University of Central Florida

College of Engineering and Computer Science

EEL 4914
Senior Design 1

Programmable Trackpad
Divide & Conquer, Version 2.0

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1 Project Description

1.1 Motivation

On the market today, there exists a subset of a common computer peripheral meant to boost a basic end-user's productivity. This product is the programmable mouse. The concept is simple; it is a computer mouse that contains several extra buttons that the user can map to any shortcut or command which he/she chooses. The added convenience of these extra buttons means that a user can save valuable time when performing common, repetitive tasks.

Currently, this type of device only exists for the mouse, but not for the trackpad which has millions of users every day. This is where our project comes in. Our purpose in creating the Programmable Trackpad is to bring this type of technology to the trackpad, for users who prefer to use a trackpad over a mouse. Our trackpad will contain a suite of macro keys and rotary encoders, all of which end users can program themselves. With these, trackpad users will be granted the same convenience and functionality as programmable mouse users in a compact and ergonomic package. This device is intended to completely replace the default trackpad on a traditional laptop.

1.2 Goals and Objectives

The major goal of this project is to take a task from people's daily use of their PCs and attempt to create an overall convenience and improved efficiency in their work. Whether they use their computer for personal or work use, this project strives to reduce the steps taken in repetitive and common tasks done on the computer. The project aims to create an external trackpad device that exists outside of the computer that is compact and portable, yet also purposeful and meaningful in its functionality.

To reach the goals of this project, there are certain objectives that need to be met based on specific design choices in hardware and software. The following table lays out the general goals that will guide our team's design process, as well as the specific objectives that we intend to accomplish as a means to reach each goal.

Table 1: Goals and Objectives

Goal	**Objective** (how we plan to achieve said goal)
Reduce common and repetitive tasks	Add buttons with macro key capabilities that are programmable.
Convenient and Ergonomic	● Cordless with Bluetooth capability. ● Ambidextrous ● Feet at bottom of device, propping it off the surface
Low Learning Curve	Application with user-friendly interface to program macro keys.
Customizable for user	Ability to easily remove keys to the user's liking

1.3 Function

Table 2: Functions

Function	Description
4 Mechanical Keys	Capable of macro and keybind function
3 Rotary Encoders	Capable of audio mixer, adjusting windows, etc. functions, (per-application functionality)
USB Connection	For charging the bluetooth battery or having a wired connection
Bluetooth Connection	Main connection for using the device
Touchpad/Trackpad	Mouse replacement offering ergonomics
4 Buttons under the trackpad	Availability changes based on dominant hand usage

1.4 Stretch Goals

At this early stage of the project, we have set manageable goals for the basic operation of the Programmable Trackpad. However, with the permission of time and resources, there are several features that could improve our project. The following is a general list of goals that our team is interested in implementing after the product's basic functionality is established.

Table 3: Stretch Goals

Goal	Explanation
On-board memory	The current model requires software on the user's PC to store macro functions for re-use. This could be avoided with memory on the device itself.
Accelerometer	To accommodate left and right-handed users, the trackpad can be rotated 180 degrees. The current model allows for this change to be made using software on the user's PC. This could be automated with orientation tracking on the device itself.
Mac support	The Programmable Trackpad will work for Windows devices. Ideally, there would be software to allow it to work on Mac devices, as well.
LCD Touch Screen	An LCD screen built into the device could open new possibilities for immediate feedback for the user, as well as additional macro controls.

1.5 Market Analysis

Millions of PC users use trackpads every day, largely due to their standard presence in laptop computer design. Many consumers who use laptop computers at stationary desks, however, still prefer to use their trackpads over the traditional mouse. Mac users, in particular, commonly prefer trackpads to mice. This trend is due to the prevalence of Apple's Magic Trackpad, a relatively high-end external trackpad. It is safe to conclude that there is a market for external trackpads among Mac users, and there would likely be a similar market among Windows users if more convenient options were commonly available.

As mentioned previously in this document, the programmable mouse is the market standard solution to the goals prescribed in our project. The following table shows a few popular options currently available. Each of these mice interfaces with a PC application to program the various buttons on the device.

Table 4: Programmable Mice on the Market

Name	Image	Price
Logitech MX Master[1]		$99.99
Razer Deathadder v2[2]		$69.99
Microsoft Surface Precision Mouse[3]		$99.99

A broad description of the market niche we intend to fulfill is the market for any peripheral trackpad device that interfaces with PC software to facilitate custom button inputs. The following is a list of the devices currently on the market that are most comparable to our own.

