

GNG2101  
**Design Project Progress Update**

**A5.3 Opti Click**

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September 24, 2023

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Codes:

## //right and left movement

```
#include <Mouse.h>
const int buttonLeftPin = 4; // Connect the left button to digital pin 2
const int buttonRightPin = 5; // Connect the right button to digital pin 3
int mouseSpeed = 5; // Adjust the speed of mouse movement

void setup() {
  pinMode(buttonLeftPin, INPUT_PULLUP); // Set pin 2 as an input with internal pull-up resistor
  pinMode(buttonRightPin, INPUT_PULLUP); // Set pin 3 as an input with internal pull-up resistor
  Serial.begin(9600);
}

void loop() {
  int buttonLeftState = digitalRead(buttonLeftPin);
  int buttonRightState = digitalRead(buttonRightPin);

  if (buttonLeftState == LOW) {
    Mouse.move(-mouseSpeed, 0);
  }

  if (buttonRightState == LOW) {
    Mouse.move(mouseSpeed, 0);
  }

  delay(10); // Adjust this value for the desired update rate
}
```

## //up down cursor movement:

```
#include <Mouse.h>

const int buttonUpPin = 4; // Connect the up button to digital pin 4
const int buttonDownPin = 5; // Connect the down button to digital pin 5
int mouseSpeed = 5; // Adjust the speed of mouse movement

void setup() {
  pinMode(buttonUpPin, INPUT_PULLUP); // Set pin 4 as an input with internal pull-up resistor
  pinMode(buttonDownPin, INPUT_PULLUP); // Set pin 5 as an input with internal pull-up resistor
  Serial.begin(9600);
}

void loop() {
  int buttonUpState = digitalRead(buttonUpPin);
  int buttonDownState = digitalRead(buttonDownPin);

  if (buttonUpState == LOW) {
    Mouse.move(0, -mouseSpeed); // Move the cursor up
  }

  if (buttonDownState == LOW) {
    Mouse.move(0, mouseSpeed); // Move the cursor down
  }
}
```

```
    delay(10); // Adjust this value for the desired update rate
}
```

## //code for right click, left click and drag:

```
#include <Mouse.h>

const int buttonPinLeft = 2; // Left click button pin (Connect to digital pin 2)
const int buttonPinRight = 3; // Right click button pin (Connect to digital pin 3)
const int buttonPinDrag = 4; // Drag button pin (Connect to digital pin 4)

int buttonStateLeft = HIGH;
int lastButtonStateLeft = HIGH;
int buttonStateRight = HIGH;
int lastButtonStateRight = HIGH;
int buttonStateDrag = HIGH;
int lastButtonStateDrag = HIGH;

unsigned long lastDebounceTimeLeft = 0;
unsigned long lastDebounceTimeRight = 0;
unsigned long lastDebounceTimeDrag = 0;
unsigned long debounceDelay = 50;

bool isDragging = false; // Flag to track if the drag action is active

void setup() {
    pinMode(buttonPinLeft, INPUT);
    pinMode(buttonPinRight, INPUT);
    pinMode(buttonPinDrag, INPUT);

    digitalWrite(buttonPinLeft, HIGH); // Enable internal pull-up resistor
    digitalWrite(buttonPinRight, HIGH); // Enable internal pull-up resistor
    digitalWrite(buttonPinDrag, HIGH); // Enable internal pull-up resistor

    Mouse.begin();
}

void loop() {
    int readingLeft = digitalRead(buttonPinLeft);
    int readingRight = digitalRead(buttonPinRight);
    int readingDrag = digitalRead(buttonPinDrag);

    // Left button handling
    if (readingLeft != lastButtonStateLeft) {
        lastDebounceTimeLeft = millis();
    }

    if ((millis() - lastDebounceTimeLeft) > debounceDelay) {
        if (readingLeft != buttonStateLeft) {
            buttonStateLeft = readingLeft;

            if (buttonStateLeft == HIGH) {
                Mouse.click();
            }
        }
    }

    lastButtonStateLeft = readingLeft;

    // Right button handling
    if (readingRight != lastButtonStateRight) {
        lastDebounceTimeRight = millis();
    }

    if ((millis() - lastDebounceTimeRight) > debounceDelay) {
        if (readingRight != buttonStateRight) {
```

```

    buttonStateRight = readingRight;

    if (buttonStateRight == HIGH) {
        Mouse.click(MOUSE_RIGHT);
    }
}

lastButtonStateRight = readingRight;

// Drag button handling
if (readingDrag != lastButtonStateDrag) {
    lastDebounceTimeDrag = millis();
}

if ((millis() - lastDebounceTimeDrag) > debounceDelay) {
    if (readingDrag != buttonStateDrag) {
        buttonStateDrag = readingDrag;

        if (buttonStateDrag == HIGH) {
            if (isDragging) {
                Mouse.release(MOUSE_LEFT); // Release left button to stop dragging
                isDragging = false;
            } else {
                isDragging = true;
                Mouse.press(MOUSE_LEFT); // Press left button to start dragging
            }
        }
    }
}

lastButtonStateDrag = readingDrag;
}

```

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# List of Acronyms and Glossary

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**Table 1. Acronyms**

<b>Acronym</b>	<b>Definition</b>

**Table 2. Glossary**

<b>Term</b>	<b>Acronym</b>	<b>Definition</b>

# **1 Introduction**

## **2 Business Model Canvas and DFX**

### **2.1 Business Model and Sustainability Report**

#### **2.1.1 Value Proposition**

After preliminary research, there is not a large market for foot mice. Many foot mice available on the market do not seem very user friendly. Our product will not only provide a more comfortable experience, but also it will encourage the use of computers, making them more enjoyable for people that are limited in their ability to use a regular computer setup. Our design will revolve around user experience, so a welcoming design and satisfying user involvement with the product will be our priority. This will be achieved by looking at other competition and identifying what customers/clients want out of their foot mice. The proper use of materials will be important for customer satisfaction. Being able to strike a good balance between price and quality will play a big role in manufacturing a product that achieves such high standards.

#### **2.1.2 Triple Bottom Line**

Our business model canvas will follow the triple bottom line with an emphasis on the social and environmental costs and benefits. We've chosen this model as Alex Osterwalder's standard business model canvas isn't as inclusive. Our emphasis is on our client. By improving his keyboard, we can improve the quality of his time spent on the computer by adding new functions which will increase the opportunities he's currently limited to.

**Key Partners:** Our product will be designed with our client George in mind. It is our intention to make his needs our priority. George is limited in mobility, and it is important our design is easy to use and accessible.

**Key Activities:** Our client has said to us that he is limited to his current keyboard as it lacks right click and drag. George would use his foot mouse for emails as well as tinkercad those are the current activities he enjoys most with his computer.

