GNG2101

Design Project Progress Update

Group 3.5

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition

Table 2. Glossary

Term	Acronym	Definition

1 Introduction

This document presents a detailed progress update on our design project, which focuses on developing a wheelchair-accessible mouse device. The device is specifically designed to address the needs of individuals with limited mobility, offering a reliable and intuitive solution for controlling a computer interface.

Context and Assumptions

The project’s primary objective is to design a robust, easy-to-use mouse system that seamlessly integrates with wheelchair controls. We have made the following key assumptions in guiding our design and development process:

The device will be used by individuals requiring assistive technology to interact with computers, primarily via a joystick mounted on their wheelchair.
Durability and usability in various environments are critical. The device must withstand regular use, including exposure to different elements, and remain functional over extended periods.
The system must be simple to install and remove, ensuring convenience for users or caregivers, and should connect via Bluetooth or USB.
Document Structure

Purpose and Scope

The purpose of this report is to provide an update on the project's current status, describe the progress made with Prototype 1, and outline the next steps in the development process. It also addresses the feedback received and highlights the economic and IP considerations that are being factored into the design. The report aims to ensure that all project stakeholders are informed of the project’s direction and future objectives.
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2 Prototype 1, Project Progress Presentation, Peer Feedback and Team Dynamics

2.1 Prototype 1

One problematic element outlined in Project Deliverable D is the product's compatibility with the wheelchair, specifically regarding the mounting. As it stands, the bottom surface area of the mouse buttons casing is greater than that of the Velcro platform on the wheelchair. This could pose an issue regarding the balance and ability to resist force of the product. Possible tests to diagnose these issues are Velcro durability tests and SolidWorks balance/force tests on a simulated platform. These tests relate to Design for Usability.

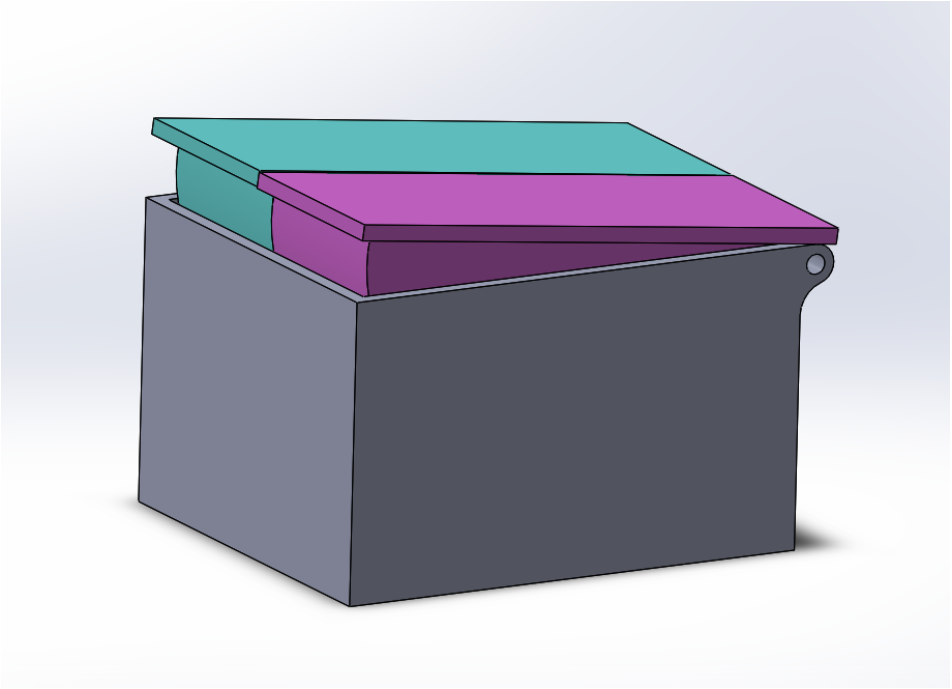
Another unknown element is the definition of "double click" for the user. We initially assumed that a double click would be two rapid consecutive clicks, but it was brought up during in-class presentation that such may not be a possibility for a user with motor disabilities. To validate or redefine this issue, our client will be consulted. This relates to Design for Usability.

Casing

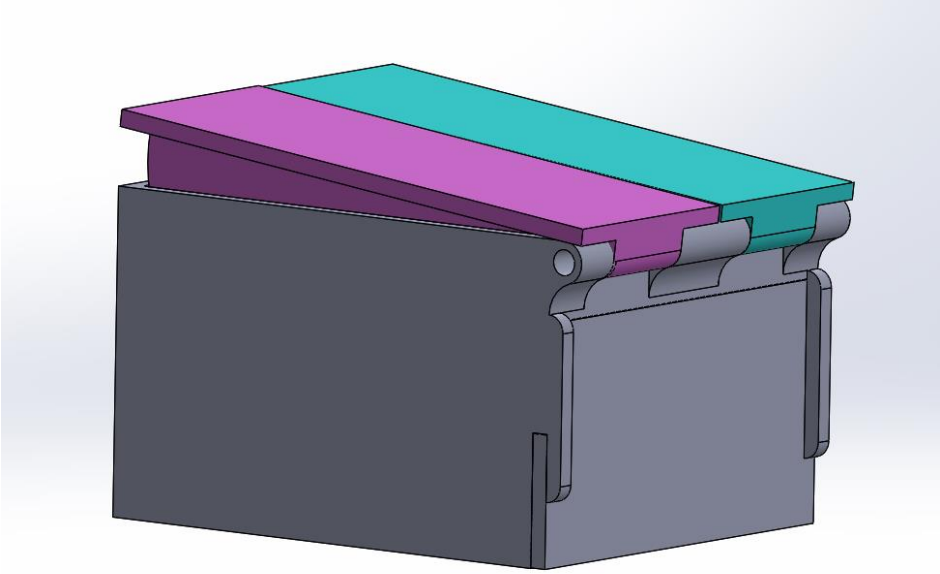
Assembly:

Shown below is an overview of prototype 1 design of the mouse clicker. The maximum height of the clicker including the height of the buttons is 2.48''. The length and width of the clicker is 3.3'' by 2.6''. This values are subject to slight changes in future prototypes.

Front:

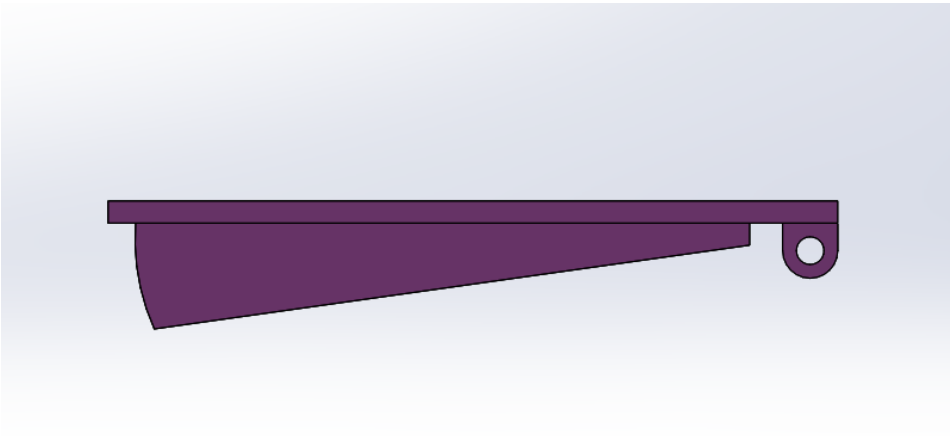


Back:

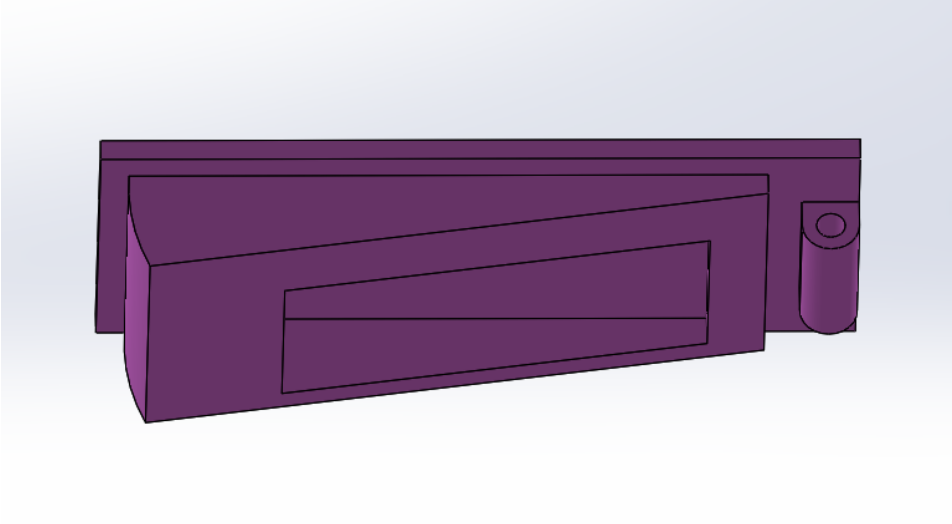


Two Identical Buttons:

