ENP 64 Fall 2022

Methods for Human Factors Final Project

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The GuitarJam

General Product Information

The GuitarJam learning tool is a tool that is designed to help people of all ages learn how to play guitar, while encouraging good habits in guitar like doing exercises, taking breaks, and playing with accurate timing. The product is a clip on screen that syncs up with your phone via Bluetooth, and displays the chords for songs with accurate timing and an audio and visual metronome. Level up your playing experience with the GuitarJam!

Research methodology

Before starting this report, I wanted to take a moment to outline the methodology and how I am approaching this design problem. In class, we have been choosing a problem, then doing analyses and research to further understand the problem, then coming up with a solution. I propose a different path which stems from myself already having a thorough understanding of the problem, and already having an idea for a solution. The report will start with the inspiration for the product, followed by some initial sketches. With these sketches, I got some initial reactions from people who also play guitar. From these sketches I reiterated upon the design to come up with something better which I could refine. From this, I then performed some comparative tests with the product and the current standard to validate the usefulness of the product. Once the value of the product was confirmed, I then moved onto anthropometric analyses to decide the specifications of the final product. After this, I designed the interface for the app and the device, and used all of these to get final comments from users.

General terminology that will be used in this report

Chords: A group of notes played together
Chord changes: Changing from one chord to another, can take a longer time for beginners
Fret board: The flat face of the neck of the guitar where you can play notes and chords
Fretting hand: The hand used to play notes and chords on the fretboard
Strumming hand: The hand used to strum the strings, often in a rhythmic pattern

The Process I: Inspiration

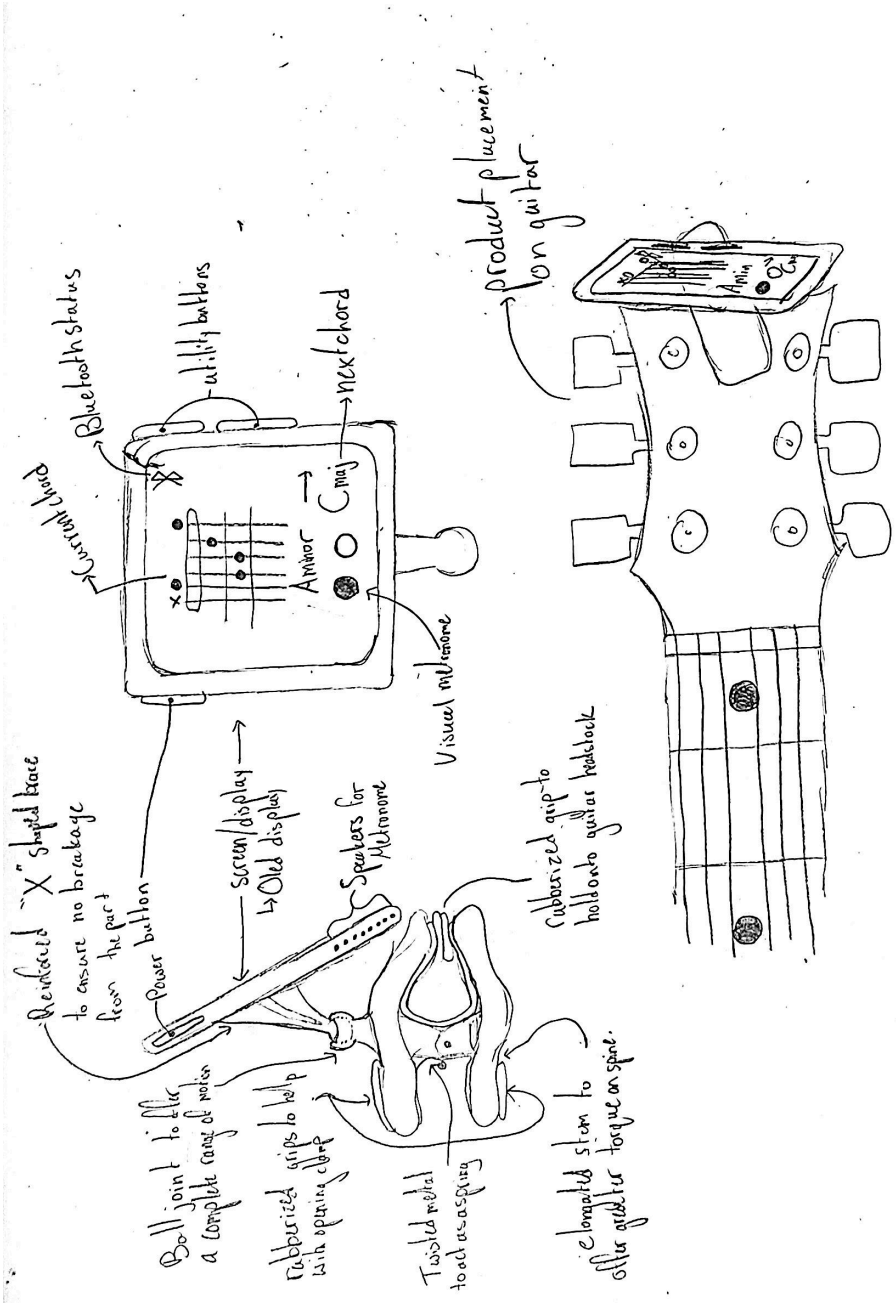
The idea for this product was born from the want for a better way to play songs. I have a bad memory, and when I learn to play a song on my guitar one day, it is often forgotten within that very same week. The troubles I encounter when learning how to play songs from chord charts is the difficulty in being able to switch between the phone and the guitar.