**Key Resources:** To create this product, we will need to gain knowledge surrounding the electronic components and the actual creation of the mouse.

**Customer Relationship:** We want to ensure an excellent relationship with our client and for him to be able to contact us easily if our product goes awry.

**Customer Segments:** Our design will target those who are not currently adapted for the standard hand mouse. Our design aims to include a group that has been limited by computers up until now.

**Social and Environmental impact:** We wish to make a social and environmental impact on our client's quality of life. We hope our client will allow new opportunities and open new doors for George.

### **2.1.3 Core Assumptions**

The core assumptions that we are making in respect to our business model are that most clients looking for a foot mouse are not power users or are interested in a premium experience. We assume that our clients have some sort of disability, meaning that accessibility and mobility are essential when it comes to the design of our product. It is essential that our keyboard will be simple

and intuitive to use but still has the functionality of a traditional mouse. This comes at the cost of missing advanced features such as shortcuts, but we assume most potential customers are not interested and it would only increase complexity.

#### **2.1.4 Sustainability Report**

This product will change the way that people with disabilities interact with computers. This could also be a possible alternative for people whose hands are occupied with other tasks, and therefore are unable to use a regular mouse. This could have a big impact on how people interact with computers. Regarding the environmental impacts, the materials used in the development will be properly researched to have the most eco-friendly polymers for the product. That being stated, if it comes down to cost, it could also limit the accessibility of the product. We will be sure to choose materials that are eco-friendly, while still providing a quality product. Overall, the product will help people who have a hard time with generic mice, and potentially change the way people interact with computers while being as eco-friendly as possible.

## **2.2 Design for X**

### **1. Functionality:**

Our client told us that his current keyboard is his favorite to use. However, he expressed to us that he would like additional features such as right-click and “click and drag” buttons. These new buttons would increase the functionality over his current foot mouse, which is essential for the foot mouse to cover all the fundamental functions of a hand mouse.

### **2. Simplicity:**

Our client expressed to us that too many buttons can feel overwhelming and increase the time to use. When designing the new foot mouse, it is important that the buttons picked for the design are carefully picked to only include those that are necessary. Additionally, keeping buttons as the control interface simplifies the design as well as keeping the format familiar to our client.

### 3. Speed:

The controls of the client's foot mouse are slow to accomplish certain tasks on a computer. To improve upon the current design, an improved layout can speed up actions by situating the buttons in more optimal and practical locations.

### 4. Portability:

The foot mouse will be used from the base of our client's wheelchair, which limits the dimensions that the mouse can take up. The new foot mouse must fit on the wheelchair, and it should be light to be easier to transport around when the client is not at home. Additionally, the foot mouse needs a flat base to be compatible with the client's current setup on his wheelchair.

### 5. Accessibility:

Ultimately, the goal for the foot mouse is to help people with disabilities to use computers more easily in their everyday lives. Accessibility should therefore take the highest priority in any of the design features introduced in the new foot mouse. If our design is not accessible, it will fail to be useful for our client and others searching for a better foot mouse.

### 3 Problem Definition, Concept Development, and Project Plan

#### 3.1 Problem Definition

##### 3.1.1 Client Needs and Relevant Information

CLIENT NEEDS	PRIORITY LEVEL
The mouse is directionally controllable	5
The mouse is quick to move along the screen	2
The mouse moves the cursor accurately	2
The mouse can select items (left click)	5
It can drag selected items	4
The mouse can open context menus (right click)	4
The dimensions fit within a wheelchair tray	3
The control layout is simple to operate	4

Priority level uses a 1-5 scale with 5 being the highest priority.

The client's current mouse uses four arrow keys to maneuver the cursor on the screen and a select button to left click. While it is simple and reliable, it lacks a right click no button for right click and it is unable to do tasks that require the user to drag selected items. Introducing these features to the new foot mouse design is important for the user to perform all basic functions found in programs. The client mostly uses his computer for emails and editing documents, but he is interested in using TinkerCAD and playing games should the new mouse permit it. The client wants to use the mouse from his wheelchair, which imposes a size limit of up to 15 in. (38.1 cm) in width. The limits to the length and height are unknown currently. Finally, the client has good foot mobility, so more complex control schemes are possible.

### 3.1.2 Problem Statement

Computer Wise is interested in a foot mouse that can select and drag items and open context menus while being simple to operate and omnidirectional.

### 3.1.3 Metrics and Benchmarking

CLIENT NEEDS	CRITERIA	METRIC	UNIT
The mouse is directionally controllable	Cursor Movement	Number of directions for cursor movement	#
The mouse is quick to move along the screen	Speed	Time to move diagonally from corner to corner	sec
The mouse moves the cursor accurately	Accuracy	Rating based on control scheme	1-5
The mouse can select items (left click)	Left Click	Left click function	Yes/No
It can drag selected items	Drag	Drag function	Yes/No
The mouse can open context menus (right click)	Right Click	Right click function	Yes/No
The dimensions fit within a wheelchair tray	Dimensions	Length, width, and height	cm
The control layout is simple to operate	Simplicity	Rating based on control scheme	1-5

Device Name	Features	Pros	Cons
Boomer the Foot Mouse 	<ul style="list-style-type: none"> <li>-Rechargeable battery</li> <li>-Bluetooth</li> <li>-Left and right click</li> <li>-Cursor</li> <li>-Anti-skid pads on bottom</li> </ul>	<ul style="list-style-type: none"> <li>-Minimal buttons</li> <li>-Cursor is easy to use</li> <li>-Has left and right click buttons</li> <li>-Easy to clean</li> <li>-Compact</li> </ul>	<ul style="list-style-type: none"> <li>-Very expensive (\$1,196)</li> <li>-No drag button</li> </ul>

<p>Footime Mouse</p> 	<ul style="list-style-type: none"> <li>-Plugs in</li> <li>-Left click, right click and double click</li> <li>-2 programmable buttons</li> <li>-2-part system (cursor and mouse buttons)</li> <li>-Scroll up and down</li> </ul>	<ul style="list-style-type: none"> <li>-Has left and right click buttons</li> <li>-Can scroll up and down</li> <li>-Cheaper (\$149)</li> <li>-Compact</li> </ul>	<ul style="list-style-type: none"> <li>-2-part system is less simplistic</li> <li>-No drag button</li> </ul>
<p>SMASHmouse</p> 	<ul style="list-style-type: none"> <li>- Mouse mode and video playback mode</li> <li>- Directional pad</li> <li>- left click, right click and media controls</li> <li>-USB and Bluetooth</li> <li>-12-hour rechargeable battery</li> <li>- Customizable shortcuts</li> </ul>	<ul style="list-style-type: none"> <li>- Good mouse controllability (can move diagonal)</li> <li>- has left/right click and shortcuts</li> <li>- includes media shortcuts</li> <li>- solid construction (aluminum base)</li> <li>- cheap (\$150)</li> </ul>	<ul style="list-style-type: none"> <li>- D-pad requires good foot control</li> <li>- No drag button</li> <li>- Right click is small</li> </ul>

