlled
Unit/Metric:	Celsius
Objective:	Convenience
Unit/Metric:	Subjective Surveying
Objective:	Portable
Unit/Metric:	Weight (kg) / Size (m)
Objective:	Aesthetically Customizable
Unit/Metric:	Customizability
Objective:	Durable
Unit/Metric:	Young's Modulus
Constraint:	Cost
Unit/Metric:	Dollars ($)

Criteria	Weighting	Pencil Case with Strap		Hanging Case		Hanging Case with support		Suspended ÷ Velcro Box	
		Score	Total	Score	Total	Score	Total	Score	Total
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Charges Phone	**3**	3	9	5	15	5	15	5	15
Weather Resistant	**4**	3	12	5	20	5	20	5	20
Ease of Access	**4**	5	20	3	12	3	12	3	12
Provides extra storage	**1**	5	5	1	5	1	5	0	0
Durable	**3**	3	9	5	15	5	15	5	15
Customizability	**1**	4	4	5	5	5	5	4	4
Portable	**5**	5	25	5	25	5	25	5	25
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Function	**Means**			
Hold Phone Securely	Pocket	Strap	Cup-holder	Phone stand
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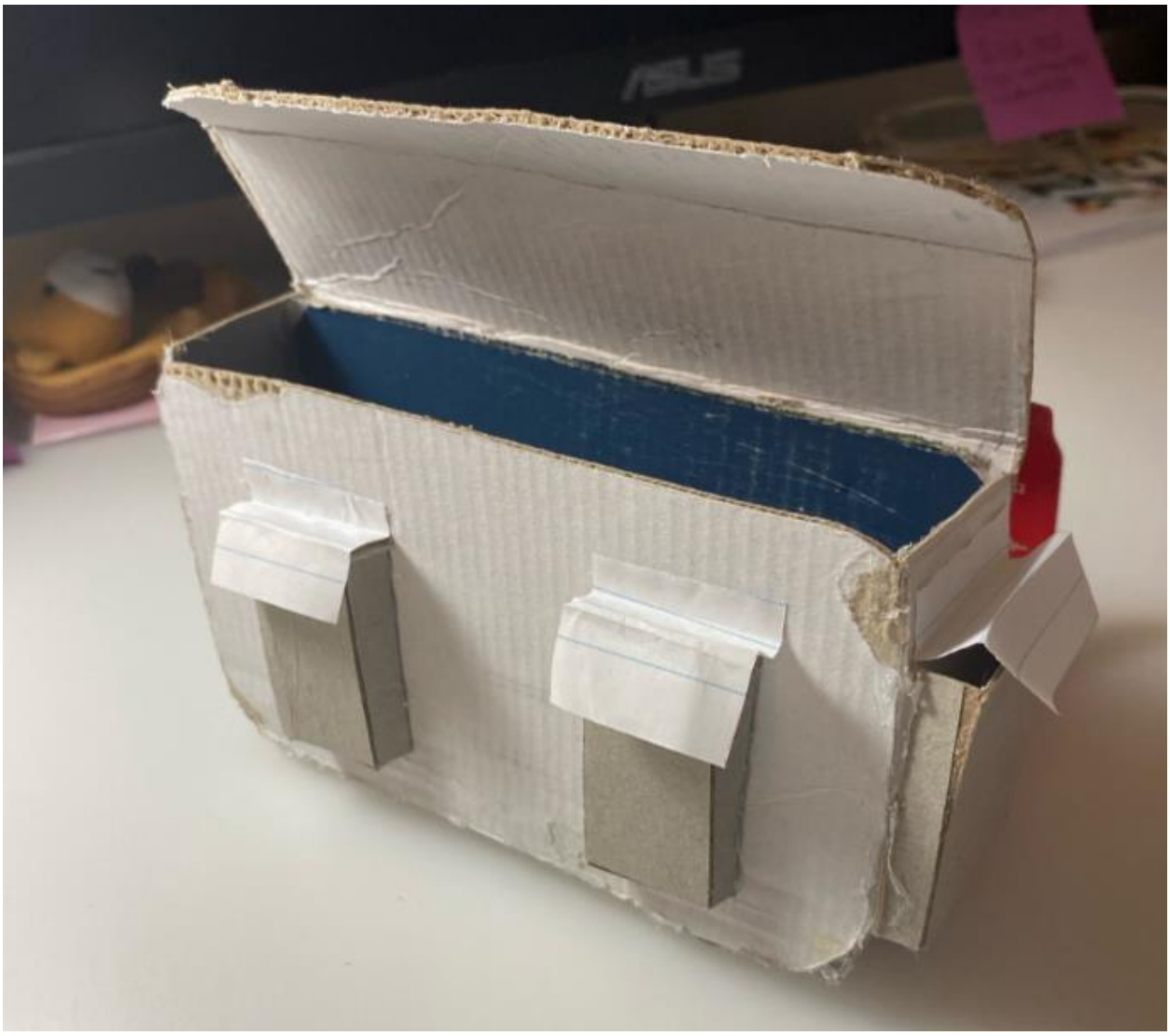
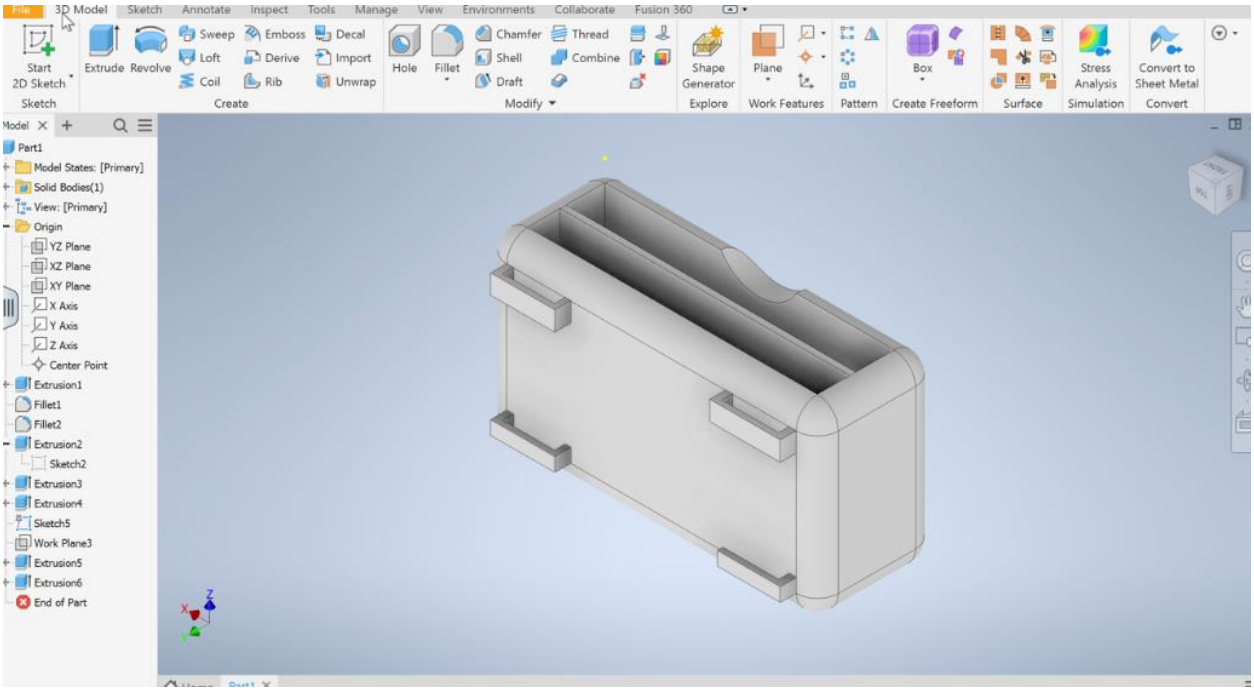




Design Review Feedback:

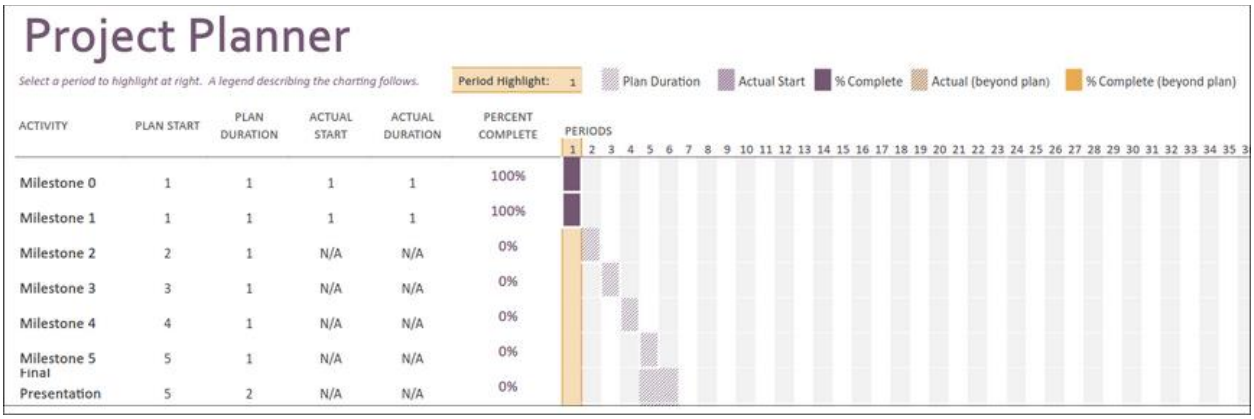
- Clear plastic top possibly
- Could use a hinge mechanism or magnets for close and open lid

Add insulation into divider to prevent phone from overheating

- Allow air to leave but prevent water from entering
- Could use a diagonal channel—not a straight path
- Or use a heat sink at the bottom to dissipate heat

Appendix B: Project Schedule

Preliminary Gantt Chart:



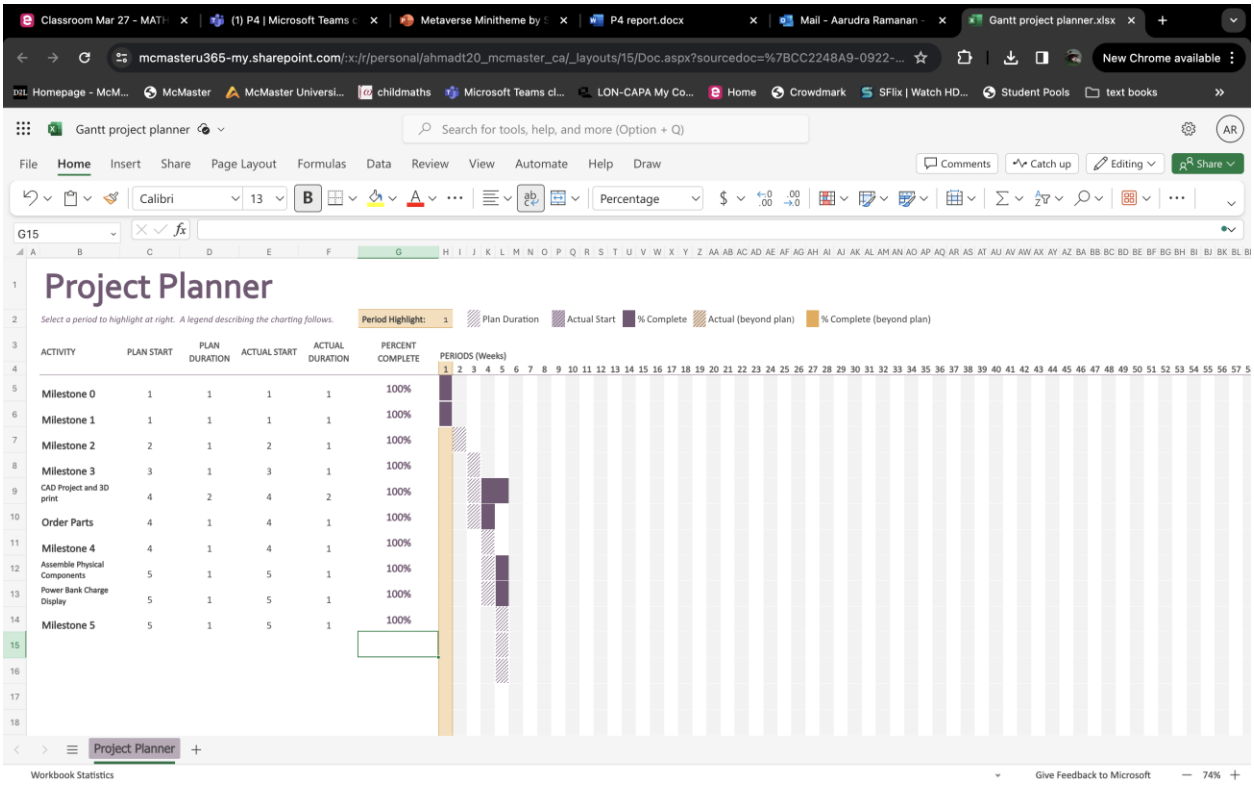
Project Planner

Select a period to highlight at right. A legend describing the charting follows. Period Highlight: 1 Plan Duration Actual Start % Complete Actual (beyond plan) % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Milestone 0	1	1	1	1	100%
Milestone 1	1	1	1	1	100%
Milestone 2	2	1	N/A	N/A	0%
Milestone 3	3	1	N/A	N/A	0%
Milestone 4	4	1	N/A	N/A	0%
Milestone 5 Final Presentation	5	1	N/A	N/A	0%
	5	2	N/A	N/A	0%

PERIODS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35

Final Gantt Chart:



Project Planner

Select a period to highlight at right. A legend describing the charting follows. Period Highlight: 1 Plan Duration Actual Start % Complete Actual (beyond plan) % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Milestone 0	1	1	1	1	100%
Milestone 1	1	1	1	1	100%
Milestone 2	2	1	2	1	100%
Milestone 3	3	1	3	1	100%
CAD Project and 3D print	4	2	4	2	100%
Order Parts	4	1	4	1	100%
Milestone 4	4	1	4	1	100%
Assemble Physical Components	5	1	5	1	100%
Power Bank Charge Display	5	1	5	1	100%
Milestone 5	5	1	5	1	100%

PERIODS (Weeks) 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57

Logbook of Additional Meetings and Discussions: April 1st

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Talha Ahmad**	**ahmadt20**	**Yes**
Administrator	Aarudra Ramanan	ramana16	**Yes**
Coordinator	Maria Shevchuk	shevchum	**Yes**
Subject Matter Expert	Adrian Ali	ali247	**Yes**

Agenda Items

1. Go through presentation and practice
2. Split up tasks for Design Report

Meeting Minutes

1. Practiced presentation with a live demonstration
2. Split up report

Post-Meeting Action Items

1. Present final solution [All]
2. Finish design report [All]

Appendix C: Scheduled Weekly Meetings

Weekly Design Studio Meetings: Week 1

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Talha Ahmad**	**ahmadt20**	**Yes**
Administrator	Aarudra Ramanan	ramana16	**Yes**
Coordinator	Maria Shevchuk	shevchum	**Yes**
Subject Matter Expert	Adrian Ali	ali247	**Yes**

Agenda Items

1. Discuss findings made during research
2. Receive feedback on the sketches as well as some guidance on how the project will turn out
3. Discuss functions and next steps to take for project

Meeting Minutes

1. Merged research findings
    a. Material to use
    b. Gripping mechanism
    c. How design complies with her abilities
2. Received feedback on design components
    a. Discussed electric vs. manual solutions
    b. Materials used for design must be comfortable to hold
    c. Value added to solution in comparison to her existing gripper
3. Discuss how to merge designs
    a. Keep TA notes in mind on improvements

Post-Meeting Action Items

1. *Merge current designs*
2. *Implement TA improvements (keep objectives in mind)*
3. *Find ways to keep door open*

Weekly Design Studio Meetings: Week 2

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Talha Ahmad**	**ahmadt20**	**Yes**
Administrator	Aarudra Ramanan	ramana16	**Yes**
Coordinator	Maria Shevchuk	shevchum	**Yes**
Subject Matter Expert	Adrian Ali	ali247	**Yes**

Agenda Items

3. Show prototypes and receive feedback.

Meeting Minutes

1. Show prototypes and receive feedback.
    a. Consider how client will charge power bank
    b. Maybe conserve battery somehow
    c. Consider size of power bank and everything so it fits on chair
        i. Could use space under arm rest to maximize space and comfort
    d. Protect against weather conditions
    e. Keep heat of power bank in mind—sensitive skin

Post-Meeting Action Items

3. *Choose top two prototypes*
4. *Implement TA improvements (keep objectives in mind)*
5. *Plan timeline*

Weekly Design Studio Meetings: Week 3

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Talha Ahmad**	**ahmadt20**	**Yes**
Administrator	Aarudra Ramanan	ramana16	**Yes**
Coordinator	Maria Shevchuk	shevchum	**Yes**
Subject Matter Expert	Adrian Ali	ali247	**Yes**

Agenda Items

1. Show main prototype.
2. Receive feedback on prototype.
3. Discuss fabricating the actual design.

Meeting Minutes

1. Showed and justified main prototype
2. Feedback on protype
    a. Maybe use Velcro for straps---in terms of mobility
    b. Make sure items are protected with lid
    c. Add insulation into divider---prevent phone from overheating
    d. Allow for air to leave but prevent water from entering
        i. Make a diagonal channel---not a straight path
    e. What battery will be used
    f. Make bigger divot to make it easier to take phone out
3. Discussed materials: PLA but ideally carbon fiber
    a. 3D print

Post-Meeting Action Items

1. Implement TA suggestions into design [All]
2. Finish 3D prototype [All]
3. Get straps and battery [All]
4. Combine everything [All]

Weekly Design Studio Meetings: Week 4

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Talha Ahmad**	**ahmadt20**	**Yes**
Administrator	Aarudra Ramanan	ramana16	**Yes**
Coordinator	Maria Shevchuk	shevchum	**Yes**
Subject Matter Expert	Adrian Ali	ali247	**Yes**

Agenda Items

1. Show model
2. Receive feedback on meeting expected criteria

Meeting Minutes

1. Showed model
2. All criteria met

Post-Meeting Action Items

1. Finish 3D prototype: add straps and buckles [All]
2. Print full size for final demonstration [All]

Weekly Design Studio Meetings: Week 5

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Talha Ahmad**	**ahmadt20**	**Yes**
Administrator	Aarudra Ramanan	ramana16	**Yes**
Coordinator	Maria Shevchuk	shevchum	**Yes**
Subject Matter Expert	Adrian Ali	ali247	**Yes**

Agenda Items

1. Discuss testing plan
2. Check-in

Meeting Minutes

1. Discuss testing plan
    a.
2. Check-in
    a. How will client charge power bank—charging port does not line up on the model
    b. Use a wireless charger instead
    c. Add a lid—make sure its weatherproof

Post-Meeting Action Items

1. *Finish prototype modifications*
2. *Implement TA comments (keep objectives in mind)*
3. *Prepare presentation*

Appendix D: Design Studio Worksheets

ENGINEER 1P13:
PROJECT FOUR WORKSHEETS (INDIVIDUAL)

Table of Contents

PROJECT FOUR MILESTONE ONE: PROBLEM FRAMING AND TEST PLAN

MILESTONE 1.1 – CLIENT NOTES

Team ID: Mon-45

Complete this worksheet individually before coming to Lab A for Week 6.