One of the solutions is to revert to how people used to play decades ago; Playing chords based off of a piece of paper, so that way you can just look on and play without having to take your hands off of the guitar. The trouble with this method is that you are limited to one song per page, and you don't always have a printer nearby.

The problems I have experienced with using phones is that most songs take more space on the phone than a single page, which requires you to let a chord ring out, and lift your strumming hand to quickly scroll to the next section of the song. The closest solution I found was a subscription to a website that scrolls through the chords itself, but you still have to move your eyes from your phone to your fretting hand, something which can be difficult for beginners.

In order to fix this problem, I had to design a device that has the functionality of a phone and its access to the wealth of information on the internet, but with the ease of use of the paper. The device also had to not distract from what the player should be focusing on, which is the fretting hand. All of this resulted in the designs which are sketched out on the next page.

Initial sketches



The Process II: User analysis

This product is designed to target a certain group of people. The general archetype of users falls under the categories of people ages 11-19, and relies on them being able to function basic technology both through the device and the companion phone application. In order to bring this product to life, two user personas were created to show the usefulness of this device to different types of people. The first persona, Bertha Bertruce, is a teenager who has basic guitar skills, but wants to expand upon her knowledge of songs as well as become better at playing her instrument. The second persona, Gerald Gimbralt, is an 11 year old boy who has just received a guitar for his birthday and wants to begin to learn how to use it. These personas are expanded upon below.

Bertha Bertuce, 16 years old

Bertha is an only child, and is currently in high school. She just received an acoustic guitar for her birthday.

Her only job is to do well in school and participate in afterschool activities like the track team and academic decathlon.

Due to her being busy with school, she does not have much free to play guitar, so when she does have time to play, she wants a quick solution. (2-3 times/week)

Bertha also has trouble seeing long distances and has to wear contacts.

Dislikes: Pop music, Working too much

Likes: Rock, hanging out with friends, playing video games, listening to music

Aspirations: An outlet to destress and have a good time, keep good grades

Motivations: Wants to play songs she has listened to, wants to impress parents and peers

Gerald Gimbralt, 11 years old

Gerald is the youngest child, with an older brother and sister. He is currently entering his first year of middle school, and his parents bought him a guitar for his birthday.

Gerald has a passion for music, and has been playing the piano since he was 7. He listened to Cat Stevens for the first time, and has been begging his parents for a guitar ever since.

Gerald has all the time in the world to play guitar, but his parents are really busy with two full time jobs, and his siblings also don't have the time to help him learn to play the guitar.

Gerald, is quite short, given that he is not yet done growing!

Dislikes: Conventional teaching styles, mathematics

Likes: Playing piano, eating candy, and reading books

Aspirations: Gerald wants to be able to play guitar as well as he plays piano

Motivations: He loves music, and wants to go to music school when he grows up

Persona Needs

- Needs to be simple to use (Streamlined process so that people of all ages can use it)
- Needs to be safe to use (The clamping mechanism cannot be dangerous to the user)
- Needs to be easy to see (The screen has to be the correct size so that it is small enough to fit on the headstock, but big enough to be visible from the seated position)
- Needs to be fun to use (Provides more value to the consumer)
- Needs to be educational (Provides value to parents, who will be inclined to purchase this product for their children)

These are the major product requirements to make the product useful and viable in the commercial market. With these needs in mind, I conducted some initial observations and research into what real consumers would want out of the product, and into whether the problems that I experience also exist for other people.

