# CtrlUP-Stick Project Designing and Concept

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***Abstract*—This document outlines the concept and creation of a one-handed game controller called the CtrlUP Stick. It outlines methods of development, a timeline of progress, QFD and usability results, and the takeaways from development.**

***Index Terms*—accessibility, controller, devices, game, one-hand**

Fig. 1. Product Logo.

## I. Introduction

The video games industry is larger than TV and sports, making video games the most popular sources of entertainment that people use [1]. There are many different ways people can play video games but the most common are controller, touch screen, and mouse  keyboard. However, there are some problems with these common methods of interaction, particularly with the need to use two hand in order to use these input devices.

It is not uncommon for individuals to suffer from missing upper body limbs that prohibit them from using everyday controllers on the market. In the U.S, limb amputations from trauma occur quite frequent, with 3.8 individuals per 100,000 and 2.8 of those commonly being fingers. This totals at around 1.7 million people living with missing upper body limbs [2]. In addition, there are also those who are born with missing arms or fingers [3]. Those who suffer from these issues or others such as a weaker hand from carpal tunnel may find it hard to use a normal gaming setup.

A large amount of people will benefit from being able to use a controller with only one hand. This project explores the idea of creating a one-hand controller with the main implications of using it for games. The goal of this project is to provide a possible solution in accessibility, for those people missing limbs. Without accessible controller designs - such as a one handed controller - millions of people are left unable to play video games.

## II. Literature Review

Accessibility in video games can be simplified into 4 categories; visual impairment, hearing impairment, cognitive impairment and motor impairment [4]. Motor impairment is what we are attempting to help provide a solution to, players who struggle to provide correct inputs when playing a game due to difficulty using ordinary controllers and/or keyboard+mouse. Popular consoles such as *Xbox* and *PlayStation* amd common PC setups require 2 hands to use their out-of-the-box controllers and mouse with keyboard. Individuals suffering from weakened or missing upper limbs may find it difficult to properly use common devices and struggle to play games.

The paper "Design of a Game Controller for People with Motor Impairment" goes over insights for designing a controller made for motor accessibility. Some elements that are important are making sure the controller can be placed on a fixed surface for stable support [5]. Ergonomic research also shows that people have better control on thumb, index and middle finger [5]. This means that the key buttons used for games should ideally be controlled by those while less important buttons are triggered by the rest. Another finding in the paper suggests using light switch options, so less force is required to activate, especially if user has reduced motility [5].

A commercial one-handed controller we looked at was the Razer Tartaurus V2, which was an improved version of the original Razer Tartaurus. This controller consists of 32 programmable keys, 8-way directional thumb pad and a scroll wheel [6]. The overall ergonomics and the way the controller curves is very well designed. One thing flawed with this product is that it's goal is not to be used for the purpose of accessibility; rather it is used more as a video game accessory. While this product can be used for accessibility, it is unfortunately only produced for the left hand.

A homemade prototype done by Benjamin Heckendorn was of a single handed PS4 controller. This prototype consists of both analog triggers stacked on each other wrapping behind the controller (pointer and middle finger), an analog stick controlled by the thumb, a D-pad to the left of the analog stick, O+X buttons are triggered by index+pinkie and the analog stick typically used for movement is at the bottom of the controller to be pressed against the users leg [7]. Some flaws we analyzed from this design were that the controller size

was not universal - only right hand, and shaped around the size of the creators hand. This heavily limits the amount of users that can make use of this controller. The requirements for the movement analog to be up against an object incomplete, which is something we have addressed and designed in our prototype.

## III. Methods

We used the design thinking process to ensure we are being intentional with everything we do in this project.

### A. Design thinking outcome

Empathize: An individual is unable to properly play games on consoles and on the PC. This may be because of only having one hand or other motor impairment.

Define: There are many people that are unable to play with a standard controller for various reasons, some of which we listed earlier in the paper. Additionally, many one handed controllers only have a version for only one hand - left or right, not both. We are creating a controller that allows people to play video games using only one hand regardless of which hand it is - right or left.

Ideate: In order to solve the problem we design a few ideas that we developed an improved upon over the term.

Selection: We would then select our best ideas and add them onto our working and constantly improving design. A timeline of our different controller version can be seen later in the report.

To get an idea of our workflow and iterative design here is a flowchart showing our work process.

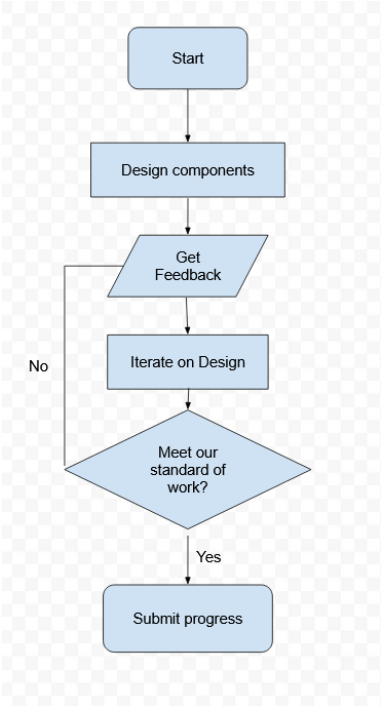



Fig. 2. Workflow process.

## IV. Results

As mentioned earlier in the report, we went through various amounts of iteration and changes. In order to showcase the most significant changes here is a timeline of the three major design changes the controller undertook during the course of this term.

