Exploring a Mouse Replacement for use in Racing Video Games

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***Abstract*—Standard PC gaming controls do not provide enough accuracy for use in Racing Games. The Racing Game market is large and contains many users who desire better controls, but don't want to purchase a Racing Wheel. Our team enjoys Racing Games, but find that Racing Wheels take up too much space and take too long to set up. Our team has created a new style of controller which combines the footprint of a mouse with the precision and immersion of a wheel.**

***Index Terms*—Games, User interfaces, Human-Computer interaction, entertainment**

I. Introduction

The basic control scheme on PC of a mouse and keyboard does not afford users the necessary precision that is needed to play racing games. Unlike console controllers, with 6 axes of analog control, most PC players only have analog control with mouse movement, giving them 2 axes. A racing controller optimally has analog controls for Steering, Acceleration, and Braking.

The main way of solving this problem is using an alternative input device, such as a gamepad or a Racing Wheel

Racing wheels offer users the ability to create an immersive simulation of driving vehicles. Currently most racing wheels are large, taking up large volumes of space and feature lengthy set up times.

This can make it difficult for users to transport the racing wheel with them, as well as use it in a space on the go. The lengthy set up time can discourage users from using the racing wheel even in their home space and decreases its portability even furthur hindering the options users have when it comes to using the device.

Alternatively the gamepad is convenient and portable, but it is not optimized towards the racing experience. This option can suffer from a lack of precision in steering controls if the game is not tuned for thumbsticks. It is also not easy to use the keyboard at the same time as a gamepad, which is not optimal for PC players used to such an experience.

To make the racing wheel more portable we propose the creation of a one-handed variation of the racing wheel that is much smaller whilst still offering most of if not all features present on an industry standard racing wheel. The smaller size of this variation will allow for a much more portable alternative that takes up little space and very little time to set up. This will additionally allow the player use of their keyboard in their other hand.

II. Literature Review

Our research has provided us with a lot of information on how racing games are interacted with and experienced. Our findings indicate that the player's enjoyment of a racing game is very dependent on which input device they use [1]. To us, this stressed that the use of our device could result in new types of players finding enjoyment in racing games. Additionally, we discovered that users themselves consider their input device very important to how they interact with their games [2]. The way that a player interacts with an input device is also very personal [2], so we consider putting our device into the world valuable. Hopefully, we are able to find people who find that our device suits their exact needs. We discovered that players, while they performed best with controllers, actually had a better sense of flow when using a wheel [3]. We aim to capture elements of both devices and combine high performance with a high sense of immersion. A positive relation between perceived enjoyment and perceived success is strangely absent [3]. It's a refreshing take on games that the most enjoyment comes simply from the experience of how things feel. Perhaps players understood that they could get better the more they played. New input devices can be a very exciting prospect.

III. Methods

See Appendix A

A. *Identify Need*

Our first step in making the product is always to identify needs. Our core needs were originally simply having sensors for acceleration, braking, and steering, but as the project developed we found needs for feel and ergonomics as well.

B. *Brainstorm Solutions*

At this point we would create as many solutions as possible for our need. For the steering control we had come up with using a gyroscope, a potentiometer with bearings, and even using two ultrasonic distance sensors in the pedestal. In the end we selected the inverted joystick design we use now.

C. Digitally Prototype Best Solution

During this phase, we model our modifications in Fusion 360 using models of our parts. We also experiment and research the various ways to make this function in code. By the end of this phase we aim to at least be able to theoretically read serial values in the Arduino IDE, assuming the need involves electronics.

D. 3D Print New Design

In this phase, we 3D print our new design. We are fortunate enough to have access to a 3D printer full time, so we were able to prototype rapidly. For the top housing of our mouse alone we printed at least six versions.

E. Test and Review

Finally, we test our newly printed part or newly implemented sensor and make sure that it works as intended. This prototype is shown to as many of our peers as possible to gain feedback for when we continue into the next iteration of the cycle.

