

GNG2101
Design Project Progress Update

Team B3.5

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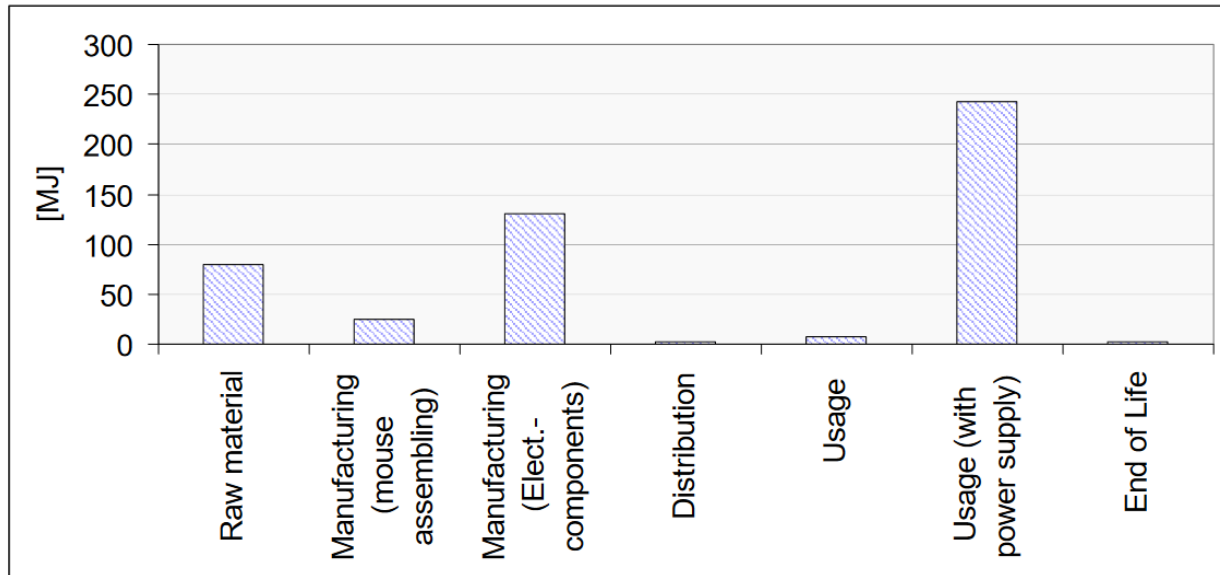


Figure 1: Graphic summary of a life cycle stages model (Stachura)

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition

Table 2. Glossary

Term	Acronym	Definition

0 Introduction

The goal of this report is to provide an overview of our design project's development, which is to create a reliable, user-friendly, and easily accessible mouse button system for a power wheelchair. The client navigates the computer cursor with a joystick on the left side of their wheelchair, but they need a way to turn on the clicks for the left and right. The design enables the buttons to be positioned next to the joystick, offering a user-friendly solution that satisfies the client's requirements for portability, durability, functionality, and repairability.

Throughout this project, assumptions were made regarding the client's wheelchair's ability to accept a customized button attachment and the sufficiency of Bluetooth or USB connectivity for computer interaction. Furthermore, we presume that the client needs simplicity of use—buttons that are reachable and easily operated—and that the design must endure normal wear and tear, including severe handling.

This document is structured in the following manner:

Sustainability Report and DFX: This part offers a framework for sustainability and design considerations while assessing the product's effects on society, the environment, and the economy.

Problem Definition, Concept Development, and Project Plan: In this section, the main issue being tackled is defined, several conceptual solutions are examined, and the project plan—which includes milestones and timetables—is presented.

Detailed Design and Bill of Materials (BOM): This part goes into great detail about the final design's technical requirements, including material selections and an exhaustive inventory of all necessary components.

Conclusions: A review of the work completed, and the lessons discovered during the design process, together with any unresolved issues or ramifications for further work.

1 Sustainability Report and DFX

1.1 Sustainability report Provide a sustainability report that reflects on at least three of your product's major social, environmental, and economic impacts, both positive and negative. Perform a simple analysis of these impacts and use this analysis to help you define the sustainability constraints of a triple bottom line table. See the table in the appendix.

Triple Bottom Line (EVERYONE)	Positive Impact	Negative Impact
Economic	Using the free facilities at Makerspace and open-source apps in designing the product will decrease the production cost.	Financial burden to the users could be imposed from the ongoing maintenance costs, if the device is not robust
	A custom-made product specifically for one user will rid of the need for the user to spend money on purchasing different products to try.	initial investments in eco-friendly manufacturing processes may increase costs in the short term, potentially reducing profitability for small manufacturers.
	Creation of jobs related to manufacturing, distribution, and maintenance services boosts local economies.	Individuals and communities with limited financial means may not be able to afford a custom-designed product, resulting in an accessibility gap.
Environmental	Reducing waste and encouraging reuse of the product if it is durable	Failure to recycle materials used for prototyping properly will pose harm to the environment.

	Using PLA when 3D-printing prototypes poses less threat to the environment, since PLA is recyclable and compostable.	Electronic components such as circuit boards or wires will eventually end up as waste, as well as any batteries that may be used.
	Use of recyclable materials and modular design reduces the environmental impact, as individual components can be replaced without discarding the entire product.	Waste and emissions can be produced by production and prototyping procedures if they are not run responsibly.
Social	Improving quality of life to the users, supporting and enhancing accessibility	While making life convenient, an easy-to-use mouse-clicker may increase the user's computer usage time significantly.
	Improving the quality of life of the people around the user, who previously had to assist whenever the user had to click on a computer.	Individuals who cannot face-to-face interact could be at risk of social isolation if they rely too heavily on assistive technology.
	Promotes inclusivity by allowing individuals with disabilities to participate	Limited access to repair services in rural or underdeveloped regions could

	more effectively in digital environments, which can also extend to education, employment, and social engagement.	result in usability issues for clients, limiting the product's long-term value.
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Using the LCA framework, define the 4 steps of the assessment for your product by basing yourself on an existing similar product: objective and scope, inventory analysis, impact assessment and interpretation.

The following steps of the LCA framework will be defined based on existing computer mice.

Define Objectives and Scope: This assessment's scope will comprise the materials and manufacturing of the mouse and the usage after it is produced. This assessment focuses on the energy consumption involved in the processes above, specifically the power needed to process materials, manufacture and power the mouse. Aspects such as carbon emissions and water usage will be excluded. Aspects such as transportation and packaging will not be considered.

Inventory Analysis: As seen in Figure 1 (Stachura), significant energy consumption is involved in both the manufacturing and usage of the computer mouse.

- **Manufacturing and Materials:** Computer mice are primarily made of plastics such as acrylonitrile butadiene styrene (ABS plastic) through injection moulding (Advameg). Most electrical components such as micro-switches, integrated circuits/chips, electrical cables and end connectors can be supplied by third parties (Advameg).
- **Usage:** Computer mice require electricity to function. As seen in Figure 1, usage comprises “extreme” energy consumption within the product’s lifetime (Stachura).

Impact Assessment: It might also be beneficial to consider the significant energy usage involved in the post-production steps of the mouse’s life cycle, given its significant weight in the life cycle’s

total energy consumption, seen in Figure 1. Reducing the energy involved in the usage of the product could significantly reduce the total energy involved in the process.

Interpretation: Following impact assessment, it might be optimal to consider specific DFXs to lead with, in order to better optimize energy consumption (Design for Sustainability / Design for Usability). A further comparison involving alternative manufacturing methods could be useful for reducing energy consumption.

1.2 Design for X

Based on your research and what you have heard from your client, list the 5 most important factors in your design. Justify the choice of each of those factors including common objectives/needs for this DFX, examples of metrics, examples of constraints as well as examples of design criteria for each DFX.

