PC Gaming Made Easy For One-Handed Gamers: The 9 Mouse (Course Project)

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Frederic Lai
Game Development and Entrepreneurship
Ontario Tech University
2000 Simcoe St N,
Oshawa, ON L1G 0C5
Student Number: 100748388
Email: frederic.lai@ontariotechu.net

James Pham
Game Development and Entrepreneurship
Ontario Tech University
2000 Simcoe St N,
Oshawa, ON L1G 0C5
Student Number: 100741773
Email: james.pham2@ontariotechu.net

***Abstract*—The problem that the 9 Mouse tries to solve is, that one-handed gamers on PC tend to use a plethora of accessories and peripherals in order to have enough reachable inputs for them to play games. The market for this is niche but we believe that our product will appeal to not only one-handed gamers but also other gamers that could utilize more inputs on their gaming mice especially an analog stick that can function as multiple inputs. The motivations in creating the 9 Mouse are the fact that accessibility becomes more and more prevalent. Creating a product with accessibility in mind and also functioning as a product that regular people can still utilize can appeal to multiple groups of people. The outcome of the 9 Mouse is that we experienced scope creep and greatly reduced the promised inputs to meet deadlines. But further iterations will definitely address these problems.**

Keywords—One handed, 9 Mouse, inputs, analog stick

I. Introduction

Although it is more niche as only 3% of the United States amputee population are people with an upper limb loss (VII-F), the 9 Mouse (see **Fig. 8**) aims for a niche gamer group of people that game with one hand for PC, our product could also be used by regular gamers who could utilize additional inputs. A website written by Robbie MacGillivray (VII-A), is a one-handed gamer. On his website he showcases the peripherals and software that he uses to game. There's a plethora of peripherals like racing pedals and stream decks with custom programmable buttons as well as software for voice commands, all just to perform the same tasks that other gamers do on the regular. The goal of 9 Mouse is to condense all those extra inputs into a comfortable device with usability being one of our priorities. The solution to condensing a large amount of inputs like movement, is to utilize an analog stick. We will have a vast amount of inputs through buttons and an analog stick as well as key-switches as alternatives for left/right click for a great feel and also less travel time, we not only provide comfort but also a great feeling product that can also alleviate additional costs for additional peripherals for the one-handed gamers. This document will go through some product comparisons between our 9 Mouse and other similar peripherals on the market, sources that support our problem and justify why we are making what we are making, how our product came to be through the numerous iterations the 9 Mouse has gone through, results of surveys and questionnaires that affected our product, and lastly, what we got out of everything and how the 9 Mouse ended up where it is as well as things we as the designers could have done better.

II. Literature Review

In this section there will be an analysis of a couple of scholarly sources as well as an competitor analysis of two potential competitors. One of the sources we will be discussing here will be the people we are targeting with the 9 Mouse while the other source will be an analysis on controllers in general and basically identify the strengths/weaknesses of each, which we can utilize to maximize the usability as well as comfort of the 9 Mouse. The two main competitions the 9 Mouse will face is the ROG Chakram as well as the Vertical mouse with a joystick that can be found on amazon.

An article by Diane W. Braza MD, and Jennifer N. Yacub Martin MD, discusses the statistics of amputations of upper body limbs (VII-F). While it is significantly less frequent than lower limb losses, with the statistics of upper limb losses being 3% of the United States' amputation population, which is around 41,000 people, we believe that just because that there are a lot less people who truly need our product does not mean that they should be ignored. Obviously it would not be realistic to create a product for an extremely niche market which is why our product, the 9 Mouse, is simply a PC gaming peripheral that has many inputs with one-handed use capabilities. The idea is that we can appeal to those who need to use our mouse with one hand no matter what the circumstance is or it can appeal to those that just want more inputs on a mouse.