Table 5: Comparable Trackpads on the Market

Name	Image	Price	Similarities to our design	Differences from our design
Apple Magic Trackpad[4]		$129.99	Fits conveniently on a desk.	No physical customizable buttons.
Mousetrapper Advance 2.0[5]		$200-$300 (Not currently available for purchase from manufacturer)	Fully programmable physical buttons, ergonomic.	Too large to be comparable to a mouse, wired only.
Keymecher MANO-703UB[6]		$39.99	Includes macro buttons, fits conveniently on a desk.	Macro buttons are hard-coded for specific purposes (not customizable).

While there exist many comparable products, there is no single device that meets all of the goals for our project currently on the market.

2 Requirement Specifications

2.1 Requirements

The requirements for this project should highlight the system's technical needs, which will determine our estimated budget for the overall design. The specifications we are aiming to achieve support our aforementioned goals of convenience, flexibility, and programmability.

Table 6: Requirements and Specifications

Requirement	Justification
Device dimensions 5" x 5" x 2"	Device should be portable and have a small form factor accentuating ergonomic qualities
Device weight should be ≤ 1 lb	Device should be light and portable
Device trackpad latency ≤ 48 ms	Device should have a low latency for an accurate and precise experience for the user
Hot-swappable switches	User customization
4 mechanical switch inserts	Optimal amount of macro keys to provide efficiency
3 rotary encoders	User should be able to control audio and customize sliders based on programmability
USB connection	User should have a usable connection when bluetooth doesn't work
Bluetooth connection	User should be able to have wireless connection for ease of use and less cable clutter
Battery lifetime should be ≥ 10 hours of average usage	User should be able to use the device during a full day of wireless utilization without having to plug it in or charging

2.2 Constraints/Standards

The constraints and standards highlight the implied limitations caused by budget, environment, or market standards.

Table 7: Constraints/Standards

Constraint/Standard	Reasoning
USB-C	Standard in the tech industry due to its fast transfer speeds and power efficiency
Bluetooth 5.0-5.3	Low bandwidth, reliable and fast speeds over air
… ≤ 400 for development budget	Due to limited budgeting of the group, we must keep the development budget low for the whole project
Total budget for the project should not exceed $1000	We wanted the device to be budget friendly while also have the development of the project be efficient and cost effective based on other market items

2.3 House of Quality

The following diagram is a house of quality, a graphic representation of the various requirements of our design and how each one interacts with each other. Plus signs represent positive correlation between quantities; minus signs represent negative correlation. Each column represents a requirement of the design process; each row represents a consumer requirement.

Figure 1: House of Quality

3 Block Diagrams

3.1 Prototype Illustration

The following figures are the illustrations coming up to the final design, each representing what we wanted in the final render. With the goals and objectives we had in mind, we wanted a sleek, almost minimal design while offering everything a user would need in an all-in-one convenient peripheral.