1. Usability
 - a. A simple design that is self-explanatory can make its use easy for a user, even without a manual
 - b. A suitable size for a bigger hand; 1 inch x 1 inch per button
 - c. A Shape that accommodates use by thumb only, which is how the user generally prefers to use the clicker
 - d. Easy recharging mechanism, either by USB charging or replacing triple-A batteries
2. Durability
 - a. Due to the user's discomfort in motor abilities, the mouse clicker must be able to withstand rough usage
 - b. Add padding (ex: stiff foam) around the buttons to reduce the impact force from hitting the buttons or from dropping the clicker
 - c. Minimize protuberances on the surface of the clicker that may make components more prone to breaking off
 - d. Carry out a drop/impact test to determine the maximum force the clicker can withstand. Back up the experimental data with SolidWorks FEA analysis results
3. Functionality
 - a. Based on client interview aesthetics is not important and the main objective is to provide a functional prototype.

- b. Seamless integration with the existing joystick to avoid interfering functionalities.

Incorporate fully functional right and left clicks with an options menu from the right click just like

a regular mouse.

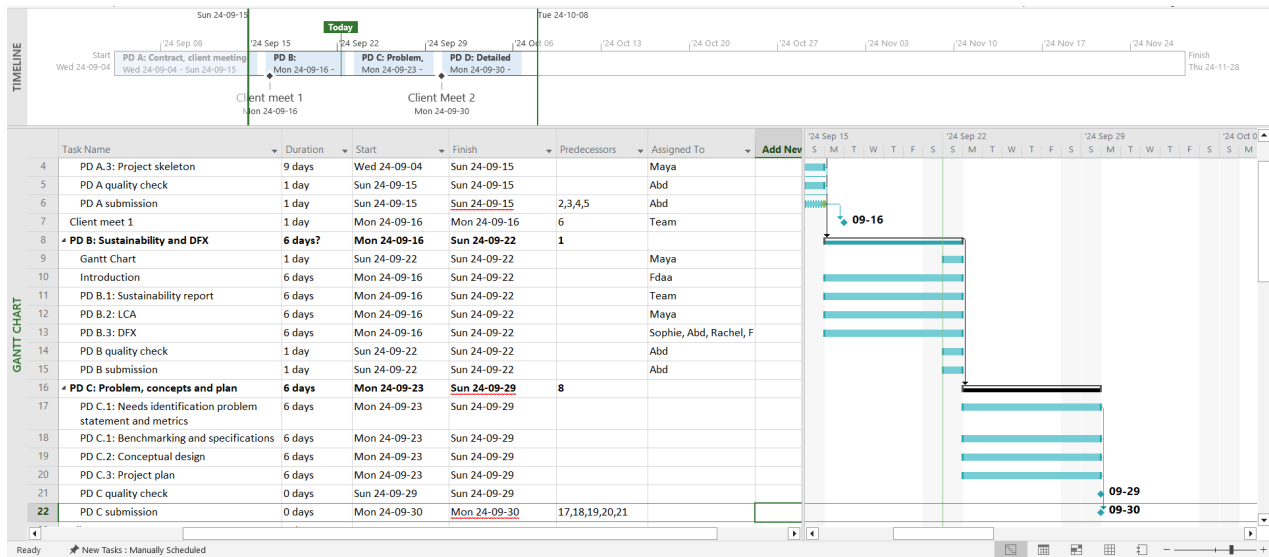
4. Repairability

- a. Repairability score to evaluate replacing the parts, disassemble the drive, access repair manuals
- b. Availability for spare parts to facilitate quick and easy repairs to reduce the need for replacement
- c. Modular design to allow individual components to be easily replaced without needing to discard the entire product.
- d. Use of recycled materials to reduce ecological and carbon footprint from new material production

5. Portability

- a. sturdy construction that holds steady when moving but is simple to take apart for storage or cleaning.
 - b. There are no parts or sharp edges that could hurt or impede joystick movement.
- c. The computer may be used with ease when connected via Bluetooth.

Gantt Chart (as of September 22):



2 Problem Definition, Concept Development, and Project Plan

2.1 Problem definition

1. List and prioritize client needs/problems and define all relevant known and unknown information.

Priority #	Client Needs
1	The mouse click buttons need to be functional right and left click buttons
2	The device connects to a computer via Bluetooth (USB would be acceptable)
3	The device is durable, and the buttons are resistant to significant pressure
4	The device can last at least 1-2 years, and is easily repairable
5	The device can be easily installed and uninstalled from the wheelchair platform
6	The buttons on the device are smoothly integrated within the casing
7	The device is waterproof

Known Information	Unknown Information
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<ul style="list-style-type: none"> - The device should be about 5-6 cm in diameter (approximate sizing guide) - There exists a platform on the armrest of the wheelchair which will house the device (images have been received) - The previous mouse buttons used by the client were 3d printed, 1 by 2 inches total, fastened with Velcro, somehow integrated within the wiring of the wheelchair, 	<ul style="list-style-type: none"> - Precise dimensions of the platform which will hold the mouse buttons
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2. Create a problem statement (what is the problem, who has the problem, and what form can the solution be).

A user with mobility impairments needs a mouse clicker that is wireless, easy to repair, and mountable onto a wheelchair to be used alongside an already-existing joystick. The mouse clicker must be simple to use and made durable to withstand the user's rough handling.

3. Provide a list of need inspired metrics with appropriate units and conduct benchmarking on similar solutions (can satisfy some or all needs). Provide descriptions and pictures when possible.






List of need-inspired metrics

#	Need	Imp	Units
1	The device easily mounts and detaches from the wheelchair	5	Time (seconds) or Qualitative (easy, moderate, difficult)
2	The device can be operated with the thumb	5	Force (newton) or qualitative(easy, moderate, difficult)
3	The button is integrated inside the body instead of protruding	3	Protrusion measurement (mm)
4	The device is durable after exposure to the environment (water, etc.)	5	IP rating or qualitative(high, medium,low resistance)
5	The device does not need to be repaired continuously and last long	4	Time (months or years) or number of cycles (clicks)
6	The device can be connected through both Bluetooth and USB	5	Bluetooth or USB

7	The device integrates seamlessly with the existing joystick controls	5	Compatibility rating (percentage or qualitative: fully, partially, not compatible)
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Benchmarking

	[Microsoft] Adaptive Dual Button	[Microsoft] Adaptive Mouse	[Pretorian Technologies] n-ABLER JAZZ Joystick	[AbleNet] BIGtrack 2	[TECHNET] Ergonomic Mouse
Link	https://www.microsoft.com/en-ca/d/microsoft-adaptive-dual-button/911z415gjlr?act=ivetab=pivot:overviewtab	https://www.microsoft.com/en-ca/d/microsoft-adaptive-mouse/8pjl97lnqd7	https://www.pretorianuk.com/jazz-joystick#vids	https://www.ablenetinc.com/bigtrack-2/	https://tecknet.com/products/tecknet-2-4g-wireless-silent-mouse-with-4800-dpi-5-adjustable-dpi-6-buttons