A paper written by Kathrin M. Gerling, Matthias Klauser, and Joerg Niesenhaus, is about measuring the impact of game controllers on player experience in FPS games. The relevancy of this paper lies in the fact that they're talking about FPS games specifically which is the game genre our product is mainly geared towards, although it can be used for other games. The controllers that are mentioned in this study include, Wii remotes, Xbox 360 controllers, and Computer mice. With the precision of a mouse out performing the other two in terms of aiming, it is fair to say that our direction of choosing a mouse as the aiming portion of a FPS game works since our goal is to be able to play an FPS game with one-hand without sacrificing too much precision. While the method of aiming differs in each of these controllers in their respective platform, every one of these with the exception of the computer mouse, utilize an analog stick for movement. Although movement with a keyboard could arguably be better, it's unrealistic or it offers too big of a learning curve for a player to master WASD movement with only their thumbs (if we were to put "WASD" movement on the side of a mouse). Instead we opted to use an analog stick on the side of our mouse to act as movement for the player thus removing the need for a keyboard. With both movement and aiming all on one hand, just adding a few more inputs on the mouse should be enough to fully replace the need to use a keyboard.

The Asus ROG Chakram and the Vertical Mouse with a Joystick made by Zelotes, seem to be our main competition. The reason why either of these PC gaming mice can be considered competitors is mainly because both of them have an analog stick but at the same time neither of them claim to be a one-handed mouse but rather they have it marketed as an analog stick that just functions as additional inputs. Compared to the ROG Chakram which has a more traditional mouse body (see **Fig. 1**), what is lacking about this product is the fact that it uses a circle pad type of analog stick, something you would find on a Nintendo 3DS. The inputs for movement is not impossible on a circle pad but an actual joystick would definitely provide much better accuracy, and usability is one of our main priorities. With reviews of the ROG Chakram being relatively low as well we think we can definitely beat this competitor. On the other hand, there is the Zelotes vertical mouse (see **Fig. 2**), this mouse has a joystick, but the problem lies with the learning curve of using a vertical mouse and many gamers would prefer a regular mouse body for gaming evident from our survey (see **Fig. 3**).

III. Methods

Our 9 Mouse prototype has been through a number of iterations (see **Fig. 4**. Beginning with the original concept (see **Fig. 5**), we wanted more inputs as well as more actuators to meet requirements, more inputs to make us distinct and also because our product could use more inputs. After figuring out what we needed to make, we went on to create our first prototype (see **Fig. 6**). Our first prototype did not make it to the class where we had peers answer surveys because it was printed too thin and fragile also the joystick was sticking out with no supports, which led to the second prototype (see **Fig. 7**). The main takeaway we got from the first prototype is the lack of support for the joystick which led to us making the case thicker so it does not break on print and also wider to hold the joystick. The problems with this prototype is that it is not ergonomic and reaching the joystick is awkward, the inside of the model also was measured wrong so the Arduino did not fit in it's slot, also the little hole for the joystick did not allow for a full range of motion. The third and final prototype (see **Fig. 8**) is where we finally realized that our scope was way too large and there was no way we can do everything and fit everything together in the time frame we were given. On this iteration we cut down on the amount of inputs simply because the case could not fit them all, the joystick stuck out again but this time the reason being that the wide case iteration just was not comfortable, and some core components of a mouse were not functional. The mouse sensor was something that we could not figure out how to work, the mouse scroll wheel when moved for some reason disconnected the Arduino from the computer altogether, and the joystick we had outputting values in the logs but we could not get it to do anything in the scene. We ran into tons of problems at the last minute leading to a relatively unfinished assembly. Originally we had our final iteration being printed relatively early on, with the print failing and with a long queue forcing us to print relatively close to the deadline. We managed to get the bottom piece printed (see **Fig. 9**), while the top piece (see **Fig. 10**) remained unfinished and half printed because filament ran out. Our final assembly had the top piece made out of cardboard (see **Fig. 11**). Though aesthetically unfinished, we got some of the components working, with left and right clicks functioning properly, and LEDs and vibration motors activating on key presses. The joystick itself did not function with the scene but it outputted values in the logs, and the joystick button functioned.