Figure 2: Preliminary prototype designs

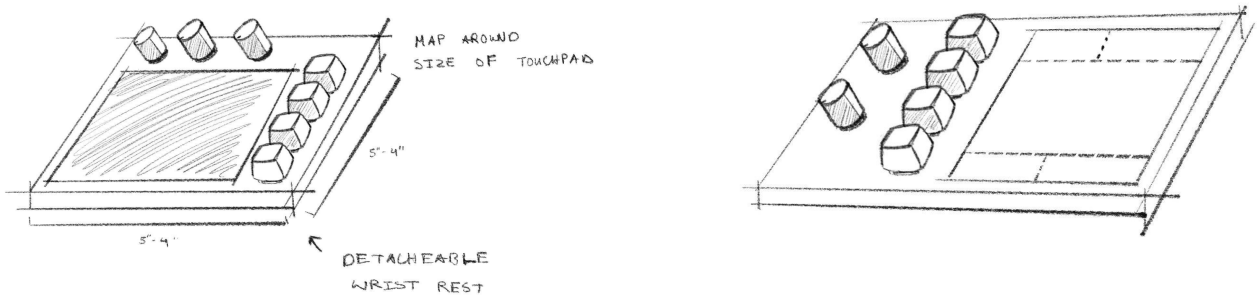


Figure 3: Initial blueprint of prototype design

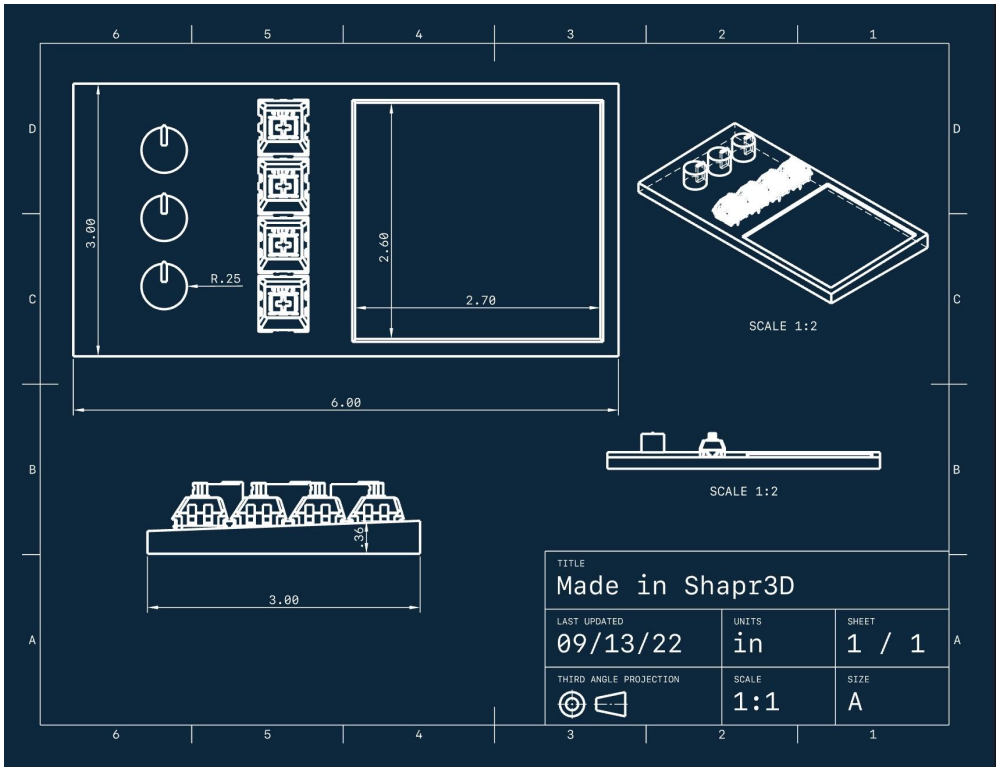
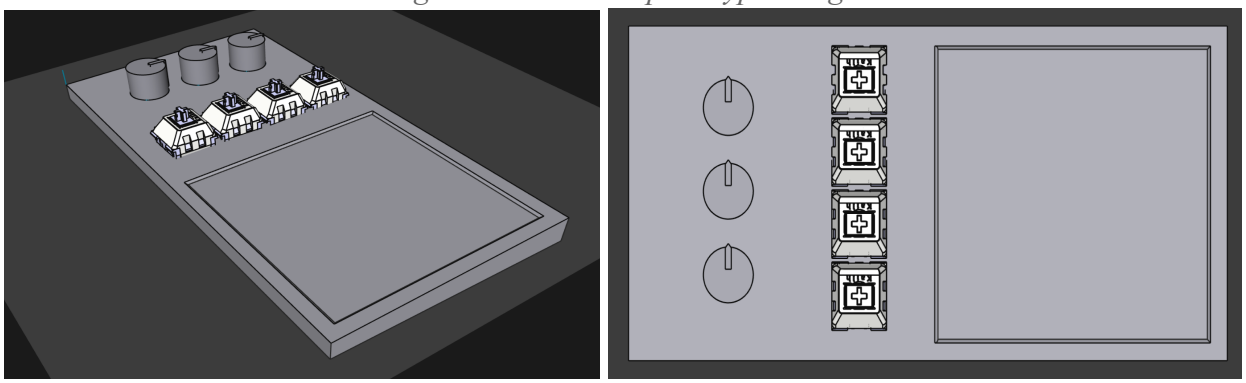