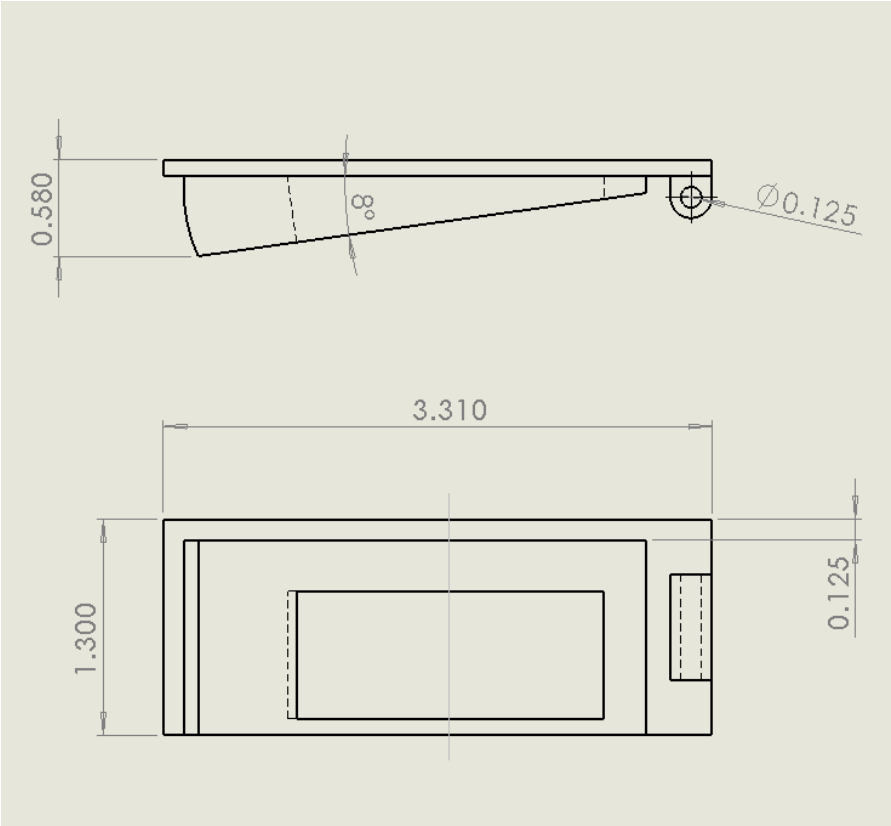
Sideview:



Bottom view:

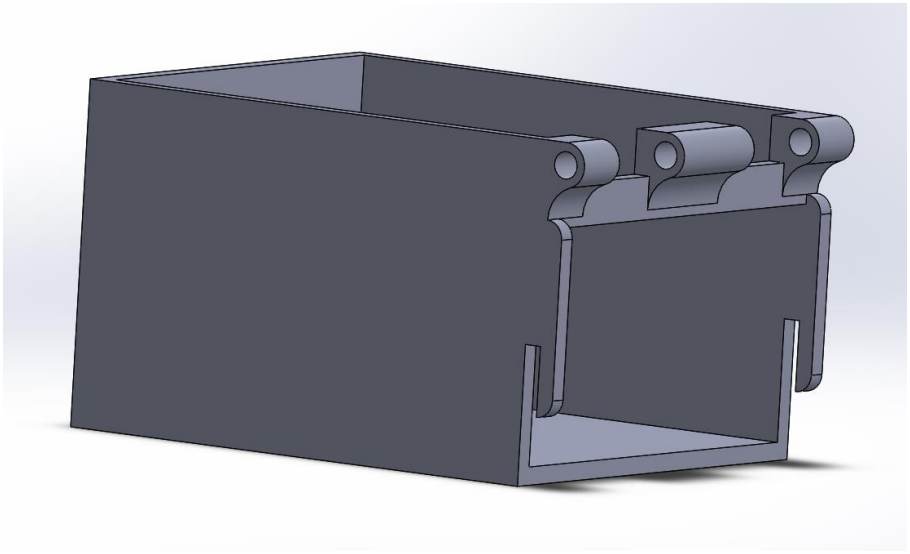


Relevant Dimensions:

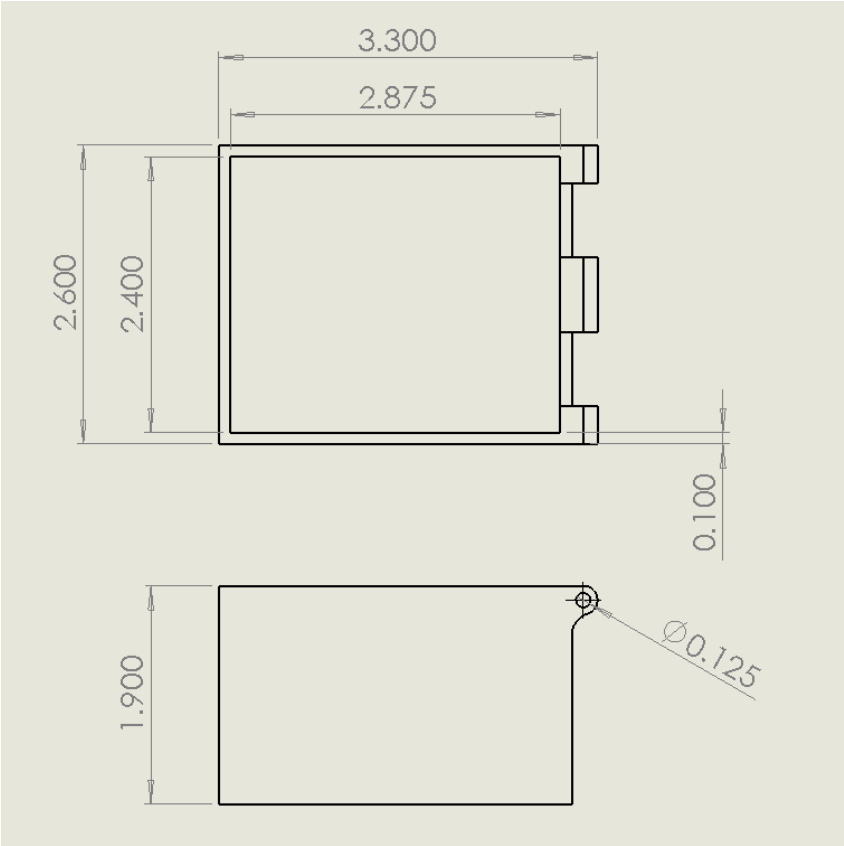


Bottom Casing Rear View:

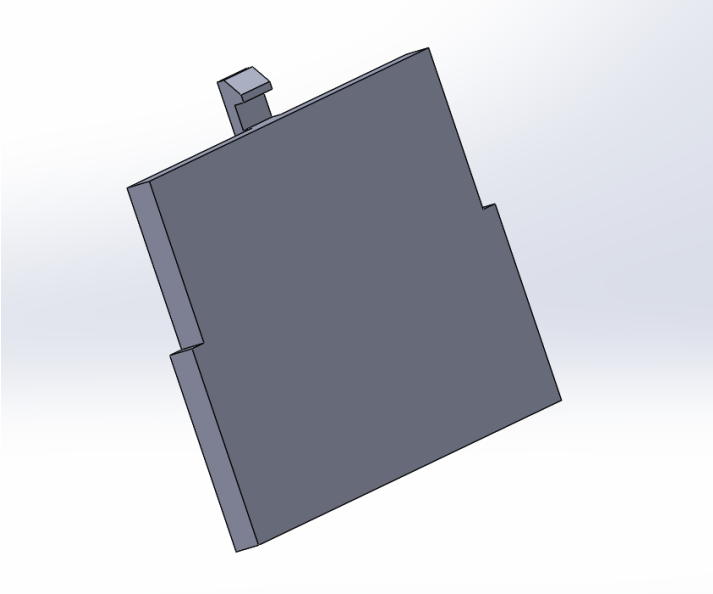
The buttons will be attached to the bottom casing by a hinge. A brass rod of corresponding size will be inserted into the extruded holes. Batteries will be accessible from the back of the casing. The slots at the back are designed for the battery lid/cover to slide in.