IV. Results

Our timeline (see **Fig. 12**) shows the start where we had a finalized concept of what we want our product to look like with where the buttons could be. The second part shows the circuitry done in tinker cad that's missing a number of components like scroll wheels and more buttons, also missing the actuators. We also created a paper prototype at this point in time to better visualize the shape and button placement. The next part shows our first fusion 360 design of our product which had plenty of flaws like how the design is too thin and broke during the print but based off of feedback from the first assignment we tries to make our product more unique with key switches instead of regular mouse buttons and additional inputs. The fourth part of the timeline shows our second fusion 360 design that had a wider body to hold the joystick and the print was more solid this time allowing it to print without breaking. Next part of the timeline shows the finalized tinker cad circuitry with everything labelled properly and all the components we used. Sixth part of the timeline shows our third and final iteration for this course with the scope greatly reduced to meet deadlines also we made some changes in reducing the width of the case since the second iteration is too wide and awkward to hold. The bottom piece is printed properly as you could see on the next part but the top piece ran out of filament and is incomplete. Due to the printing queue we could not reprint and finish the top piece so we made the top out of cardboard. Next we have the physical wiring based off of the tinker cad, at this point we had to figure out how to wire components like mouse encoders and joysticks properly as there were placeholders in the simulation, we also had to learn how to solder properly which was somewhat a learning curve as the solder refused to stay on the wires but later down the line we learned to heat the wire first. Lastly we have the final assembled prototype that looks a bit rough since the top piece couldn't be finished but it's functional with the exception of the missing optical sensor and the scroll wheel that disconnects when used, also the joystick that technically is connected and outputs strings but since we don't know how to convert it to integers those values are useless and can't be read in unity.

Moving on to the QFDs (see **Fig. 13** **Fig. 14**) some results we got from these is that there were a number of factors or aspects of the product that just didn't really matter to people. How lightweight the product is, the compactness, the number of inputs, and whether or not it's one-handed, all did not matter to the people we surveyed, granted nobody we asked was someone who games one-handed on the regular which is an error on our part as we should have sought out people who better fit our target market to survey. These results also helped us compare ourselves to competitors and we had to improve our compactness to match competitors as compactness was not that as important but the survey showed that there is some level of importance and we were behind our competitors in that aspect. The bottom part of the QFD is how we compare ourselves to our competitors and we think that we can be better than our competitors based off of the targets we set, although some of them like lifespan and materials aren't something we can control until we get to the manufacturing process which is not within the scope of this course.

The System Usability Scale (SUS) (see **Fig. 15**) also provided us with plenty of information. Our SUS score is a 60% which is below the average of 68% but we think with the corners we had to cut to make this project meet the deadline it makes sense that our SUS score is lower, also when we were doing surveys our parts were not printed properly and thus an accurate assessment is difficult as we were being judged simply based off of our fusion 360 model. Some results we agree with like the unnecessarily complex part and how the functions were not well integrated at the time.

V. Takeaways

There were tons of things that we've learned throughout this journey in creating the 9 Mouse. The paper prototype (see **Fig. 16**) did little to nothing for us besides having an idea of where components could be placed potentially, perhaps a better prototype would be to use blender to have a higher fidelity idea of what our product could look like. During the designing process of the first prototype we briefly did a stress test on whether or not first iteration can survive regular use, but that iteration's print broke during the print process before it could even be used. We lacked experience in both 3D printing and designing prints so we had no idea what to expect with 3D printing. The components placements were also relatively close to each other so not accounting for the space we need for wiring made it a hassle to figure out later down the line. There were also lots of other factors that we had not considered, like the force of someone pressing the buttons could cause the components to move, especially the joystick button where it required a little more force to press could break the entire device's case if it was made too thin. The second iteration we took what we learned from the first prototype, but the issues we learned from this prototype is that we have to consider the shape and size of the case. There was no way we could fit everything in with wiring, the design was too snug and there just was no margin of error, and also the bottom piece was too thin and there was no way to attach to the top piece without glue. The final prototype is probably where we learned the most, and realized that we needed so much more planning. We definitely did not have time to figure out how to get everything to work even after wiring them like the optical sensor and scroll wheel, and with the size of the case and Arduino there was no room leading us to cut down on inputs. The side buttons were removed because we had not considered how to allow players to press them without them moving. The joystick stuck out since the other iteration was simply too awkward to use. This entire process we acquired many skills like soldering, Fusion 360 designing, wiring, etc. Neither of us had any experience in any of this so learning from scratch was definitely a difficult process but rewarding nonetheless.