		?activetab=pivot:overviewtab			
Picture					
Cost (before tax)	\$89.99	\$99.99	£232.80 (\$420.73 CAD)	\$100.00	\$25.99
Dimensions	Length: 55mm (2.2inch) Width: 55mm (2.2inch) Height: 24.9mm (1.0inch)	Length: 57.3mm (2.3inch) Width: 57.3mm (2.3inch) Height: 20.6mm (0.8inch)	180x102x112mm high (joystick) Palm rest height approx. 35mm	Trackball size: 3in (7.6cm)	11.94x7.37x0.1 cm
Weight	0.048kg (0.11 pounds)	0.0443kg (0.10 pounds)	Not provided	Not provided	0.11793g (0.26 pounds)
Connection	Bluetooth® 5.1 Wireless USB 2.0 full speed (USB-C® receptacle)	Wireless USB-C	Wired USB	USB and PS2 Adapter (USB Type A receptacle required)	Wireless USB-C
Buttons	2 sizeable rectangular button areas	Same as MS Dual Button, but with scroller added in between	2 left & right clicks, 1 drag lock, all relatively small (can only be clicked with fingers)	Oversized buttons	Similar to regular computer mice in market
Repairability	Initial design not easily repairable by user, but the additive customizations can be repaired by user	Same as MS Dual Button	Not easily repairable by user	Not easily repairable by user	Not easily repairable by user
Versatility	Downloadable 3D printed designs to customize adaptive devices, such as replacing mouse tails and button toppers.	Same as MS Dual Button	Some cursor speed settings can be customized 3 different kinds of knobs with the joystick for different needs/preferences	Used as is.	Adjustable Level DPI (irrelevant to our project)

			Configurable for 'left-handed' operation.		
Accessibility	Since 1 simple original design can turn into many different designs, it can accommodate different kinds of motor disabilities. Gives more power to the users than traditional one-size-fit-only computer mice.	Same as MS Dual Button	Minimal hand movement which reduces wrist and elbow fatigue The symmetrical design enables users to work with either hand without having to angle the wrist, Configurable for 'left-handed' operation. Large, integrated hand support/palm rest	Allows user to easily move and position the mouse cursor on the computer screen while using fine or gross motor movements of the hand, arm, or foot	Ergonomically designed so that palm is positioned close to a vertical angle with the desktop, reducing pressure and pain on the wrist.
Usability	Must create custom inputs Not designed specifically to be a computer mouse, so it must be customized by the user (user must have some technical knowledge and dexterity for initial set up)	Easy 'plug and play' installation,	Easy 'plug and play' installation, but does need to set up some setting option.	Easy 'plug and play' installation Color-differentiated right and left click buttons	Easy 'plug and play' installation
Charging Mechanism	Rechargeable Li-polymer battery	Rechargeable Li-polymer battery	N/A	N/A	Replaceable AAA batteries (2)
Impact Resistance	N/A	N/A	Advertised as a "robust design	"Designed to be dropped, encounter moisture and dirt, and keep performing so users can achieve best outcomes"	N/A
Satisfied Needs	Button-only design, wireless	Simple design, easier usability compared to	Robust design, usability	Large buttons, robust design, usability	While such a design is not needed, the

		Adaptive Button, wireless			ergonomic design may be referenced
Irrelevance		Scroller	Joystick	Trackball	Scroller

4. Develop a set of target specifications (both ideal and marginally acceptable values). Provide reasons for your choices.

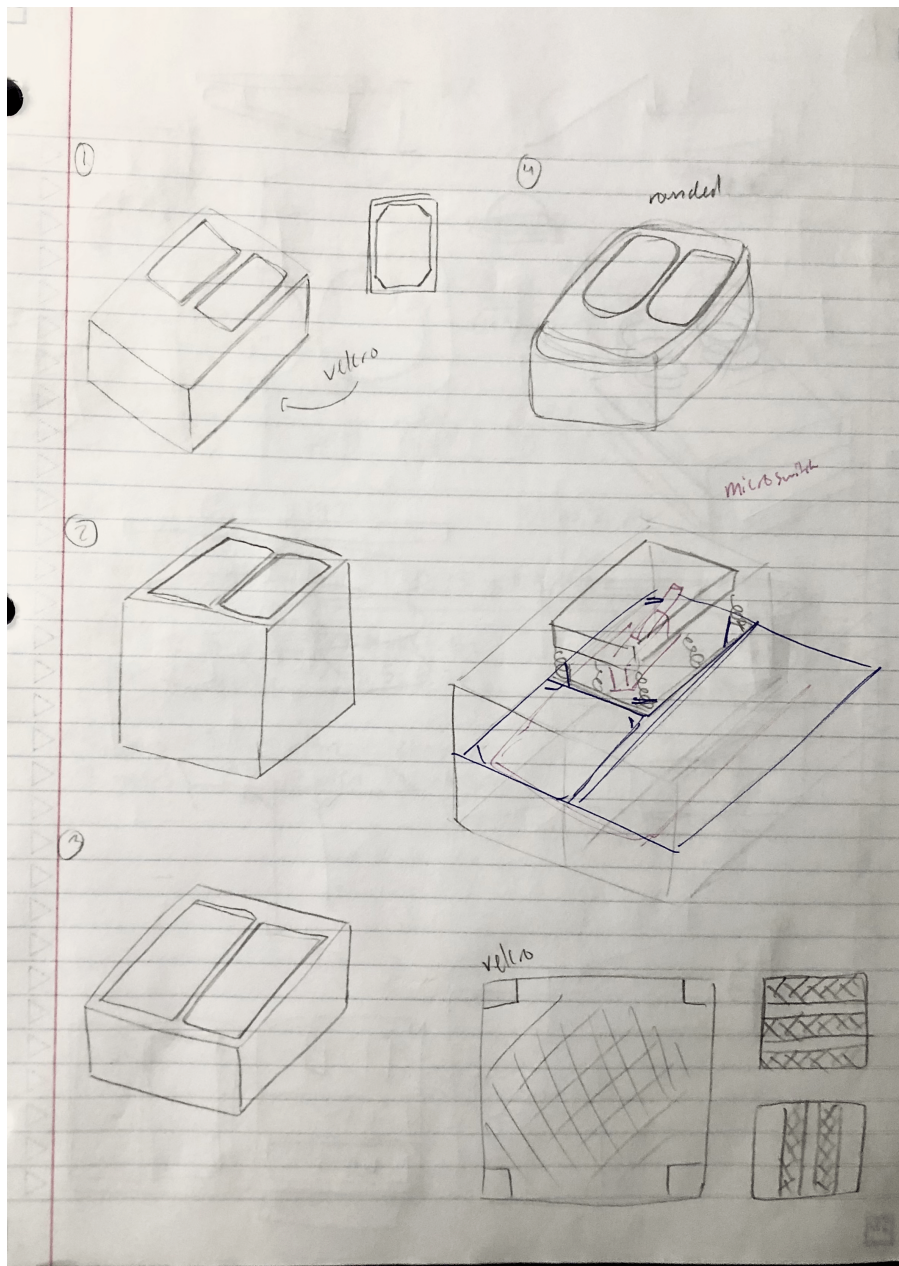
Specification	Ideal value	Marginally Acceptable value	Reasons for Choice
Button Size	2 inch by 1 inch	1.5 inch by 1.5 inch	Ensures ergonomic comfort and ease of use, particularly for thumb operation, minimizing hand strain.
Battery life	<u>Replace it every 1 to 3 months.</u>	Replace it every 3 to 5 months.	A flexible battery replacement schedule of 1 to 5 months accommodates different usage levels, ensuring convenient maintenance and uninterrupted operation. Also, there is no need to

			charge them, just replace the battery.
Weight	Between 100grams to 200 grams	Between 100grams to 300 grams maximum.	A weight range of 100 to 300 grams ensures the device is light enough for seamless integration with the wheelchair, while also allowing for easy cleaning and installation.
Response Time	Less than 20ms to respond after the button click.	Not more than 50ms to respond after the button click.	Ensures real-time interaction without noticeable lag, which is crucial for users.
Operating Range	Bluetooth ranges between 1 to 2 meters.	Bluetooth ranges more than 2 meters.	A Bluetooth range of more than 2 meters allows for greater flexibility in device placement, while 1 to 2 meters is sufficient for close-range use.