IV. Results

We have 61 versions total of our device with see Appendix B being notable. Our earliest, version 4 of the device, featured the initial construction of the top housing for our mouse. By version 10 we had completed the bottom housing as well as the mouse buttons that would fit into the top housing. Versions 12 was where the top housing was completed, with the addition of both a hole featured at the front for the wires as well as a hole through the side to mount the mouse buttons. In addition, version 12 also featured a more finalized version of the mouse buttons which were made longer as well as rounded in order to facilitate rotation when in the housing. Version 14 features no changes to the mouse housing overall however, it should be noted that it features the addition of a new piece created in order to affix the mouse buttons to the top housing. By version 17 We began working on the podium component for the mouse; this would support the players hand as they tilted the mouse left and right to steer. Version 50 features the addition of the snap fit joints that are used to hold the mouse housing together as well as notches to aid in facilitating the pieces fitting. Version 56 is close to our completed build that features altered snap fit joints that are now present at both the front and back of the mouse to make the connection much more sturdy. It should also be noted that version 56 also features rotated notches to help guide the pieces. In addition to all the previous changes, the top component of the housing features a curve on the inside for the snap fit joints. Lastly, We have version 61 which is the final build of our racing mouse which has minimal changes, Some of the most prominent changes in this version are the lengthening of the mouse buttons as well as the lowering of the front mouse face to prevent fingers from getting caught on the edges of previous versions.

In addition to our version iterations we also conducted both a QFD as well as SUS evaluation on our product, See Appendix C. On the SUS evaluation we scored an 85, an excellent score. We were able to locate certain elements of the product that could still be improved by locating the disparities in the data particularly in Question 5 and Question 8. We were also able to receive feedback from our QFD test as well as locate the needs of our end user, See Appendix D. One of the biggest issues that we noted from our customer needs that we were lacking in contrast to our competitors was that our device did not grip the surfaces it was placed on.

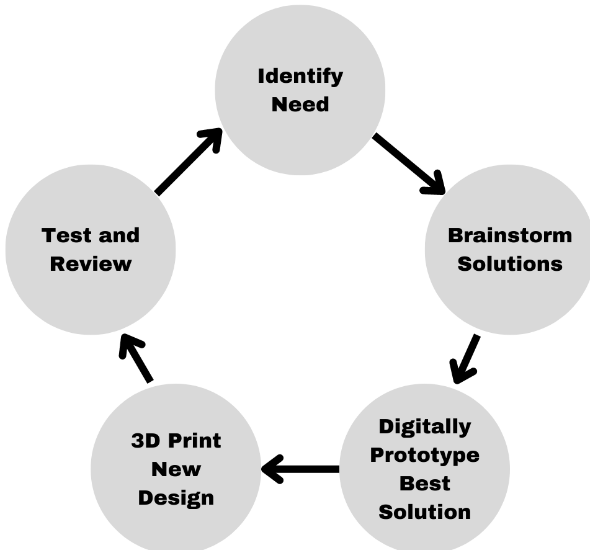
V. Takeaways

One of the biggest elements that we learned from the process of creating our device was the importance of having a physical prototype when it comes to the design, prototyping, and assessment procedures. Because a team member had their own private 3d printer we were able to get our hands on physical components much quicker. The benefits of this are that we were not only able to see what our designs would look like in their current state of the creation process, but it also allowed us to hand the prototype components to our end users and get their feedback as we progressed through each stage of the prototypes construction. In addition to this we were also able to ourselves evaluate the designs in its final form and learn what elements meet our functional needs as well as our functional requirements. However, we also learned the importance of viewing the final product as a whole on top of individual components. Because we experienced some technical difficulties we were not able to acquire feedback on the device when it was fully assembled. When the device was fully assembled we were unable to accurately identify problems prior to submission so that we could fix them before it was demonstrated to our end users. Another element we learned was the importance of visualizing feedback on components. Not only is verbal feedback good, but the usage of the QFD as well as the SUS allowed us to more easily evaluate our device at varying stages of development. It's because of the QFD that we were able to see if our idea had any validity, but also if it was possible to meet the customers needs without sacrificing other elements of the device. On top of this, the SUS allowed us to evaluate the product based off the changes we made from the QFD to see if the designs we came up with were effective.