CRITERIA	CURRENT	BOOMER THE FOOT MOUSE	FOOTIME MOUSE	SMASHmouse
Cursor Movement (directions)	4	60	360	8
Speed (s)	6	3	1.5	4
Accuracy (1-5)	5	2	4	3
Left click	Yes	Yes	Yes	Yes
Drag	No	No	No	No
Right click	No	Yes	Yes	Yes
Dimensions (cm)	30x17x1	40x23x8	38x28x5	29x24x15
Simplicity (1-5)	5	4	2	3

Benchmarked Product Links:

[https://www.specialneedscomputers.ca/index.php?l=product\\_detail&p=7035](https://www.specialneedscomputers.ca/index.php?l=product_detail&p=7035)

<https://www.fentek-ind.com/footime.htm>

<https://www.kickstarter.com/projects/smashmouseusa/smashmouse-universal-pedal-for-hands-free-computer>

Benchmarking Comparison:

Currently, there is not an exceptionally large market for foot mice and there are not a lot of very great options. We were able to find a few products to use as benchmarks. Some pros shared between the benchmarked products were that they all had left- and right-click buttons and good mouse controllability. Some cons that we found were that all the products didn't have an option for a drag button which is a priority for our client, some of them were also not overly simplistic, and lacked overall trustworthiness when it came to design. Ideally, we will take some ideas from the benchmarked products, as well as some of our own, and combine them to make a product that will be best suited for our client.

### **3.1.4 Target Specifications**

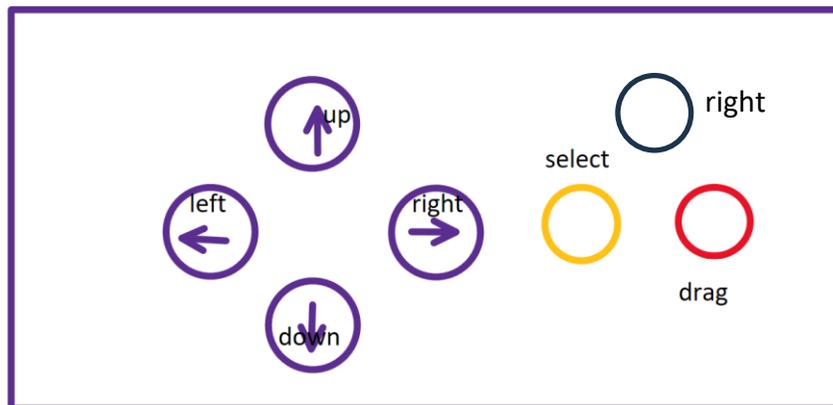
One of the biggest differences between the client's current foot mouse and the benchmarked products is the number of directions the cursor can move. Although four movement directions for the cursor is the lowest result out of the four devices, we think it is sufficient as a marginally acceptable value as it helps keep the design simple, which we want to have a rating of

4 out of 5. Increasing to eight or more directions would be ideal as it allows for diagonal movement, but that is not our priority. According to the client, the speed of his current mouse is a little slow, so we ideally want the speed to reach opposing diagonal corners to be under 3 seconds, but a slight improvement of 4 seconds or less is acceptable. Instead, we want the mouse to retain high accuracy by having its rating be at least a 4 out of 5 to ensure the user can select the desired point on the screen, which could otherwise be frustrating. For the mouse's functionality, it must have a left click, right click, and drag option as these are features the client specifically wants as they encapsulate all essential mouse functions. None of the benchmarked products had a drag option, so introducing it would set our foot mouse apart from the competition. Finally, the width of the mouse cannot exceed 38 cm, so the design should fit within a 38x38 square, although it would ideally fit within a 30x30 square for better portability in the wheelchair.

## 3.2 Concept development

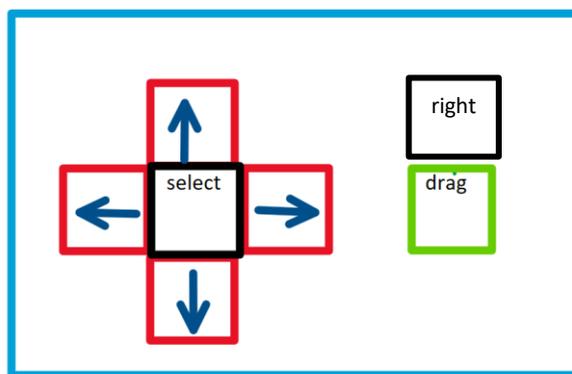
### 3.2.1 Solution Concepts

Solution #1:



The first solution concept is the most like the client's current layout. The first change that we made was to group the arrow buttons into a diamond shape instead of having them be in a horizontal line. The arrow buttons retain the high cursor accuracy and keep the design simple, and having the buttons closer together should help reduce the distance the foot needs to travel to change cursor directions, making it faster. Joining the select button on the side are dedicated right click and drag buttons. As the client likes the spacing of his current mouse, the spacing of the buttons in this solution retains it, but introducing more buttons means that the overall size of the mouse will increase. As such the dimensions would be larger than ideal, yet still fall under the acceptable values. Overall, this solution is the simplest one that introduces all the core changes that the client asked for, making it familiar but failing to make large improvements on cursor speed or direction quantity.

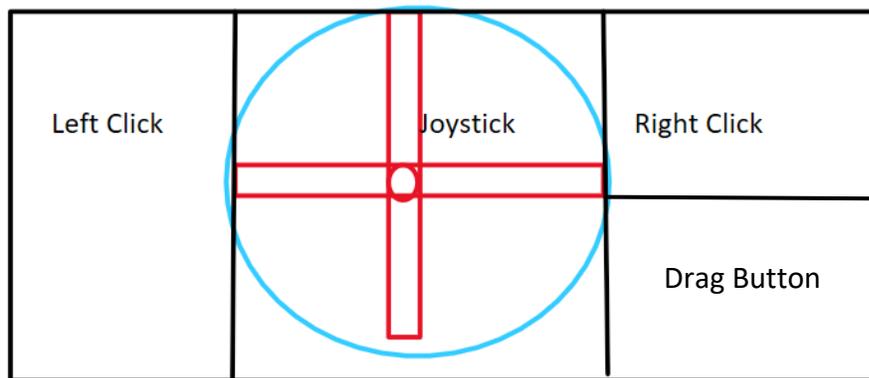
Solution #2:



The second solution concept builds upon the first one but makes more changes to improve cursor speed while retaining the four direction arrows. To fasten actions on the mouse, the spacing between buttons has been removed for a more compact design. The select button has been moved to the center of the arrow diamond, which reduces the amount of time a user's foot needs to travel to the right side of the mouse. This gives a more significant increase to mouse action speed compared to the first solution. With the buttons being so close together, more precise foot movement is required, which could be challenging for potential users and could be less comfortable to use. The smaller design makes the mouse more portable than other options, so it can be compatible with the most amount of wheelchair configurations.