Waterproofing	Fully waterproof	Water-resistant	Protects the device from accidental spills or exposure to moisture, enhancing longevity.
Height of mouse	1.5 to 2 inch	2 to 4 inches	A height of 1.5 to 2 inches provides comfortable accessibility, while anything over 1.5 inches may make it harder for the user to grip and operate effectively.
Charging Method	<u>Non-rechargeable replaceable battery</u>	AA batteries	A long-lasting non-recharging battery reduces replacements and ensures continuous, convenient use, with a 3-month lifespan still adequate for regular use.

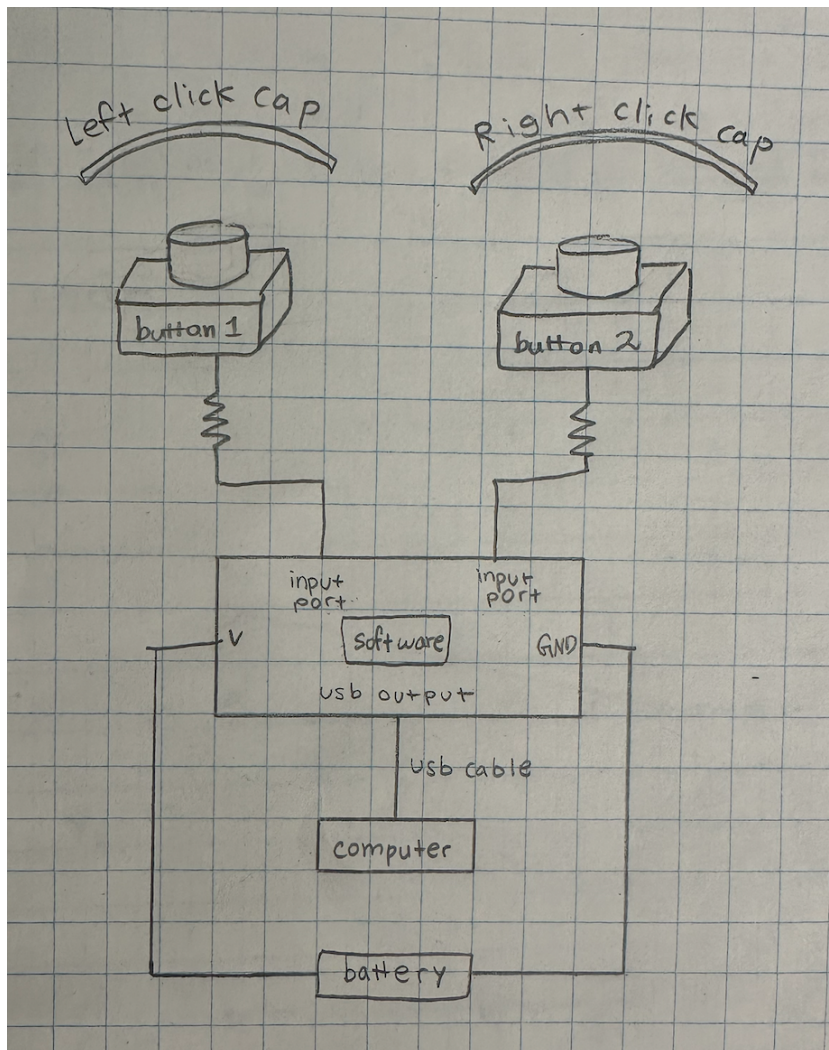
2.2 Concept development

1. Based on your problem statement and the DFXs in PD B, develop final prototype concepts for each sub-system, as well as the entire assembled system required to solve the problem.
 - a. Casing with buttons



b. Electronic circuit (USB in drawing is optional)

A general outline:



c. Bluetooth connection

1.Components Needed:

2. **Arduino board** (e.g., Arduino Uno or Nano)
3. **HC-05 or HC-06 Bluetooth module** (for Bluetooth connectivity)

4. **Push buttons** (for left and right clicks)
5. **Resistors** (typically 10kΩ for pull-down or pull-up configuration with buttons)
6. **Wires and breadboard**
7. **Computer with Arduino IDE** (for programming)

2. Adding the Bluetooth Module:

- Connect the **HC-05/HC-06 module** to the Arduino:
 - o VCC to **5V**
 - o GND to **GND**
 - o TX of HC-05 to RX of Arduino (D0 or any other pin if using SoftwareSerial)
 - o RX of HC-05 to TX of Arduino (D1 or any other pin if using SoftwareSerial)

3. Arduino Code:

The Arduino code will read the state of the buttons and send the corresponding signals via Bluetooth to emulate mouse clicks.

3. Setting Up the Bluetooth on the PC:

- Pair the **HC-05/HC-06 Bluetooth module** with the PC or smartphone.
- On the PC, we will need software to listen to the Bluetooth COM port and interpret the "LeftClick" and "RightClick" signals. This can be done using a simple Python script or a custom driver if necessary.

4. Handling Bluetooth Input on PC:

On the PC side, you can write a script (in Python, for example) to read the Bluetooth data and send the corresponding mouse click events:

a. Software

A simple program runs in the background, ensuring the buttons perform left and right mouse clicks without affecting the joystick's movement. If using bluetooth, the software will handle the connections to ensure that the buttons will respond quickly. If using USB, the buttons will be automatically detected and function.

8. Analyze and evaluate all concepts against the target specifications you defined. Use simple calculations and/or simulations to make decisions. Justify the process and methods used for analysis and evaluation.

Concept	Defined Target Specs	Analysis & Evaluation
Casing with buttons	Physical casing designed to enclose electronic circuits and sensors securely.	The design of the casing must accommodate the electronic components and the buttons in a user-friendly manner.
Electronic circuit	Less than 20ms to respond after the button click Non-rechargeable replaceable battery	Button sensors with response rates equivalent to or less than 20ms will be purchased. The circuit board/Arduino will be powered by AA batteries which are widely accessible and affordable, as well as easy to integrate into the design. The wired USB option portrayed will be used in case Bluetooth option is not successful.
Bluetooth connection	Wireless communication via Bluetooth for sending button press data to a computer or another device.	The Bluetooth module (such as an HC-05 or similar low-power module) should provide fast, reliable communication between the circuit and the external device.
Software	The software must process the button click input and trigger corresponding response within 20ms	Software must respond within 20ms and work with the electronic circuit powered by the batteries. We will use Arduino to simulate button presses and check response times with an LED. Debounce logic will prevent false triggers, while performance will be tested. Error handling