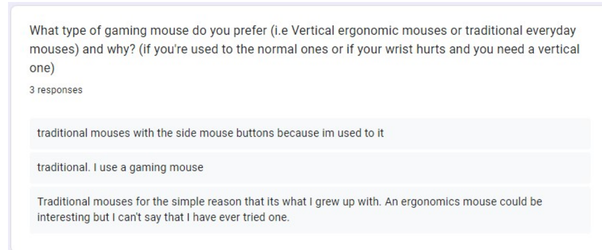
There was lots to learn from the assessment procedures as well, with our peers giving us useful feedback and changing what we thought should be priorities and what really is not important. Although it might seem unrealistic but ideally we should have tried to get some feedback from the group of players we're targeting as some of the feedback we got from our surveys were irrelevant, namely this question where we asked whether they would rebind the joystick as inputs or utilize it for movement (see **Fig. 17**), the results we got did not matter here as nobody we asked would actually NEED a one-handed product. When we actually had to differentiate ourselves from our competitors we also realized that we were not that different at the beginning when all we had was the paper prototype, which led to the key switches and weird inputs on the first iteration.

The things that we would do differently, first and foremost would definitely be more planning and research, especially because we had no experience, we needed all the information we could get. We definitely should have looked into 3D printing sooner and learnt how to use it beforehand as there were tons of groups that needed to print when we were taught how to print. The complexity of the mouse case shape could have definitely be simplified as well making every process easier, with later adjustments like sanding rough edges, being pushed to the end being an option would make our project much easier and maybe even the print might not mess up as often. Using a smaller Arduino or making the case bigger could also solve our problems with not being able to fit the buttons and wiring as we often found ourselves struggling to figure how to place the joystick and key switches without the Arduino being in the way. Using custom PCBs could have definitely made the wiring process much more painless and greatly reducing the chances of the wiring and soldering failing our final assembly felt like it was pure luck that none of the connections were loose also would have saved so much time soldering each pin to a wire for every component from key switches to joystick. Some other things we should have done differently was perhaps trying to make a controller rather than a mouse as it was very difficult finding mouse parts on amazon and ordering it elsewhere was unrealistic with the shipping times, leading us to desolder the encoder and optical sensor from a cheap mouse on amazon, the problem being since the parts were different from the data sheets we could find, we could not find out how to wire and implement them into our unity scene. Perhaps doing a controller mouse with a trackball or gyroscope could have been more doable compared to what we have now.

VI. Appendices (All Images in Github)

Fig. 1. Asus ROG Chakram

Fig. 2. Zelotes Vertical Mouse With Joystick



What type of gaming mouse do you prefer (i.e Vertical ergonomic mouses or traditional everyday mouses) and why? (if you're used to the normal ones or if your wrist hurts and you need a vertical one)

3 responses

traditional mouses with the side mouse buttons because im used to it

traditional. I use a gaming mouse

Traditional mouses for the simple reason that its what I grew up with. An ergonomics mouse could be interesting but I can't say that I have ever tried one.