### Solution #3:

- Guided Joystick Controls
- All of board in reactive and deliberate
- Closer to a hand mouse layout



The third design is the most exotic, as it replaces the direction arrows with a joystick for better controllability of the cursor. This allows for diagonal movement which greatly increases cursor movement at the cost of being harder to control precisely since the joystick is not limited to two axes like the arrows. Therefore, good foot motor coordination would be required for this solution, which limits the target demographic when compared to the solutions that use arrows. The space at the sides of the joystick is dedicated to the three types of clicks which are left deliberately large so users can reach them easily without having to worry of clicking the wrong button. Ultimately, this solution has the most potential out of the three if the user can learn to use the joystick. Our client is already familiar with joysticks since he uses one to control his wheelchair, but this design is not a universal solution.

### 3.2.2 Solution Comparison and Final Solution

<b>Client Needs</b>	<b>Priority level</b>	<b>Option 1</b>	<b>Option 2</b>	<b>Option 3</b>
<b>The mouse is directionally controllable</b>	<b>5</b>	<b>3</b>	<b>3</b>	<b>5</b>

<b>The mouse is quick to move along the screen</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>5</b>
<b>The mouse moves the cursor accurately</b>	<b>2</b>	<b>5</b>	<b>5</b>	<b>2</b>
<b>The mouse can select items (left click)</b>	<b>5</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
<b>It can drag selected items</b>	<b>4</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
<b>The mouse can open context menus (right click)</b>	<b>4</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
<b>The dimensions fit within a wheelchair tray</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>4</b>
<b>The control layout is simple to operate</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>3</b>

<b>Total Score</b>		61	58	63
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All solutions employ similar concepts and will uphold the same features for this <<design for x>>. Much of the criteria is whether it is able to uphold the features as it is meant to appease the specific request of our client; add a right click and add a drag button. The difference between our designs is aesthetics mostly and we will let our client choose to see which concept we will evaluate further. Based off our metric, option 3 (joystick) is the solution we will develop further, although all three options scored similarly.

### **3.3 Project plan**

<https://www.wrike.com/workspace.htm?acc=4975842#/folder/1214255598/timeline3?viewId=202136040>

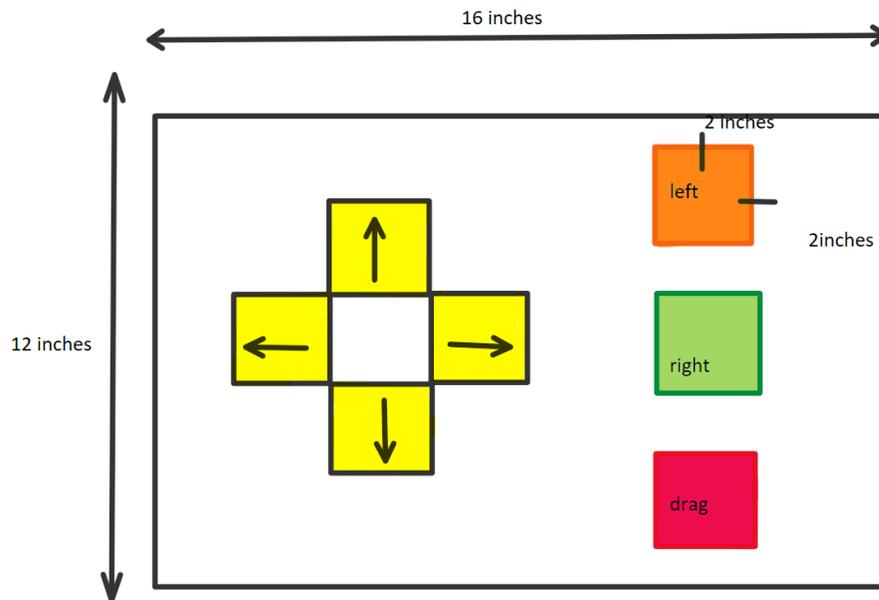
## 4 Detailed Design and BOM

### 4.1 Detailed design

#### 4.1.1 Client Feedback

Our client was enthusiastic about all three options. He indicated to us that the concept for the second design would be his preference with all the directional controls on the left side and the select drag and right click buttons on the right. He would prefer a concept that is familiar to his current solution. We learned George's current solution is 15.5\*6 inches and the maximum space we can work with is 21\*16 inches.

#### 4.1.2 Physical Design



**Directional functions:**

According to the Arduino website ([Mouse.move\(\) - Arduino Reference](#)), we can program direction functions into each of the different keys such that the buttons we create can act like a mouse. We can isolate the y and x variables into two directions (-x for left +x for right and -y for down and +y for up). This will allow us full range over the screen when inputting the variables.

### **Left and right click functions:**

According to the Arduino website ([Mouse.click\(\) - Arduino Reference](#)), we can create a program that will link a specific button to the left and right click function.

Note: With the utilization of the Arduino uno, this will allow us to emulate the current elements of Georges solution as well as add the addition of a right click.