		will confirm accurate button press registrations
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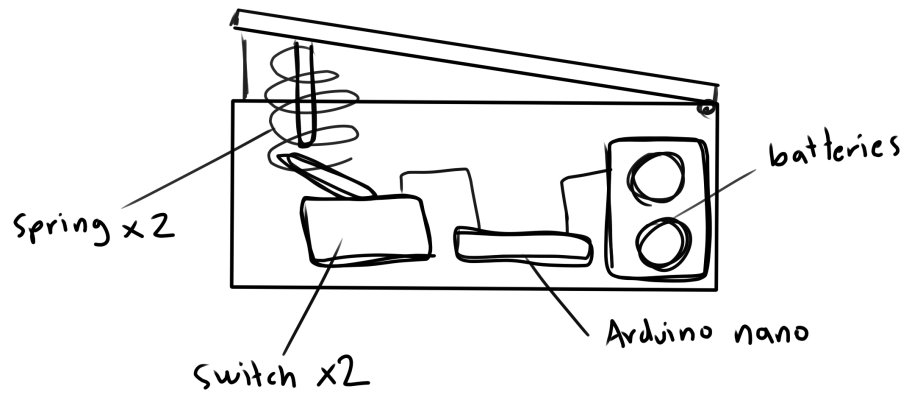
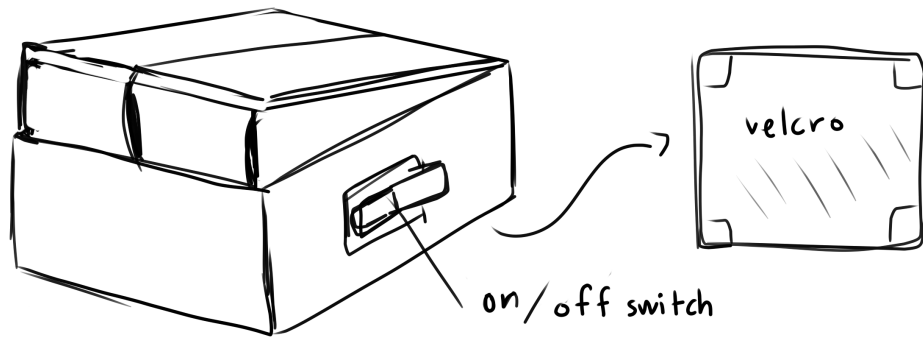
9. Choose one or a few promising solutions you wish to develop further based on your evaluation (see below).

10. Develop a global design concept which is either an integration or modification of the promising concepts chosen in the previous step, or a brand-new concept created from these ideas. Justify your approach. [Maya]

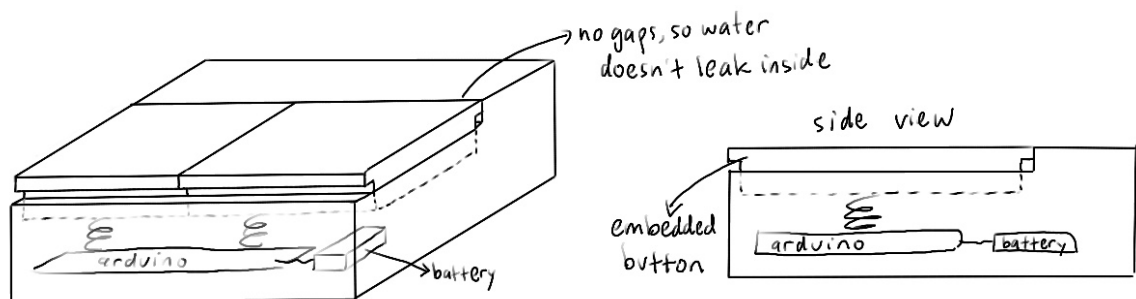
- A brand-new concept was developed after discussion between group members. It features:
- An Arduino nano: (to take up less space in the case) instead of an Arduino Uno, which was initially suggested. This Arduino should also be capable enough to incorporate a Bluetooth chip.
- Wireless Capability: The team made the decision to focus on creating a wireless design. This means the mouse buttons will be battery powered, and function through Bluetooth. This was decided upon based on the client's needs. Also, focusing solely on a wireless design improves resource allocation, compared to focusing on both wired and wireless.
- An integrated switch-spring system to create the button mechanism: this mechanism is the current design for constructing a functional button which we will connect to our electronic components. The spring helps to dampen the button when it is being pressed, and the switch sends the signal to the Arduino.
- Two variations on rectangular buttons have been included as options, in addition to a circular design (see below). Multiple options were included to provide the client with alternative designs.
- Velcro bottom: This aspect was included to seamlessly integrate the mouse buttons into the client's wheelchair, which already includes a platform with Velcro attached to it.

11. Visually represent (sketch, diagram, CAD model, etc.) your global concept.

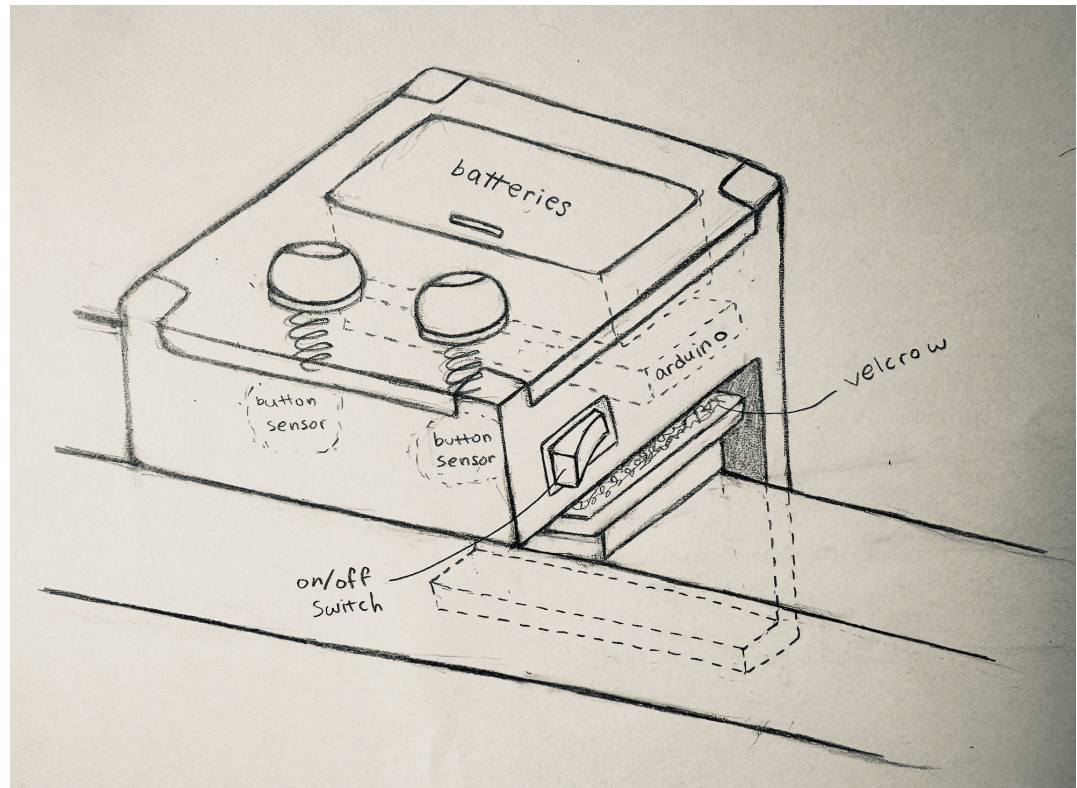
- Option A (ledge button)



- Option B (Square button)



- Option C (Circular M&M button)



12. Provide a few lines explaining your concept's relationship to the target specifications, as well as its benefits and drawbacks.