Relevant Dimensions:

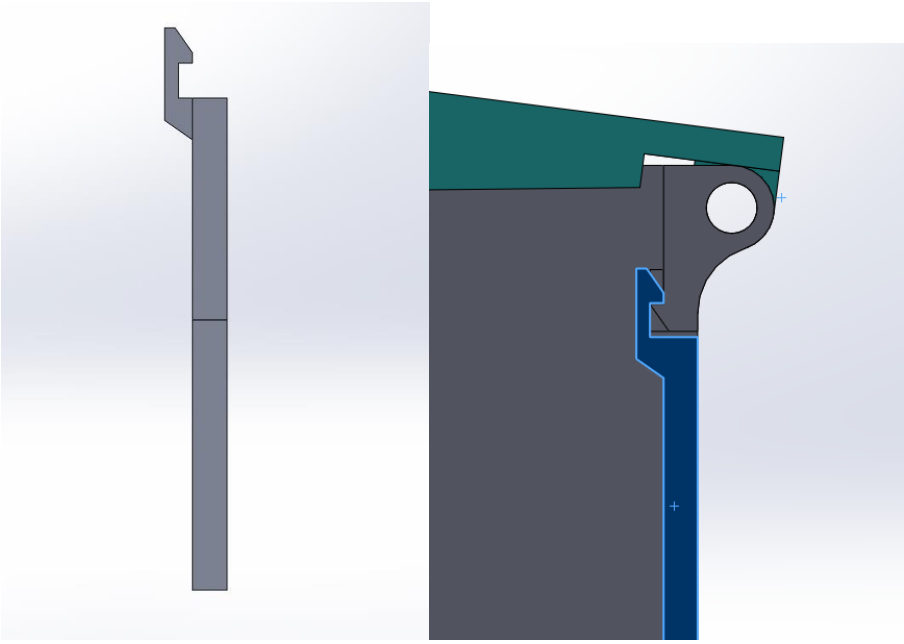


Latch Door for Battery Holder:



Sideview of Latch Mechanism:

The lid that will go over the batteries placed at the back end of the bottom casing will be secured by a latch system.



Connection

The circuit consists of an Arduino Nano microcontroller, HC-05 Bluetooth chip, two push switches and replaceable batteries as a power source.

Below is a video for the testing of prototype 1 which showcases the functionality of the left and right clicks via USB connection. The Arduino is connected to the computer via USB and then using the Arduino IDE we coded the functionality of the buttons, then uploaded the code on the Arduino. After the upolad and successful compilation, the buttons were tested and the desired output results was displayed on the IDE terminal.

https://www.youtube.com/shorts/rWdsAjHbUdQ

For outer design:

Specification	Ideal Value	Marginally Accepted Value	Actual Value
Button Size	2'' by 1''	1.5'' by 1.5''	3.31'' by 1.3''
Weight	100g - 200g	100g - 300g	TBD
Waterproofing	Fully waterproof	Water-resistant	Water-resistant material for the casing, but with some inevitable gaps in between the buttons
Height of mouse	1.5'' - 2''	2'' - 4''	2.48''
Charging Method	Non-rechargeable replaceable battery	AA batteries	Non-rechargeable replaceable batteries (2) with easy access by user.

For Software and electronics:

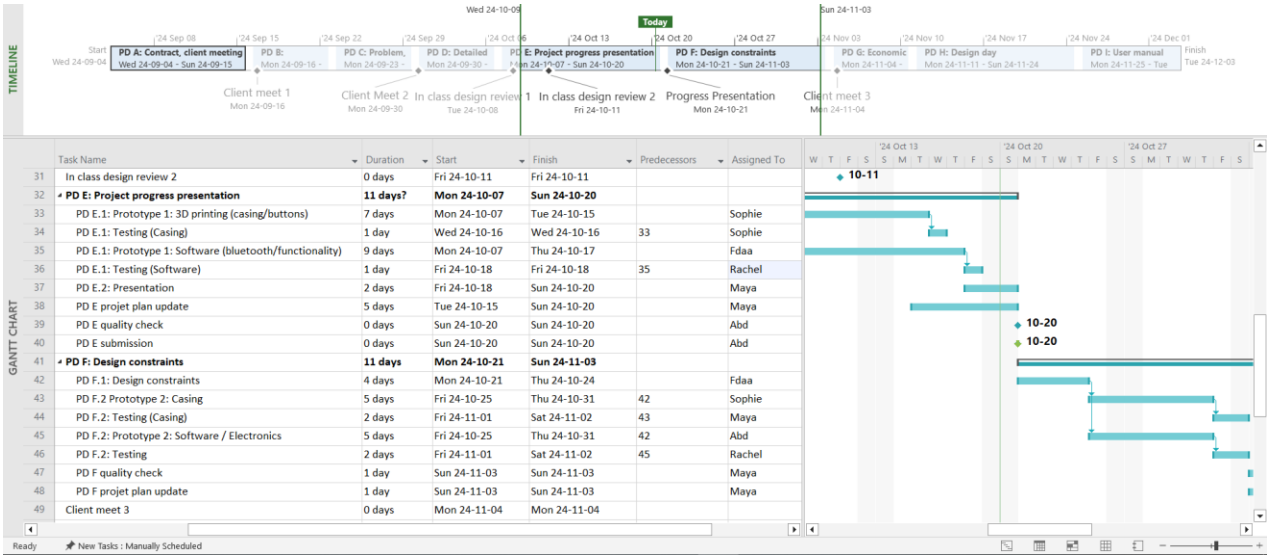
Specification	Ideal Value	Accepted value	Actual Value
Response Time	≤ 20ms	≤ 100ms	≤ 50ms
Bluetooth Pairing Time	≤ 5 seconds	≤ 10 seconds	8 seconds

Bluetooth Signal Range	≤ 2 meters	2 meters	Still under testing
Reconnection Time	≤ 3 seconds after disconnection	≤ 5 seconds	5 seconds

2.2 Project Progress Presentation

[GNG2101 - Project Progress Presentation.pptx]

2.3 Project plan update



3 Design Constraints and Prototype 2

3.1 Design constraints

DFX

- **Durability**: Since the button will undergo frequent and possibly forceful use, durability is critical to ensure a long lifespan without degradation in performance. A durable design can withstand repeated strong pressing, potential drops, and wear over time, minimizing the need for frequent replacements or repairs.
- **Usability**: Usability is essential to ensure that the button provides a smooth, responsive, and intuitive user experience. For a mouse click button, ergonomic design considerations like button size, positioning, and required pressing force are vital to make it accessible and comfortable, especially if users have limited mobility. Usability enhances functionality by making the device easy to operate effectively.

Design Constraints

- **Compactness**:
    - **Reduce Dimensions**: Scale down all components and reduce the case size to fit comfortably on a wheelchair armrest without obstructing movement or posing a risk of toppling.
    - **Use Smaller Buttons**: Select buttons with minimal height to reduce the overall profile of the clicker. Low-profile buttons, such as keyboard switches, may fit this need.
    - **Remove the Hinge**: Without a hinge, the design can maintain a lower height and a more stable structure, eliminating an extra point of potential instability.
    - **Optimize Arduino Placement**: Position the Arduino Pro in a flat orientation within the case, or explore a custom PCB layout that aligns with the new compact form.
- **Durability**:
    - **Stable Mounting Mechanism**: Develop a mounting solution, such as an aluminum strap or guide, that secures the clicker firmly to the wheelchair arm to prevent shifts from forceful presses.
    - **Use Smaller Springs**: If springs are necessary for the button mechanism, choose sturdy but compact springs that provide the right resistance without adding bulk.
    - **Button Mechanism**: Choose button shapes and materials that are robust enough to handle repeated, forceful presses without wearing down quickly or losing sensitivity.

Low-Profile Switches: Research on low-profile mechanical switches, like those in slim laptops and keyboards, shows that they offer durability and fit well in limited spaces. Using similar switches keeps our

design compact and user-friendly, with switches that can withstand over 10 million clicks, supporting long-term durability.

PCB Integration for Size Reduction: Consolidating components onto a single custom PCB can save space. By integrating the Arduino into a smaller, custom PCB, we reduce the device's overall footprint.

Material Choice for Stabilization: Studies comparing materials show that aluminum is ideal for lightweight but sturdy stabilization. Using an aluminum strap or guide to secure the clicker to a wheelchair arm ensures stability without adding excess weight.

Durability Adjustments:

1. Force Resistance: Research on devices under frequent use, like wheelchair controls, recommends using ABS plastic or aluminum alloys for housing due to their impact resistance and durability.
2. Force Tolerance: Studies show that components should withstand forces up to 30-40N without damage. Compact buttons on the market are designed for this, aligning with our choice of low-profile switches and sturdy materials.
3. Durable Springs: Compact springs with high tensile strength give necessary feedback without adding bulk, supporting frequent use.

Using durable materials and compact springs ensures the clicker handles regular, forceful use.

Testing Process:

1. Iterative Prototyping: Successive prototypes help us refine the design for usability, stability, and size reduction. Each iteration allows us to make informed adjustments based on actual performance.
2. User Feedback: Gathering feedback from wheelchair users who test the clicker provides valuable insights into real-world usability and comfort.

3.2 Prototype 2

The client meeting did not reveal any new information. The group opted to continue with the slanted button design. The purpose of Prototype 2 is to test for durability, as well as combine all the project subsystems together. Therefore, durability is the priority for updating the casing design, and the electronics need to be positioned within the case properly to minimize damage in case of a drop.