### **Drag button:**

Code for Arduino:

```
const int switchPin = 2; // Connect the switch to digital pin 2

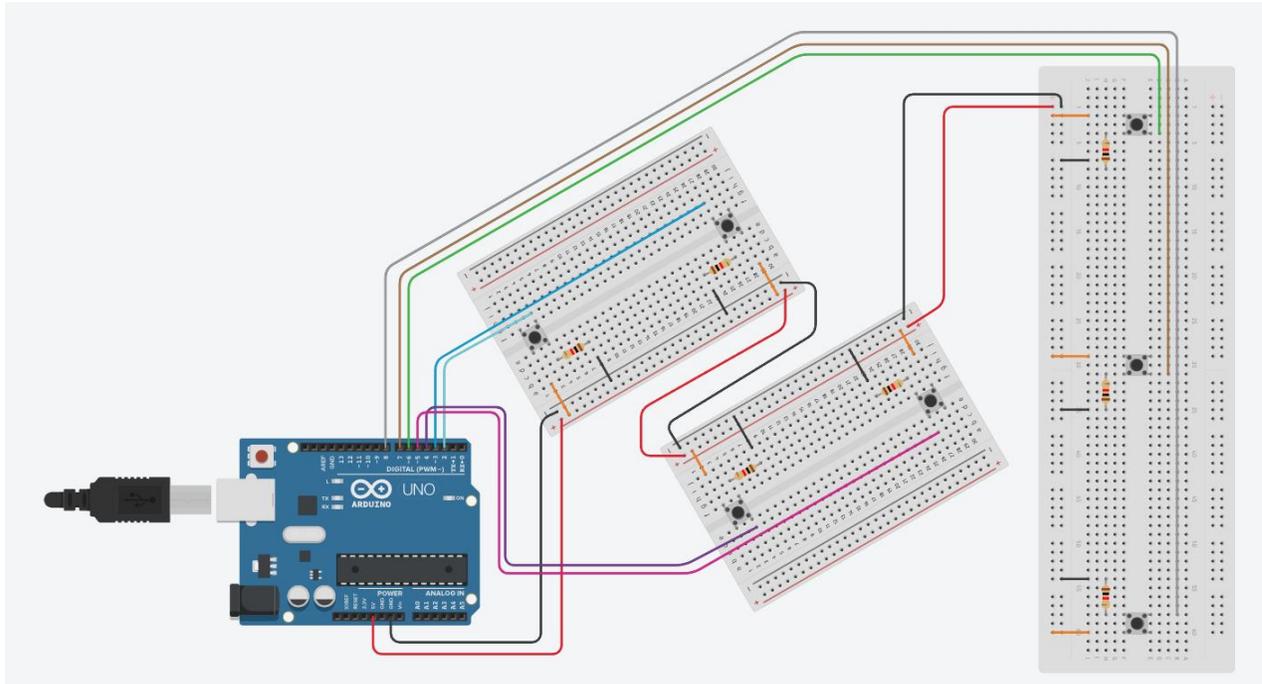
void setup() {
  pinMode(switchPin, INPUT);
}

void loop() {
  int switchState = digitalRead(switchPin);

  if (switchState == HIGH) {
    // Drag motion detected, do something
  }

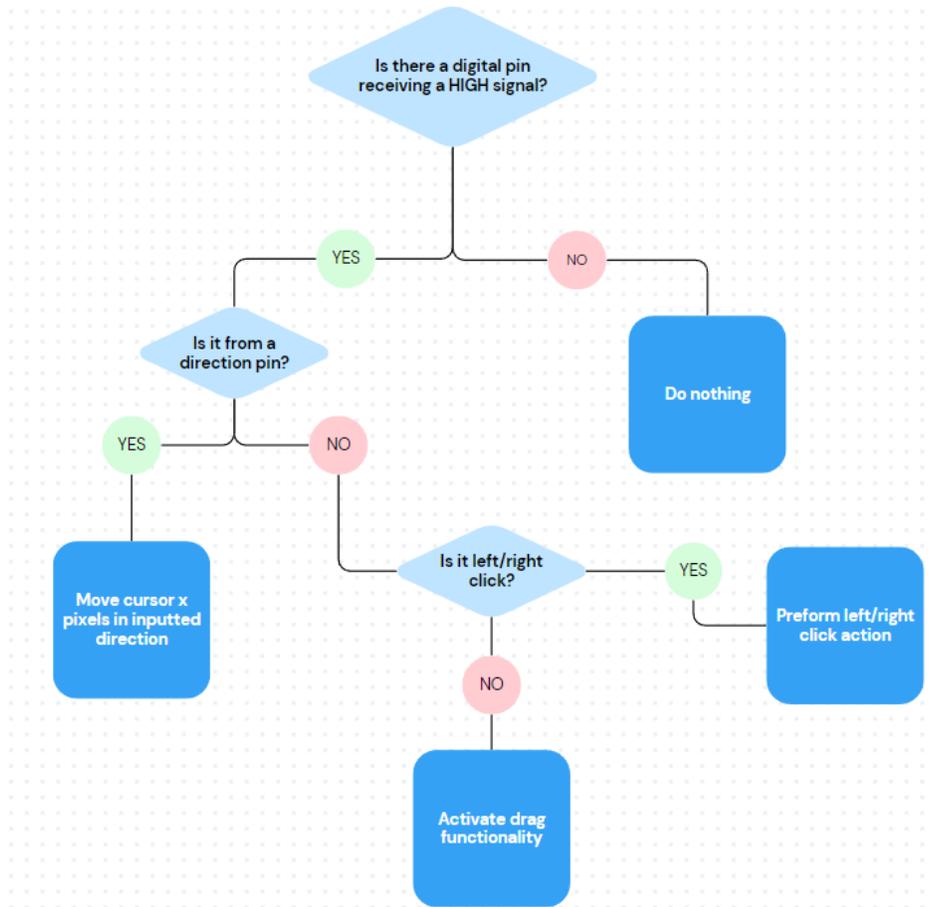
  delay(100); // Add a small delay to debounce the switch
}
```

### 4.1.3 Electrical Design



The current electrical design uses pushbuttons to send signals to the Arduino for what action the user wants. The top small breadboard has left and up buttons, the bottom small one has down and right, while the rightmost breadboard has the left click, right click, and drag buttons. When the pushbutton is pressed, the two terminals are connected, and a signal is sent to one of the digital pins of the Arduino. By changing the input of one of the digital pins from low to high, the Arduino can know which action the user wants the mouse to do. As the circuit only transmits data, the USB connection should be capable of providing all the necessary power, so an external battery would not be required.

#### 4.1.4 Software Design



The code's main decision structure will work by first identifying what type of action the user wants, and then performing the right action. If the Arduino detects the signal from the direction pins (2-5), it will then move the cursor a predetermined amount depending on the time the signal is received. For select (pin 6), a signal will cause the mouse to perform a left click, while a signal for right click (pin 7) opens a context menu. Finally, a signal for drag (pin 8) will toggle it to change how select functions, allowing objects to be dragged instead of a left click.

