FT Bow: Training Archery Form and Technique

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***Abstract*—This paper describes a bow and arrow controller prototype that aims to help train proper form and technique to both experienced and aspiring archers. Form and technique are the foundation of an archer and vital for successful performance. Being able to train efficiently and effectively is important for archer's and this prototype remediates this problem by providing archers a safe practice environment to reduce the risk of injuries and poor performance. The controller will utilize a strap-able case that attaches to the archer's arm containing an accelerometer and gyroscope to gauge arm movement and orientation as well as a vibrator and LED to provide feedback. In combination with the bow, this prototype provides a solution to open the door to people who want to get into archery safely and effectively.**

***Index Terms*—Form, Technique, Archery, Prototype, Training**

I. Introduction

Archery is a sport that relies heavily on the mechanics and techniques of the individual. Training however can be difficult to do indoors or in a limited space. Proper training, like with all sports, strives on ensuring safe training conditions. This means reducing the risk of injuries and feeling comfortable and knowledgeable of how to achieve the best results. This prototype can help archers practice more freely and build the muscle memory for proper form and technique more quickly. Those that also want to pick up the sport of archery can use this prototype to learn the ropes as well. As not many people have the opportunity to go and practice at a range due to costs or seasonal weather making it inaccessible, this prototype can help deliver a good training regiment for those wanting to stay in form. The FT Bow aims to provide users with quality form and technique training while reducing injuries and eliminating target-panic. The bow does not use a physical arrow to be fired, instead it focuses on training one's form through stance, drawback, and release. These fundamentals can help eliminate shaky aim, loose grip and poor follow-through. Throughout this report, we will be presenting our final prototype of our FT Bow and how we built it up from an idea to a physical device. Using flex sensors attached to the ends of the bow limbs will help us detect how far back the string is being pulled. The accelerometer and gyroscope in the case compartment will help track the direction the bow is being aimed at and the arm position of the archer. Furthermore, an LED light will signal to the user if their aim is steady and the vibration motor will provide haptic feedback for a more immersive and simulated experience when drawing back the string.

II. Literature Review

The first paper we looked at described an E-Archery Prototype. This device analyzed an archer's release by using an accelerometer to track hand motion. Release is critical when using a bow and arrow as it helps increase performance and reduce injury. In addition, the paper explained how an archer's form can be defined based on posture, grip and position of the archer's arms. Furthermore, the paper went on to explain the NTS method (Figure 1). These twelve steps outline the proper way to shoot a bow and arrow, all of which contribute to an archer's form. There are three types of forms: Good Release, Dead Release and Pluck Release and following the NTS method, archer's can achieve a good release whereas poor form can lead to a dead or pluck release - both of which can cause injury and damage to both the bow and the archer [1].

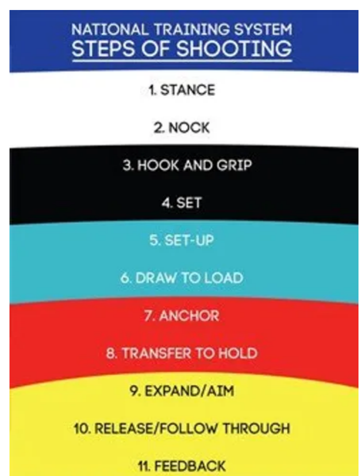

Fig. 1. NTS Method of Shooting a Bow and Arrow

The other paper we looked at described a tactile display device to help improve feedback when learning archery. It was designed for novice archers to provide real time feedback on their performance through a non-invasive and natural interaction methods. This device helped train and create a closed-loop system for archers to practice their form utilizing tactile cues on the posture of the bow to help train motor skills, and by using an accelerometer and gyroscope to measure the orientation of the bow. These tactile cues aimed to improve muscle memory for sensing the proper stance and the haptic feedback helped the archer adjust to make subtle changes and to signal if their bow or posture shifted so they can adjust accordingly [2].

Two commercial devices that we looked at were the Accubow and the DeadEye VRcher. The Accubow is considered as the most complete archery training device. It is designed to improve strength, stamina and accuracy and offers resistance adjustability for those that want more tension. With a built-in laser sight to help with stability control and accuracy, the Accubow helps with proper draw form, grip and stance while you train at various resistances [3]. The DeadEye VRcher is a VR bow controller with an adjustable draw length as well. With an ambidextrous grip and a secure strap to help hold the bow when drawing the string, this bow is compatible with multiple VR platforms enabling for a smooth and rich experience.

III. Methods

Based on the research that we had gathered, we ended up with the necessary knowledge as to what we needed electronics wise and how we were going to go about creating this bow. The flowchart in Figure 2, depicts our workflow and how we went about the project.