Fig. 3. Survey Results

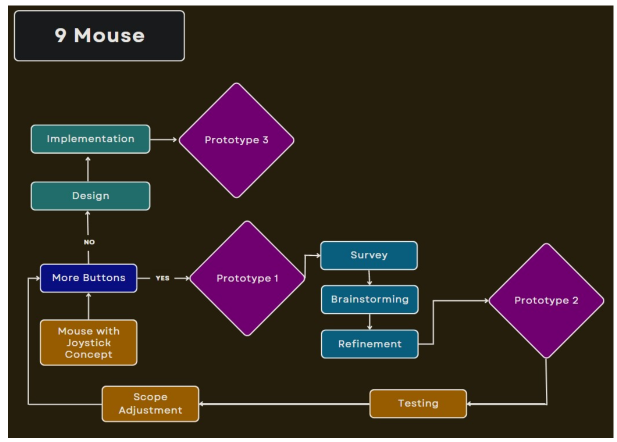


Fig. 4. Methods Flowchart

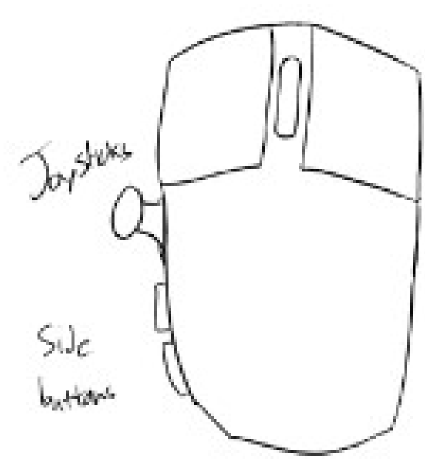


Fig. 5. Rough sketch of our product idea

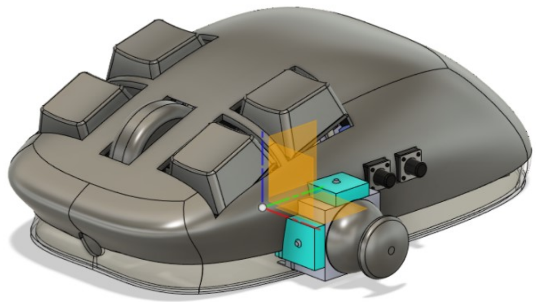


Fig. 6. First Prototype

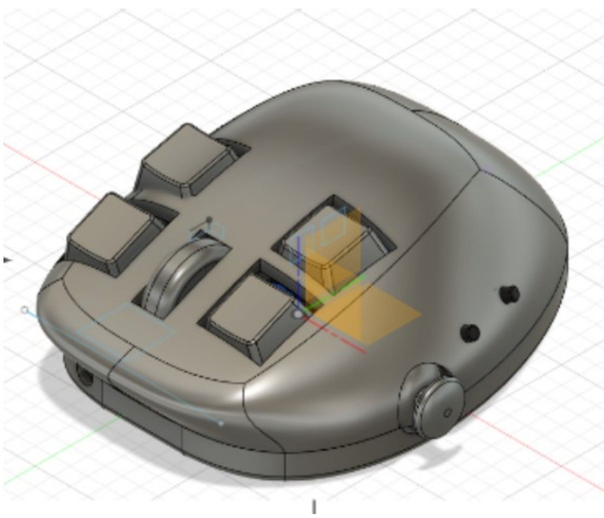


Fig. 7. Second Prototype

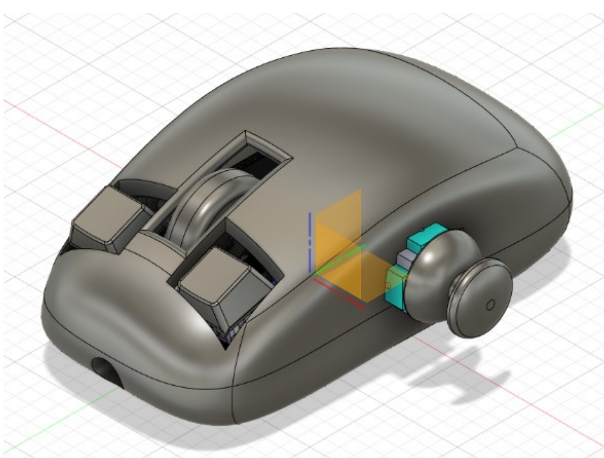


Fig. 8. Third Prototype

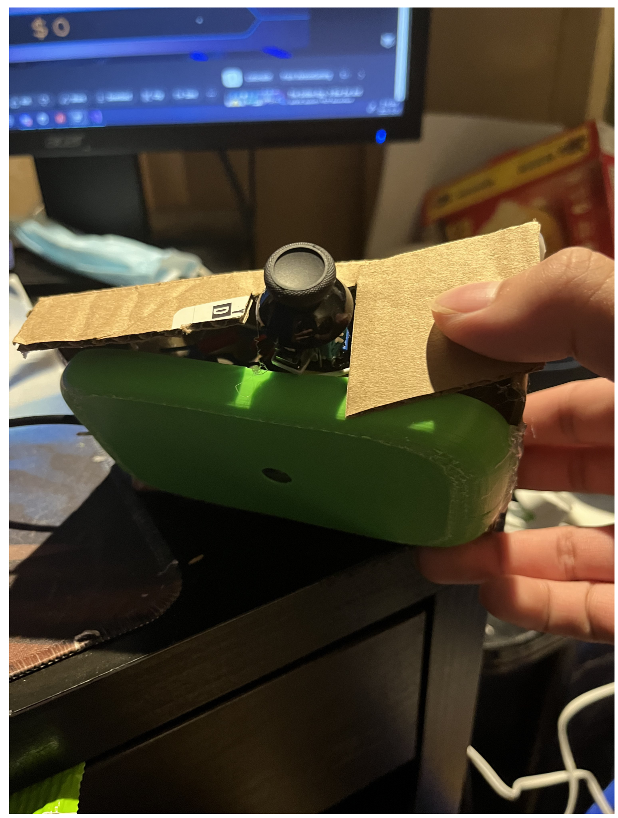


Fig. 9. Final Assembly Bottom

Fig. 10. Unfinished Top Piece

Fig. 11. Final Assembly Top