1. Include your client notes from the introductory client visit

Name: Maria	MacID: shevchum

spinal bifida

Stores:

Reacher/grabber: not portable bc too big

- Wear and tear
- Stores have grabber in each aisle

Prices hard to see in stores

Battery 5x $500

Snow:

- Salt gets into battery
- Get hit by car if on bike lane

Crosswalk: cannot click button, not enough time to cross

Doors: too narrow to pass

Outlet: not too high or low

Stress from external and internal environment (wheelchair and environment)

Hard to reach low and high

- Phone drops cannot get it
- Difficultly getting bag

PROJECT FOUR MILESTONE TWO: DESIGN EXPLORATION AND DESIGN REVIEW #1

MILESTONE 2.1 – CLIENT NOTES

Team ID: Mon-45

Complete this worksheet individually before coming to Lab A for Week 7.

Include your client notes from the introductory client visit

Name: Maria Shevchuk	MacID: shevchum

spinal bifida

- Latex allergy

Stores: Reacher/grabber: not portable because too big (not collapsable)

- Wear and tear
- Stores have grabber in each aisle

Prices hard to see in stores

Battery 5x $500

Snow:

- Salt gets into battery
- Get hit by car if on bike lane

Crosswalk: cannot click button, not enough time to cross

Cooking: stove too high

Doors: too narrow to pass

Outlet: not too high or low

- Always breaking cords

Used to charge phone on wheelchair but that drained batter

- Portable charger on wheelchair?

Stress from external and internal environment (wheelchair and environment)

Hard to reach low and high

- Phone drops cannot get it
- Difficultly getting bag

More storage on wheelchair

Right-handed

- Put items on right side of wheelchair--> near toggle

Hard to get through door if stuff added to sides (gets broken off)

Cannot reach stove, counter, and other kitchen appliances

iPhone 15 Plus phone

Favourite colours: pink, purple and red

Favourite characters: Groot from Guardians of the Galaxies, Sonic the hedgehog, Pac-man.

MILESTONE 2.2 – RESEARCH ASSIGNMENT

Team ID: Mon-45

Complete this worksheet before Lab A for Week 7.

- State the question you plan to answer through your research
- Summarize your research findings (answer). Your answer should be a coherent, well-written summary of your research, not a "brain dump".
- You may include images, but don't forget to cite them properly.
- Aim for a length of about 500 words
- Properly cite your sources using IEEE formatted references and in-text citations. For information on referencing formats and choosing sources, see Design and Communication Workshop 1.

Name: Maria Shevchuk	MacID: shevchum

What is your question?

What solutions (patents) already exist that aid people in wheelchairs to open doors?

What is your answer?

Long-reach tools exist for a variety of applications: opening car doors, grabbing items, and aiding accessibility. Existing solutions follows the same basic design of having a long reaching base and a top portion that latches/hooks onto handles. The designs differ in the top part, as well as different features they possess.

The "Handy Hook", or "Long Reach Door Opener" is the most well-known solution to help people in wheelchairs to open inaccessible doors. As seen in *Figure 1.,* the hook design can grip both round and square handles—allowing for adaptability of the design. This patent will expire in 2029.

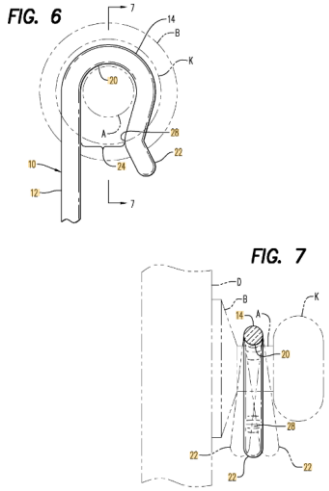


Figure 1. Door Opener Hook Design

Source [2]

There is another solution that uses a suction mechanism to grip handles. Although this allows for heavier doors to be opened more comfortably, it lacks adaptability; the suction cup cannot grip square handles. This design patent expired in 2015.

Many of the design lack versatility to adapt to different door types and to account for the weight of doors. This can be deducted based on the many DIY tutorials on making your own door opener. The prototyped design, as seen in *Figure 2.,* uses a cane as a base and attaches a rope to the top: allowing the top of the cane to open square door handles, the rope to open round ones, and the bottom of the cane to push doors open.

Figure 2. DIY Door Opener

Source [4]

While solutions exist, they lack versatility, and are thus not used; the market is not large for these designs. While there are patents for specific designs, the same concepts are used throughout: a long stick and a gripper design at the top.

List of sources:

Bibliography

[1] "Long Reach Door Opener :: helps wheelchair users reach and open locked doors," *The Wright Stuff, Inc. | Mobility-Aids.com*. https://www.mobility-aids.com/long-reach-door-opener.html#:~:text=The%20Long%20Reach%20Door%20Opener%20is%20designed%20to%20turn%20a (accessed Feb. 26, 2024).

[2] E. A. Hielm, "Door opening device for a handicapped person," *Google Patents*, May 10, 2011. https://patents.google.com/patent/US7938464B1/en (accessed Feb. 26, 2024).

[3] D. J. Holden, "Wheelchair passenger door opener," *Google Patents*, Sep. 17, 1996. https://patents.google.com/patent/US5555779A/en (accessed Feb. 26, 2024).

[4] "Door Opener and Stopper (originally for People in Wheelchairs)," *Instructables*. https://www.instructables.com/Door-Opener-and-Stopper-originally-for-People-in-W/ (accessed Feb. 26, 2024).

MILESTONE 2.2 – INITIAL CONCEPT EXPLORATION

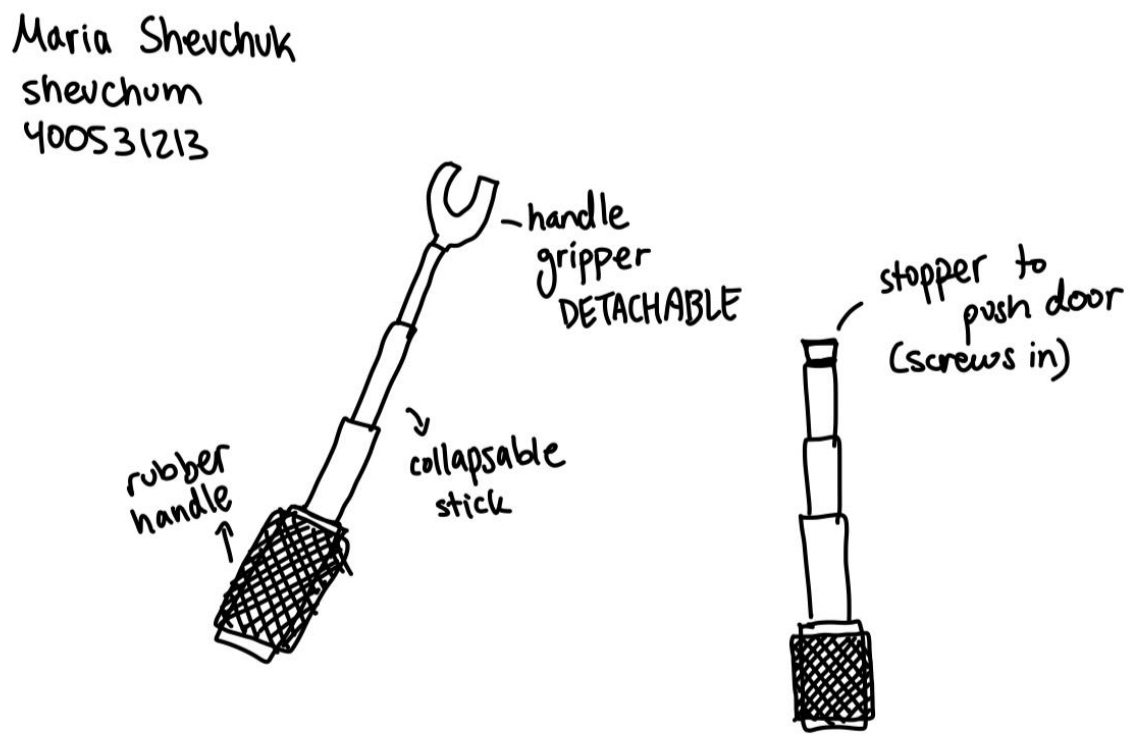
Team ID: Mon-45

Complete this worksheet before Lab A for Week 7.

1. Include multiple images of your **initial** concept exploration, if needed
   - → Include necessary annotations to help in the communication of your ideas
   - → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   - → Include your Team Number, Name and MacID on *each* concept image
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* concept images per page**

Name: Maria Shevchuk	MacID: shevchum

Insert screenshot(s) of your concept below.



MILESTONE 2.4 – REFINED CONCEPT EXPLORATION

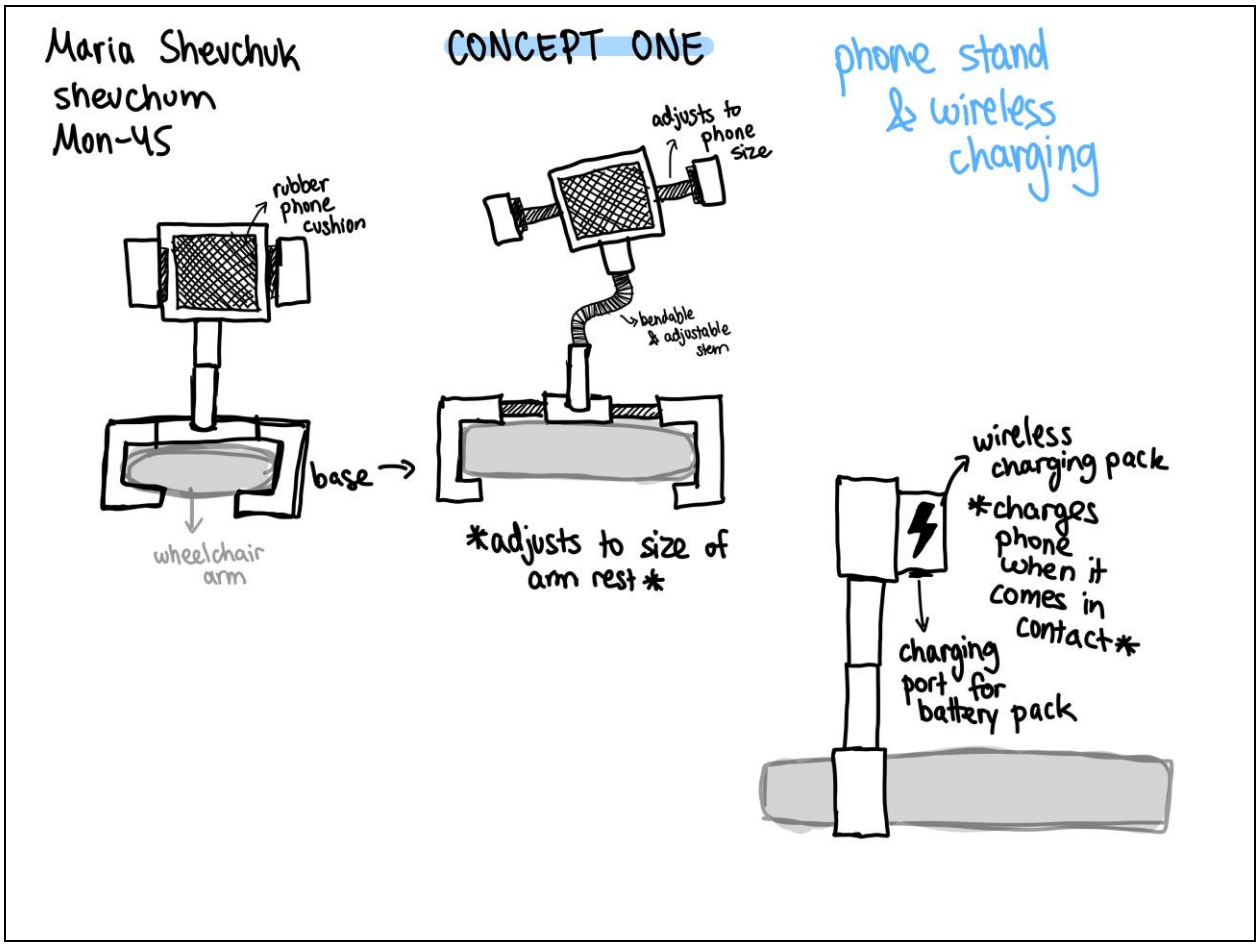
Team ID: Mon-45

Complete this worksheet during Lab A for Week 7.

4. Include multiple images of your **refined** concept exploration, if needed
   - → Include 2 distinct concepts based on the functional analysis
   - → Include necessary annotations to help in the communication of your ideas
   - → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   - → Include your Team Number, Name and MacID on *each* concept image
5. Insert your photo(s) as a Picture (Insert > Picture > This Device)
6. **Do not include more than *two* concept images per page**

Concept 1:

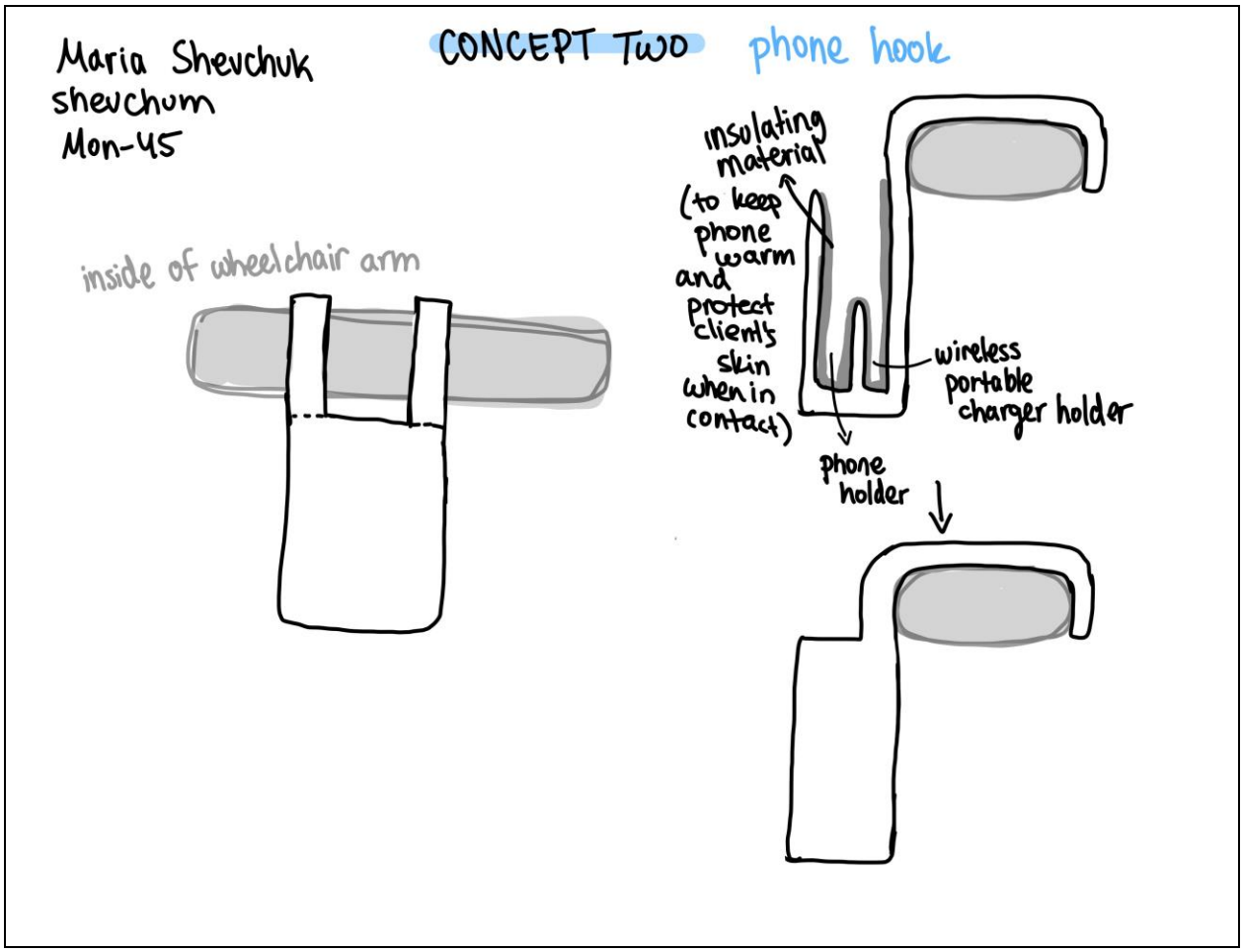
Name: Maria Shevchuk	MacID: shevchum
Insert screenshot(s) of your concept below. ***Note problem statement changed after Design Studio*	



Team ID: Mon-45

Concept 2:

Name: Maria Shevchuk	MacID: shevchum
Insert screenshot(s) of your concept below. ***Note problem statement changed after Design Studio*	


Maria Shevchuk
shevchum
Mon-45
CONCEPT Two
phone hook
inside of wheelchair arm
insulating material
(to keep phone warm and protect client's skin when in contact)
wireless portable charger holder
phone holder

PROJECT FOUR MILESTONE THREE: PROTOTYPING, DECISION MAKING AND DESIGN REVIEW #2

MILESTONE 3.1 – REFINED CONCEPT: INITIAL PROTOTYPE

Team ID: Mon-45

Complete this worksheet individually before coming to Design Studio/Lab A for Week 8.