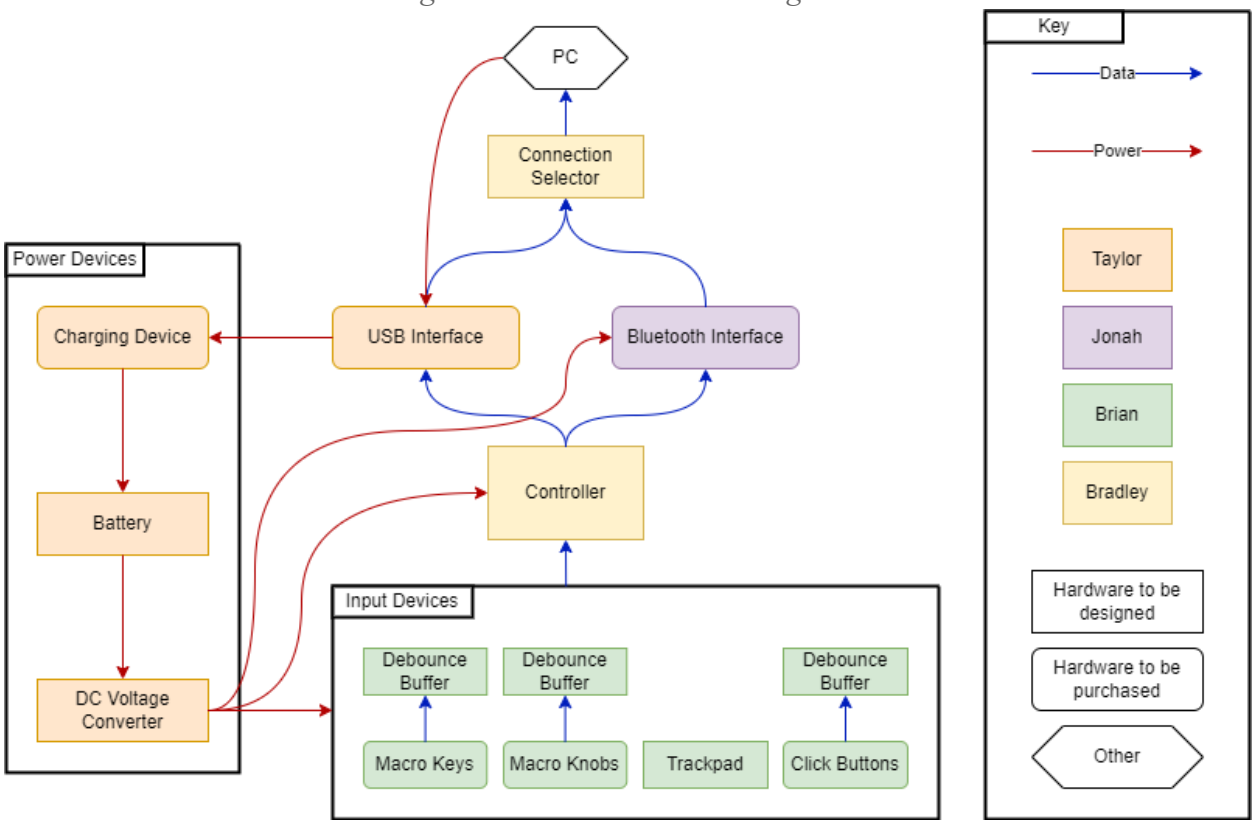
Figure 4: Initial 3D prototype design



3.2 Hardware Block Diagram

The following figure models the hardware device in subsystems. The power subsystem provides regulated power to the entire system and also manages the battery's recharging. The input subsystem is comprised of the sensors with which the user interacts. The miscellaneous hardware blocks represent the basic computing and communication functions that the device will need in order to work as a whole. Each block is color-coded based on the team member responsible for research and development of that piece of hardware. Each arrow is color-coded to indicate whether the block is transmitting data or delivering power.