## 4.2 BOM

Item	Price	Link
Arduino	\$21.38	<a href="https://www.amazon.ca/Leonardo-Development-Board-ATMEGA32U4-Arduino/dp/B08JKM63MS/ref=sr_1_1?crid=3AMZ98K56X98J&amp;keywords=leonardo+r3&amp;qid=1697040093&amp;sprexif=leornado+r3%2Caps%2C93&amp;sr=8-1">https://www.amazon.ca/Leonardo-Development-Board-ATMEGA32U4-Arduino/dp/B08JKM63MS/ref=sr_1_1?crid=3AMZ98K56X98J&amp;keywords=leonardo+r3&amp;qid=1697040093&amp;sprexif=leornado+r3%2Caps%2C93&amp;sr=8-1</a>
Breadboard	\$5.00	<a href="https://makerstore.ca/shop/ols/products/breadboard/v/B15-HLF">https://makerstore.ca/shop/ols/products/breadboard/v/B15-HLF</a>
Protoboard	\$7.44	<a href="https://www.amazon.ca/Universal-Breadboard-Electrical-Experiment-Electronic/dp/B0C8KFVZ6C/ref=sr_1_2_sspa?crid=235XG65SICPF&amp;keywords=protoboard&amp;qid=1698453398&amp;refinements=p_36%3A-900&amp;mid=12035759011&amp;sprexif=protob%2Caps%2C85&amp;sr=8-2-spons&amp;sp_csd=d2lkZ2V0TmFtZT1zeF9hdGY&amp;psc=1">https://www.amazon.ca/Universal-Breadboard-Electrical-Experiment-Electronic/dp/B0C8KFVZ6C/ref=sr_1_2_sspa?crid=235XG65SICPF&amp;keywords=protoboard&amp;qid=1698453398&amp;refinements=p_36%3A-900&amp;mid=12035759011&amp;sprexif=protob%2Caps%2C85&amp;sr=8-2-spons&amp;sp_csd=d2lkZ2V0TmFtZT1zeF9hdGY&amp;psc=1</a>
Wires (10 pack)	\$1.00 (x2)	<a href="https://makerstore.ca/shop/ols/products/jumper-cables-per-10">https://makerstore.ca/shop/ols/products/jumper-cables-per-10</a>
Push Buttons	\$0.25 (x4)	<a href="https://makerstore.ca/shop/ols/products/soft-tactile-button-8mm">https://makerstore.ca/shop/ols/products/soft-tactile-button-8mm</a>
Buttons	\$11.99	<a href="https://www.amazon.ca/Gebildet-Waterproof-Momentary-Lockless-Doorbell/dp/B07YC78THX/ref=sr_1_19?keywords=Gebildet&amp;qid=1698453207&amp;sr=8-19&amp;th=1">https://www.amazon.ca/Gebildet-Waterproof-Momentary-Lockless-Doorbell/dp/B07YC78THX/ref=sr_1_19?keywords=Gebildet&amp;qid=1698453207&amp;sr=8-19&amp;th=1</a>
Resistors	Free	-----
Shell (3D Print)	Free	-----
<b>Total</b>	<b>\$48.81</b>	

## **Skills and Resources**

We will need to use MakerLab to 3D print the shelling for our keyboard case. We will also use the 3D printers in MakerLab to create larger covers for the buttons to make them easier to press. We may need to solder wires in the electrical parts of our design. We are planning to use breadboards as our budget of \$50.00 is extremely limited to what we can use. Another resource we have access to is the Arduino libraries. Hopefully, this will assist us when creating the code for the buttons. Some group members have experience with SolidWorks, which will be helpful with 3D printing and 3D modelling. All group members have limited experience with coding and electrical circuits.

## **Realistic Time Assessment**

For Wednesday October 18<sup>th</sup>, our group is tasked with presenting our progress so far and we will have one prototype to share during the lab session. Despite all members' availability being limited due to midterms, we will be able to have a CAD model of our design. After this presentation, our TA will approve of our design and bill of materials, and this will allow a transition into prototype 2 after reading week.

## **Critical Product Assessment**

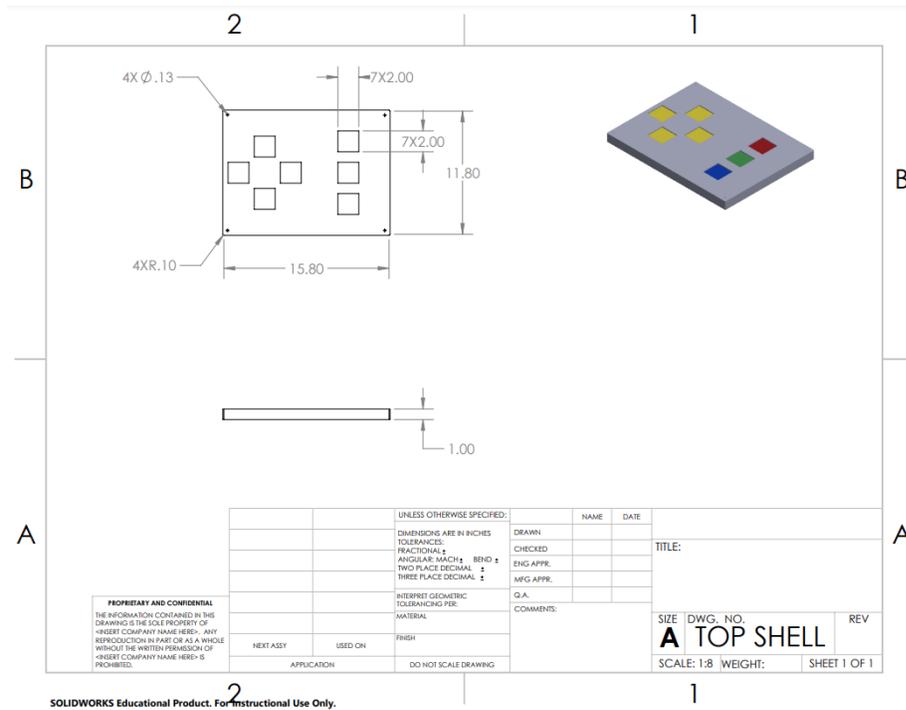
The main constraint that we have already found to be a slight issue is the budget. We are limited to \$50.00, which reduces the number of options we must work from. As stated previously, we are planning on using breadboards rather than something like a PCB board which we could solder wires/components into as our budget wouldn't allow us to use them. We are still able to implement our design, it just may not be as reliable as it would be if we had a higher budget.