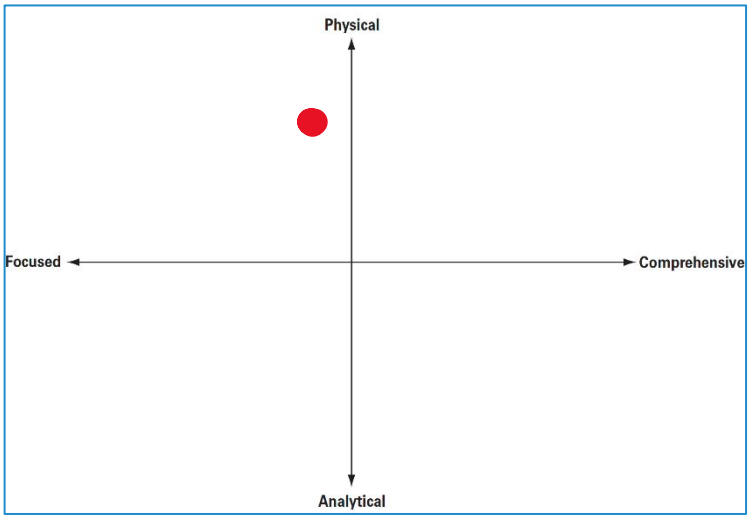
1. Write a small description of your initial prototype. Be sure to include what problem it aims to solve, how your initial prototype will be fabricated, and what functionality will be included and omitted in this initial prototype.
2. Classify whether your prototype is Physical or Analytical, and Focused or Comprehensive. Include the purpose of this prototype in the context of project 4 and the level of fidelity (low, medium, or high fidelity)
   → **Physical vs. Analytical:** Physical prototypes are tangible artifacts that are created to approximate the final product. Analytical prototypes are non-tangible and represent the product using usually visual or mathematical models.
   → **Focused vs. Comprehensive:** Focused prototypes implement only one or a few of the attributes of the final product. Comprehensive prototypes aim to implement most, if not all of the attributes of the final product.
3. Create a list of objectives and metrics for your initial prototype. There is no required amount of objectives or metrics, so long as the list is comprehensive.
4. Create a rough experimental plan for how you might test your prototype. Consider the methods you might use to test various objectives, how you will measure how effective each test proves to be and how realistic it would be to implement. This does not need to be detailed plan but should consider several of your objectives for the prototype.
5. Take picture(s) of your refined concept (initial prototype)
   → Insert your photo(s) as a Picture (Insert > Picture > This Device)
   → **Do not include more than *two* refined concept pictures per page**
   → Include details on how concept was refined (what feedback was incorporated, what features are different than previous concept exploration, etc.)
   → You can continue this process within the allocated time of the LabA/DS and seek feedback and discussions from your team members and/or the instructional team (IAIs, TAs, etc.).

Name: Maria Shevchuk	MacID: shevchum

Write a short description of your initial prototype below.

The prototype is meant to hang on the handle of the wheelchair—through the curved handles—and has a section for the phone and portable charger. The phone is meant to be wirelessly charged through contact to the phone.

Indicate where your prototype falls on the scale below.



Kind of Prototype:

☒ Physical or ☐ Analytical

☒ Focussed or ☐ Comprehensive

Purpose of Prototype:

Physically demonstrate refined concept

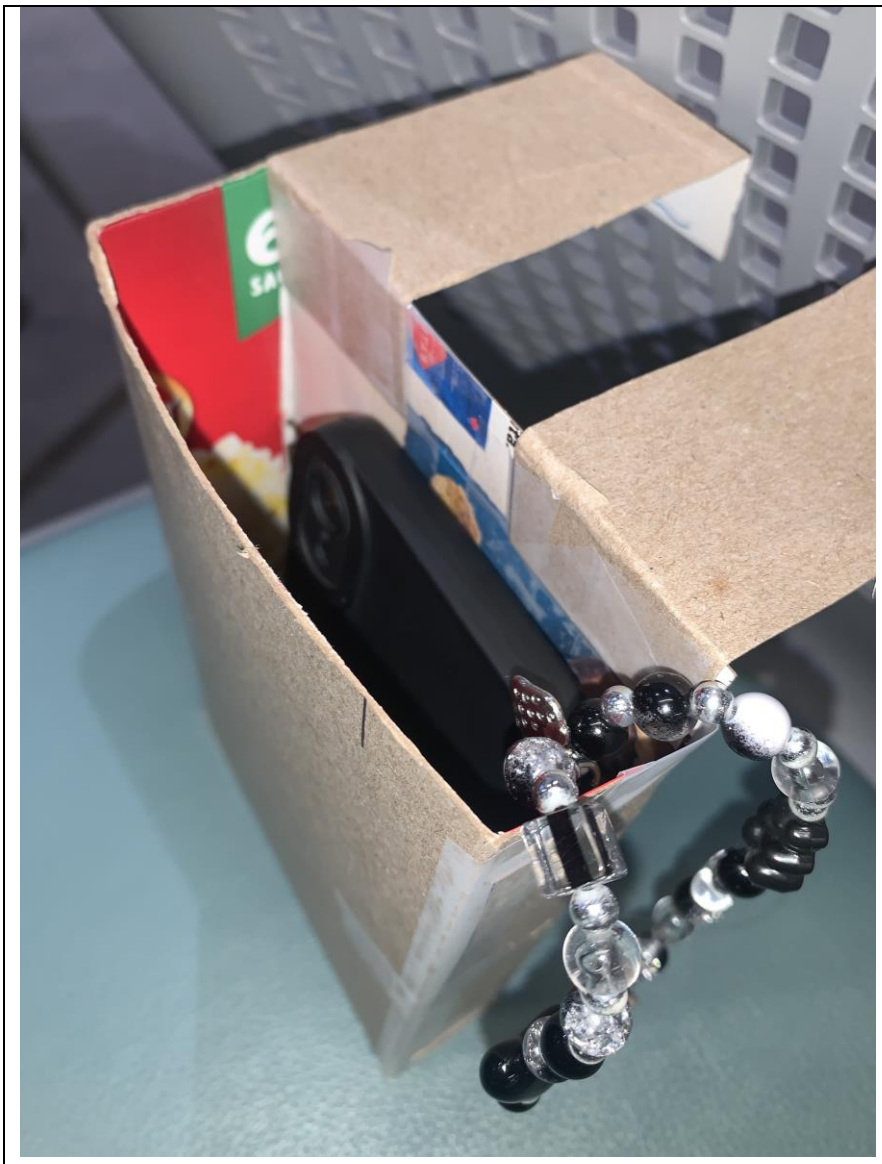
Level of Fidelity:

Low

Include a list of objectives and metrics for your prototype below.

Objectives	Metrics
• **Portable**	• Binary of does it need to be attatched to a stationary object
• **Insulated**	• Measure heat inside and outside of design to see whether heat transfers
• **Durable**	• Measure material with Young's Modulus and Granta

Include a rough experimental plan on how you might test your prototype below.



PROJECT FOUR FINAL DELIVERABLE: PROJECT REFLECTION

The activities in this handout are intended to be completed by the end of the project 4. You will apply what you learn in Design Communication Workshop 4 to complete this task.

Submission Details

Each Team Member: upload your reflection essay as a PDF to the Avenue Dropbox titled P4 Reflection using the MacID_P4_Reflection.pdf as naming convention

Grading of Reflection

Your reflection assignment is worth 1 mark of your total Project-4 grade (12.5%). Rubric is provided on Avenue to Learn.

If you need to review the content, go back to Design Communication Workshop 4 and/or go through the online reflecti0on module. Here is the link:
https://ecampusontario.pressbooks.pub/engineeringreflectiontoolkit/

Reflection Activity

Consider your experience with the design process as a first-year engineering student working on Project 4 over the past couple of months in ENG 1P13. After exploring the client's challenges and gaining insights, your team, decided to focus on one area to improve our client's daily life. You have defined the problem in a problem statement that included objectives, constraints, etc. Through this exploration, you performed a functional analysis that was used to come up with different alternative ways to solve the problem. Your team needed to make a decision between the different alternatives, and you tested your ideas for feasibility. You have been encouraged to iterate as you gained deeper insight and developed empathy for the client. Through the process of iteration, you have had the opportunity to improve upon your ideas. Engineers are continually iterating through the design process. Informed designers are involved in continual learning: learning by doing, learning from brainstorming and prototyping, learning by iteration and from feedback and failure, learning by noticing and troubleshooting, learning by drawing and dialoging about ideas, materials, and people. While iteration is an informal form of reflection, you will deepen your understanding of what you have learned through formal reflection. All of these emphasize the metacognitive and reflective practice aspects of learning through design (Lawson & Dorst, 2009; Crismond & Adams, 2012).

Part 1: What?

In this section you will describe a critical incident that you will be reflecting on as related to the "Generating/Testing ideas" and "Decision-making". For each of these steps of the design process:

In three to five sentences, identify and describe ONE critical incident, breakthrough or big thought-provoking moment that either challenged your assumptions, had a positive impact on you or validated your understanding of the design process. Here are some questions to consider.

Generating & Testing Ideas:

- How did you go about exploring ideas?
- How deeply did you explore your design options?
  - How much research?
  - Did you look into Biomimicry tools?
  - Did you consider any "What if?" questions in your explorations?
- Did you test your ideas?
- If yes, how did you test your ideas?
  - What were you trying to test (e.g., desirability, feasibility, etc.)?
  - What tool/ method did you use? (physical prototype, CAD model, etc.)
  - How much time did you spend on testing each idea?
  - How many ideas did you test?
  - How many prototypes did you make for testing each idea?
  - Did you test your ideas early on or waited until you had more details of the ideas?
- What was one challenge that you faced in the testing process of the design? (we encourage you to write more than one challenge). And What did you do to solve that challenge? (you can attach photos to explain your attempted solutions)
- From the results of our testing, one change we made to improve our design solution was … (add your response) and this change made our design solution better because … (add your response).

Response:

When brainstorming concepts, we initially wanted to make a gripper (to open doors) and did all the research and initial worksheets about the gripper. But when thinking ahead to prototyping we decided to change up the design; also given that she stated she has no problem opening doors because she had an aid and placed more emphasis on other issues. From there I came up with a concept that we could prototype and fit better to the client's need: a phone charger.

Decision Making:

- What happened during decision-making?
  - Where in the process, relative to the design process steps, did you make decisions?
  - What were the decisions about? Decisions could be about the process (e.g., how much searching of the design space was enough?) or about the design (e.g., which alternative to prototype).
  - How many options did you have to choose from?
  - How many criteria did you have to compare the options? How did you choose those criteria?
  - What tools did you use to make a decision?
- At what stage did you make a decision?
- When did this experience take place? Did you already have one final solution in mind or you were still exploring the ideas?
- What challenges did you face during decision-making process?

Response:

Initially we were going to have software that coincided with the model—charged the phone based on its charged and stopped when fully charged. But due to functionality, resources and lack of time, we decided on getting a more advanced portable charger instead. We made this decision also to make the actual model—and concept—good, rather than spreading up tasks and having a not so good model and software.

Part 2: "So What?"

In this section you will explore what you learned and describe why this incident matters to you.

In three to five sentences, discuss what you learned from this incident about idea generation, testing ideas, and decision making and that either surprised you, made you confront a misconception, or improved your understanding of the design process.

To help you think about this, consider the following:

- What was the outcome of early or late testing processes?
- Do you think delaying any of your decision-making may have improved the design?
- Could you have collected better observations or data that would have led to better decisions?
- Did you repeat your decision-making process at any other stage?

Response:

When we changed our initial concept, to better fit our capabilities, I learned the importance of not being stuck on a specific solution while you are solving the problem. The focus should be on solving the problem and not one specific solution; when designing you need to keep an open mind to what is possible. From focussing on one aspect of the solution instead of 'spreading ourselves thin' by trying to do ten things at once, we were able to prototype and test our model a lot more thoroughly than we would have otherwise. Through this I learned the importance of playing to your strengths and understanding the capabilities of your group.

In two to three sentences, explain why these new insights are important to you.

Response:

These insights are important as they taught me important aspects of the design process and allowed me to grow as an engineer. I will be able to apply this knowledge in future projects as well.

Part 3: "Now What?"

In two to three sentences, discuss how you will integrate this new insight into future design projects, including next week prototyping and design review 2 where you still have a chance to improve your design. To help you think about this, consider the following:

- I learned that... (Express and important learning, not a statement of fact)
- This learning matters because... (Consider how this learning has value to you as an engineer)
- How will I apply my learning?
- How will I design differently next time?
- How will I deal with a similar situation in the future?
- Considering this learning, I will... (Set specific, assessable goals; consider benefits and challenges involved in this plan)

Response:

In future projects I will communicate more clearly with group members and set clear objective for what we can achieve. Additionally, I will learn the strengths and weaknesses of group members and pay to them. Most importantly I will think about the problem I am solving and not the specific solution. Design process is not linear

In two to three sentences, describe the possible benefits and challenges involved in your plan.

Response:

Benefits are creating design solutions that pertain to the problems. Challenges would be sticking to it and keeping the same mindset. Communicating with group members goes two ways, so they have to hold similar mindsets.

References:

Lawson, B., & Dorst, K. (2009). Design expertise. Oxford, UK: Architectural Press.

Crismond, D. P., & Adams, R. S. (2012). The informed design teaching and learning matrix. Journal of Engineering Education, 101 (4), 738-797.

PROJECT FOUR MILESTONE ONE: PROBLEM FRAMING AND TEST PLAN

MILESTONE 1.1 – CLIENT NOTES

Team ID: Mon-45

Complete this worksheet individually before coming to Lab A for Week 6.

1. Include your client notes from the introductory client visit

Name: Talha Ahmad	MacID: ahmadt20

Background info:

- *Tiffany is a 33 year old with spina bifilda. She does not have mobility below the waist.*
- *She has a nurse and PSW to help her with daily tasks.*
- *Tiffany works at Walmart and struggles to reach higher shelves while stocking.*
- *They want to be at eye level while greeting other people.*
- *They want better services and accommodations for wheelchairs.*
- *She prefers stronger and more durable things.*

Ideas/possible areas of development:

- *Weather is a problem.*
- *Opening doors.*
- *Seatbelts on the wheelchair tend to break*

PROJECT FOUR MILESTONE TWO: DESIGN EXPLORATION AND DESIGN REVIEW #1

MILESTONE 2.1 – CLIENT NOTES

Team ID: Mon-45

Complete this worksheet individually before coming to Lab A for Week 7.

Include your client notes from the introductory client visit

Name: Talha Ahmad	MacID: ahmadt20

Transportation:

- *Edge 3 wheelchair. Weights 250 lbs.*
- *Tiffany decorates her wheelchair.*
- *Crosswalk buttons aren't accessible for her.*
- *Wants to be able to drive.*
- *Struggles with reaching power outlets.*

Hobbies:

- *Likes dancing and practices martial arts.*
- *Likes listening to music but can't see artists at the actual concert.*
- *Enjoys cooking.*

Preferences (design aesthetic considerations):

- *Favourite colours are pink and purple.*
- *Likes Sonic the Hedgehog, and Groot.*

MILESTONE 2.2 – RESEARCH ASSIGNMENT

Team ID: Mon-45

Complete this worksheet before Lab A for Week 7.

- State the question you plan to answer through your research
- Summarize your research findings (answer). Your answer should be a coherent, well-written summary of your research, not a "brain dump".
- You may include images, but don't forget to cite them properly.
- Aim for a length of about 500 words
- Properly cite your sources using IEEE formatted references and in-text citations. For information on referencing formats and choosing sources, see Design and Communication Workshop 1.

Name: Talha Ahmad	MacID: ahmadt20

What is your question?

What is the optimal method for us to test the muscle strain our developed device will take on a user's body?

What is your answer?

One of the primary objectives that our developed product aims to do is reduce the strain on a user's body while opening a door. Our client reported that opening doors manually for them is a tedious and uncomfortable task, so the question remains, how can we test and make sure that positive progress has been made towards the completion of this objective?

According to a paper by Jerry Chen et al. titled "Pain and Stress Detection Using Wearable Sensors and Devices – A Review," wearable sensors such as wristband sensors, chest strap sensors, and EEG headsets provide cost effective and accurate ways to detect both pain and stress in human bodies [1]. While this paper was more focused towards the applications of these sensors in the healthcare industry, it could also be a possible direction to direct the development of our product's testing plan. For example, if we were to monitor a user's heart rate while they are using the product for its intended purpose and compare that to their heart rate normally, we could receive valuable insight into how much a user needs to exert themself while using the tool.

Now that it has been established that one valuable way to track the user's comfort is through wearable devices and sensors, the next area of research is what data should we be specifically looking for and tracking. That is, is it heart rate, muscle tension, or should we be using EEGs and EMGs to track brain and muscle activity respectively? According to a paper by Guozhong Chai et al., heart rate is strongly correlated to muscle fatigue [2]. This paper exclusively studies runners, however, it should also be applicable when it comes to the development of our product. What this

means is that measuring heart rate seems to be the most efficient method to test and measure muscle fatigue for our product.

To condense the answer to my question which aims to find the ideal method we, as the product designers, can measure the muscle strain that our designed product takes on a user's body, the research reveals that we can use wearable sensors to find a user's heart rate. The first paper analyzed reveals that wearable sensors provide a low cost and easy way to collect data on bodies, and the second paper reveals that the amount of muscle fatigue a person experiences strongly correlates with that person's heart rate [1][2]. Therefore, our testing plan for our primary objective of reducing the muscle strain that the product will take on a user's body should consist of having multiple individuals use the tool while we track their heart rate.

List of sources:

[1] J. Chen, M. Abbod, and J.-S. Shieh, "Pain and Stress Detection Using Wearable Sensors and Devices—A Review," *Sensors*, vol. 21, no. 4, p. 1030, Feb. 2021, doi: https://doi.org/10.3390/s21041030.

[2] G. Chai, Y. Wang, J. Wu, H. Yang, Z. Tang, and L. Zhang, "Study on the Recognition of Exercise Intensity and Fatigue on Runners Based on Subjective and Objective Information," *Healthcare*, vol. 7, no. 4, p. 150, Nov. 2019, doi: https://doi.org/10.3390/healthcare7040150.