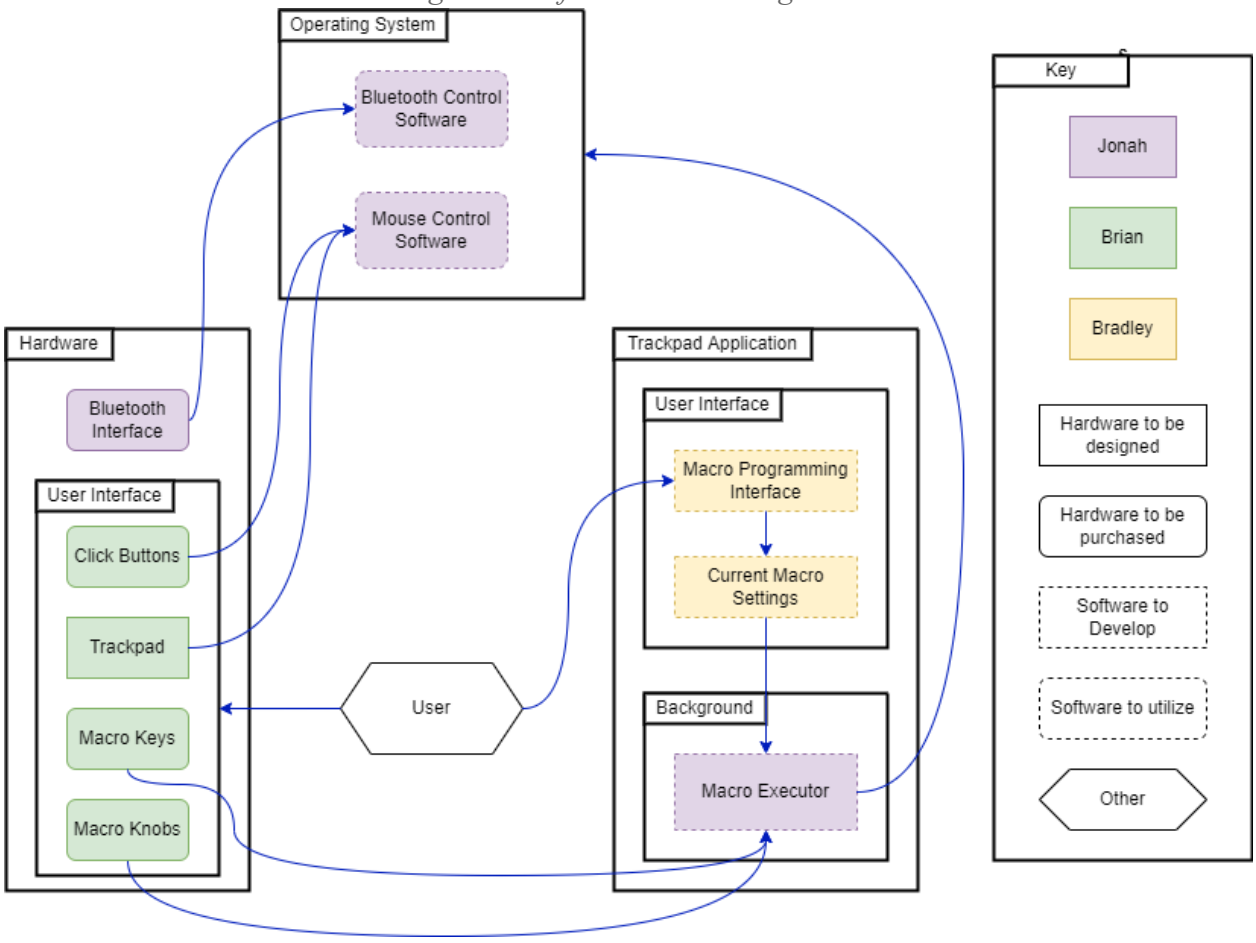
Figure 5: Hardware Block Diagram



3.3 Software Block Diagram

The following figure models the project's software functionality in subsystems. The trackpad functionality of the device communicates directly with the connected PC's operating system. However, the macro keys and knobs communicate indirectly through an application that our team will develop.

Figure 6: Software Block Diagram



4 Finance Information

4.1 Finance

This project is not sponsored and is not receiving any other source of outside funding. All funding for this project will be put forth by the 4 members of this team equally. As of now, we estimate that the total cost of gathering all the necessary materials will be between $200 - $300. Being that we are still in the design phase, our final total cost will fluctuate, but our goal is to keep the final amount of money spent under $200. The table below represents a working list of parts that we are anticipating we will need. As our team brainstorms and refines our ideas, this list will most likely change. The most accurate version of this materials list will be present in future documents. Below is a detailed breakdown of our parts list.