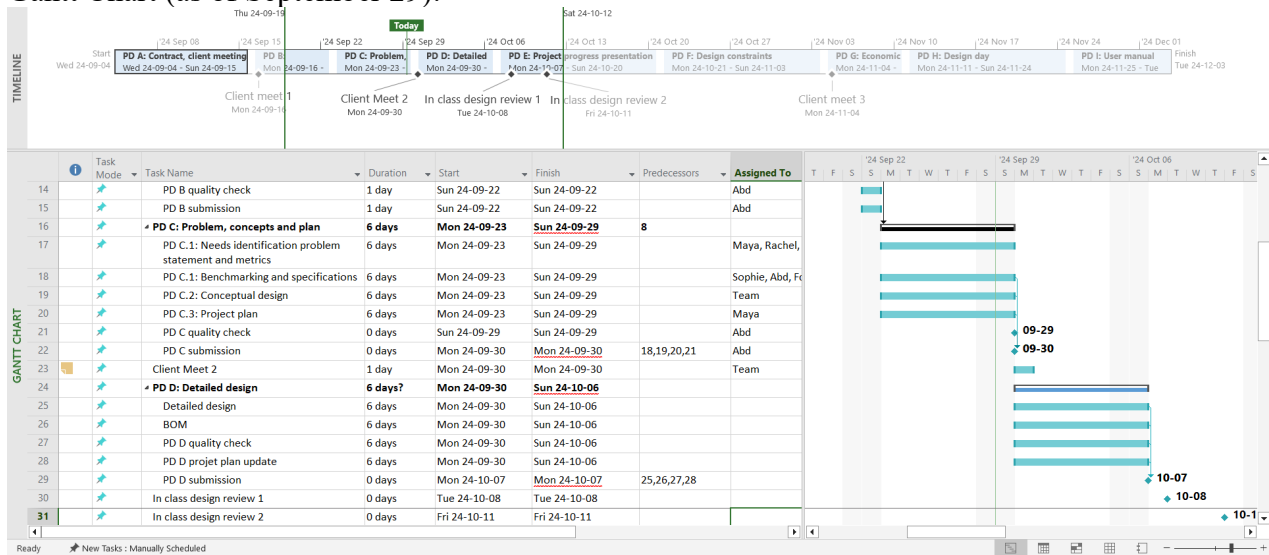
The concept meets the target specifications by offering a compact, 1-inch-by-1-inch button design, ensuring ease of use and integration with the joystick. Its lightweight, durable construction meets portability and durability requirements, while the modular design allows for easy repairs. The Bluetooth connectivity ensures flexibility in use. The benefits include user-friendliness, reliability, and easy maintenance, while a potential drawback is the need for occasional battery replacements, which could cause minor inconvenience.

13. Provide a few lines explaining your concept's relationship to the DFX factors you identified in Project Deliverable B.

- The design concept aligns with key DFX factors by ensuring intuitive usability, robust durability, and seamless functionality with the joystick. It incorporates a modular design for easy repairs and is lightweight for portability and ease of installation. This approach guarantees the product is user-friendly, reliable, and easy to maintain.

2.3 Project plan

Gantt Chart (as of September 29):



3 Detailed Design and BOM

3.1 Detailed design

1. Summarize the client feedback that you received during your second client meeting and clearly state what needs to be changed or improved in your design.

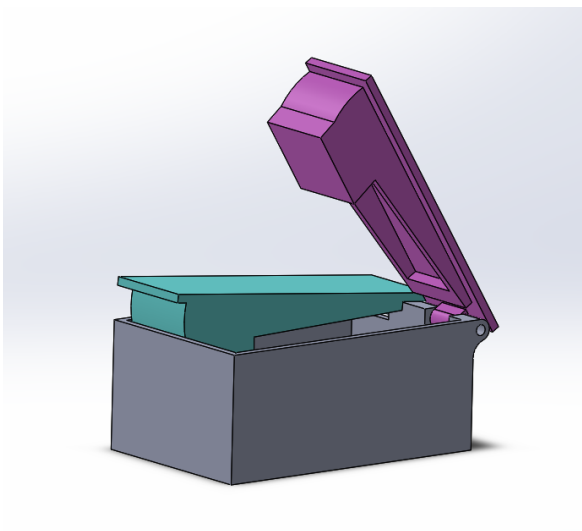
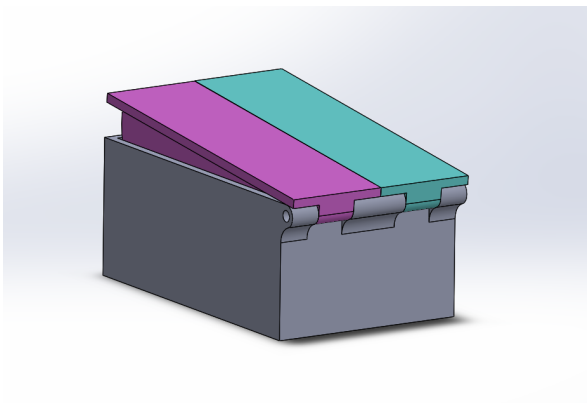
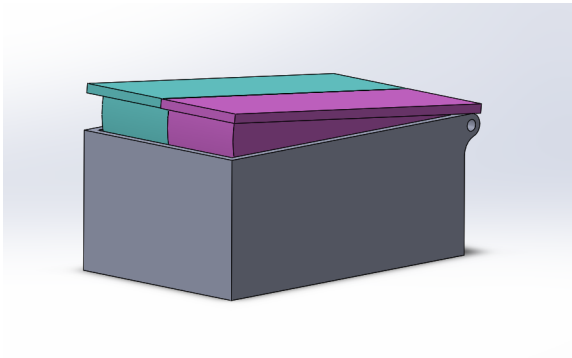
While the client liked all three of the concept ideas, he chose Concept #1 (with the slanted button design) as his first choice. He found the unique design intriguing, and appreciated the large surface area of the button, and how the click can be activated by pressing on any part of the button. The water-resistive aspect of the slant (that allows spilled fluid to roll off to the side) was a plus as well. He thought Concept #2 was traditional and a good option. He mentioned that Concept #3 would be familiar to the user as it looks similar to the previous mouse clicker the user owned. He commented that the additional features of Concept #3 may be superfluous.

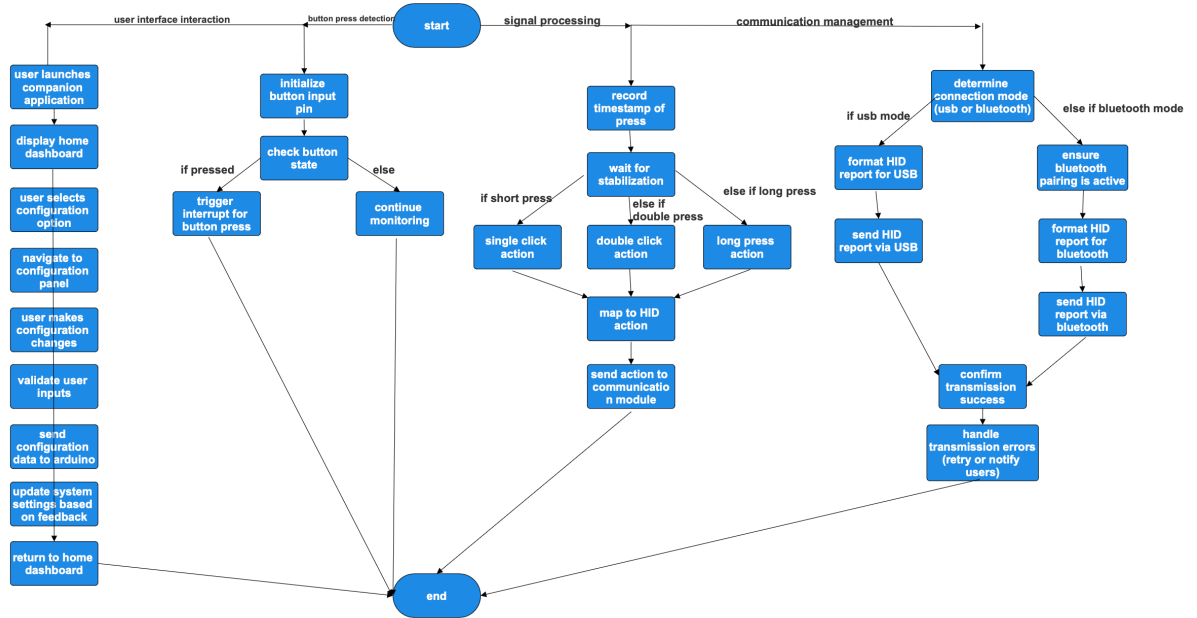
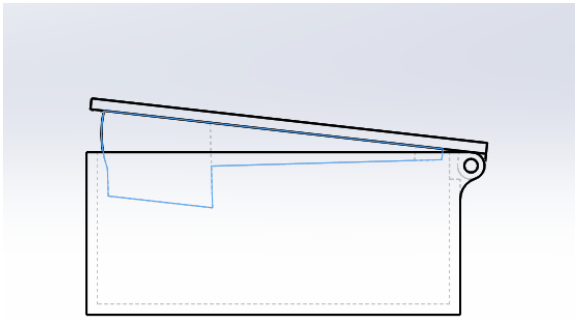
Going forward, we should finalize the dimensions to fit the size of the Velcro that is already attached to the wheelchair arm, which is 7/4 x 7/4 inches. However, if needed, the client mentioned that the Velcro could be taken off as well. There were no recommended changes, only that it be durable and easy to use.