MILESTONE 2.2 – INITIAL CONCEPT EXPLORATION

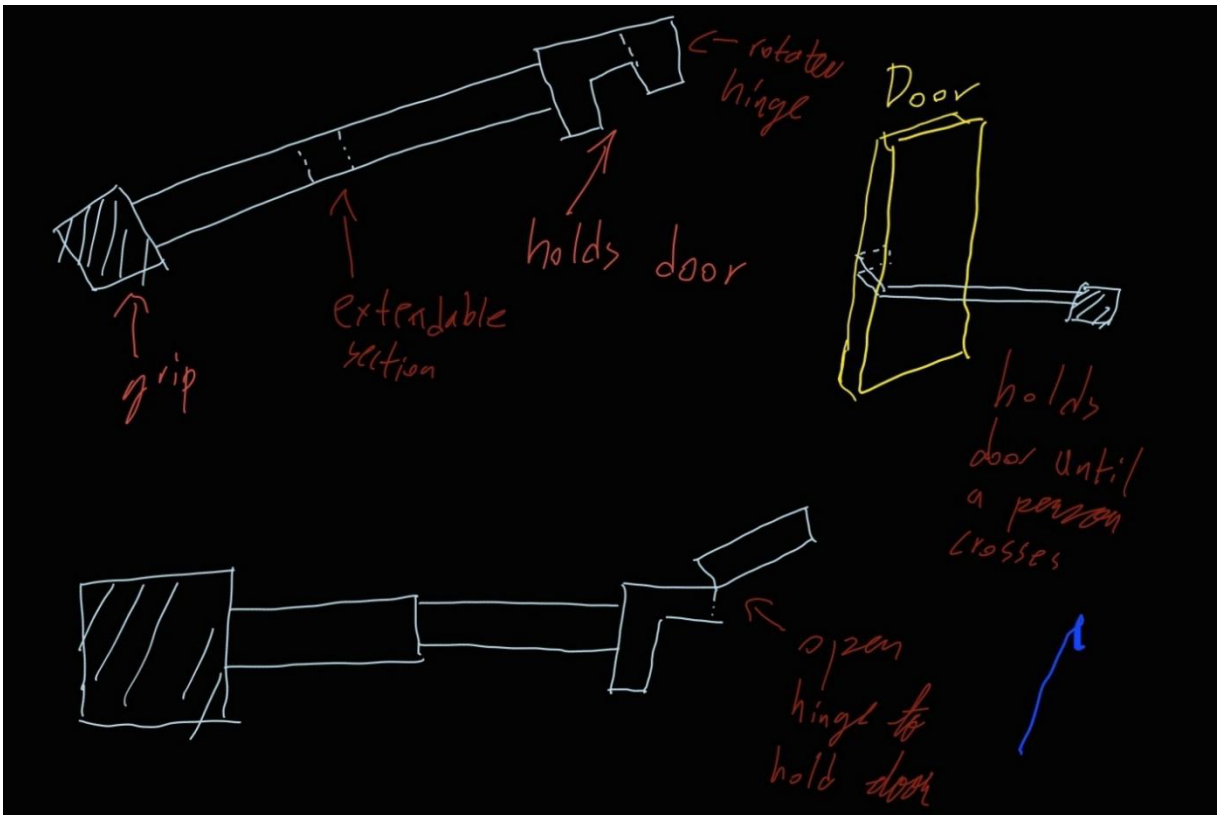
Team ID: Mon-45

Complete this worksheet before Lab A for Week 7.

1. Include multiple images of your **initial** concept exploration, if needed
   → Include necessary annotations to help in the communication of your ideas
   → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   → Include your Team Number, Name and MacID on *each* concept image
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* concept images per page**

Name: Talha Ahmad	MacID: ahmadt20

Insert screenshot(s) of your concept below.



NOTE: This preliminary design considered our previous problem of opening doors.

MILESTONE 2.4 – REFINED CONCEPT EXPLORATION

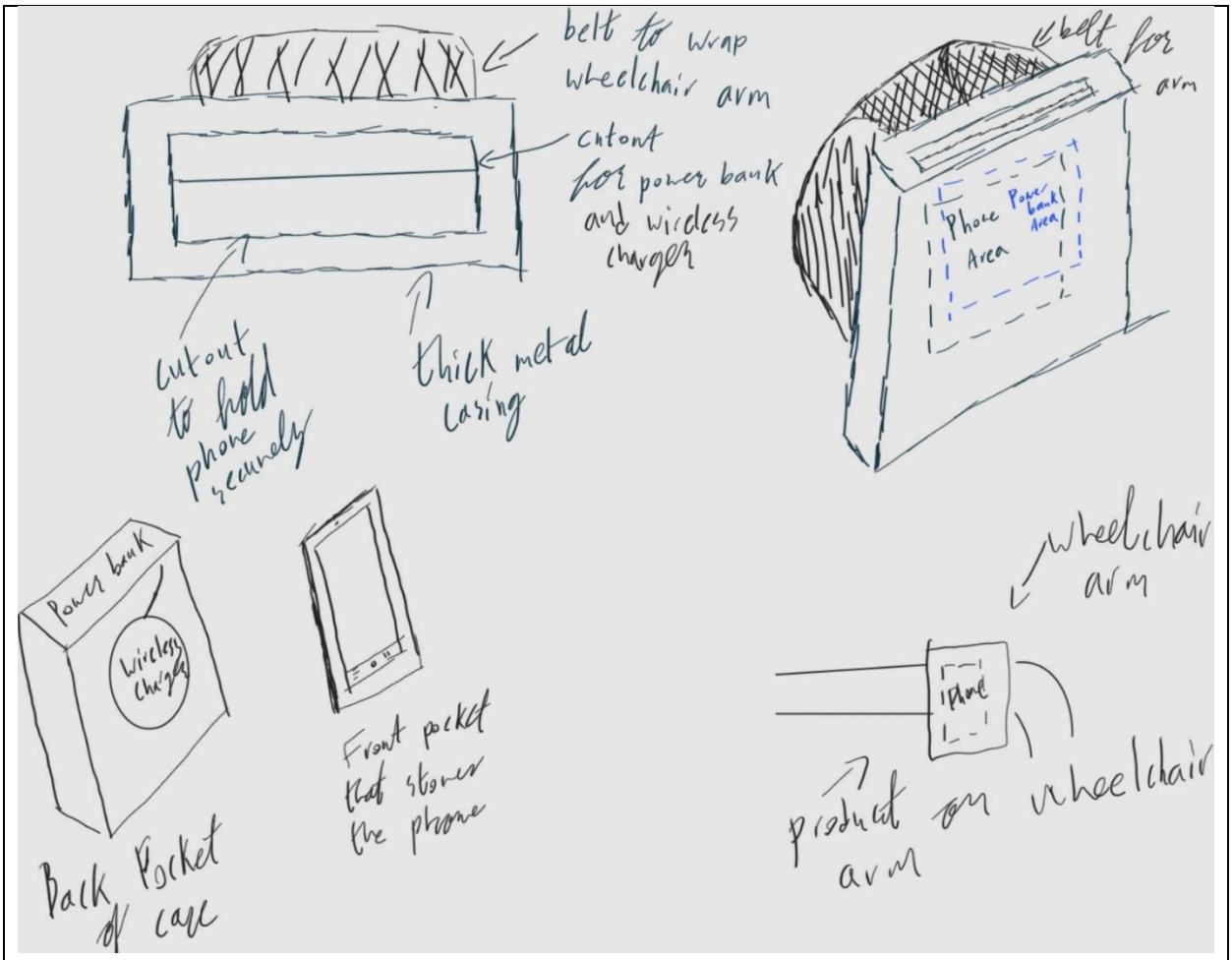
Team ID: Mon-45

Complete this worksheet during Lab A for Week 7.

4. Include multiple images of your **refined** concept exploration, if needed
   → Include 2 distinct concepts based on the functional analysis
   → Include necessary annotations to help in the communication of your ideas
   → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   → Include your Team Number, Name and MacID on *each* concept image
5. Insert your photo(s) as a Picture (Insert > Picture > This Device)
6. **Do not include more than *two* concept images per page**

Concept 1:

Name: Talha Ahmad	MacID: ahmadt20
Insert screenshot(s) of your concept below.	


belt to wrap wheelchair arm
cutout for power bank and wireless charger
cutout to hold phone securely
thick metal casing
belt for arm
Phone Area
Power bank Area
Power bank
Wireless charger
Back Pocket of case
Front pocket that stores the phone
wheelchair arm
iPhone
product on wheelchair arm

Team ID: Mon-45

Concept 2:

Name: Talha Ahmad	MacID: ahmadt20

Insert screenshot(s) of your concept below.

Pseudocode for an android app that will measure and report the power bank's level so that the user knows when to charge their power bank.

BAREBONES ANDROID APP

Curr_charge = power bank charge

If curr_charge < 20%:

    Send notification "warning: power bank charge is low"

Display curr_charge on notification bar

Information regarding this concept: In order to get the power bank charge, the main method we're considering is using an arduino with an ESP8266 to get a voltage curve and based on that calculate the power bank's charge.

PROJECT FOUR MILESTONE THREE: PROTOTYPING, DECISION MAKING AND DESIGN REVIEW #2

MILESTONE 3.1 – REFINED CONCEPT: INITIAL PROTOTYPE

Team ID: Mon-45

Complete this worksheet individually before coming to Design Studio/Lab A for Week 8.

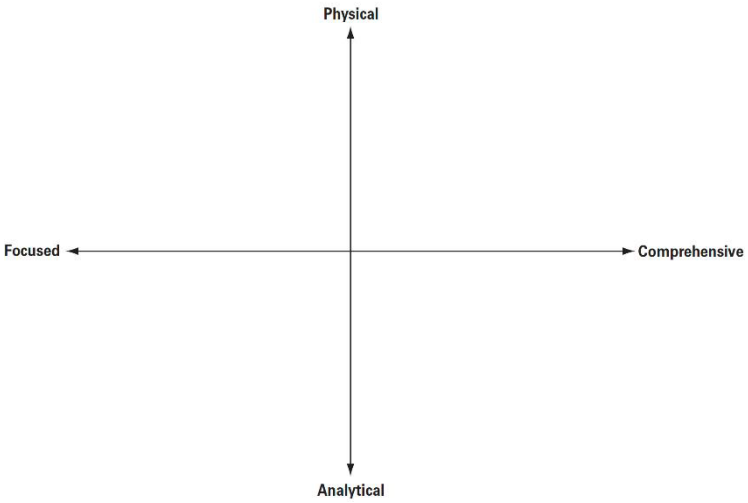
1. Write a small description of your initial prototype. Be sure to include what problem it aims to solve, how your initial prototype will be fabricated, and what functionality will be included and omitted in this initial prototype.
2. Classify whether your prototype is Physical or Analytical, and Focused or Comprehensive. Include the purpose of this prototype in the context of project 4 and the level of fidelity (low, medium, or high fidelity)
   - → **Physical vs. Analytical:** Physical prototypes are tangible artifacts that are created to approximate the final product. Analytical prototypes are non-tangible and represent the product using usually visual or mathematical models.
   - → **Focused vs. Comprehensive:** Focused prototypes implement only one or a few of the attributes of the final product. Comprehensive prototypes aim to implement most, if not all of the attributes of the final product.
3. Create a list of objectives and metrics for your initial prototype. There is no required amount of objectives or metrics, so long as the list is comprehensive.
4. Create a rough experimental plan for how you might test your prototype. Consider the methods you might use to test various objectives, how you will measure how effective each test proves to be and how realistic it would be to implement. This does not need to be detailed plan but should consider several of your objectives for the prototype.
5. Take picture(s) of your refined concept (initial prototype)
   - → Insert your photo(s) as a Picture (Insert > Picture > This Device)
   - → **Do not include more than *two* refined concept pictures per page**
   - → Include details on how concept was refined (what feedback was incorporated, what features are different than previous concept exploration, etc.)
   - → You can continue this process within the allocated time of the LabA/DS and seek feedback and discussions from your team members and/or the instructional team (IAIs, TAs, etc.).

Name: Talha Ahmad	MacID: ahmadt20

Write a short description of your initial prototype below.

This prototype has two compartments in it. One stores a power bank and wireless charger while the other stores the user's phone. There's a band of tape which allows the user to hang this over their wheelchair's arm.

Indicate where your prototype falls on the scale below.



Slighting more focused and fully physical

Kind of Prototype:

☐ Physical or ☐ Analytical

☐ Focused or ☐ Comprehensive

Purpose of Prototype:

Understand possible problems that may arise with the design.

Level of Fidelity:

Medium

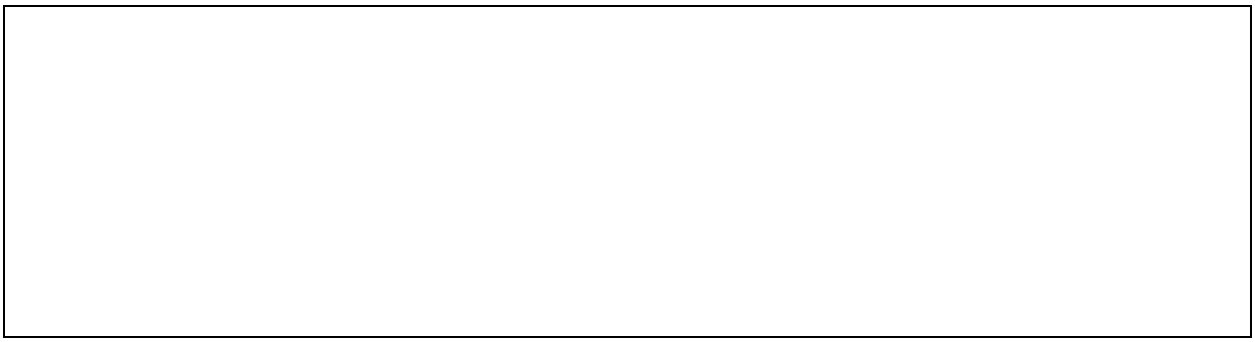
Include a list of objectives and metrics for your prototype below.

Objectives	Metrics
• **Durability**	• **Maximum stress it can handle on it.**
• **Efficiency**	• **Time a phone can spend inside while being charged.**
• **Comfort**	• **Survey**
•	•
•	

Include a rough experimental plan on how you might test your prototype below.

I would test this prototype by putting weights in it and seeing how much it can handle before collapsing. Moreover, for efficiency, I'd put a power bank and wireless charger pair in, put a phone in, and see how long it'd take until the phone stops charging.

Insert picture(s) of your refined concept (initial prototype) below.



PROJECT FOUR FINAL DELIVERABLE: PROJECT REFLECTION

The activities in this handout are intended to be completed by the end of the project 4. You will apply what you learn in Design Communication Workshop 4 to complete this task.

Submission Details

Each Team Member: upload your reflection essay as a PDF to the Avenue Dropbox titled P4 Reflection using the MacID_P4_Reflection.pdf as naming convention

Grading of Reflection

Your reflection assignment is worth 1 mark of your total Project-4 grade (12.5%). Rubric is provided on Avenue to Learn.

If you need to review the content, go back to Design Communication Workshop 4 and/or go through the online reflecti0on module. Here is the link:
https://ecampusontario.pressbooks.pub/engineeringreflectiontoolkit/

Reflection Activity

Consider your experience with the design process as a first-year engineering student working on Project 4 over the past couple of months in ENG 1P13. After exploring the client's challenges and gaining insights, your team, decided to focus on one area to improve our client's daily life. You have defined the problem in a problem statement that included objectives, constraints, etc. Through this exploration, you performed a functional analysis that was used to come up with different alternative ways to solve the problem. Your team needed to make a decision between the different alternatives, and you tested your ideas for feasibility. You have been encouraged to iterate as you gained deeper insight and developed empathy for the client. Through the process of iteration, you have had the opportunity to improve upon your ideas. Engineers are continually iterating through the design process. Informed designers are involved in continual learning: learning by doing, learning from brainstorming and prototyping, learning by iteration and from feedback and failure, learning by noticing and troubleshooting, learning by drawing and dialoging about ideas, materials, and people. While iteration is an informal form of reflection, you will deepen your understanding of what you have learned through formal reflection. All of these emphasize the metacognitive and reflective practice aspects of learning through design (Lawson & Dorst, 2009; Crismond & Adams, 2012).

Part 1: What?

In this section you will describe a critical incident that you will be reflecting on as related to the "Generating/Testing ideas" and "Decision-making". For each of these steps of the design process:

In three to five sentences, identify and describe ONE critical incident, breakthrough or big thought-provoking moment that either challenged your assumptions, had a positive impact on you or validated your understanding of the design process. Here are some questions to consider.

Generating & Testing Ideas:

- How did you go about exploring ideas?
- How deeply did you explore your design options?
  - How much research?
  - Did you look into Biomimicry tools?
  - Did you consider any "What if?" questions in your explorations?
- Did you test your ideas?
- If yes, how did you test your ideas?
  - What were you trying to test (e.g., desirability, feasibility, etc.)?
  - What tool/ method did you use? (physical prototype, CAD model, etc.)
  - How much time did you spend on testing each idea?
  - How many ideas did you test?
  - How many prototypes did you make for testing each idea?
  - Did you test your ideas early on or waited until you had more details of the ideas?
- What was one challenge that you faced in the testing process of the design? (we encourage you to write more than one challenge). And What did you do to solve that challenge? (you can attach photos to explain your attempted solutions)
- From the results of our testing, one change we made to improve our design solution was … (add your response) and this change made our design solution better because … (add your response).

Response:

Initially, we came up with a problem that we wanted to solve and then we discussed solutions surrounding those problems. We researched existing solutions for the problem, and then discussed existing flaws surrounding them. We tested our model with CAD models and physical prototypes. For example, we tested the strength of temperature resistance of different designs and decided that a hard partition in the middle would be the best solution to isolate the phone and power bank.

Decision Making:

- What happened during decision-making?
  - Where in the process, relative to the design process steps, did you make decisions?
  - What were the decisions about? Decisions could be about the process (e.g., how much searching of the design space was enough?) or about the design (e.g., which alternative to prototype).
  - How many options did you have to choose from?
  - How many criteria did you have to compare the options? How did you choose those criteria?
  - What tools did you use to make a decision?
- At what stage did you make a decision?
- When did this experience take place? Did you already have one final solution in mind or you were still exploring the ideas?
- What challenges did you face during decision-making process?

Response:

For the decision making, we tested prototypes and discussed the pros and cons of each through a matrix. Then we chose the best features from each while still staying true to our initial objectives and constraints. For example, we debated between having a hard case versus a soft case and in the end decided to go with the hardcase due to the safety it offered to internal components.