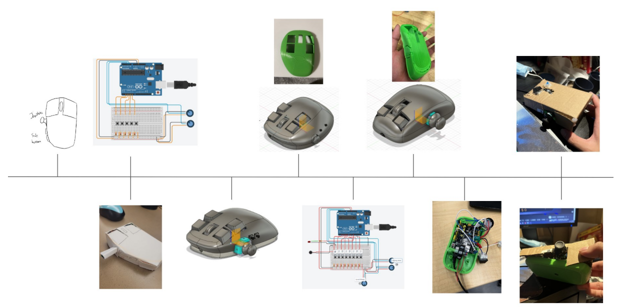


Fig. 12. Project Timeline

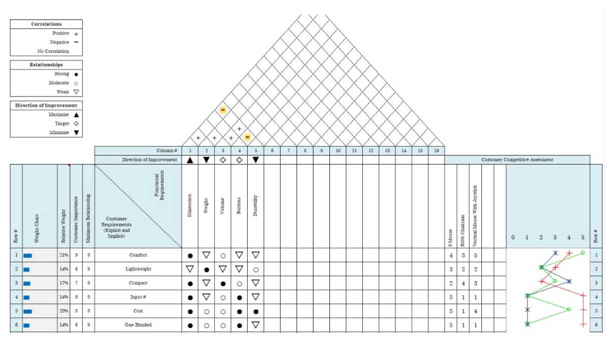


Fig. 13. Top Part of QFD

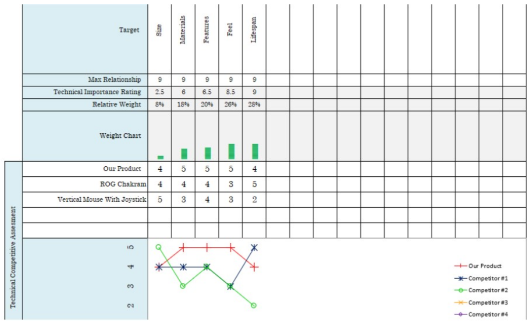


Fig. 14. Bottom Part of QFD

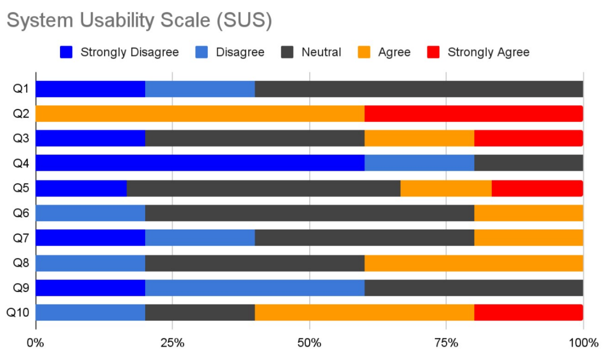


Fig. 15. System Usability Scale (SUS)

Fig. 16. A paper prototype of what we envision for our product

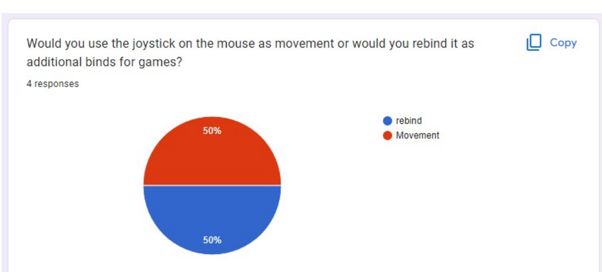


Fig. 17. Survey Question

VII. Bibliography

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