2. Develop an updated and detailed design of your concept, based on your client meeting, which includes:

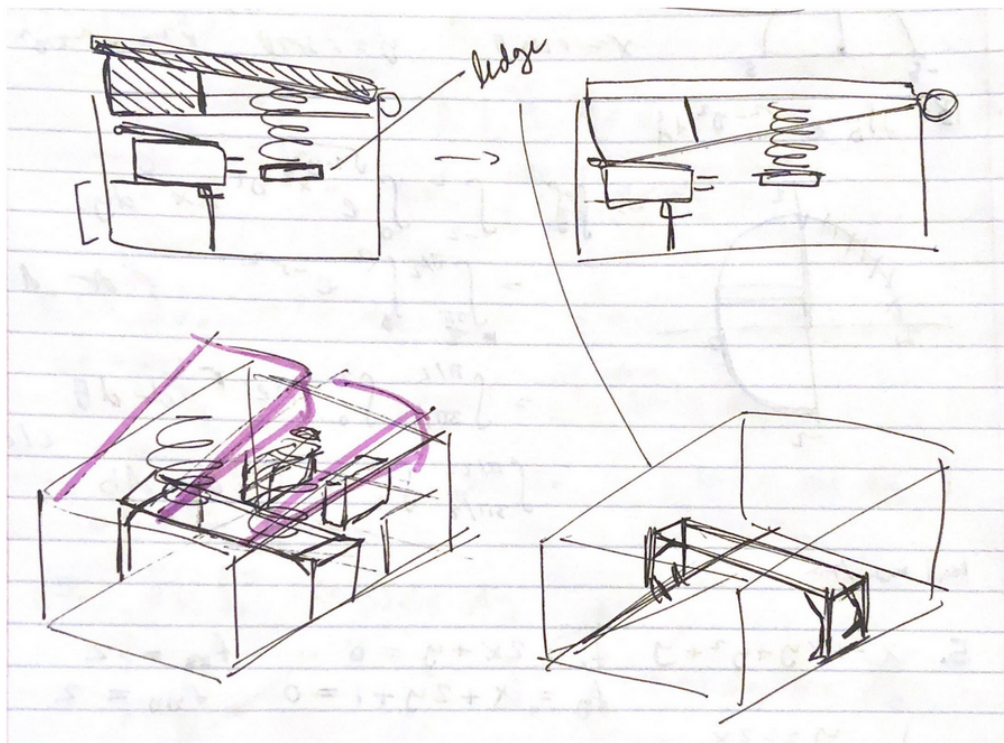
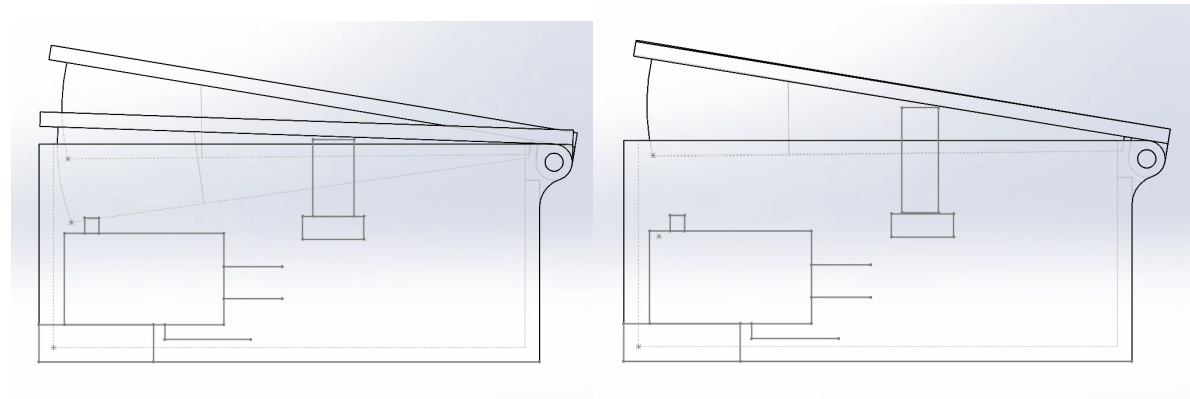
- a. For physical prototypes: Visual representations of the overall concept, as well as each subsystem. Clearly define how each subsystem is linked to other subsystems (including fasteners and electrical wires).
- b. For software prototypes: User interface and flow chart diagrams of the overall concept, as well as each subfunction. Clearly define how each subfunction is linked to other subfunctions.

Outer Casing with Buttons:





Switch Mechanism (based on dimensions of switch): The right two rectangles represent the spring and the ledge which it rests on.



c. See https://en.wiki.makerepo.com/wiki/Professional_development/Design_thinking/Detailed_designs.

d. Make sure that the level of detail in your design is high enough that you could give your design documents to an external person so that they could fabricate / assemble / program your design with minimal input from your group! Leverage your TA and PM extensively for guidance on this.

3. Explain what considerations you must take to design or manufacture your concept, based on your updated detailed design, to meet your DFX factors. Are some factors more important than others? Why?

For usability, the size and shape must accommodate easy thumb use, ensuring it's self-explanatory and intuitive without needing a manual. The clicker also needs an easy recharging mechanism, like USB charging or replaceable AAA batteries.

For durability, since the user may have limited motor control, the design must withstand rough usage. Adding durable velcro to attach to the velcro is important. The design should minimize breakable parts and undergo drop/impact testing, and using strong materials that can withstand impact.

For functionality, the clicker must integrate smoothly with the existing joystick, focusing solely on performance rather than aesthetics, which is less important for this prototype.

Some factors are more critical than others. For example, usability is essential because the device is tailored to a specific user, and ease of use directly affects their experience. Durability is equally important because the device must endure rough handling to remain functional. Functionality is key, but since aesthetics are not a priority, performance takes precedence.

In summary, usability and durability are likely more important than aesthetics, as they directly impact how well the product performs and meets the user's needs.

4. Provide a detailed list of skills and resources you have at your disposal that will enable you to create your design. If there are skills or resources missing to complete your design, describe how you will obtain them.

Known Skills / Resources	Missing Skills / Resources
3D printing: Members of our team already have experience with 3D printing and modeling. Additionally, the Makerspace has printers and plastic available for use in our design.	<p>Electronics: The team is missing crucial electronic components such as an Arduino nano, as well as the relevant experience needed to incorporate it into the product. This will be resolved through further research on the topic.</p> <p>Software/Bluetooth: Similarly, the team lacks experience with coding Bluetooth into Arduinos. This skill will be developed within lab 5 of GNG2101 as well as further online research concerning how to program a Bluetooth connection and integrate it within the desired code in the mouse buttons' Arduino nano.</p>

5. Provide a realistic assessment of the time required to implement your design and the actual time your group and its individual members have at their disposal.