Part 2: "So What?"

In this section you will explore what you learned and describe why this incident matters to you.

In three to five sentences, discuss what you learned from this incident about idea generation, testing ideas, and decision making and that either surprised you, made you confront a misconception, or improved your understanding of the design process.

To help you think about this, consider the following:

- What was the outcome of early or late testing processes?
- Do you think delaying any of your decision-making may have improved the design?
- Could you have collected better observations or data that would have led to better decisions?
- Did you repeat your decision-making process at any other stage?

Response:

The outcome of our early testing process was that our design had lots of flaws and areas for improvements. For example, our design was not wide enough for a charger. We repeated our decision-making process when we wanted to create a lid for our object and had to choose its design.

In two to three sentences, explain why these new insights are important to you.

Response:

These insights are important to me because going forward as an engineer it's important. For me to do this consider these options.

Part 3: "Now What?"

In two to three sentences, discuss how you will integrate this new insight into future design projects, including next week prototyping and design review 2 where you still have a chance to improve your design. To help you think about this, consider the following:

- I learned that... (Express and important learning, not a statement of fact)
- This learning matters because... (Consider how this learning has value to you as an engineer)
- How will I apply my learning?
- How will I design differently next time?
- How will I deal with a similar situation in the future?
- Considering this learning, I will... (Set specific, assessable goals; consider benefits and challenges involved in this plan)

Response:

In future design projects I will create a lot more prototypes and consider far more solutions. In the future, if a situation arises where we change our design part way through, these steps will be very important to do my stuff.

In two to three sentences, describe the possible benefits and challenges involved in your plan.

Response:

My benefit from this plan was that the plan worked. The challenge was that the plan didn't work which caused unfortunate.

References:

Lawson, B., & Dorst, K. (2009). Design expertise. Oxford, UK: Architectural Press.

Crismond, D. P., & Adams, R. S. (2012). The informed design teaching and learning matrix. Journal of Engineering Education, 101 (4), 738-797.

ENGINEER 1P13:
PROJECT FOUR WORKSHEETS (INDIVIDUAL)

Table of Contents

PROJECT FOUR MILESTONE ONE: PROBLEM FRAMING AND TEST PLAN

MILESTONE 1.1 – CLIENT NOTES

Team ID: Mon-45

Complete this worksheet individually before coming to Lab A for Week 6.

1. Include your client notes from the introductory client visit

Name: Adrian Ali	MacID: ali247
-	

PROJECT FOUR MILESTONE TWO: DESIGN EXPLORATION AND DESIGN REVIEW #1

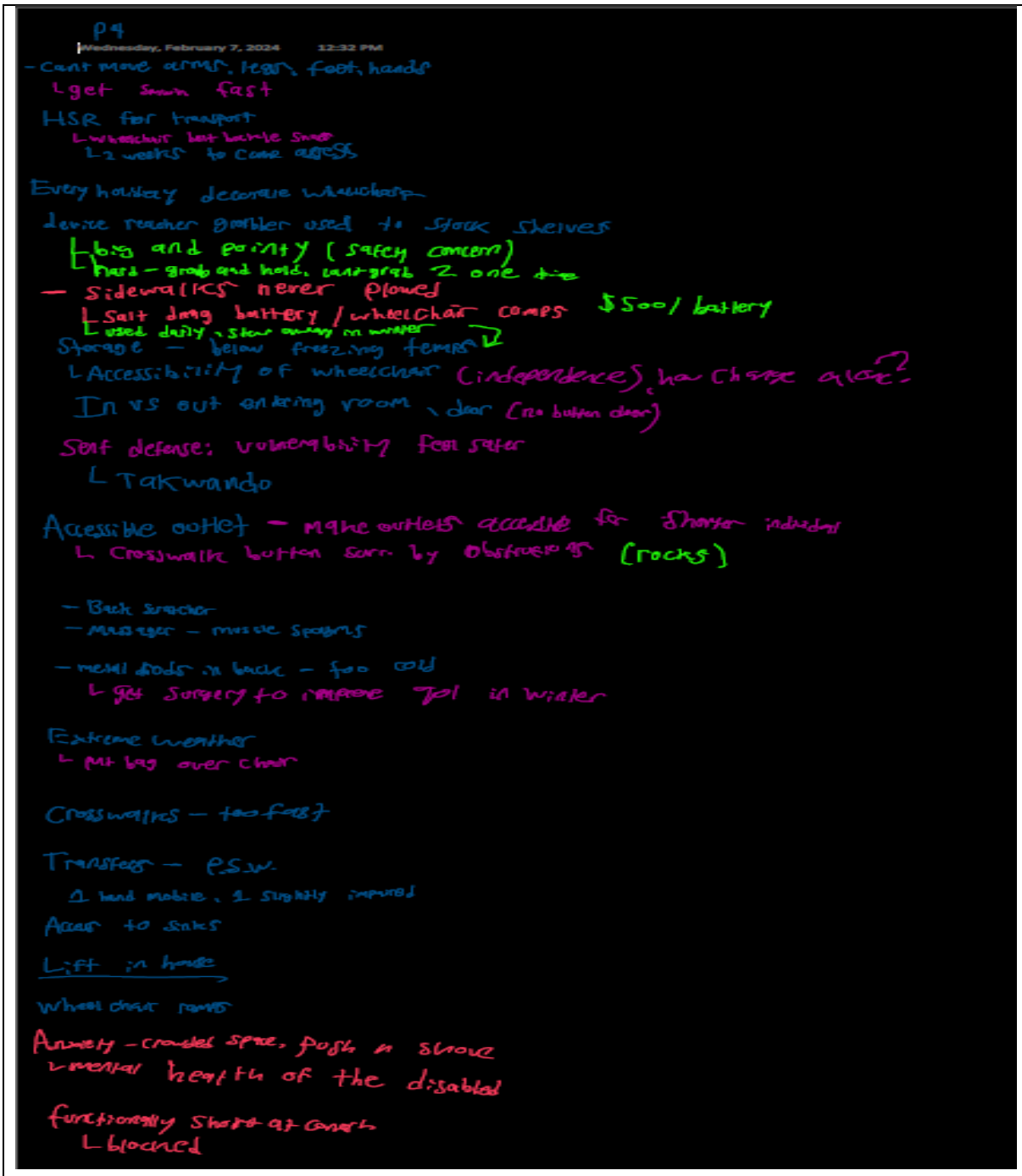
MILESTONE 2.1 – CLIENT NOTES

Team ID: Mon-45

Complete this worksheet individually before coming to Lab A for Week 7.

Include your client notes from the introductory client visit

Name: Adrian Ali	MacID: ali247


P4
Wednesday, February 7, 2024 12:32 PM
- Cant move arms, legs, feet, hands
L get sworn fast
HSR for transport
L wheelchair bent handle snap
L 2 weeks to come across
Every holiday decorate wheelchair
device reacher grabber used to stock shelves
L big and pointy (safety concern)
hard - grab and hold, can grab 2 one time
- sidewalks never plowed
L salt dang battery / wheelchair comps $500/battery
L used daily, stay outside in winter
Storage - below freezing temps
L Accessibility of wheelchair (independence), ha change alot?
In vs out entering room, door (no button door)
Self defense: vulnerability feel safer
L Takwando
Accessible outlet - make outlets accessible for shorter individual
L Crosswalk button sorr by obstructions (rocks)
- Back scratcher
- Massager - muscle spasms
- metal rods in back - too cold
L get surgery to improve tol in winter
Extreme weather
L Mt bag over chair
Crosswalks - too fast
Transfers - P.S.W.
1 hand mobile, 1 slightly impaired
Access to stairs
Lift in house
Wheel chair ramps
Anxiety - crowded space, push a stroller
L mental health of the disabled
functionality shared at times
L blocked

MILESTONE 2.2 – RESEARCH ASSIGNMENT

Team ID: Mon-45

Complete this worksheet before Lab A for Week 7.

- State the question you plan to answer through your research
- Summarize your research findings (answer). Your answer should be a coherent, well-written summary of your research, not a "brain dump".
- You may include images, but don't forget to cite them properly.
- Aim for a length of about 500 words
- Properly cite your sources using IEEE formatted references and in-text citations. For information on referencing formats and choosing sources, see Design and Communication Workshop 1.

Name:	MacID:

What is your question?

What are the challenges of living with Spina Bifidia across one person's entire life?

What is your answer?

Spina Bifidia is a relatively uncommon but severe birth defect, affecting 1 in 2000 according to [1]. It develops within the womb before a child is born when the neural tube only partially closes within the developing fetus, which leaves a portion of the spinal area open and susceptible to damage. The condition is usually caused by genetics but can also result from a lack of folate during pregnancy. Spina Bifidia can be diagnosed through regular ultrasound check ups within the gestational period. Thus, it is usually more effectively treated via fetal surgery, or otherwise immediately after birth. However, there is still a chance the condition still impacts the individual's life post surgery, and posessing this condition can also lead to further health complications, as well as bring about unique challenges in everyday life.

There are several severity and types of Spina Bifidia, depending on the level of exposure of the neural tube and the exact origin of the crevice. For example, if this area is located near the brain, the child can easily develop meningitis. Furthermore, sometimes Spina Bifidia can stagnate the development of the brain leading to further mental and physical challenges in affected children. This can manifest as learning disabilities, issues with controlling the bowel and bladder, bone, joint and muscle irregularities, sleep apnea, depression and many more. But, most of these conditions can be managed with routine checkups and minor operations across the lifespan of an affected child. Immediately after surgery, there are routine checkups that occur to monitor the child as it

grows. As mentioned in [1], a common issue that develops in 85% of patients is a lack of blood or fluid circulation throughout the body. To address this issue, metal shunts are usually implanted in children to facilitate this transport of vital nutrients across the body. Another issue that can begin at a young age is the tethered spinal cord. As the child grows, these spinal cords are unable to grow with the child and can result in a loss of function or increase in disability as the individual reaches adulthood.

Generally, a person suffering from Spina Bifidia experiences some form of loss in sensory or motor functions. So, throughout the life of the affected individual, they need to develop adaptations to maintain a high quality of life. At a young age, this can include disability education to help the child learn and properly take care of their unique needs as well as advocate for themselves. Physical therapists and other personnel can help to guide the affected individual toward a balanced life. This may also involve the use of adaptive equipment such as wheelchairs, prosthetics, and etc. There are also several social and mental issues that may arise as a result of having this disability, and they may be amplified as the individual affected reaches adulthood. However, with proper care and guidance, those with spina bifidia can live significant lives.

List of sources:

[1]T. C. H. of Philadelphia, "Spina Bifida Causes, Symptoms and Treatment," *www.chop.edu*, Mar. 30, 2014. https://www.chop.edu/conditions-diseases/spina-bifida

[2]"Spina bifida - Symptoms and causes," *Mayo Clinic*. https://www.mayoclinic.org/diseases-conditions/spina-bifida/symptoms-causes/syc-20377860#:~:text=Spina%20bifida%20is%20a%20condition

[3]"Growing Up with Spina Bifida what we have learned NCODH North Carolina Office on Disability and Health." Available: https://fpg.unc.edu/sites/fpg.unc.edu/files/resources/reports-and-policy-briefs/NCODH_SpinaBifida.pdf

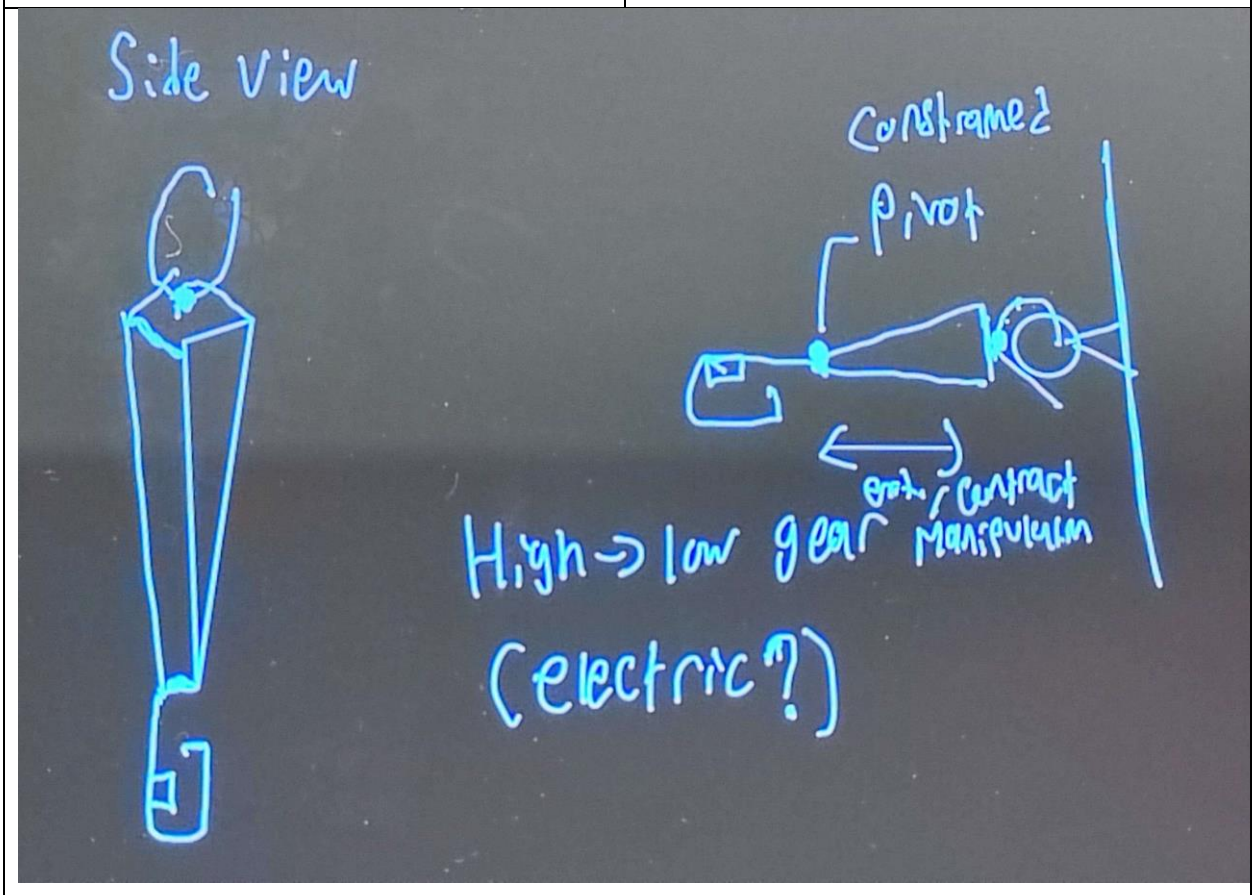
MILESTONE 2.2 – INITIAL CONCEPT EXPLORATION

Team ID: Mon-45

Complete this worksheet before Lab A for Week 7.

1. Include multiple images of your **initial** concept exploration, if needed
   → Include necessary annotations to help in the communication of your ideas
   → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   → Include your Team Number, Name and MacID on *each* concept image
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* concept images per page**

Name: Adrian Ali	MacID: ali247



MILESTONE 2.4 – REFINED CONCEPT EXPLORATION

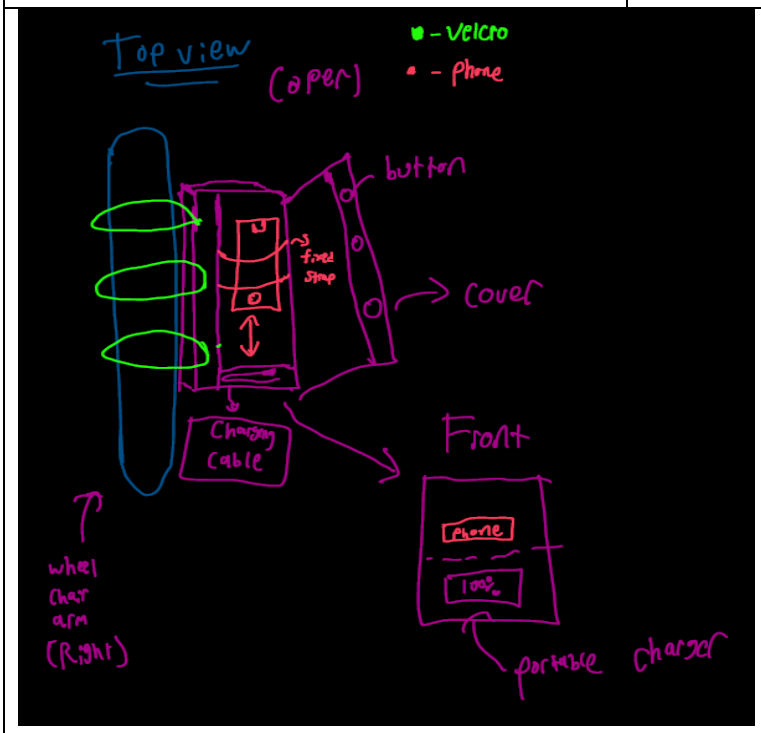
Team ID: Mon-45

Complete this worksheet during Lab A for Week 7.