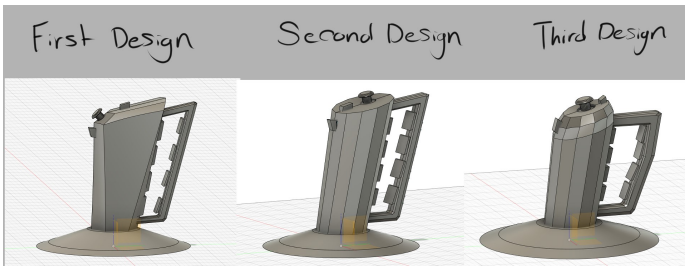



Fig. 3. Timeline of all controller versions.

- First Design: Developed during assignments 1-3. It was a large 17cm tall controller, that was very blocky and contained a regular arduino..
- Second Design: Developed during assignments 45. Reduced height to 13cm and made round. Now using a mirco arduino but general feedback still showing it was too large.
- Third Design: Developed during final assignment. Smaller radius of body, height reduced to 10cm. More round and ergonomic designs.

The final design took all of the feedback we had received in order to make it as functional and use-able as possible. As mentioned above the feedback we received was primarily based on the controller's size.

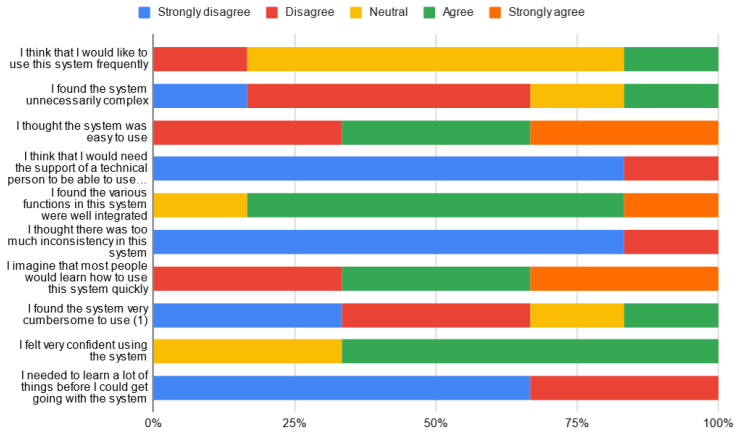
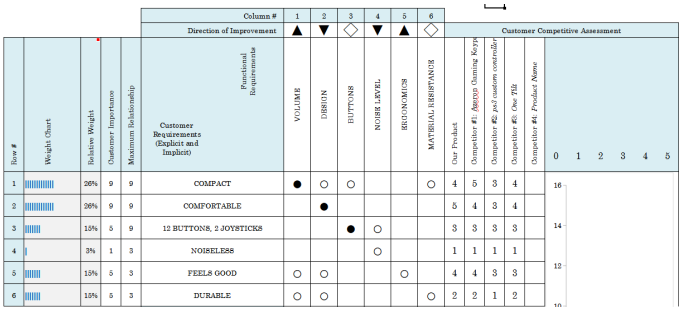



Fig. 4. Feedback from class.

Finally we developed and filled in our QFD chart.



| Row # | Weight Chart | Relative Weight | Customer Importance | Maximum Relationship | Customer Requirements (Explicit and Implicit) | Functional Requirements: VOLUME | DIRRION | BUTTONS | NOISE LEVEL | RGONOMICS | MATERIAL RESISTANCE | Our Product | Competitor #1: Razerp Gaming Keyp | Competitor #2: ps3 custom controller | Competitor #3: One PH | Competitor #4: Product Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Column # | 1 | 2 | 3 | 4 | 5 | 6 | Customer Competitive Assessment | | | | |
| | | | | | Direction of Improvement | ▲ | ▼ | ◇ | ▼ | ▲ | ◇ | | | | | |
| 1 | | 26% | 9 | 9 | COMPACT | ● | ○ | ○ | | | ○ | 4 | 5 | 3 | 4 | |
| 2 | | 26% | 9 | 9 | COMFORTABLE | | ● | | | | | 5 | 4 | 3 | 4 | |
| 3 | | 15% | 5 | 9 | 12 BUTTONS, 2 JOYSTICKS | | | ● | ○ | | | 3 | 3 | 3 | 3 | |
| 4 | | 3% | 1 | 3 | NOISELESS | | | | ○ | | | 1 | 1 | 1 | 1 | |
| 5 | | 15% | 5 | 3 | FEELS GOOD | ○ | ○ | | | ○ | | 4 | 4 | 3 | 3 | |
| 6 | | 15% | 5 | 3 | DURABLE | ○ | ○ | | | | ○ | 2 | 2 | 1 | 2 | |

Fig. 5. QFD chart. This is just a small image of the entire chart. The full thing is visible in the project repository

## V. Takeaways

During the creation of this controller we were able to learn, develop, and improve a lot over the course of the term. In designing we were able to learn about creating more ergonomic and compact controllers. Throughout the term the size of our controller was an issue along with it's ergonomics. We addressed this by making iterative changes to the design until we got a good result. Furthermore, we learned a lot by prototyping each version of our controller with a physical version. We would make a prototype out of cardboard then gather feedback and learn what improvements needed to be made. A standard procedure for making assessments in our design, prototypes, and overall product came down to the feedback and insights we gained from others and ourselves.

We constantly kept changing the design after getting feedback then submitted the best version we created. If there was one thing we would change during the term, it would be putting a little more focus on the electronics implementation as this is what appeared to be losing us the most marks throughout the term. We did our best to address this later on, but a greater focus at the start would have been helpful.

The development of this controller ended up being quite successful with a well-designed controller coming out in the end. We are now confident that if this controller would be 3D printed a good one handed controller could be developed. Therefore our project goal of creating a functional universal controller has been achieved.

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