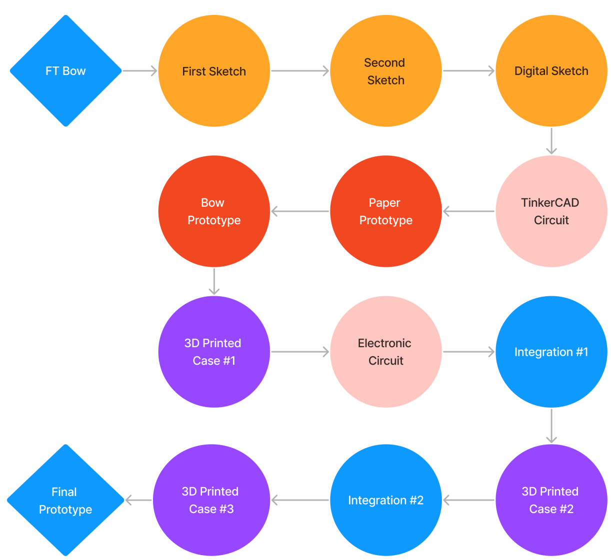

Fig. 2. Workflow and Iterative Design

Initially, we started with rough sketches to get a picture of what the bow would look like. We started with pen and paper and transitioned to a digital workspace for more detail. At the same time, we played around in TinkerCAD to get an idea of how the electronic configuration would work and of course, what kinds of electronic components we would need. This led to us creating our paper prototype. We used cardboard, tape, and string to construct a mock bow and arrow to simulate a feel of what the bow would be like in our hands. The bow was not exact to the bow we would be buying, but for the time being, it gave us a rough estimate. During this process, we modelled our first iteration of our case but did not have time to 3D print it. When we got our bow that we were going to re-purpose, we then got to work on making our electronic circuit with the components we obtained. We also 3D printed our case for the first time and ran into some issues that we needed to resolve. While this delayed our project, we ended up using the bow and the electronics to mock up where they would go and how we would be connecting and securing everything now that we had the parts physically in front of us. We remodelled our case and after a few bumps in the road, we managed to print our final case and lid that we were going to use for the bow. However, throughout this final phase of our project, our focus shifted from attaching the case to the bow, to keeping it separate and having it attached to the user using Velcro straps. This ended up being our final iteration and the FT Bow prototype was born.

IV. Results

Our FT Bow project was developed in the span of three months, from September 2022 to November 2022. Throughout these months of prototyping, we were able to perform several tests and iterations. The timeline in Figure 3 depicts the progression of our prototype and what changes each iteration offered. In the beginning, we started with a simple sketch of the bow outlining the parts and where they should go.

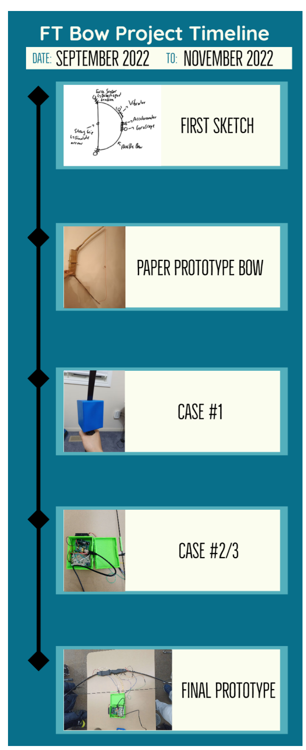

Fig. 3. Timeline of Prototype Progression

Next, we made a low-fidelity paper prototype out of cardboard. In this iteration, we constructed a cardboard bow and arrow, attached a string to the limbs and taped it to secure everything. Making this paper prototype allowed us to gauge the size and length we were working with, how drawing back the string feels and where the limbs flex the most to see the best spot for the flex sensors to be placed, and where other major electronic parts would be able to go. The next step was 3D printing our first iteration of the bow's case compartment. The intention of the case was to hold all of our electronic components and would be attached directly to the bow. While the case managed to fit onto the bow, we did not leave enough space in the case to hold all the parts and it was too thin thus we were scared of its durability. Most importantly, we did not take into account how the wiring and other parts would connect with it. We then began our second and third iteration of the case which massively improved the space to hold our electronics as it was more thicker since we increased the infill. We also added a small hole in the case for wires to go in and out of, solely to connect our flex sensors, LED, vibration motor and battery to the breadboard. We also added divots and snap-joints to the lid to be able to close it properly. Finally, for our final prototype, we made the decision to remove the case from the bow and instead opted to use Velcro straps and attach the case to the user's arm. This decision was made to remove the intrusiveness of the case being in the way and moving it to the user's arm would still give us measurements of movement and orientation while simultaneously giving the user more agency to use the bow.

From our QFD results, Figure 4, we were able to identify customer needs and see what our project has in terms of technical requirements to support these needs.