4. Include multiple images of your **refined** concept exploration, if needed
   → Include 2 distinct concepts based on the functional analysis
   → Include necessary annotations to help in the communication of your ideas
   → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   → Include your Team Number, Name and MacID on *each* concept image
5. Insert your photo(s) as a Picture (Insert > Picture > This Device)
6. **Do not include more than *two* concept images per page**

Concept 1:

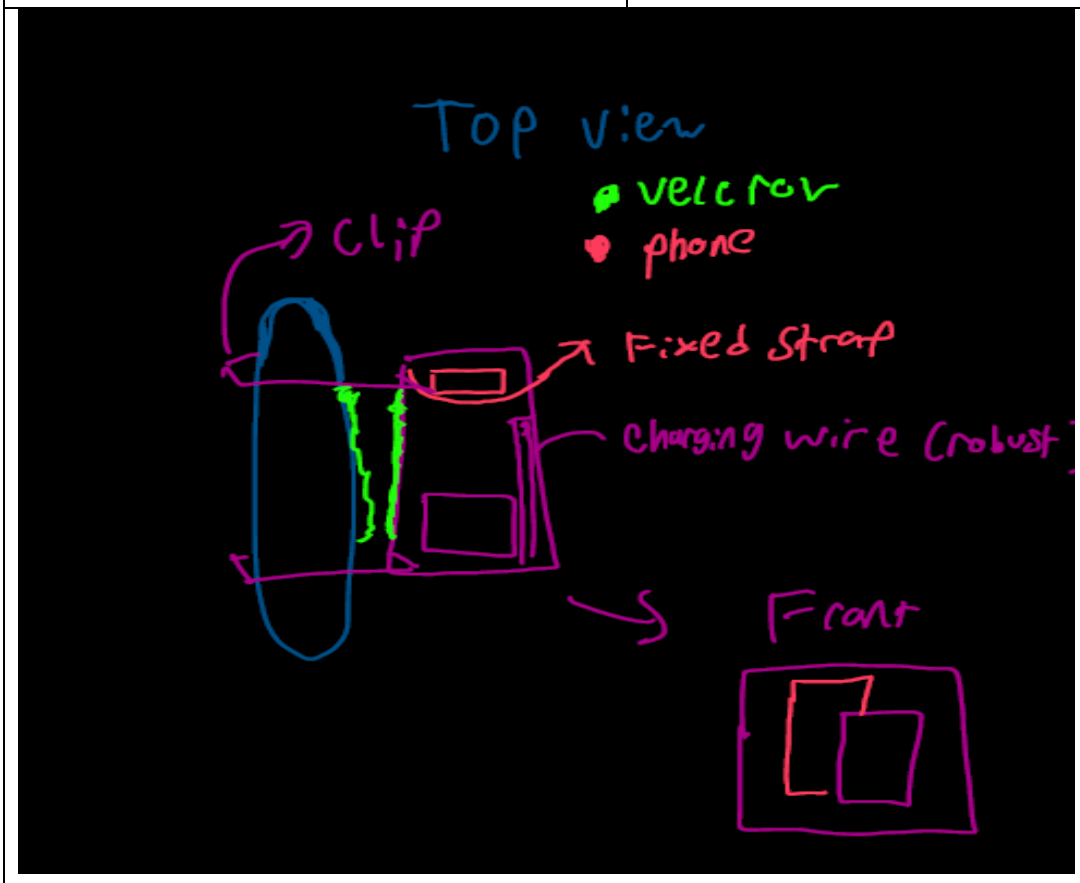
Name: Adrian Ali	MacID: ali247



Team ID: Mon-45

Concept 2:

Name: Adrian Ali	MacID: ali247



PROJECT FOUR MILESTONE THREE: PROTOTYPING, DECISION MAKING AND DESIGN REVIEW #2

MILESTONE 3.1 – REFINED CONCEPT: INITIAL PROTOTYPE

Team ID: ____

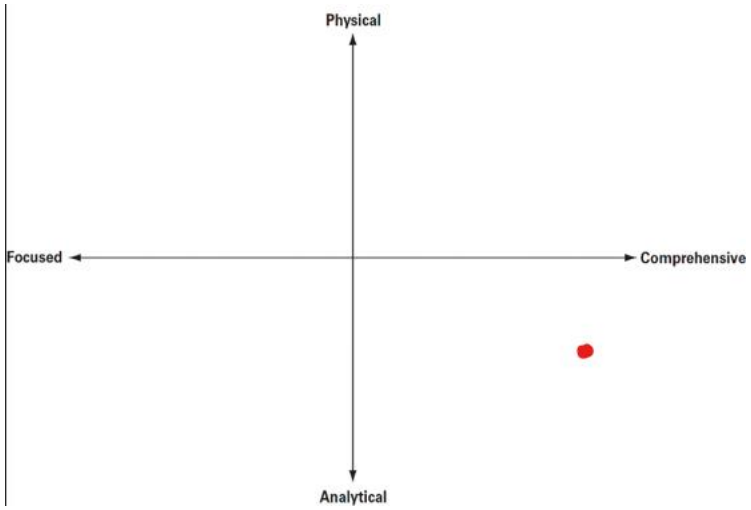
Complete this worksheet individually before coming to Design Studio/Lab A for Week 8.

1. Write a small description of your initial prototype. Be sure to include what problem it aims to solve, how your initial prototype will be fabricated, and what functionality will be included and omitted in this initial prototype.
2. Classify whether your prototype is Physical or Analytical, and Focused or Comprehensive. Include the purpose of this prototype in the context of project 4 and the level of fidelity (low, medium, or high fidelity)
   - → **Physical vs. Analytical:** Physical prototypes are tangible artifacts that are created to approximate the final product. Analytical prototypes are non-tangible and represent the product using usually visual or mathematical models.
   - → **Focused vs. Comprehensive:** Focused prototypes implement only one or a few of the attributes of the final product. Comprehensive prototypes aim to implement most, if not all of the attributes of the final product.
3. Create a list of objectives and metrics for your initial prototype. There is no required amount of objectives or metrics, so long as the list is comprehensive.
4. Create a rough experimental plan for how you might test your prototype. Consider the methods you might use to test various objectives, how you will measure how effective each test proves to be and how realistic it would be to implement. This does not need to be detailed plan but should consider several of your objectives for the prototype.
5. Take picture(s) of your refined concept (initial prototype)
   - → Insert your photo(s) as a Picture (Insert > Picture > This Device)
   - → **Do not include more than *two* refined concept pictures per page**
   - → Include details on how concept was refined (what feedback was incorporated, what features are different than previous concept exploration, etc.)
   - → You can continue this process within the allocated time of the LabA/DS and seek feedback and discussions from your team members and/or the instructional team (IAIs, TAs, etc.).

Name: Adrian Ali	MacID: ali247

This prototype helps the client to charge their phone using a strap to hold the phone, dividers to separate the phone from the power bank, fastened together with their wheelchair using bans of velcro.

Indicate where your prototype falls on the scale below.



Kind of Prototype:

☐ Physical or ☐ Analytical

☐ Focussed or ☐ Comprehensive

Purpose of Prototype:

Proof of concept.

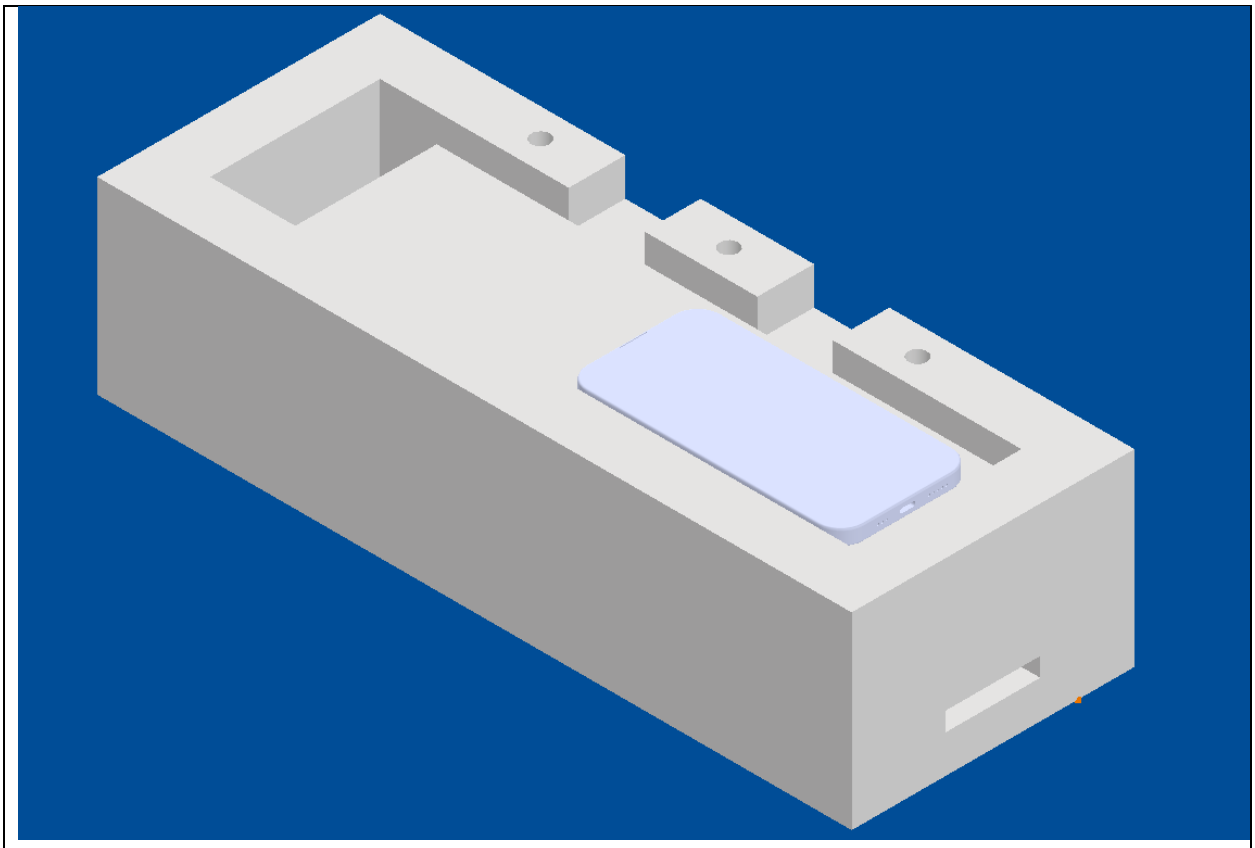
Level of Fidelity:

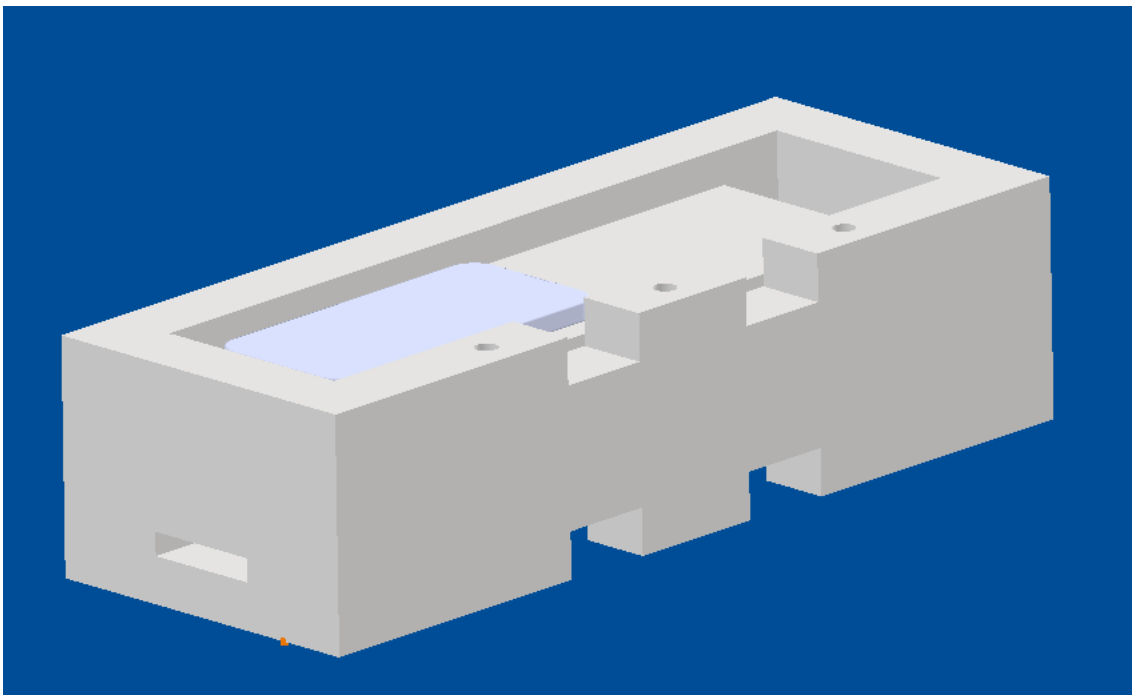
Extremely Low

Include a list of objectives and metrics for your prototype below.

Objectives	Metrics
• Durability	• Young's Modulus
• Temperature Controlled	• Degrees Celsius
• Portable	• Weight (kg) / Size (m)
• Aesthetically Customizable	• Customizability
• Cost	• Dollars

To test this prototype, since it is a software prototype, I can choose a material and use the iProperties window to determine weight and size. I can also determine young's modulus by applying pressure to the model at different locations and use it to make changes as necessary. To determine customizability, I could make a survey and send it to a greater audience.





PROJECT FOUR FINAL DELIVERABLE: PROJECT REFLECTION

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Grading of Reflection

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https://ecampusontario.pressbooks.pub/engineeringreflectiontoolkit/

Reflection Activity

Consider your experience with the design process as a first-year engineering student working on Project 4 over the past couple of months in ENG 1P13. After exploring the client's challenges and gaining insights, your team, decided to focus on one area to improve our client's daily life. You have defined the problem in a problem statement that included objectives, constraints, etc. Through this exploration, you performed a functional analysis that was used to come up with different alternative ways to solve the problem. Your team needed to make a decision between the different alternatives, and you tested your ideas for feasibility. You have been encouraged to iterate as you gained deeper insight and developed empathy for the client. Through the process of iteration, you have had the opportunity to improve upon your ideas. Engineers are continually iterating through the design process. Informed designers are involved in continual learning: learning by doing, learning from brainstorming and prototyping, learning by iteration and from feedback and failure, learning by noticing and troubleshooting, learning by drawing and dialoging about ideas, materials, and people. While iteration is an informal form of reflection, you will deepen your understanding of what you have learned through formal reflection. All of these emphasize the metacognitive and reflective practice aspects of learning through design (Lawson & Dorst, 2009; Crismond & Adams, 2012).

Part 1: What?

In this section you will describe a critical incident that you will be reflecting on as related to the "Generating/Testing ideas" and "Decision-making". For each of these steps of the design process:

In three to five sentences, identify and describe ONE critical incident, breakthrough or big thought-provoking moment that either challenged your assumptions, had a positive impact on you or validated your understanding of the design process. Here are some questions to consider.

Generating & Testing Ideas:

- How did you go about exploring ideas?
- How deeply did you explore your design options?
  - How much research?
  - Did you look into Biomimicry tools?
  - Did you consider any "What if?" questions in your explorations?
- Did you test your ideas?
- If yes, how did you test your ideas?
  - What were you trying to test (e.g., desirability, feasibility, etc.)?
  - What tool/ method did you use? (physical prototype, CAD model, etc.)
  - How much time did you spend on testing each idea?
  - How many ideas did you test?
  - How many prototypes did you make for testing each idea?
  - Did you test your ideas early on or waited until you had more details of the ideas?
- What was one challenge that you faced in the testing process of the design? (we encourage you to write more than one challenge). And What did you do to solve that challenge? (you can attach photos to explain your attempted solutions)
- From the results of our testing, one change we made to improve our design solution was … (add your response) and this change made our design solution better because … (add your response).

Response:

During our design process, we generated several distinct ideas to help our client open doors. We did not conduct additional research ahead of time into the actual design mechanism and how it would be used, we were just trying to develop a mechanism to open a door. As we continued, we realized the problem we were trying to solve was no longer useful or related to the client. So, we went back to the drawing board and consistently referred to the problem in a more solution-oriented manner around how the client would use it to develop a useful solution.

Decision Making:

- What happened during decision-making?
  - Where in the process, relative to the design process steps, did you make decisions?
  - What were the decisions about? Decisions could be about the process (e.g., how much searching of the design space was enough?) or about the design (e.g., which alternative to prototype).

- How many options did you have to choose from?
- How many criteria did you have to compare the options? How did you choose those criteria?
- What tools did you use to make a decision?

➢ At what stage did you make a decision?
➢ When did this experience take place? Did you already have one final solution in mind or you were still exploring the ideas?
➢ What challenges did you face during decision-making process?

Response:

We made decisions while generating our analytical prototype about which design we should focus on and refine into our final solution. We had 4 initial prototypes to choose from, all of which varied in how they functioned, but all achieved the same goal to varying degrees. To compare these options, we ranked them based on their attributes, giving a heavier emphasis on ease of use and security. Each design shined in it's own way, so we decided to take the best of each design and try to make a new final prototype that portrayed each attribute in it's best light.

Part 2: "So What?"

In this section you will explore what you learned and describe why this incident matters to you.

In three to five sentences, discuss what you learned from this incident about idea generation, testing ideas, and decision making and that either surprised you, made you confront a misconception, or improved your understanding of the design process.

To help you think about this, consider the following:

- What was the outcome of early or late testing processes?
- Do you think delaying any of your decision-making may have improved the design?
- Could you have collected better observations or data that would have led to better decisions?
- Did you repeat your decision-making process at any other stage?

Response:

This incident taught me that it's always a good idea to critically reflect upon our design choices early in the design process, even if it delays the timeline. While this process can take a lot of time, looking back it saved us a lot of time. If we had prototyped our design and later realized it was not useful for our client, it would have wasted even more precious resources. This questioned my assumption that doing is better than stopping and thinking, as if we hadn't stopped and thought about practical scenarios, we would have blindly developed a useless solution.

In two to three sentences, explain why these new insights are important to you.

Response:

These insights are important because I learned that when I get excited about creating a solution for a problem, I tend to narrow my view to a certain set of ideas, and I lose focus on the actual problem. I also learned that I could tend to think way too much about problems that never manifest themselves in reality.

Part 3: "Now What?"

In two to three sentences, discuss how you will integrate this new insight into future design projects, including next week prototyping and design review 2 where you still have a chance to improve your design. To help you think about this, consider the following:

- I learned that... (Express and important learning, not a statement of fact)
- This learning matters because... (Consider how this learning has value to you as an engineer)
- How will I apply my learning?
- How will I design differently next time?
- How will I deal with a similar situation in the future?
- Considering this learning, I will... (Set specific, assessable goals; consider benefits and challenges involved in this plan)

Response:

Since I learned that I tend to think about problems that might not actually exist, going forward I can make very low fidelity prototypes to test certain aspects of the design that worry me. I could also research more into the issue I'm concerned about to gain a more realistic perspective and further stimulate my thining about the issue in reality.

In two to three sentences, describe the possible benefits and challenges involved in your plan.

Response:

Although this will take a lot more time and effort, I believe over time as I sharpen my intuition, it will help me more accurately identify issues that are worth considering. However, this also ensures that my design solutions are well tailored and devleoped which may save me time in the long run.

References:

Lawson, B., & Dorst, K. (2009). Design expertise. Oxford, UK: Architectural Press.