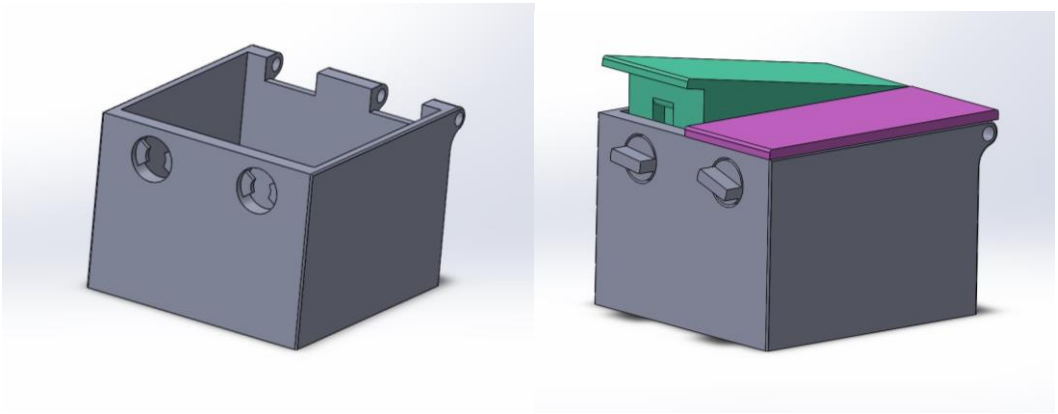
As mentioned previously, the prototype has not been tested regarding durability. It is assumed that the current case design can withstand significant pressure on the buttons and hinge. The DFX factor Design for Durability is related to the above assumption.

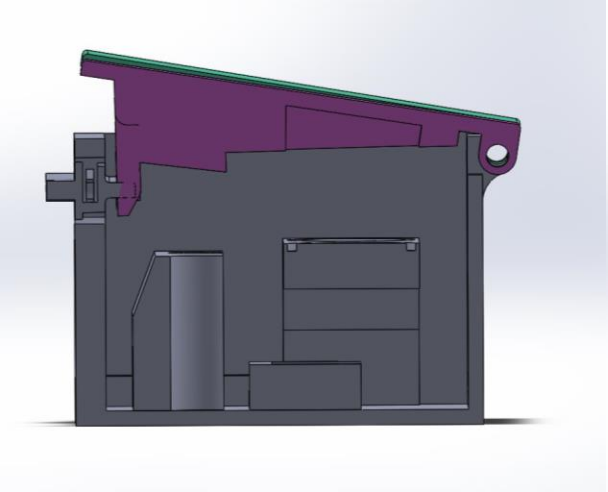
CAD File and Photos of Prototype 2

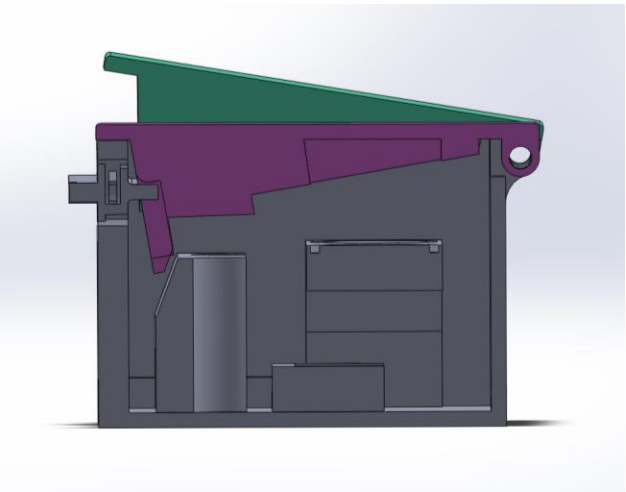
The casing has been shortened lengthwise, to improve balance on the small Velcro patch fixed to the wheelchair. Additionally, the previous door found at the back of the casing has been removed. This included the latch system and guides. In their place, a slot for the Arduino port was cut out. To access the inside of the case, a key system was implemented. A key can be inserted through a hole in the case and subsequently turned in order to lock the maximum height of the buttons, as well as allow free access to the inside of the case. A slot has been cut from each button to accommodate each key. The size of the buttons has also been adjusted to account for the new size of the casing.

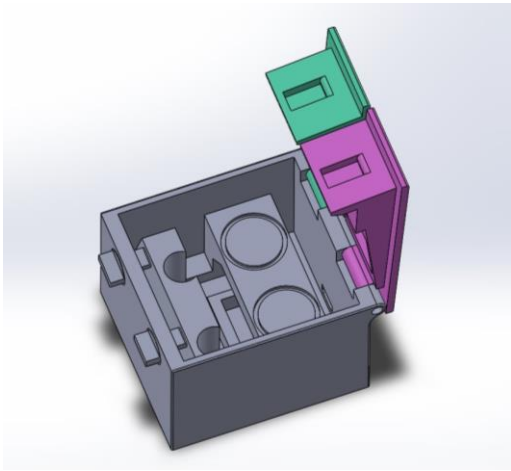
Inside the casing, there is the spring ledge, Arduino support and the button holder. The spring ledge was designed based on the height of the spring and the position of the buttons at their minimum and maximum heights. There are slight circular slots made on the top of the ledge for the springs to be more precisely positioned. The button holder's dimensions were established based on the height of the smaller buttons connected to the ciruict, as well as the position of the larger buttons in their pressed position. The holes for the buttons are cut so that they can be snapped into place. There is also a segment cut out of the front in order to make room for the protrusion from the larger buttons (see picture below). Both the spring ledge and the button holder have guides to space themselves out within the case, to line up the spring ledge with the gap in the large buttons and plan the position of the circuitry inside the case. Additionally, a supporting wall has been added at the bottom of the case in to stabilize the Arduino when it is connected to the cord.

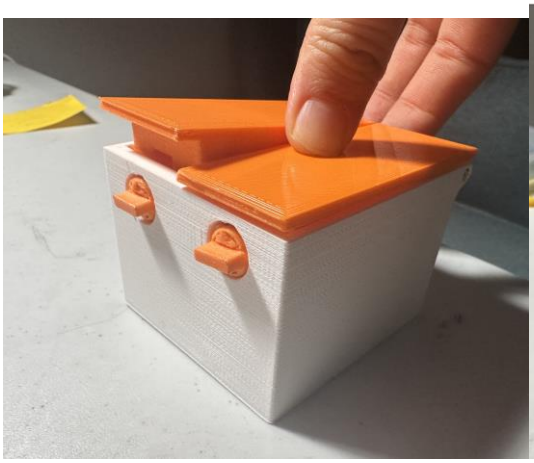
Since this is the first prototype which includes all subsystems together, (casing, circuitry, and software), it provides an opportunity to test the durability for a prototype which more closely resembles the final product.

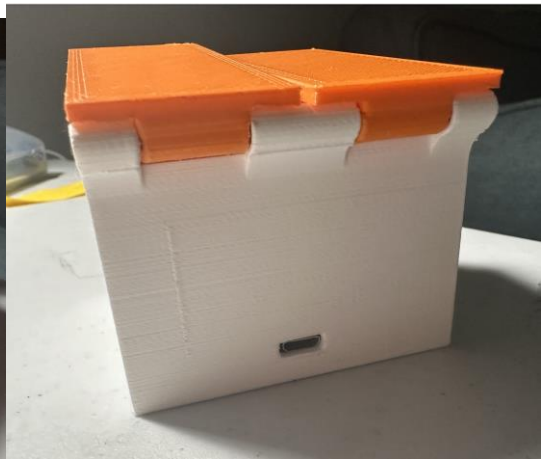












Testing: Button / Spring Durability Test

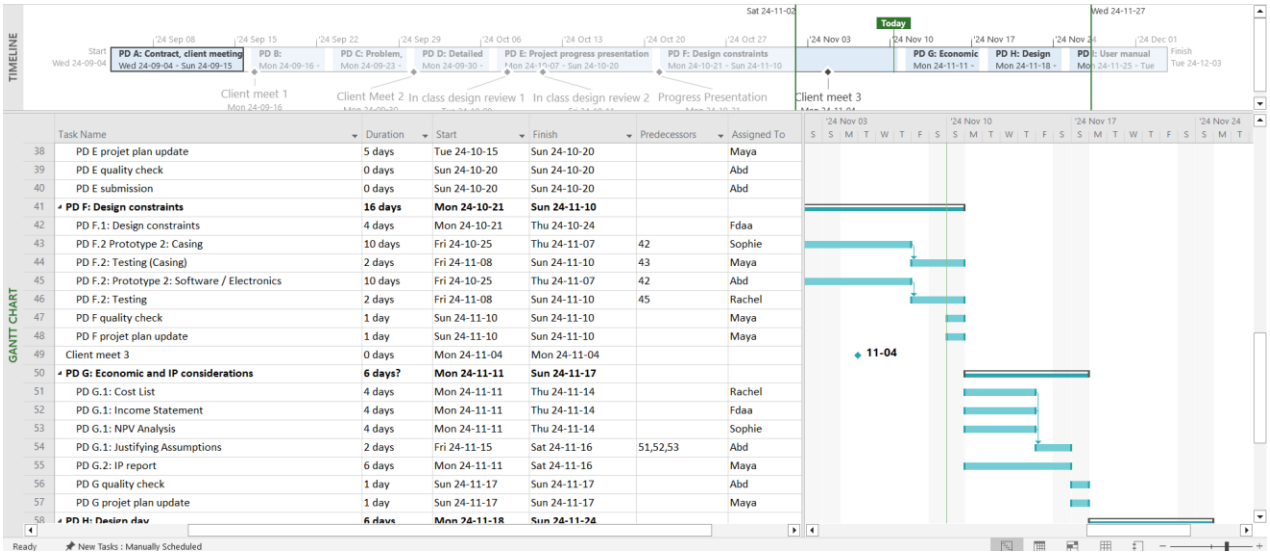
The durability of the button/spring system was tested by repeatedly pressing one of the buttons with a force of 9-10 N (a forceful press).