## 4.3 Project plan update

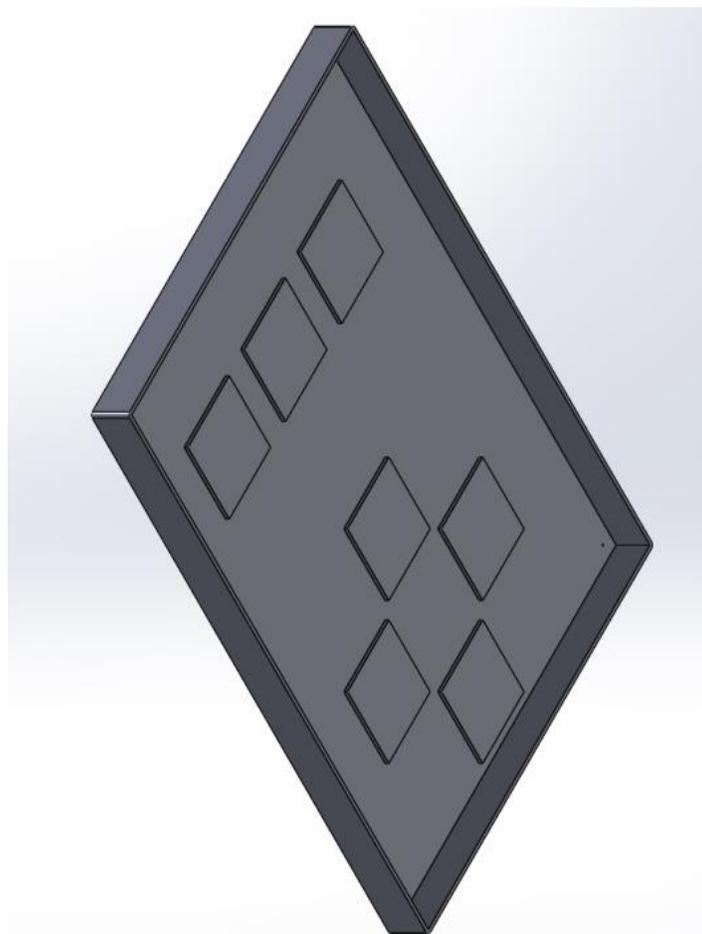
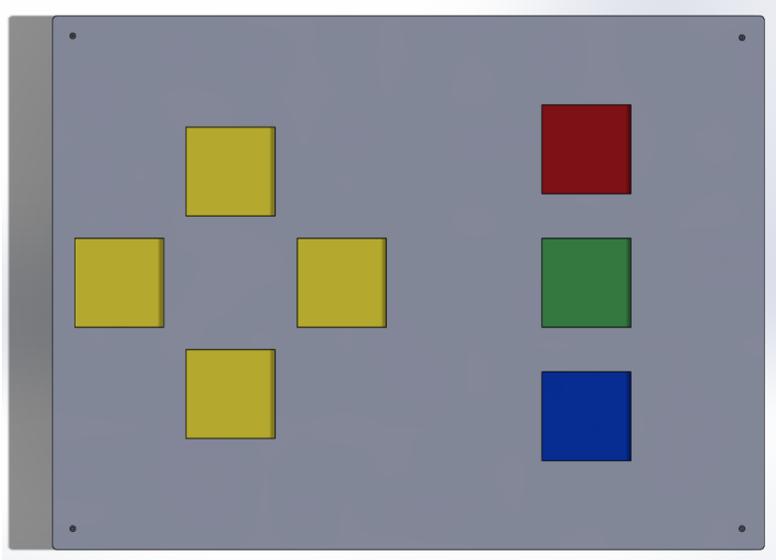
[Deliverable C - Wrike](#)

# 5 Prototype 1, Project Progress Presentation, Peer Feedback and Team Dynamics

## 5.1 Prototype 1



Our prototype 1 is a CAD model for our foot mouse design that was made in the previous deliverable. It is a focused and analytical prototype whose main purpose is to communicate the design to the client in a medium that shows the dimensions more clearly than a 2D sketch would permit. This model also includes more detailed features such as the height of the foot mouse, fillets to reduce the sharpness of edges, and the location of fasteners for the casing assembly. Apart from the CAD model, a detailed technical drawing was also included which has the updated dimensions which reflect the changes brought by the refined design. This also provides us an easily modifiable medium that be updated as further prototyping is done and the final prototype is developed.



The main change of this iteration of the design is an increase to the spacing between the directional buttons, as having the buttons touching each other increased the likelihood of an accidental miss click. Therefore, a small buffer between the directional buttons was added, making it easy to physically feel the extremities of each button. This change should improve the foot mouse's simplicity of use, especially for users with limited foot mobility.

## **5.2 Project Progress Presentation**

[Project progress.pptx](#)

## **5.3 Project plan update**

<https://www.wrike.com/workspace.htm?acc=4975842#/folder/1214255598/timeline3?viewId=202136040>

## 6 Design Constraints and Prototype 2

### 6.1 Design constraints

**Identify two non-functional design constraints that play an important role in the development of your prototypes. Justify your reasoning.**

One set of non-functional constraints is related to performance, such as the ability to handle multiple simultaneous inputs, like multiple buttons being pressed. This could be a constraint because if dragging and moving are being used at the same time, the device should be able to smoothly complete its tasks without software limitations hindering performance. The following observations were made regarding the constraints of prototype 2: the cursor jitters when stationary, the cursor moves at a fixed speed, certain pushes are not registered, and only four buttons are currently on prototype 2, which limits functionality. Some constraints mentioned are related to software and will require fine-tuning, such as the cursor jittering, which has been reported to be straining on the eyes over a period. Another software constraint is the cursor's slow speed, which makes precise movement challenging. The registering of button presses could be related to the quality of the buttons, so this will not be considered as much of a software constraint; a solution is already in action (new buttons have been ordered). The limitation of having only four buttons can be a constraint, as insufficient functionality limits the user.

The second set of non-functional constraints pertains to usability. Our goal is to make a product that is very easy to use by simply plugging it in and going. Each button will be easy to see by using different colors, and for those who have trouble seeing colors, an imprint of each button's function will also be able to be felt. This ensures that each user has an easier time using the mouse. To also ensure easy access, feedback from different people before finalizing the prototype may be

collected to satisfy usability. Prototype 2 currently displays many different wires and looks overwhelming. The buttons that are being used are not the best quality in terms of user satisfaction.

**For each design constraint, explain in detail what changes would need to be and your design to satisfy the constraint.**

Performance – The cursor jitters when stationary will require further investigation to understand the cause of the issue. There could be a couple reason this could occur; one possible reason is the hardware. If any connection is not properly installed, that could cause false signals being sent. Furthermore, a mistake in the code could also contribute to the jitters. To fully understand what causes the issue other variables must be addressed. Another constraint that was noticed is the speed of the cursor. Now this issue is most likely a code issue. As hardware would not directly influence speed as it is only a single press. So, further investigation into the code will provide the solution to this constraint. A potential time interval could be added as well, say if you wish to make fine adjustment press the button once, and say if you wish the cursor to speed up, you'd press the button longer. This would also help regarding the precise work. Finally, is the addition of more buttons, which should not be difficult to add in the code, but will be a focus of prototype 3, where everything will be put together.