Crismond, D. P., & Adams, R. S. (2012). The informed design teaching and learning matrix. Journal of Engineering Education, 101 (4), 738-797.

ENGINEER 1P13:
PROJECT FOUR WORKSHEETS (INDIVIDUAL)

Table of Contents

PROJECT FOUR MILESTONE ONE: PROBLEM FRAMING AND TEST PLAN

MILESTONE 1.1 – CLIENT NOTES

Team ID: Mon-45

Complete this worksheet individually before coming to Lab A for Week 6.

1. Include your client notes from the introductory client visit

Name: Aarudra Ramanan	MacID: ramana16

Medical Condition:
- Client has spina bifida since birth.

Limited mobility:
- Can move torso, arms, hands, and fingers, but not anything below the waist.
- Client also can not feel anything below the waist.
- Has two metal rods in her back that helps support her spine.

Mobility Aid:
- Needs a powered wheelchair to be able to move from place to place.
- Cannot go through some doors depending on their width.
- Has difficulty going through uneven terrain, especially during the winter.
- Client needs to receive daily support from either a nurse or a personal support worker to be able to tasks such as getting dressed and taking a shower.

Employment:
- Client wants to be financially independent and works at Walmart.
- In the job, client is required to do shelf stocking and must move around the store.
- Sometimes needs assistance due to heights client cannot reach, or the inability to carry the stock independently.

Tools for Independence:
- At home, client has a grabbing arm that assists in picking up and placing items at home.
- She is unable to use this tool at work.

Challenges:
- The cold weather gives client discomfort as the metal rods in her back become uncomfortable.
- Unable to use heat pads or warm water bottles against her back due to sensitivity of skin.

Personal Interests:
- Client would enjoy socializing with friends and doesn't want inaccessibility to places get in the way.
- Client also participates in dance lessons.

PROJECT FOUR MILESTONE TWO: DESIGN EXPLORATION AND DESIGN REVIEW #1

MILESTONE 2.1 – CLIENT NOTES

Team ID: Mon-45

Complete this worksheet individually before coming to Lab A for Week 7.

Include your client notes from the introductory client visit

Name: Aarudra Ramanan	MacID: ramana16

- *Arm chair is made out of foam and plastic*
- She uses "where's my ride at" app for transportation
- *She uses either "My ride" or the normal HSR bus app.*
- *Cords are always getting broken.. because of wheels?*
- *If she plugs phone into chair, the battery power gets drained and she can't use wheelchair*
- *Has to use normal wall plug*
- *When she has it plugged in, 50% of chair battery goes into phone*
- *For storage, she has a backpack on chair and can only reach it if its on the arm rest*
- *She can only carry things that are able to fit into her backpack*
- *Battery, taekwondo stuff, wtvr daily things she need*
- *She wants more storage*
- *For cooking, she can't rlly reach the stove or the counter (because she has to stay sitting) – She has no food preference but she likes pizza and chicken wings.*
- *With her grabber, she can only pick up certain shapes*
- *She's right handed – important for gripper*
- *She has more strength in her right than her left*
- *She has difficulty with some desk*
- *She has a latex allergy !! she uses non-latex gloves for personal care*
- *She puts most things on the right side of her wheelchair – because it's the dominant side?? It also doesn't get stuck*
- *Wheelchair doesn't have a cup holder (broke off cuz of hitting doors or getting stuck in their handles)*
- *There are very little arm pockets at the sides of her chair, but they aren't big and are only held by Velcro so she can't keep lots of things in it.*

MILESTONE 2.2 – RESEARCH ASSIGNMENT

Team ID: Mon-45

Complete this worksheet before Lab A for Week 7.

- State the question you plan to answer through your research
- Summarize your research findings (answer). Your answer should be a coherent, well-written summary of your research, not a "brain dump".
- You may include images, but don't forget to cite them properly.
- Aim for a length of about 500 words
- Properly cite your sources using IEEE formatted references and in-text citations. For information on referencing formats and choosing sources, see Design and Communication Workshop 1.

Name: Aarudra Ramanan	MacID: ramana16

What is your question?

What materials can be used to make the gripping tool?

What is your answer?

A gripping tool that can help the client must be lightweight while having a simplistic design and look. To achieve that, the materials used for the product are important. Also, because of the constraint being cost, the material must be cheap while still being strong enough to support the weight of being able to open a door. To find materials that could possibly be used, I decided to compare the gripping tool to a selfie stick. This is because they will be similar in shape and a selfie stick is lightweight so the user can hold it without it straining them.

Figure 1 -Gripping Tool [1]

From during some research, I was able to find that most of the time, the main extension part of the selfie sticks tends to be made from either aluminium alloy [3], carbon fibres, or stainless steel [2]. These materials are all durable materials that are great for everyday use however, the most desirable material in our case would be the aluminium alloy. This is because the aluminium alloy is made with the function of being lightweight which is important for client as it is something she must use every day [3].

Figure 2 – Selfie Stick [2]

For the handle part of the selfie stick, it is typically made out of either plastic, rubber, or foam. Out of the three, either foam or plastic would be the best option to use in this scenario. This is because the client has troubles holding things, which means it is best to have a handle that is comfortable and wouldn't hurt after holding it for a while [2]. Having it made out of rubber or

foam also helps make the handle have more friction with her hand so that it doesn't easily slip from her hand. This can be helpful because she'll need to have to hold onto the handle as she twists the gripper.

Lastly, for the part that actually grips onto the door handle, (the clamp), the material must have good grip in order for the gripper to be able to twist and open the door. This means that the gripper has to have rubber, or a material that can create good friction to get a good grasp onto the handle. But, because having only rubber will be too flimsy for it to stably hold the handle, either plastic or the same aluminum alloy can be used as the main material, with the rubber as a casing. [3]

List of sources:

[1] "Reacher Grabber Tool, 32" grabbers for elderly, Lightweight Extra Long Handy Trash Claw Grabber, reaching assist tool for trash pick up, Nabber, Litter Picker, arm extension (blue)," Amazon.ca: Health & Personal Care, https://www.amazon.ca/Reacher-Foldable-Lightweight-Reaching-Extension/dp/B078RMCFWQ?th=1 (accessed Feb. 24, 2024).

[2] N. Jonker, "8 things to consider when buying a selfie stick," MUO, https://www.makeuseof.com/things-consider-buying-selfie-stick/ (accessed Feb. 24, 2024).

[3] Kentfaith, "How To Make A Selfie Stick A Tripod ?," K&F Concept: Professional Photography Accessories, https://www.kentfaith.com/blog/article_how-to-make-a-selfie-stick-a-tripod_6892#:~:text=Some%20legs%20are%20made%20of,selfie%20sticks%20also%20offer%20versatility (accessed Feb. 24, 2024).

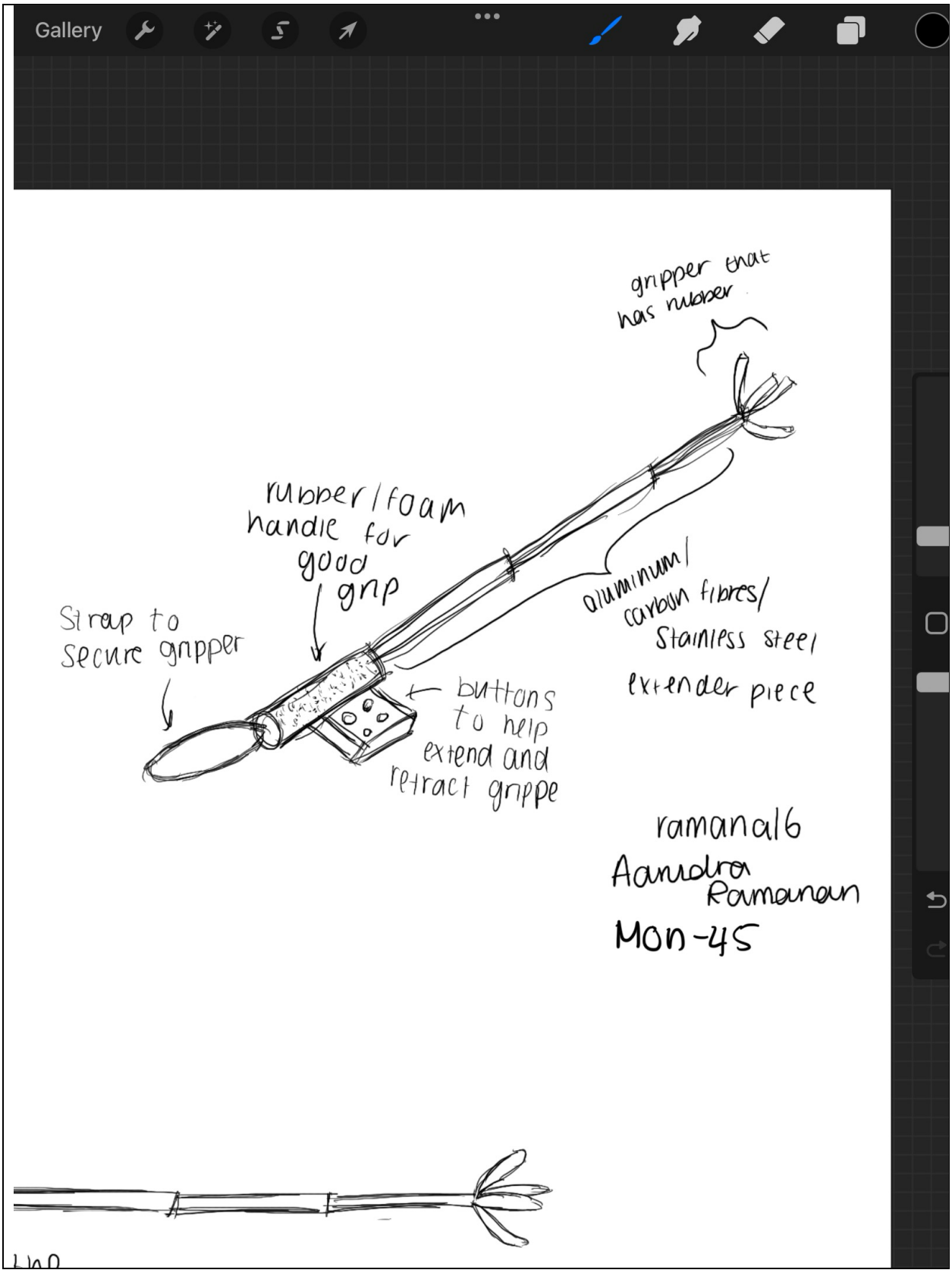
MILESTONE 2.2 – INITIAL CONCEPT EXPLORATION

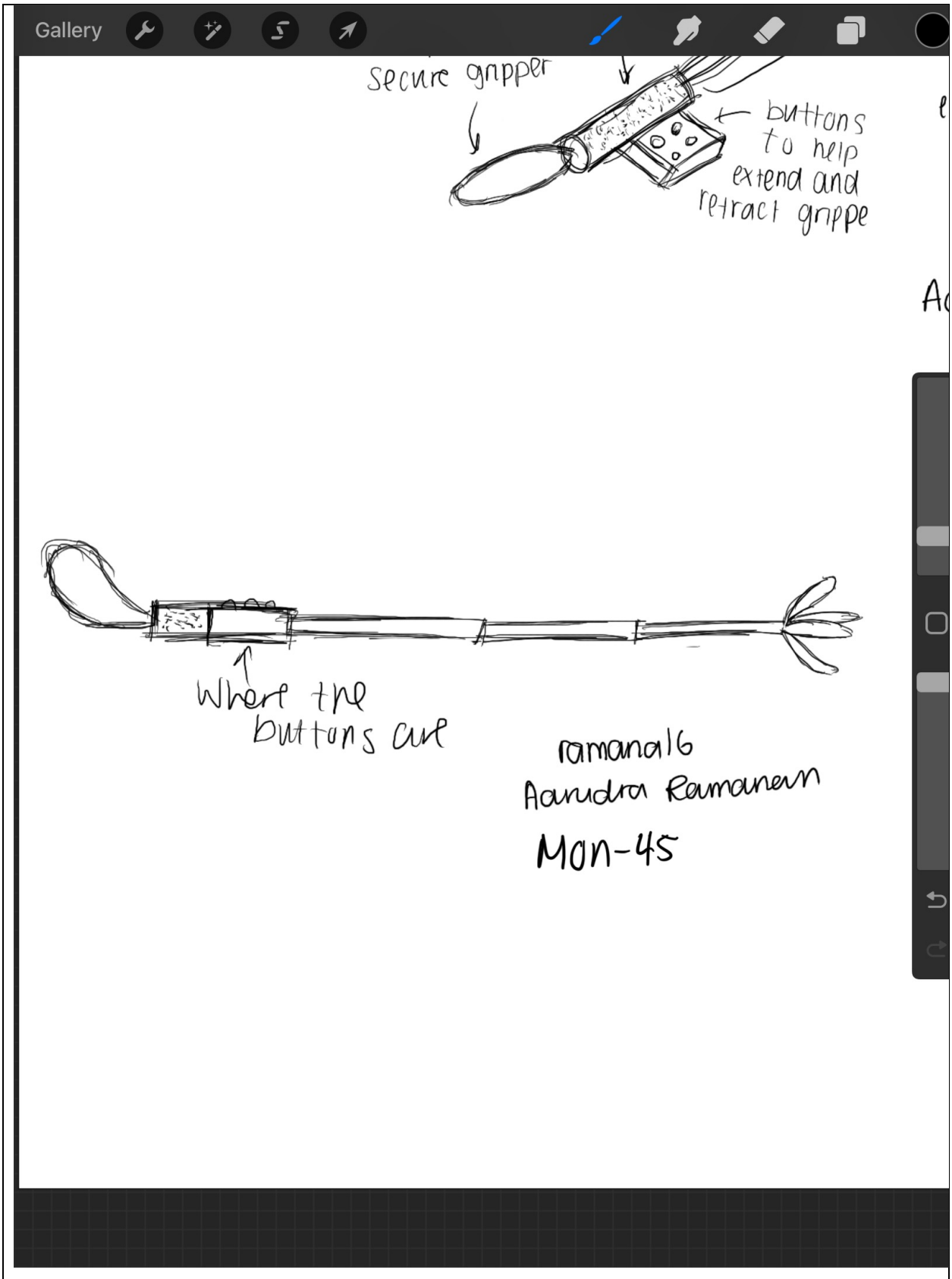
Team ID:	Mon-45

Complete this worksheet before Lab A for Week 7.

1. Include multiple images of your **initial** concept exploration, if needed
   → Include necessary annotations to help in the communication of your ideas
   → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   → Include your Team Number, Name and MacID on *each* concept image
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* concept images per page**

Name: Aarudra Ramanan	MacID: ramana16
Insert screenshot(s) of your concept below.	


Gallery
gripper that has rubber
rubber/foam handle for good grip
Strap to secure gripper
buttons to help extend and retract gripper
aluminum/ carbon fibres/ Stainless steel extender piece
ramanal6
Aanudra Ramanan
Mon-45


Gallery
secure gripper
buttons to help extend and retract gripper
Where the buttons are
ramanal6
Aanudra Ramanan
Man-45

MILESTONE 2.4 – REFINED CONCEPT EXPLORATION

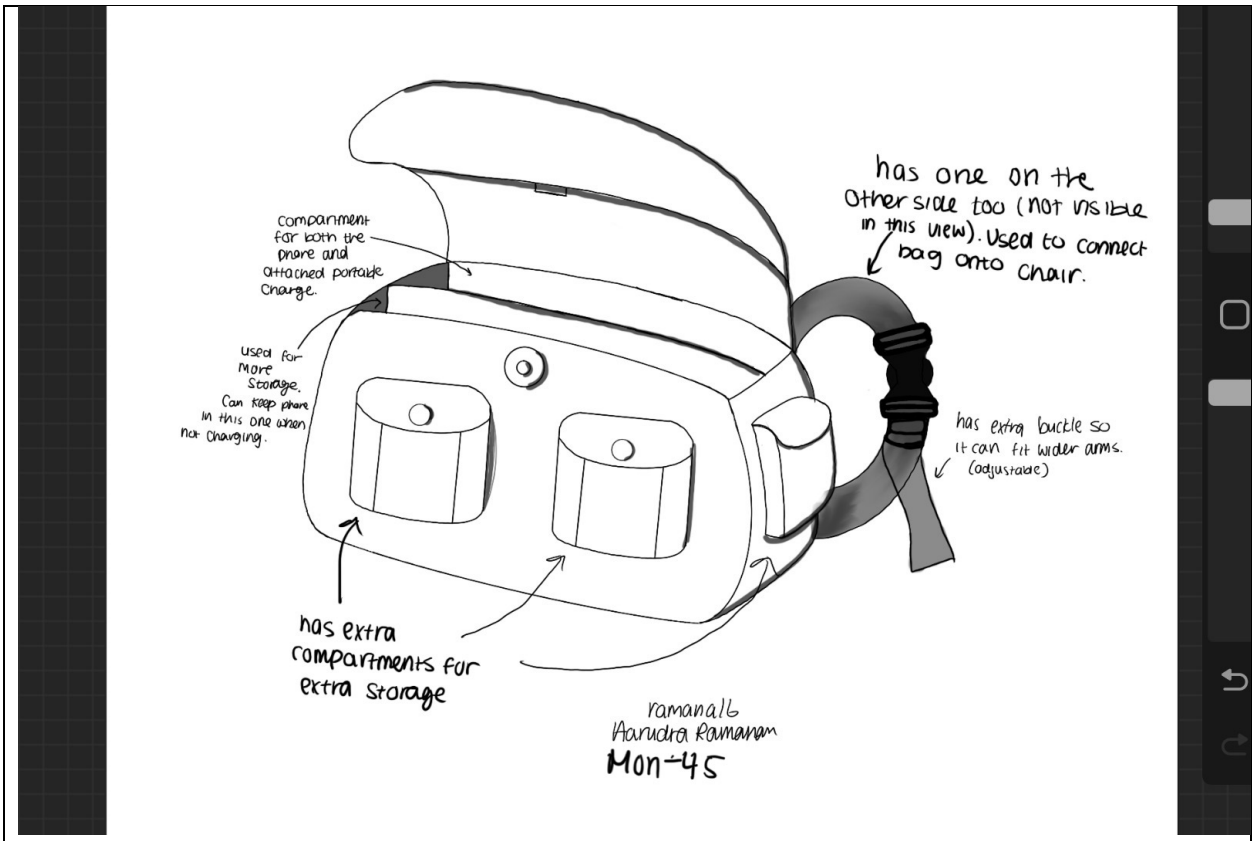
Team ID:	Mon-45

Complete this worksheet during Lab A for Week 7.