Number of Clicks	Condition of Button / Spring System
10	The condition of the system remains unchanged in comparison to before the test.
50	
100	
150	

There are no previous target specifications for force requirements of the buttons, therefore further testing needs to be completed to determine the adequacy of the current system's ability to withstand a series of forceful presses.

The team intends to present this functional prototype (Prototype 2) to the client. The team also seeks to meet the user in person to get a better understanding of their requirements regarding durability, as it has been specified by the client that the user can be quite forceful in their use of previous mouse click buttons.

3.3 Project plan update



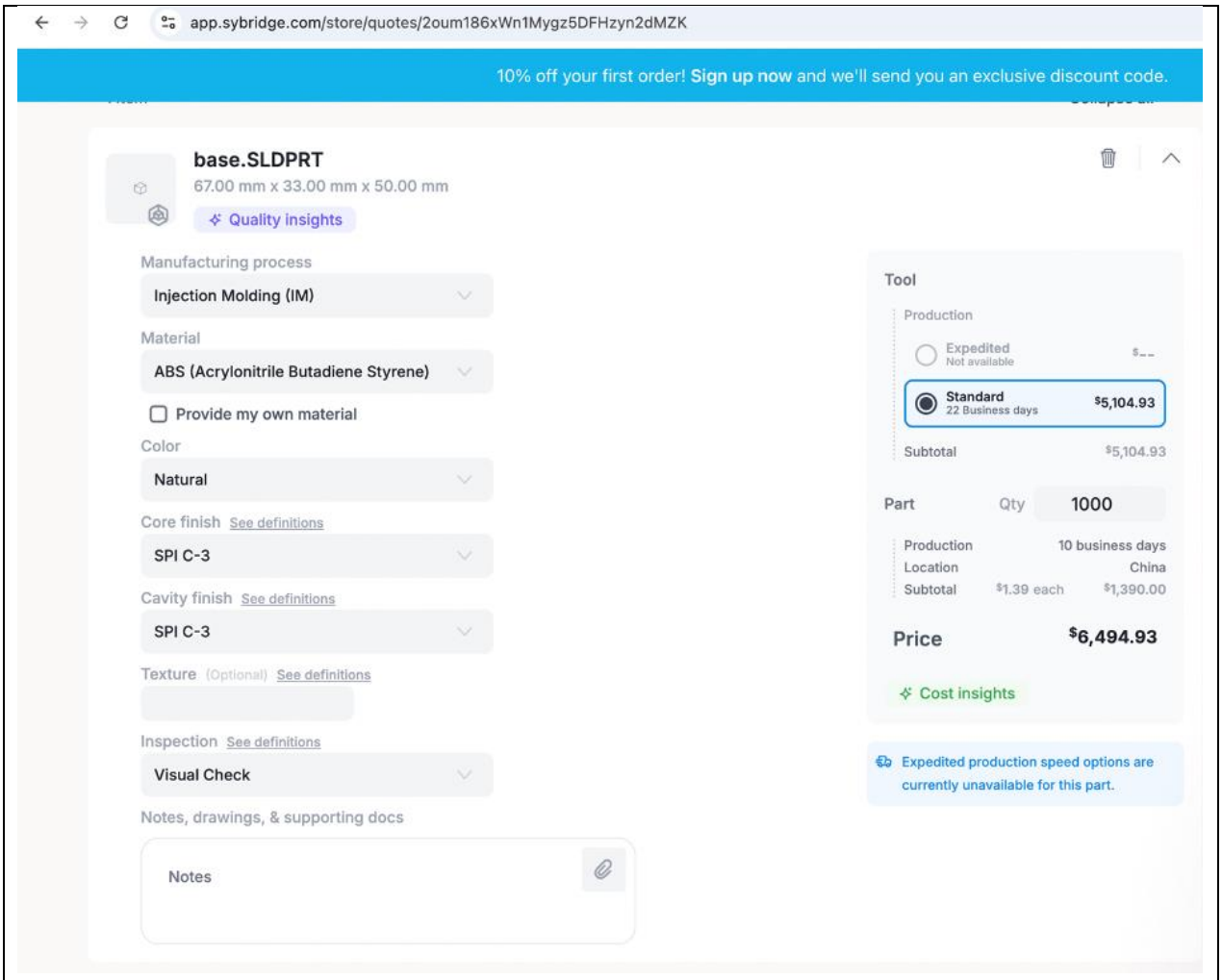
4 Economic and IP Considerations

4.1 Economics report

Important note: we expect you to make many assumptions here. However, each assumption should be identified and justified using information you gathered from various sources. Provide references when using this information.

1. Include a list of variable/fixed, direct/indirect, and material/labour/overhead costs associated with your business, based on the manufacturing and sale of your product. Make sure that you distinguish between price and cost and realize that prototyping and higher-volume manufacturing costs will probably be different.

Office/storage/final assembly or quality checking space: (fixed, indirect)
Building rental: $4000/month Electricity/power: $500/month (since most manufacturing will be done by hiring a different company, we won't consider the extra operational cost of running injection moulding equipment and such) Insurance: $100/month (however, this would depend on exactly what will be insured or not)
Materials: (variable, direct)
While we used 3D printing for our prototyping, that is time consuming and costly for mass production. For mass manufacturing, injection moulding will likely be used and done quickly by machines. Therefore, we can approximate a cost of about $2.00/clicker based on an estimate made on the biggest part of our clicker. https://app.sybridge.com/store/quotes/2oum186xWn1Mygz5DFHzyn2dMZK



Arduino Pro Micro: $16.90/clicker

https://www.amazon.ca/dp/B01N4TVIQX?ref=ppx_yo2ov_dt_b_fed_asin_title

Push buttons: $3/clicker

https://makerstore.ca/shop/ols/products/12mm-waterproof-momentary-on-off-reset-push-button

Wires: approx. $0.25/clicker

Velcrow: approx. $0.25/clicker

Felt: approx. $0.25/clicker

Total cost per clicker: approx. $22.65/clicker

Labour: (variable, direct)

$17.20/hour as machines will likely assemble most of the product, for final checks, etc., we can approximate 30 clickers completed per hour. $0.58/clicker
Overheads: (variable, indirect)
Cost to incorporate a business (one-time fee): $300 https://www.ontario.ca/page/cost-time-required-to-register-change-search-for-business-name-corporation-not-for-profit Advertising: $10,000/year (This assumption was based on examples given in previous economics assignments done in class.)

2. Develop a 3-year income statement, which includes sales revenue and costs of units sold for each year, gross profit, operating expenses and operating income (no need to include interest and taxes).

A) Units sold per year:

- **Year 1:** 1,000 units

Assumption: This is the starting year, and the business focuses on building its market. A small production volume is realistic for a new product.

- **Year 2:** 1,500 units

Assumption: As awareness grows, sales increase by 50%.

- **Year 3:** 2,000 units

Assumption: Continued marketing efforts lead to steady growth of 33%.

B) Selling price per unit:

- **$35 per unit**:

Assumption: This price allows for a reasonable markup over the production cost ($23.23/unit), considering direct and indirect costs and competitive pricing.

3-Year Income Statement:

Category	Year 1	Year 2	Year 3
Sales Revenue	$35,000	$52,500	$70,000
COGS	$24,650	$36,975	$49,300
Gross Profit	$10,350	$15,525	$20,700
Operating Expenses	$65,500	$65,200	$65,200
- Building Rental	$48,000	$48,000	$48,000
- Electricity/Power	$6,000	$6,000	$6,000
- Insurance	$1,200	$1,200	$1,200
- Advertising	$10,000	$10,000	$10,000
- Incorporation	$300	-	-
Operating Income	($55,150)	($49,675)	($44,500)

3. Using a NPV analysis, determine the break-even point (i.e. number of units that must be sold for your business to become profitable). Note: It is highly unlikely that your operating income will be positive in the first year because of fixed costs. Therefore, you must use a NPV analysis to compare costs and profits over multiple years based on present value. Draw two cash flow diagrams of the expenses and incomes for the next three years. Calculate the NPV value of each expense/income and determine the differences and then the break-event point.