Table 8: Estimated Finances

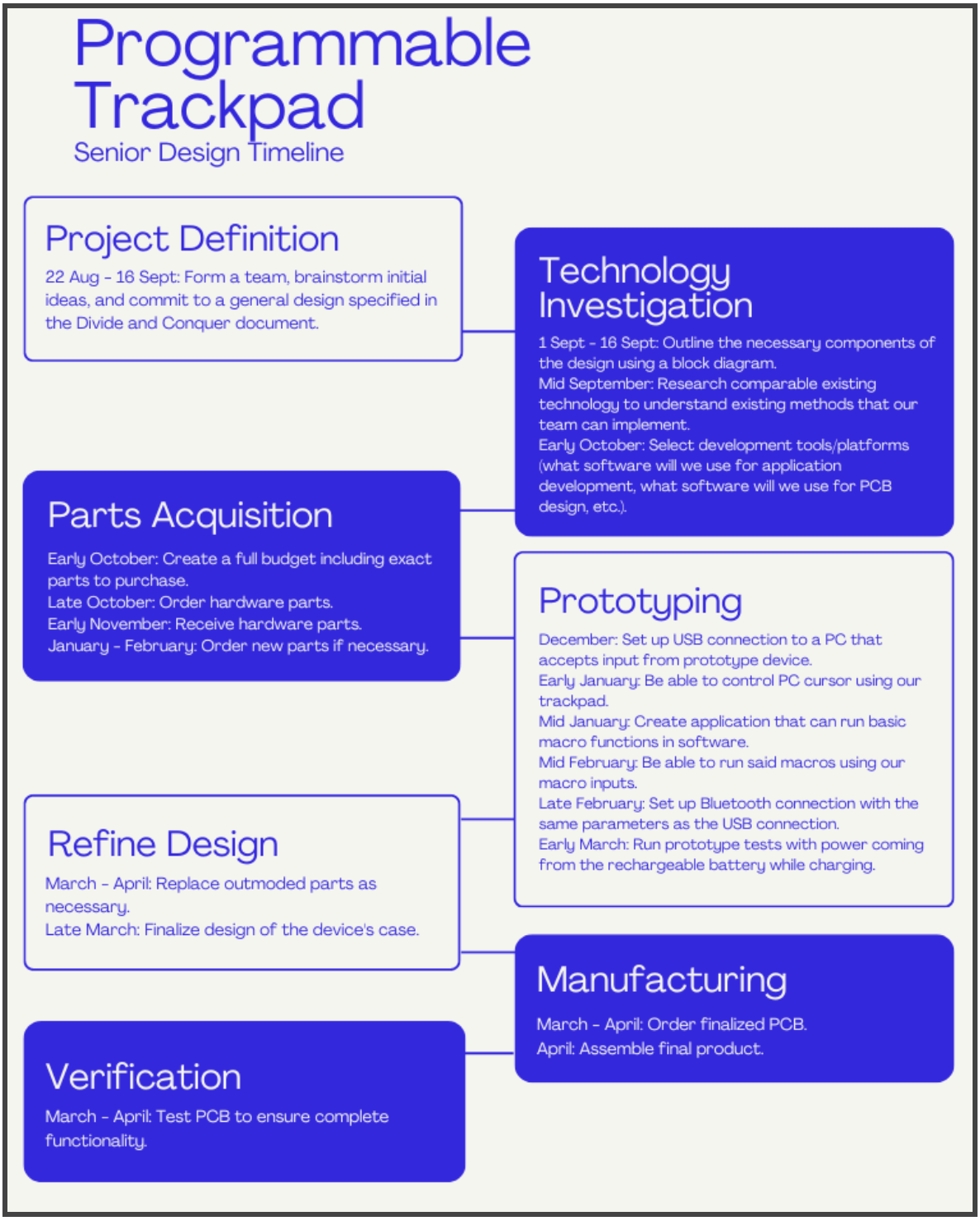
Development Costs		
Item	Price	Quantity
Development Board (Prototyping)	~$20	1
Touch Display	~$25	1
Estimated Shipping Costs	~$35	-
Supplemental Funds	~$60	-
Bill of Materials		
Item	Price	Quantity
Mechanical Switch	~$7 (10-pack)	4
Rotary Encoder w/ Button	~$4	2
Battery	~$13	1
USB Type-C Port	~$2	1
Bluetooth LE Module	~$2	1
PCB	~$30 - $50	1
Physical Housing	~$20 - $30	1
Total Cost	**$252**	-

As of right now, our total cost is estimated to be $252. Among the four of us, that comes out to $63 per person. This price point is a worst case scenario where our costs for the PCB and physical housing reach the upper bound of $50 and $30 respectively. This price point also assumes we use all $60 of our supplemental funds, which is to be used for unforeseen costs that arise during development. These costs could arise from broken/incompatible parts, or from having to source and purchase alternate parts.

5 Project Timeline

The following figure is an outline of the steps our team will take to complete this project. Estimates of dates are given in order to track progress up to the project's conclusion.

Figure 7: Project Timeline



6 Bibliography

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