4. Include multiple images of your **refined** concept exploration, if needed
   - → Include 2 distinct concepts based on the functional analysis
   - → Include necessary annotations to help in the communication of your ideas
   - → These can be photos of hand sketches, photos of initial prototypes, screen grabs of basic CAD models
   - → Include your Team Number, Name and MacID on *each* concept image
5. Insert your photo(s) as a Picture (Insert > Picture > This Device)
6. **Do not include more than *two* concept images per page**

Concept 1:

Name: Aarudra Ramanan	MacID: ramana16
Insert screenshot(s) of your concept below. **NOTE: (Our refined concepts have changed from our initial concept because we decided to change our problem statement and what we were trying to help the client in. We changed our designs during the client interview, which came after both our DS and Lab A.)**	


has one on the other side too (not visible in this view). Used to connect bag onto chair.
compartment for both the phone and attached portable charger.
Used for more storage. Can keep phone in this one when not charging.
has extra buckle so it can fit wider arms. (adjustable)
has extra compartments for extra storage
ramanal6
Harudra Ramanan
Mon-45

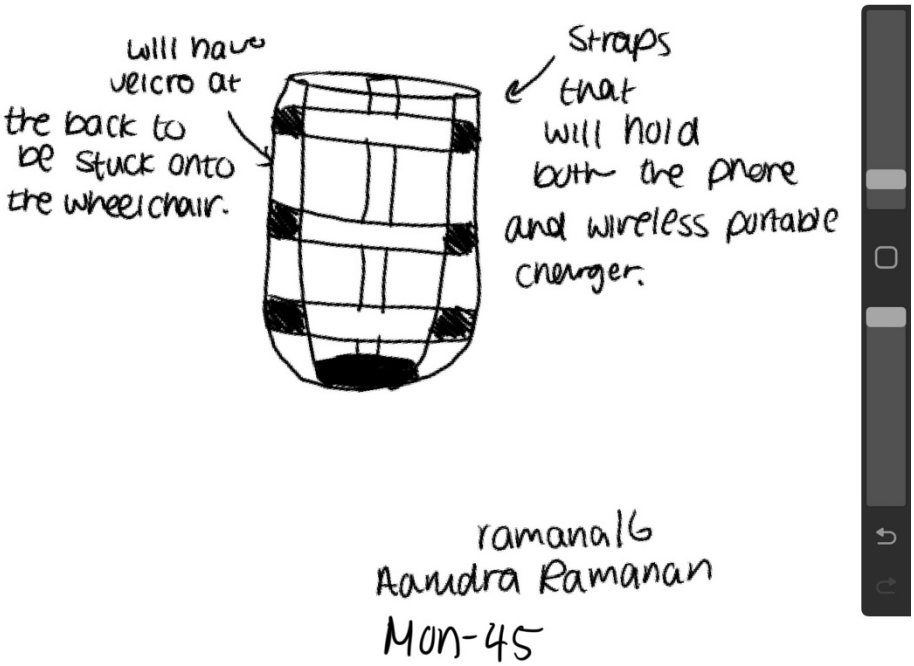
Team ID: Mon-45

Concept 2:

Name: Aarudra Ramanan	MacID: ramana16

Insert screenshot(s) of your concept below.

NOTE: (Our refined concepts have changed from our initial concept because we decided to change our problem statement and what we were trying to help the client in. We changed our designs during the client interview, which came after both our DS and Lab A.)



ramanal6
Aanudra Ramanan
Mon-45

PROJECT FOUR MILESTONE THREE: PROTOTYPING, DECISION MAKING AND DESIGN REVIEW #2

MILESTONE 3.1 – REFINED CONCEPT: INITIAL PROTOTYPE

Team ID: Mon-45

Complete this worksheet individually before coming to Design Studio/Lab A for Week 8.

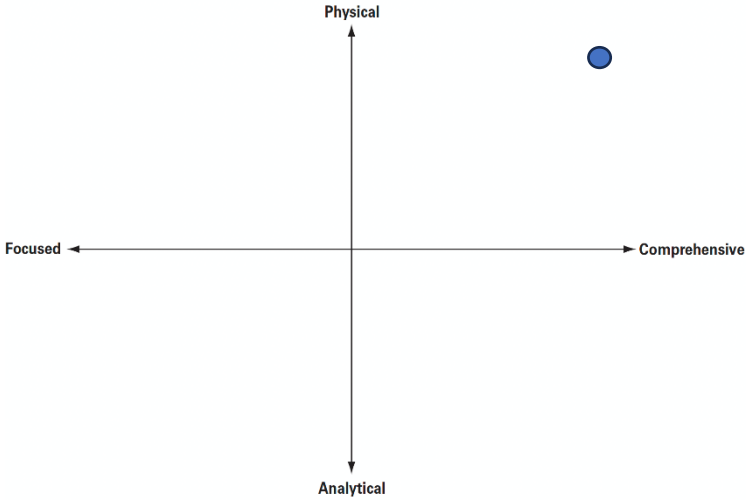
1. Write a small description of your initial prototype. Be sure to include what problem it aims to solve, how your initial prototype will be fabricated, and what functionality will be included and omitted in this initial prototype.
2. Classify whether your prototype is Physical or Analytical, and Focused or Comprehensive. Include the purpose of this prototype in the context of project 4 and the level of fidelity (low, medium, or high fidelity)
   - → **Physical vs. Analytical:** Physical prototypes are tangible artifacts that are created to approximate the final product. Analytical prototypes are non-tangible and represent the product using usually visual or mathematical models.
   - → **Focused vs. Comprehensive:** Focused prototypes implement only one or a few of the attributes of the final product. Comprehensive prototypes aim to implement most, if not all of the attributes of the final product.
3. Create a list of objectives and metrics for your initial prototype. There is no required amount of objectives or metrics, so long as the list is comprehensive.
4. Create a rough experimental plan for how you might test your prototype. Consider the methods you might use to test various objectives, how you will measure how effective each test proves to be and how realistic it would be to implement. This does not need to be detailed plan but should consider several of your objectives for the prototype.
5. Take picture(s) of your refined concept (initial prototype)
   - → Insert your photo(s) as a Picture (Insert > Picture > This Device)
   - → **Do not include more than *two* refined concept pictures per page**
   - → Include details on how concept was refined (what feedback was incorporated, what features are different than previous concept exploration, etc.)
   - → You can continue this process within the allocated time of the LabA/DS and seek feedback and discussions from your team members and/or the instructional team (IAIs, TAs, etc.).

Name: Aarudra Ramanan	MacID: ramana16

Write a short description of your initial prototype below.

My initial prototype covers the functions of a pocket, attached portable charger, and buckled with tightener. The red ribbons represent the buckle that can open and wrap around the wheelchair arm. It also represents the adjustable part where once on the arm, it can be tightened. Then the little pockets are for extra storage for small things, if the client needs it to carry smaller things. The main component is for the phone and the portable charger to be held together.

Indicate where your prototype falls on the scale below.



Kind of Prototype:

☒ Physical or ☐ Analytical

☐ Focussed or ☒ Comprehensive

Purpose of Prototype:

The purpose of the prototype is to show a physical model of how the idea would work in real life, and if it would be possible.

Level of Fidelity:

Medium because there are some parts I couldn't include due to material restrictions.

Include a list of objectives and metrics for your prototype below.

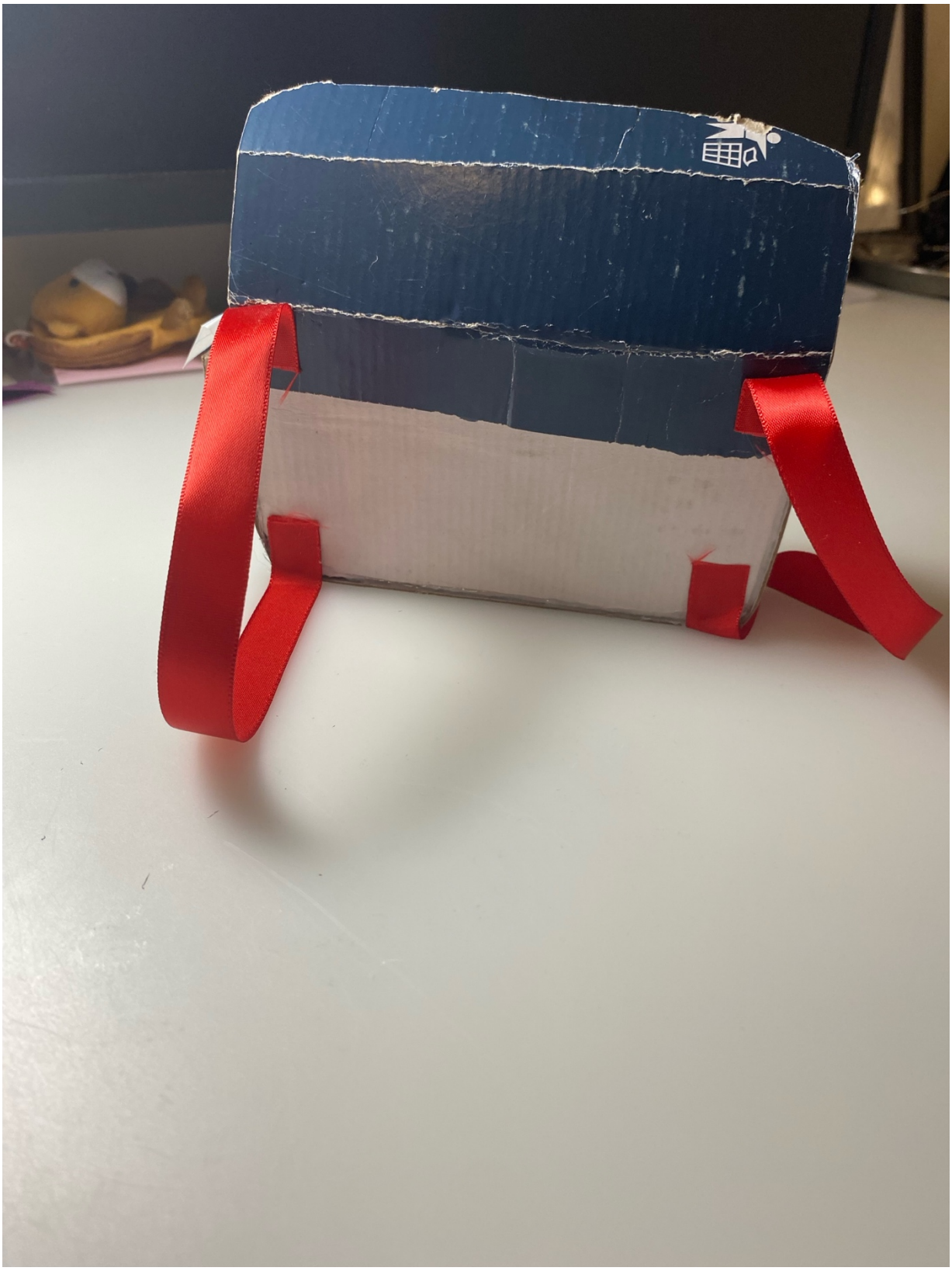
Objectives	Metrics
• **Durable**	• **Young's Modulus**
• **Portability**	• **Weight (kg) / Size (m)**
• **Aesthetically Customizable**	• **Customizability**
• **Temperature Controlled**	• **Degrees Celsius**
• **Convenience**	• **Subjective**

Include a rough experimental plan on how you might test your prototype below.

First, I would try to check whether the prototype would work. And check to see if it's able to function with something in the compartment. I would then mock how the prototype will be placed onto the wheelchair to ensure that it is convenient and can be easily accessible. I'd also mock various weather scenarios to ensure that the model is durable and can last in all types of weathers. This test can also help to make sure that the temperature of the phone doesn't get affected because of the insulation that will be put into the model.

Insert picture(s) of your refined concept (initial prototype) below.

C



PROJECT FOUR FINAL DELIVERABLE: PROJECT REFLECTION

The activities in this handout are intended to be completed by the end of the project 4. You will apply what you learn in Design Communication Workshop 4 to complete this task.

Submission Details

Each Team Member: upload your reflection essay as a PDF to the Avenue Dropbox titled P4 Reflection using the MacID_P4_Reflection.pdf as naming convention

Grading of Reflection

Your reflection assignment is worth 1 mark of your total Project-4 grade (12.5%). Rubric is provided on Avenue to Learn.
If you need to review the content, go back to Design Communication Workshop 4 and/or go through the online reflecti0on module. Here is the link:
https://ecampusontario.pressbooks.pub/engineeringreflectiontoolkit/

Reflection Activity

Consider your experience with the design process as a first-year engineering student working on Project 4 over the past couple of months in ENG 1P13. After exploring the client's challenges and gaining insights, your team, decided to focus on one area to improve our client's daily life. You have defined the problem in a problem statement that included objectives, constraints, etc. Through this exploration, you performed a functional analysis that was used to come up with different alternative ways to solve the problem. Your team needed to make a decision between the different alternatives, and you tested your ideas for feasibility. You have been encouraged to iterate as you gained deeper insight and developed empathy for the client. Through the process of iteration, you have had the opportunity to improve upon your ideas. Engineers are continually iterating through the design process. Informed designers are involved in continual learning: learning by doing, learning from brainstorming and prototyping, learning by iteration and from feedback and failure, learning by noticing and troubleshooting, learning by drawing and dialoging about ideas, materials, and people. While iteration is an informal form of reflection, you will deepen your understanding of what you have learned through formal reflection. All of these emphasize the metacognitive and reflective practice aspects of learning through design (Lawson & Dorst, 2009; Crismond & Adams, 2012).

Part 1: What?

In this section you will describe a critical incident that you will be reflecting on as related to the "Generating/Testing ideas" and "Decision-making". For each of these steps of the design process:
In three to five sentences, identify and describe ONE critical incident, breakthrough or big thought-provoking moment that either challenged your assumptions, had a positive impact on you or validated your understanding of the design process. Here are some questions to consider.

Generating & Testing Ideas:

- How did you go about exploring ideas?
- How deeply did you explore your design options?
  - How much research?
  - Did you look into Biomimicry tools?
  - Did you consider any "What if?" questions in your explorations?
- Did you test your ideas?
- If yes, how did you test your ideas?
  - What were you trying to test (e.g., desirability, feasibility, etc.)?
  - What tool/ method did you use? (physical prototype, CAD model, etc.)
  - How much time did you spend on testing each idea?
  - How many ideas did you test?
  - How many prototypes did you make for testing each idea?
  - Did you test your ideas early on or waited until you had more details of the ideas?
- What was one challenge that you faced in the testing process of the design? (we encourage you to write more than one challenge). And What did you do to solve that challenge? (you can attach photos to explain your attempted solutions)
- From the results of our testing, one change we made to improve our design solution was … (add your response) and this change made our design solution better because … (add your response).

Response:

When we first made our initial prototype, we didn't think about how a part we implemented into the design would affect how it didn't meet our objective. This made us have to review our design and have to figure out a way where the phone can still charge without being disturbed by our model. Because of this one piece, we ended up making 3 different models (the last one was our final model).

Decision Making:

- What happened during decision-making?
  - Where in the process, relative to the design process steps, did you make decisions?
  - What were the decisions about? Decisions could be about the process (e.g., how much searching of the design space was enough?) or about the design (e.g., which alternative to prototype).
  - How many options did you have to choose from?
  - How many criteria did you have to compare the options? How did you choose those criteria?
  - What tools did you use to make a decision?
- At what stage did you make a decision?
- When did this experience take place? Did you already have one final solution in mind or you were still exploring the ideas?
- What challenges did you face during decision-making process?

Response:

Because of our objective and what we wanted to help the client with, we had 4 very similar designs to choose from. We ended up talking about which one was best that fits our constraints and the design that was the most realistic for us to make. However, even though we ended up picking a specific design, throughout the milestones our model kept changing and wasn't solid until the very end.

Part 2: "So What?"

In this section you will explore what you learned and describe why this incident matters to you.

In three to five sentences, discuss what you learned from this incident about idea generation, testing ideas, and decision making and that either surprised you, made you confront a misconception, or improved your understanding of the design process.
To help you think about this, consider the following:

- What was the outcome of early or late testing processes?
- Do you think delaying any of your decision-making may have improved the design?
- Could you have collected better observations or data that would have led to better decisions?
- Did you repeat your decision-making process at any other stage?

Response:

Since we didn't think through our design properly, this resulted in time wasted and we had to rush a bit to create a fix to our problem and show it in our Design Studios. We could have avoided this had we made sure to check if the model was able to function before we printed it. We had to end up doing a decision-making process again to be able to create a fix for our design.

In two to three sentences, explain why these new insights are important to you.

Response:

These insights are important to me because it helped me learn to problem solve and think outside of the box to be able to fix our problems, while still following all the deadlines. It also helped our team work together as a team to be able to get over these problems and come together.

Part 3: "Now What?"

In two to three sentences, discuss how you will integrate this new insight into future design projects, including next week prototyping and design review 2 where you still have a chance to improve your design. To help you think about this, consider the following:

- I learned that... (Express and important learning, not a statement of fact)
- This learning matters because... (Consider how this learning has value to you as an engineer)
- How will I apply my learning?
- How will I design differently next time?
- How will I deal with a similar situation in the future?
- Considering this learning, I will... (Set specific, assessable goals; consider benefits and challenges involved in this plan)

Response:

In the future, I would make sure that our theoretical design would actually work before making a "final model" of our design, instead of just going for it. I could do this by making more prototypes that don't cost a lot of time or effort to make, so I can check to see if the model would work. I also learned that it's important to communicate with the team of all of the possibilities.

In two to three sentences, describe the possible benefits and challenges involved in your plan.

Response:

In the future, by being more careful I'd be able to avoid these problems which can help in being time efficient. But, having mistaken is what helps you learn so I am grateful that these happened so in the future, when I am working, I'll be able to avoid this from happening again.

References:

Lawson, B., & Dorst, K. (2009). Design expertise. Oxford, UK: Architectural Press.

Crismond, D. P., & Adams, R. S. (2012). The informed design teaching and learning matrix. Journal of Engineering Education, 101 (4), 738-797.