Discount Rate: 10% Discount rate

- A common assumption for small businesses to account for the time value of money and business risks.

Cash Flows:

- **Incomes:**

  i. Year 1: 1,000×35=35,000
  ii. Year 2: 1,500×35=52,500
  iii. Year 3: 2,000×35=70,000

- **Expenses:**

  i. Variable Costs (Year 1): 1,000×23.23=23,230
  ii. Variable Costs (Year 2): 1,500×23.23=34,845
  iii. Variable Costs (Year 3): 2,000×23.23=46,460

- **Fixed Costs:** $65,500 (Year 1), $65,200 (Year 2 and 3).

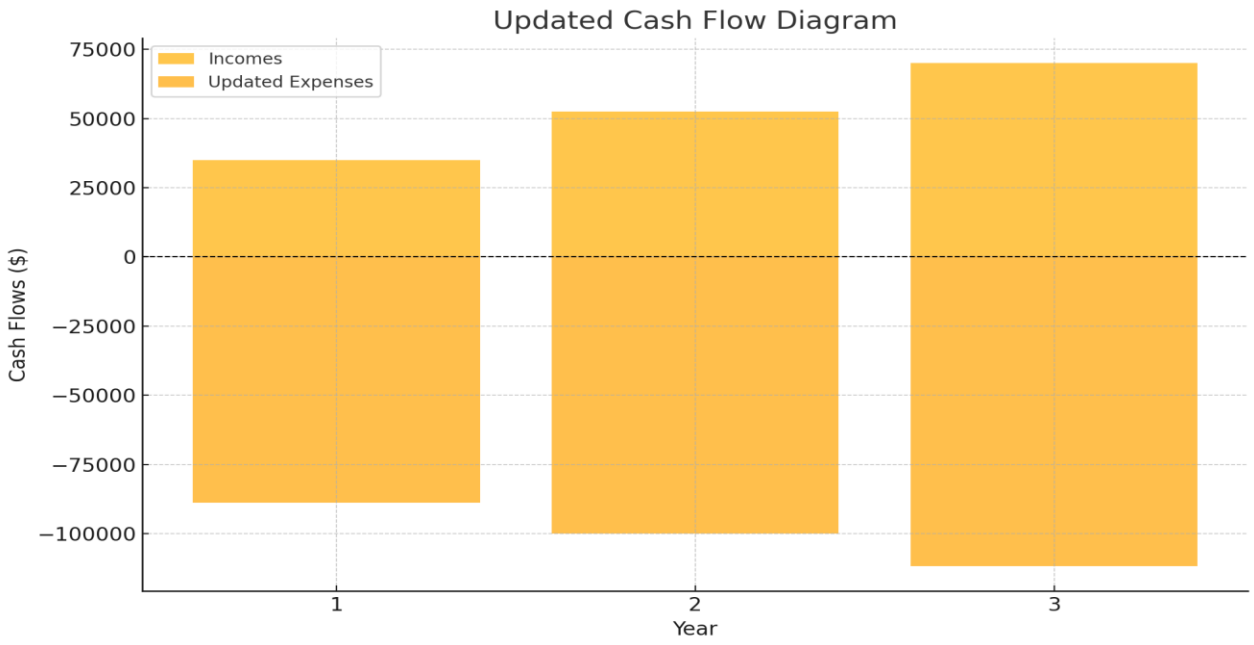
- **Net Cash Flow:**

  i. **Year1:** 35,000−(23,230+65,500) =−53,730
  ii. **Year2**: 52,500−(34,845+65,200) =−47,545
  iii. **Year3**: 70,000−(46,460+65,200) =−41,660

- **NPV Calculation:**

NPV= (−53,730) / (1+0.1)1 + (−47,545) / (1+0.1)2 + (−41,660) / (1+0.1)3 = **- $119,438.62**

- **Cash Flow Diagram:**



- **Break-Even Analysis Results:**

    i. **Year1:** 5,100 units
    ii. **Year2:** 5,600 units
    iii. **Year3:** 6,100 units

- **NPV at Break-Even:**

    At these sales volumes, the **NPV = $569.40**, indicating the business has just broken even over three years.

4. Describe and justify all assumptions that you have made in developing your economics report. The assumptions must be factual based on a preliminary market research that you conduct in order to determine the amount of demand in your target market, the expected % of the market that you would own, and the unit price of your product based on a sound pricing strategy.

Assumption 1: The target market's demand and share of the market.

It is projected that sales volumes will reach 1,000 units in the first year, 1,500 units in the second year, and 2,000 units in the third year. These projections are based on the assumption of consistent growth, which is typical for a new product in a niche market. In the initial year, the objective is to establish a market presence with a relatively modest production volume. In the second year of the forecast period, it is anticipated that sales will increase by 50% due to an increase in product awareness and an expansion of the market through advertising. In the third year, a growth rate of 33% is projected, driven by continued marketing and word-of-mouth referrals.

Assumption 2: Product unit price.

The unit price is set at $35, which is justified by a markup over the production cost of $23.23 per unit. This pricing strategy takes into account all associated costs, including materials, labour, and overheads, while also remaining competitive in the market. The price ensures a balance between affordability for customers and a sustainable profit margin for the business, with the aim of maintaining a healthy market position.

Assumption 3: Manufacturing Costs.

The estimated cost of production per unit is $22.65, calculated using injection moulding for mass manufacturing. This method was selected on the basis of its cost-effectiveness in comparison to 3D printing, which is only suitable for the production of prototypes. The costs of the components, such as the Arduino Pro Micro, which cost $16.90, and the push buttons, which cost $3.00, were determined through the use of supplier quotes. The cost of labour is minimal, given that the majority of the assembly process is automated. The final quality check incurs a cost of $0.58 per unit.

Assumption 4: Advertising and Overhead Expenses.

The advertising budget is $10,000 annually, while fixed overhead expenses include $48,000 per year for rental space and $6,000 per year for utilities. These assumptions are based on examples from similar economic reports and business scenarios. Advertising budgets are crucial for creating awareness and driving sales, while overhead costs reflect the business's operational needs.

Assumption 5: Discount rate.

For the NPV analysis, we chose a discount rate of 10%. This percentage reflects the time value of money while also considering the risks inherent to launching a new business. It’s a commonly used figure for small businesses because it strikes a balance between being realistic and accounting for uncertainty. By using this rate, we can ensure that our financial projections are grounded and account for potential challenges as the business grows.

Assumption 6: Break-Even Analysis.

The break-even analysis shows that we need to sell 5,100 units in Year 1, 5,600 units in Year 2, and 6,100 units in Year 3 to start making a profit. These numbers come from comparing our expected sales, costs, and fixed expenses. This analysis highlights that starting a business has high upfront costs, but sales growth over time helps to cover them. These estimates are based on market research and similar industry examples.

4.2 Intellectual property report

Intellectual Property 1: National Application/Registration 76290

76290

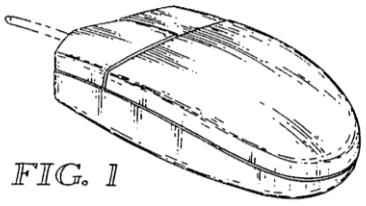


FIG. 1

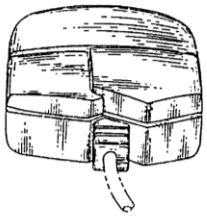


FIG. 2

FIG. 3

The above patent was found within the Canadian Industrial Design Database. It was registered by Microsoft Corporation in 1995. The patent shows the design of a wired mouse, which appears similar to our mouse click buttons. While both products make use of right and left click buttons, and a wire connected for power, the housing and general appearance of the mouse differs between them. The purpose of an industrial design patent is to establish the visual shape / configuration of the product. In this case, this IP is important in establishing a design for a mouse, but not necessarily relevant to our product given their significant visual differences. Additionally, this patent has already expired, meaning that if there were any significant similarities, our product would not be subject to any legal disputes.