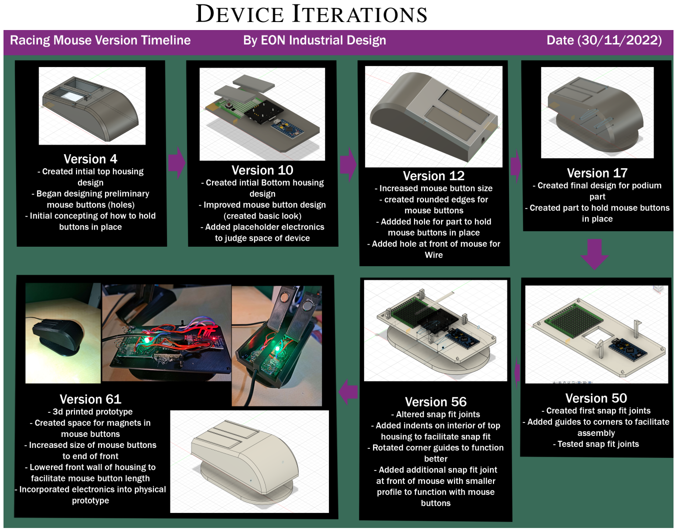
VI. Conclusion

Over the course of this problem we were able to gather valuable information to guide our project. Our initial vision was strong enough that we were able make minimal major scope changes over the course of the term. The usage of multiple physical prototypes in conjunction with data visualization tools allowed us to create a design that end users felt was effective in its task whilst also resolving our initial problem assessment that was created at the start of this project. In the end, we believe we have created a controller with a genuinely effective real world use case.

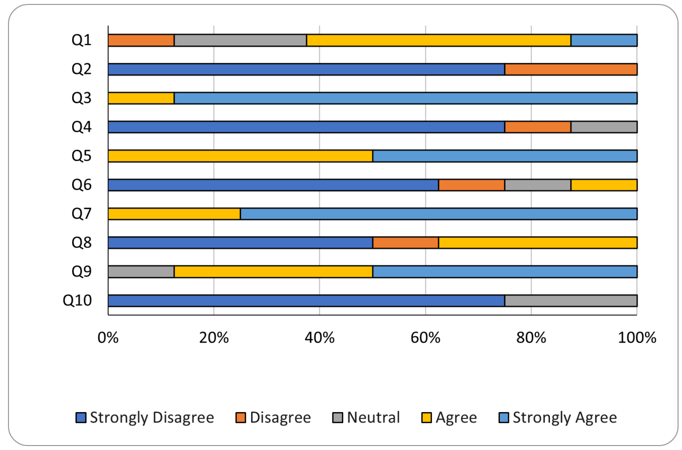
Appendix A
Method Flowchart



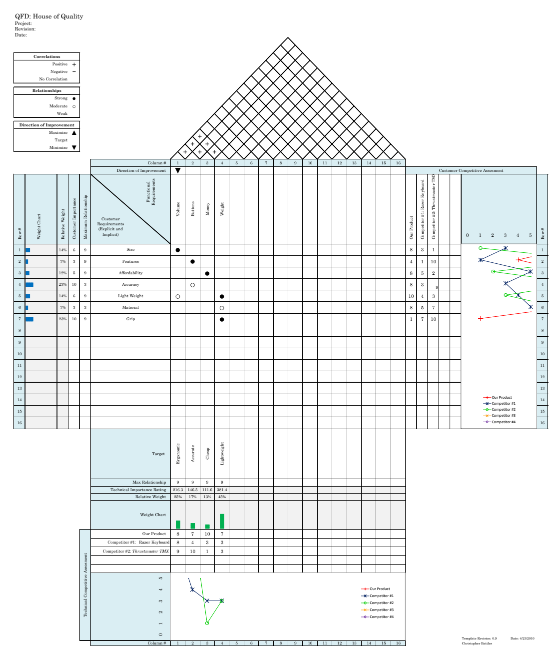
Appendix B
Device Iterations



Appendix C
SUS Evaluation



Appendix D
QFD Evaluation



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