To provide an accurate assessment of the time required to implement the design, several key factors must be taken into account:

- a. Design Development: Each subsystem, including the casing, button mechanism, and electronic components (such as Bluetooth integration and software), will progress through distinct design phases. The team estimates this phase will take approximately 2-3 weeks to complete.
- b. Prototyping: The prototyping stage, which involves 3D printing the casing and assembling the components, is expected to take 1-2 weeks, depending on the availability of printing resources and any potential issues during assembly.
- c. Testing: Following assembly, the prototype will undergo rigorous testing to assess usability, durability, and functionality. This phase is expected to last approximately 1 week to ensure the design meets the client's requirements.

- d. Adjustments: Based on the testing results, the team may need an additional 1 week to make necessary adjustments, address any malfunctions, or incorporate client feedback.

6. Define any other critical product assumptions that could affect your ability to implement your design. For example: the acceptable values for a specification, availability of material/component, or a critical functionality.

1. Material Availability: The team anticipates that all required materials, including PLA for 3D printing and essential electronic components, such as the Bluetooth module, will be readily available. However, any challenges in procuring these materials could lead to delays and extend the overall project timeline.
2. Compatibility with Wheelchair: It is assumed that the client's wheelchair will be compatible with the button system without the need for further modifications. However, if additional adjustments are required for proper mounting or integration, this may necessitate redesigning certain components of the system.
3. Bluetooth Functionality: The assumption is that the Bluetooth connectivity will work seamlessly without lag or interference, allowing for real-time interaction. Any issues in this area could significantly affect user satisfaction and the project's feasibility.
4. User Physical Capabilities is assumed that the user can operate the buttons with their thumb without requiring excessive force. Any deviation from this assumption would necessitate adjustments to the button size or sensitivity to ensure usability.

3.2 BOM

Provide a detailed preliminary bill of materials and parts (BOM) for your final prototype, which will be presented to your project managers for approval and purchase. Include web links for each item in your BOM (including \$0 items). You will be given up to \$50 or \$100 (depending on your project) for the development of your final prototype only. Before making any purchases, you must review the following guide: https://en.wiki.makerepo.com/wiki/Professional_development/Project_management/Purchasing_Guide.

Item	Quantity	Price	Website Link to item	Applicable Subsystem

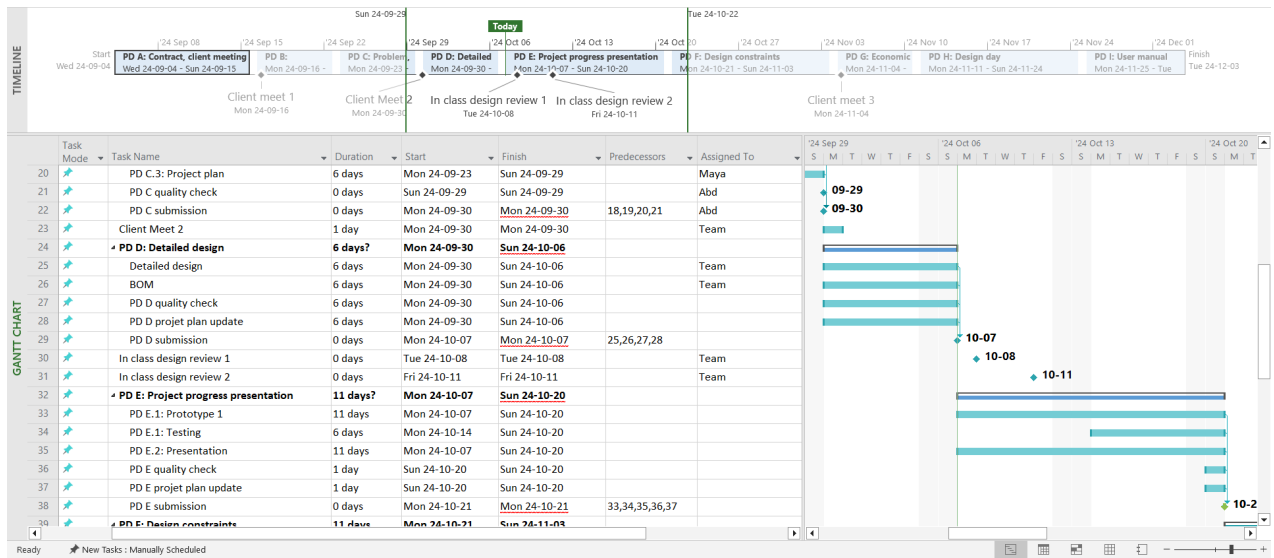
Bluetooth HC-05 Module *later returned	1	\$5.99	https://universal-solder.ca/hc-05-bluetooth-master-slave-mode/?srsltid=AfmBOoS4xn0LzRR1EqSCxsS0MCMcAqgkBm2puUStZ3Zl47Rq1aQXD4zR-M	Wireless Communication (Bluetooth)
Arduino Nano *later returned	1	\$8.00	https://makerstore.ca/shop/ols/products/arduino-nano	Microcontroller and Power Supply
CANADUINO® Pro Micro Atmega32u4, 5V, 16MHz	1	\$ 19.10	https://www.amazon.ca/dp/B01N4TVIQX?ref=ppx_yo2ov_dt_b_fed_asin_title	For code to be uploaded onto

USB to TTL Converter	1	\$6.98	https://www.digikey.ca/en/products/detail/dfrobot/TEL0010/7597059	Debugging and Programming
Brass Rod	1	\$1.38	https://www.amazon.ca/dp/B00JWTFASW?ref=ppx_yo2ov_dt_b_fed_asin_title	Connection of buttons to bottom casing (for jig hinge)
Buttons	2	\$1.50 x 2	https://makerstore.ca/shop/ols/products/12mm-latching-on-off-button	Buttons
2 x AA Battery Holder with Jumper Header Wires *later returned	1	\$1.95	https://www.adafruit.com/product/3858	Electronics

Springs	Needed 2 (However, comes in a pack of 10)	\$12.03	https://www.amazon.ca/dp/B0CM1879YJ?ref=ppx_yo2ov_dt_b_fed_asin_title	Springs to be embedded under the button to decrease the force impact from clicking
On/Off Power Rocker Switch Button *later returned	1	\$1.00	https://makerstore.ca/shop/ols/products/onoff-power-rocker-switch-button	

3.3 Project plan update

Gantt Chart (as of October 7th):



4 Conclusions

In preparing this deliverable, we learned about the importance of details, small to big, that must be considered into the design of the prototype for it to function properly. We learned the importance of communicating together to come up with a concept that respects each other's ideas, fit together, and improve along its design and brainstorming process. We also learned about the importance of time management when completing a larger deliverable. Outstanding issues for the project that remain include properly fitting in all the components that go inside the mouse clicker, insuring a successful Bluetooth connection as well as a successful switch mechanism. If the space inside the mouse clicker is not appropriately divided up and planned, it would cause future problems which may involve reprinting the casing and the buttons. Such would waste time and resources. Smaller, additional details to be incorporated remain, such as the on/off switch, and a removable top with latch for access to the battery compartment.

5 Bibliography

Advameg. (n.d.). *Computer Mouse*. How computer mouse is made - manufacture, history, used, processing, parts, components, structure, steps, product. <https://www.madehow.com/Volume-5/Computer-Mouse.html>

Stachura, M. P. (2006). *Eco-design in practice - case study with computer mouse*. Sustainable Design / The Design Society - a worldwide community. <https://sustainable.designsociety.org/publication/19155/ECO-DESIGN+IN+PRACTICE+-+CASE+STUDY+WITH+COMPUTER+MOUSE>