Intellectual Property 2: Universal Serial Bus Mouse US20120146908A1

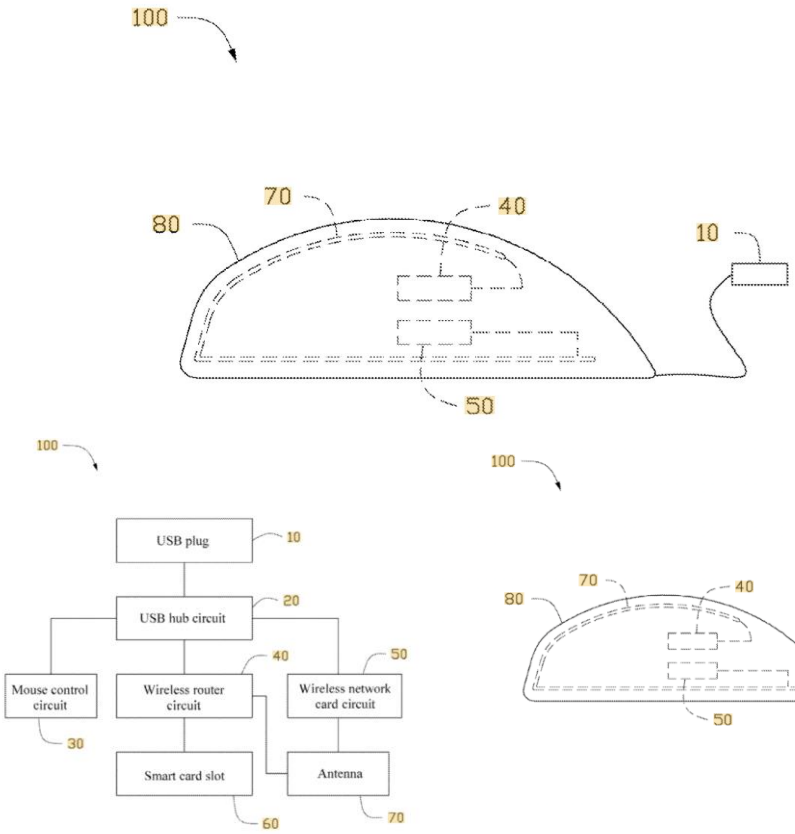
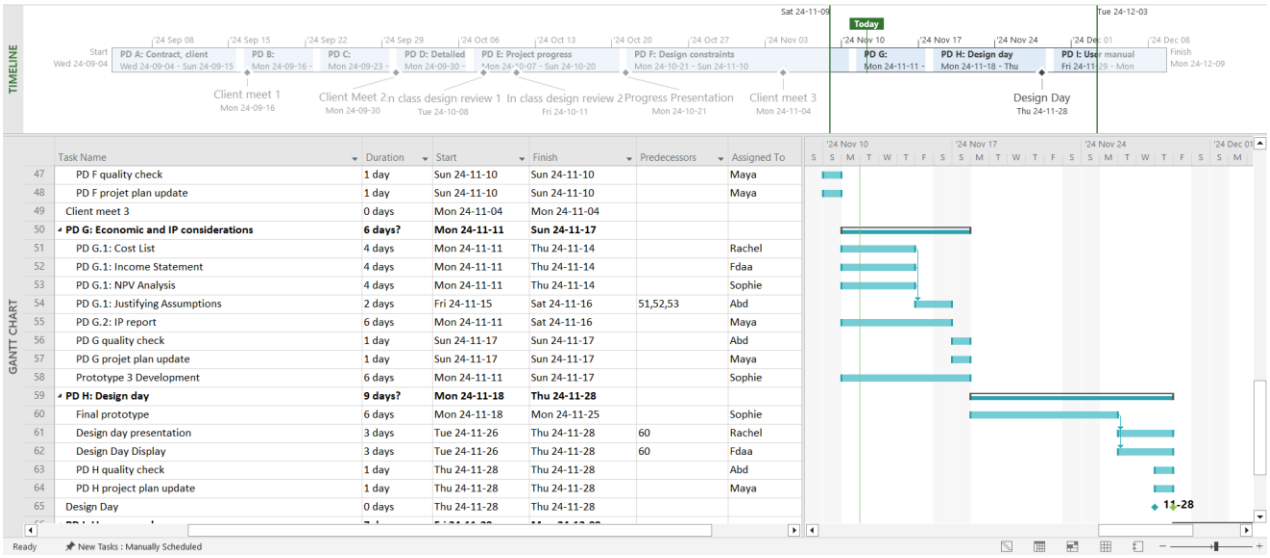


FIG. 1

FIG. 2

The present invention discloses a USB mouse, which integrates a USB hub circuit, a mouse control circuit, a wireless router circuit, and a wireless network card circuit. This patent application, published on June 14, 2012, goes on to describe just such a USB mouse that integrates all these in one. It emphasizes multifunctionality whereby the standard mouse operations will be combined with wireless networking, thus providing a new perspective in the improvement of device utility. The USB mouse could have combined several functions, thus helping us think creatively for our project with respect to embedding extra controls or connecting methods for enhancing its use. However, since this is a patent application and not an issued patent, its legal status may differ.

4.3 Project plan update



5 Design Day Pitch and Final Prototype Evaluation

1. 2-line Summary of Project for Judges

Our project is a wheelchair-mountable mouse clicker for a client with motor impairments, to be used alongside a pre-existing joystick that is currently used to move the mouse cursor. It must be small enough to fit onto the arm of the wheelchair, easy to use, durable and potentially repairable.

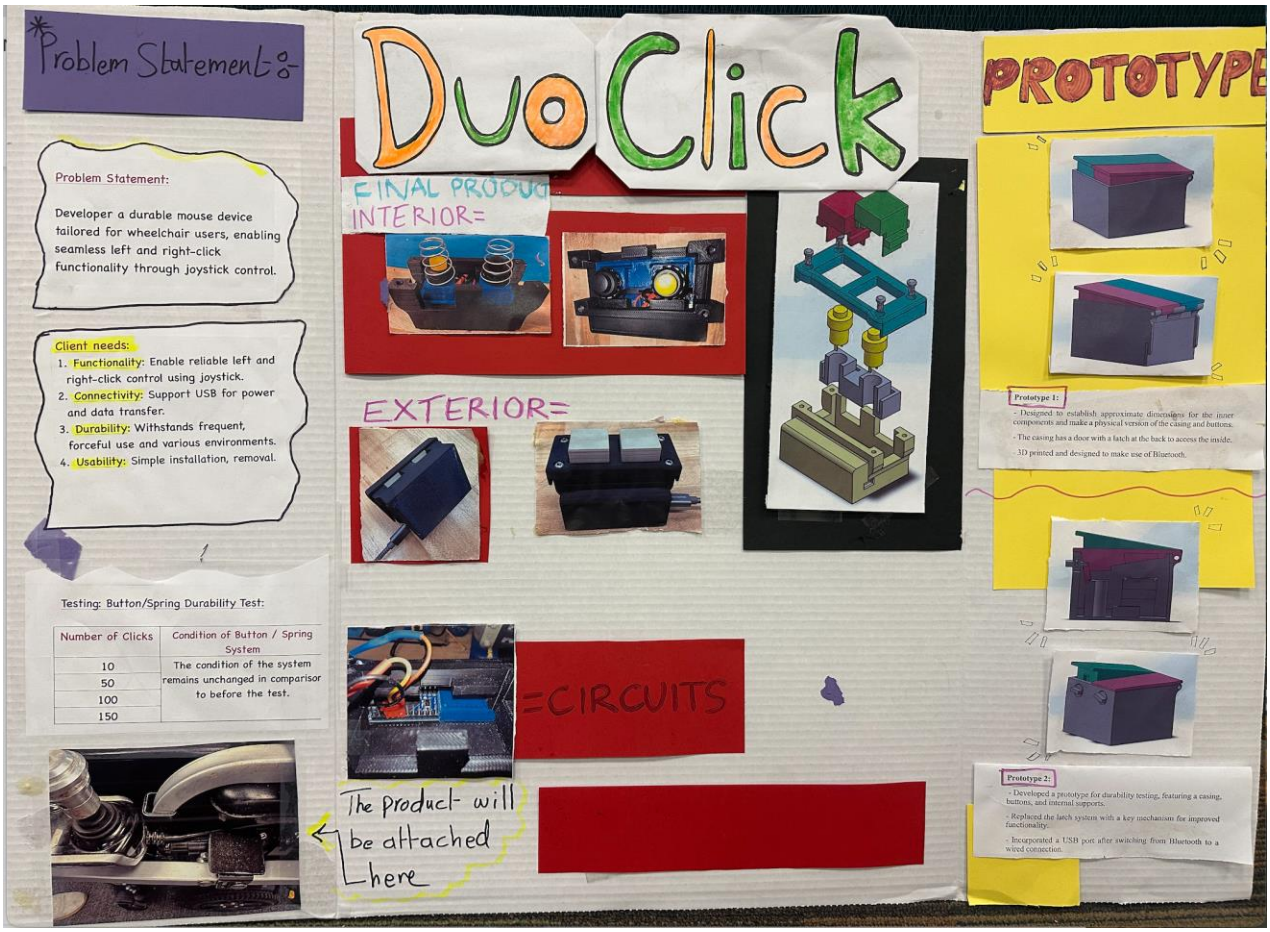
2. Pitch

Hello, we are team DuoClick, and we built a product for a client with motor impairments who needs a small, durable, and easy to repair mouse clicker that is wheelchair mountable. You might ask, aren't there countless mouse clickers on the market? Surprisingly, there was not a single product we could find that met our specific client's needs. Currently, the few products available that are targeted for users with motor impairments are expensive, bulky, with unnecessary features. The important aspect that these products fail to address is that many wheelchairs come pre-installed with joysticks to steer the wheelchair which can also be paired with computers to move mouse cursors. Additionally, most wheelchairs have limited space available for a mouse to be installed. Therefore, what users need is a simple, affordable clicker with bare minimum-functions – left and right clicks - that prioritizes compactness and easy-use over extra joysticks, scrollers, large buttons and additional features that only put strain on the budget.