Useability – as stated above it is clear that prototype 2 needs some polishing. As anyone looking at the prototype will most likely feel overwhelmed and feel drawn away from the product. First would be hiding the wires. This will be done using a shell. This shell will provide a less overwhelming look (prototype 1). The buttons will be changed out as well for more accessible buttons. This is done by changing them out for a better-quality product as well as increasing the

scale of the buttons. Each button will have a larger plate (meaning larger 3d print over it) to make the buttons stand out better also giving each button the direction they intend to do.

**Provide proof (e.g. analysis, simple calculations and/or simulations, research) to demonstrate the effectiveness of your changes in satisfying the constraints. Justify the process and methods you used.**

Performance – At the current stage no further evidence can be provided on the stage of prototype 2, but as more testing is done proof will be added to support the claims made in the change constraints section.

Useability – People are more likely to be satisfied with a product that is easy to learn, engaging, and error-tolerant (RIDGELL, n.d.). In the article published by Alan Ridgell, it underlines the importance on how product usability could have huge and positive impacts in your business. Applying the same principals to our final product we can determine that if we polish and make our product as user friendly as possible the client will be much more drawn to using our product and have a greater time with it.

## **6.2 Prototype 2**

[180pcs Fully Insulated Wire Crimp Terminal Nylon Quick Connectors Wiring Male/Female Spade, YuCool Disconnect Electrical Connectors Assortment Kit AWG 22-16, 16-14, 12-10, Terminals & Kits - Amazon Canada](#)

Buttons

Connectors

Arduino

Cables

Tougher than breadboards

Be careful with button spacing and if two buttons are pressed at the same time

### **Client feedback summary**

Client meet 3:

Customer feedback

- Client likes the drag functions.
- Likes the general idea.
- Likes the speed of the cursor of prototype 2.
- Previous product is too slow for client. (cursor speed)

### **Most critical product assumption:**

We've tested the code using two push buttons, and we've played with the code to test up to 4 functions at a time (switching wire connections). We've been successful in adapting our code to encompass multiple functions and the core assumption that has not been tested is that all 7 functions can be adapted into the same code.

### **Second Set of Prototypes:**

Our next step is to create the shell. We also need to solder the wire connections for a permanent solution. Upcoming prototypes include the soldered connected buttons and the shell casing which will lead us to our final product on design day.

## Latest Prototype:

For our latest prototype, we've adapted code to test all directional controls as well as right click, left click and drag. We were successful in testing these codes on the breadboard using pushbuttons and were successfully able to demonstrate these functions during the client meeting.

```
#include <Mouse.h>
const int buttonLeftPin = 4; // Connect the left button to digital pin 2
const int buttonRightPin = 5; // Connect the right button to digital pin 3
int mouseSpeed = 5; // Adjust the speed of mouse movement

void setup() {
  pinMode(buttonLeftPin, INPUT_PULLUP); // Set pin 2 as an input with internal
  pinMode(buttonRightPin, INPUT_PULLUP); // Set pin 3 as an input with internal
  Serial.begin(9600);
}

void loop() {
  int buttonLeftState = digitalRead(buttonLeftPin);
  int buttonRightState = digitalRead(buttonRightPin);

  if (buttonLeftState == LOW) {
    Mouse.move(-mouseSpeed, 0);
  }

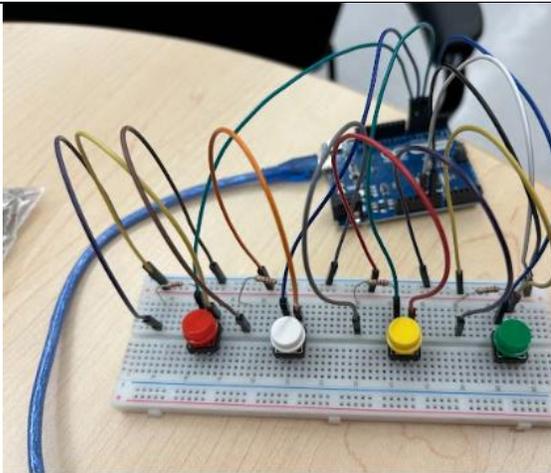
  if (buttonRightState == LOW) {
    Mouse.move(mouseSpeed, 0);
  }

  delay(10); // Adjust this value for the desired update rate
}
```

//sample code for functional right left motion  
attained with help from Chat GPT and Arduino  
website

(all code in figure at top of document)

- [ChatGPT \(openai.com\)](https://chatgpt.com)
- [Mouse.move\(\) - Arduino Reference](#)



//image of our circuit used to test codes

### **Future Prototype Testing:**

The future testing of our prototypes includes combining the directional movement code with the left/right click and drag functionality code. We then must wire these components together so the code can be tested. Once this has been completed, a permanent prototype must be completed. As stated previously, we will need to carefully solder wire connections of the non-permanent, (breadboard), solution to make them permanent. This circuit can then be tested with the code. This will be used in our final design. A shell for the Arduino and wired components must also be created to put everything together for the final design. Once this is completed our final design will be tested.

### **Target Specifications:**

<b>Client Needs</b>	<b>Priority level</b>	<b>Opti-click</b>
<b>The mouse is directionally controllable</b>	<b>5</b>	5
<b>The mouse is quick to move along the screen</b>	<b>2</b>	5
<b>The mouse moves the cursor accurately</b>	<b>2</b>	3
<b>The mouse can select items (left click)</b>	<b>5</b>	Yes (1)
<b>It can drag selected items</b>	<b>4</b>	Yes (1)
<b>The mouse can open context menus (right click)</b>	<b>4</b>	Yes (1)
<b>The dimensions fit within a wheelchair tray</b>	<b>3</b>	N/A
<b>The control layout is simple to operate</b>	<b>4</b>	N/A
<b>Total Score</b>		54

Our prototype has surpassed our expectations from our target specifications and has resulted in reaching or surpassing all functional requirements.

### **Next Client Meeting**

The next time we meet with our client will be on Design Day, so we intend to have a fully functional, high-quality prototype to give our client. This prototype will include the functional code, the permanent, soldered wire connections, a casing/shell to contain wiring and large buttons that our client can use. The prototype will be easy to use, (plug and play), and our client will be able to use it on a day-to-day basis.

### **6.3 Project plan update**

<https://www.wrike.com/workspace.htm?acc=4975842#/folder/1214255598/timeline3?viewId=202>

[136040](#)

## **7 Other Considerations**

### **7.1 Economics report**

### **7.2 Intellectual property report**

### **7.3 Project plan update**

Add your write snapshot link. Don't forget to include assignees.

## **8 Design Day Pitch and Final Prototype Evaluation**

Write your design day pitch and plan your prototype demo.

## **9 Video and User Manual**

### **9.1 Video pitch**

Add link to video.

### **9.2 User manual**

See separate template for the user manual.

## **10 Conclusions**

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

## **11 Bibliography**

Insert your list of references here.