We discovered that users wanted a bow that was lightweight, durable, not too long and had an ambidextrous grip. Our bow while having some of these needs, it did suffer a bit in durability due to the bow not being as compact and the wires being disorganized making it prone to breaking when drawing and releasing the string. Because of this, we knew that we had to make sure we secured our parts so nothing broke and the bow can be used without worry or maintenance required. The QFD analysis also let us compare to competitors. The main two competitors had the edge on our bow in terms of portability/compactness, durability, and had the upper edge on some technical features like tension/resistance and IMU accuracy. While we were able to stay on par with the haptic feedback, grip, weight and somewhat with the length, not having the same quality of the aforementioned technical features allowed us to explore opportunities to improve upon them. This allowed us to take notice of what we needed to improve on to reach target requirements, what we had that was good enough to meet standards so no change was needed, and what we needed to get rid of or tone down as it did not have any impact on the overall project.

From our System Usability Score results, we achieved an average SUS score of 74 from a pool of 5 participants. From our response distribution, Figure 5, we noticed that users thought the bow was relatively easy to use and was not complicated to get a grasp around. They thought that the various functions worked as intended and the feedback the bow provided helped with the usability. However, some things that we noticed was that some users felt the bow to be very large and difficult to use - unwieldy almost. This could be due to the wiring and the uncomfortable feeling of having a big box strapped on one's arm. To improve upon this cumbersome feeling, we could make the arm device smaller and more compact as well as lengthen the wires or tidying them up.

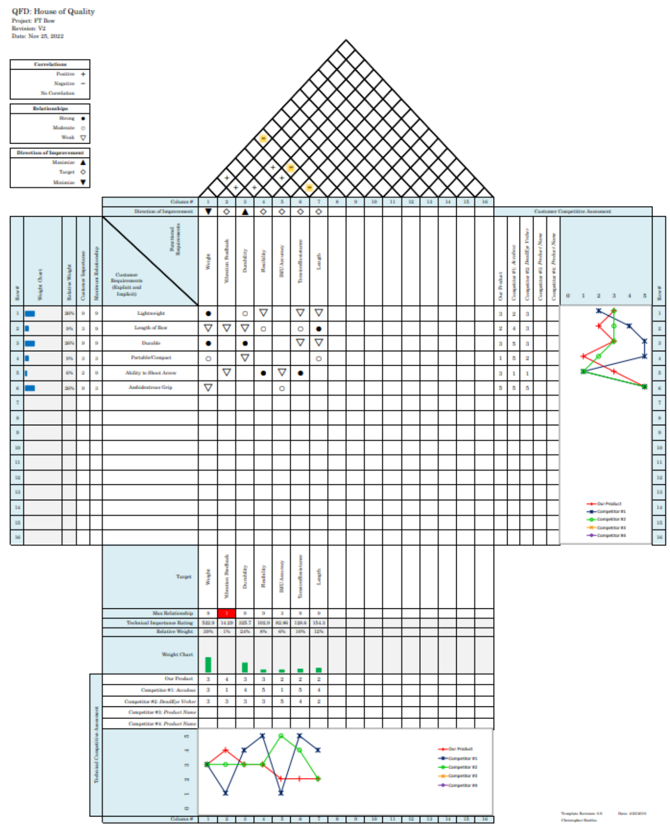

Fig. 4. QFD Results

V. Takeaways

Throughout this project, the prototyping definitely helped us with designing and making adjustments based on our iterations. The repetition of designing the case over and over again and playing around with the parts helped with problem solving and greatly increased our efficiency when going back to redesign. The assessments as well gave us valuable feedback on what others perceive about our project and what we could do to alleviate any issues that could occur or issues that we can fix for the betterment of the user. If we were to do things differently, we would probably scope our project down a bit more to a smaller scale bow. Iterating more often as well so we do not have to backtrack and go back and forth wasting time and resources is also valuable and getting an early start

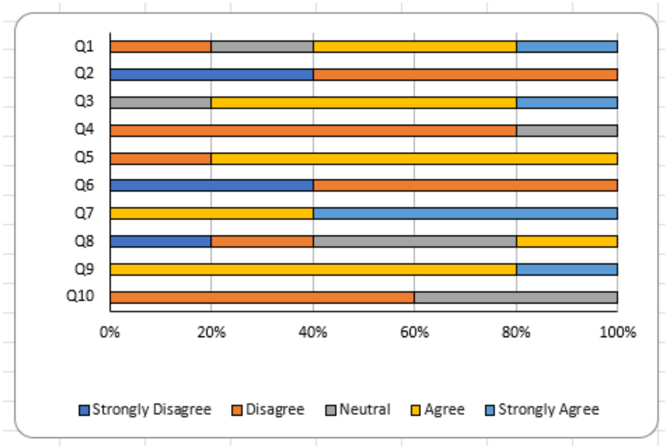

Fig. 5. SUS Usability Results

on 3D printing is important as the process of us redesigning it spent up a good majority of time which meant we had to 3D print after every iteration. We also think making a smaller form of electronic integration would be beneficial. We did not necessarily need a big case for the parts and we could have worked around this and made a contraption that is smaller and more compact.

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