In developing our prototype, we focused on compact size, usability, functionality, and durability. First and foremost, we recognized that clients like Steve, who we designed our product for, cannot help but roughly handle the clickers. When we visited Steve a few weeks ago, we realized that he puts more force when clicking the buttons than we had previously anticipated. This is why we included a tougher spring mechanism to lessen the impact on the underlying buttons by providing resistance. We also did durability tests, to make sure that the buttons underneath remain intact after varying amounts of forces are repeatedly applied, coupled with drop tests from a height of 1 to 1.5m.

To ensure that the clicks work seamlessly, we tested on different laptops and computers and you can see the final product here. Most parts are 3D printed, and there is an Arduino Pro Micro inside that is connected to the buttons, which are secured by 3D printed holders. Springs and buttons go on top, and are then screwed in. Everything is removable, which means repair is possible. Notice also that it is quite small compared to our initial testing prototypes, as size was voiced out as the top concern by our client in the final meeting. This final version is to fit perfectly onto Steve's wheelchair and secured by Velcro, and usable on any device using a USB cable, which will always provide a stable connection.

To wrap up, our goal for this project was to create a practical and trustworthy product. A product that is simple and does the job, while being affordable. We hope that these intentions are reflected in what we created here. Thank you for listening, and we will now open the floor to questions.


Problem Statement:
Problem Statement:
Developer a durable mouse device tailored for wheelchair users, enabling seamless left and right-click functionality through joystick control.
Client needs:
1. Functionality: Enable reliable left and right-click control using joystick.
2. Connectivity: Support USB for power and data transfer.
3. Durability: Withstands frequent, forceful use and various environments.
4. Usability: Simple installation, removal.
Testing: Button/Spring Durability Test:
Number of Clicks
Condition of Button / Spring System
10
50
100
150
The condition of the system remains unchanged in comparisor to before the test.
DuoClick
FINAL PRODUCT
INTERIOR=
EXTERIOR=
=CIRCUITS
The product will be attached here
PROTOTYPE
Prototype 1:
- Designed to establish approximate dimensions for the inner components and make a physical version of the casing and buttons.
- The casing has a door with a latch at the back to access the inside.
- 3D printed and designed to make use of Bluetooth.
Prototype 2:
- Developed a prototype for durability testing, featuring a casing, buttons, and internal supports.
- Replaced the latch system with a key mechanism for improved functionality.
- Incorporated a USB port after switching from Bluetooth to a wired connection.

6 Video and User Manual

6.1 Video pitch

6.2 User manual

See separate template for the user manual. Do not write the content here.

1 Introduction:

7 Conclusions

Throughout our project, we faced numerous challenges that tested our adaptability, resource management, and proactive planning. These experiences have provided us with valuable lessons and insights for the future.

1. Lessons Learned:

a. Adaptability: Unexpected issues, such as the Bluetooth module failing to connect to the computer and the need to redesign our prototype because of updated client requirements, emphasized the importance of flexibility and responsiveness to changing needs.

b. Resource Management: Running out of filament and encountering 3D printer malfunctions demonstrated the need for us to do contingency planning and maintaining backups to prevent delays.

c. Time Management: The delays caused by troubleshooting the hardware and software side and redesigning taught us the importance of stricter timelines and early completion of tasks just in case there are any unexpected issues.

d. Technical Knowledge: Deeper expertise in Bluetooth functionality and purchasing additional components for testing could have accelerated progress and improved outcomes, and we could have identified this earlier.

2. Outstanding Issues:

a. Bluetooth Functionality: The module's failure to connect remains a critical issue that hindered the prototype's performance. Further exploration of hardware and software integration is necessary so we can achieve our original prototype plan.

b. Material and Equipment Limitations: The malfunctioning 3D printer and lack of filament delayed testing and iterations, requiring us to do better resource allocation and backups.

3. Implications for the Future:

a. Proactive Planning: Setting stricter timelines will ensure deadlines are met and provide more time for adjustments.

b. Early User Engagement: Engaging with clients earlier in the process and conducting user testing will help clarify requirements and help us adjust in a timely manner.

c. Incremental Goals: Establishing clear milestones, such as achieving Bluetooth functionality in the first prototype, will allow for early identification and resolution of critical challenges.

d. Skill Development: Enhancing technical understanding, particularly of Bluetooth and related technologies, will improve the quality and reliability of future projects. By implementing these strategies, we can minimize risks to improve project outcomes and better complete the user needs.

2 Overview

2.1 Conventions

2.2 Cautions & Warnings

4. Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the DUO CLICK Mouse Buttons.

4.1 Click Buttons

4.1.1 Left, Right or Double Click

- **Input:** Press the left, right button on the mouse click device. Press the left button twice to do a double click.
    - The button is tactile, requiring low-force actuation for accessibility.
- **Output:** The system sends a signal to the connected computer to execute a left, right, or double-click action.
- **Special Instructions:**
    - Ensure the device is securely attached to the wheelchair armrest.
    - Confirm that the button is pressed fully to register the input and USB cable is plugged to the computer.
- **Caveats:**
    - Avoid excessive force, as it may affect durability despite robust testing.

4.2 Connectivity

4.2.1 USB Wired Connection

- **Input:** Connect the device to the computer using the provided USB cable.
- **Output:** Establishes a stable wired connection for input signals.
- **Special Instructions:**
    - Ensure the USB cable is securely connected to both the device and the computer.
    - Verify the cable is not damaged or obstructed.
- **Caveats:**
    - The operating range is limited to the cable's length (1.5 meters).

4.3 Mounting the Device

4.3.1 Velcro Attachment

- **Input:** Use the Velcro strap to mount the device onto the wheelchair armrest.
- **Output:** Secures the device in place for optimal usability.
- **Special Instructions:**
  - Ensure the Velcro strap is tightly secured but not overtightened to prevent damage.
  - Test the attachment for stability before use.
- **Caveats:**
  - Ensure the mounting surface is clean for proper adhesion.

4.4 Durability and Maintenance

4.4.1 Drop Resistance

- **Input:** Subject to drop/impact tests up to 1 meter during operation.
- **Output:** Device remains functional and intact.
- **Special Instructions:**
  - Use padded surfaces for testing to prevent damage.
- **Caveats:**
  - Frequent or deliberate impacts may degrade performance over time.

4.4.2 Component Replacement

- **Input:** Remove the device cover using a screwdriver to access internal components.
- **Output:** Facilitates part replacement or repair.
- **Special Instructions:**
  - Follow the assembly manual for reattaching the cover securely.
  - Use only compatible replacement parts to maintain performance.
- **Caveats:**
  - Avoid disassembling without proper tools or training.

8 Conclusions

Summarize your lessons learned and your work related to your project. Discuss any outstanding issues or implications for the project.

Throughout our project, we faced numerous challenges that tested our adaptability, resource management, and proactive planning. These experiences have provided us with valuable lessons and insights for the future.

1. **Lessons Learned:**
    a. **Adaptability:** Unexpected issues, such as the Bluetooth module failing to connect to the computer and the need to redesign our prototype because of updated client requirements, emphasized the importance of flexibility and responsiveness to changing needs.
    b. **Resource Management:** Running out of filament and encountering 3D printer malfunctions demonstrated the need for us to do contingency planning and maintaining backups to prevent delays.
    c. **Time Management:** The delays caused by troubleshooting the hardware and software side and redesigning taught us the importance of stricter timelines and early completion of tasks just in case there are any unexpected issues.
    d. **Technical Knowledge:** Deeper expertise in Bluetooth functionality and purchasing additional components for testing could have accelerated progress and improved outcomes, and we could have identified this earlier.
2. **Outstanding Issues:**
    a. **Bluetooth Functionality:** The module's failure to connect remains a critical issue that hindered the prototype's performance. Further exploration of hardware and software integration is necessary so we can achieve our original prototype plan.
    b. **Material and Equipment Limitations:** The malfunctioning 3D printer and lack of filament delayed testing and iterations, requiring us to do better resource allocation and backups.
3. **Implications for the Future:**
    a. **Proactive Planning:** Setting stricter timelines will ensure deadlines are met and provide more time for adjustments.
    b. **Early User Engagement:** Engaging with clients earlier in the process and conducting user testing will help clarify requirements and help us adjust in a timely manner.
    c. **Incremental Goals:** Establishing clear milestones, such as achieving Bluetooth functionality in the first prototype, will allow for early identification and resolution of critical challenges.

d. **Skill Development:** Enhancing technical understanding, particularly of Bluetooth and related technologies, will improve the quality and reliability of future projects.

By implementing these strategies, we can minimize risks to improve project outcomes and better complete the user needs.

9 Bibliography

- *National Application/Registration: 76290*. Government of Canada. (n.d.). https://www.ic.gc.ca/app/opic-cipo/id/dsgnDtls.do?appNm=76290&lang=eng&status=OK&ordNum=1