Needs analysis

In addition to the formal task analyses done, I presented the design sketches and idea to 5 guitarists that I know and asked them the following questions:

1. What additional features would you like for the device?
2. Do you have any concerns about the usability of the device?
3. Would you purchase this device?

I opted for open ended questions as it gives me more feedback from users that are actionable, as opposed to numbers which while they give me feedback, they would not offer me a direction for what users want.

There were a few important notes from the results of this survey

- The product received positive feedback in its mission to solve the problem of having to learn songs from your phone. Every guitarist I talked to also had experienced the same problems that I had and were interested in a solution
- The major concern was with the usability of the physical features of the device, being able to read the screen, being able to operate the clamping motion.
    - These concerns are addressed in the anthropometric section and heavily influence the final interface design and the CAD mode.
- There was a desire for two new features, a tuner feature as well as the ability to transpose songs and change the bpm from the source.
    - Both of these features are easy to implement, and so it is reflected in the design. Confirmations were added in the interface for the screen to prompt the user to change the key/bpm should they wish to. The tuner was a little more difficult, as the screen of the device is an E-Ink display with a low refresh rate. Having the tuner on the screen would be frustrating to use, and not very efficient. Instead, offering the tuner function in the app keeps the process user friendly and streamlined.

The Process III: Task Analysis and observations

In order to understand how people approach learning guitar and confirm the problem I am trying to solve, I asked a guitar player to learn a song. The details of the task analysis and the subject are outlined below.

Subject: True Becker
Time playing guitar: <1 year
Instructions given: Please learn the song "Winds of Change" by the Scorpions
Tools given: Phone, Guitar, Pick

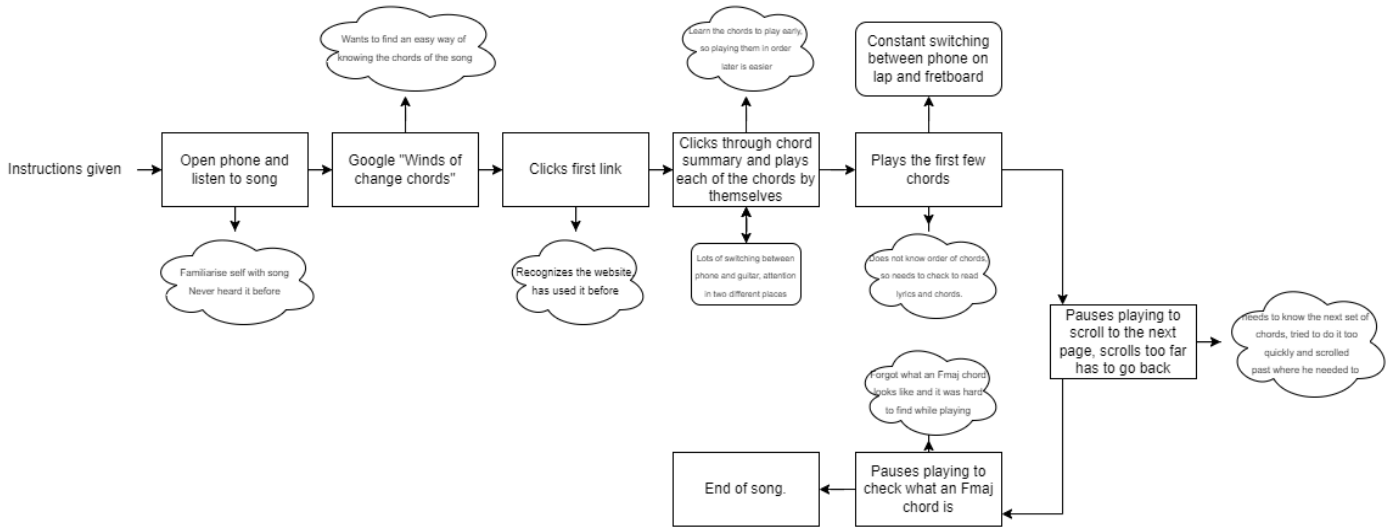
The purpose of this task analysis is to observe what a novice guitarist does to learn a song, and locate any pain points they experience. Additionally, observations will be taken to initial some anthropological concerns with the learning process of playing guitar.

Sequential observations:

- The subject began by opening the phone provided and googling the song. He noted that he had never heard of the song or the band before.
- After listening to the start of the song, the subject said that he got a feel of what it was like
- The subject then searched "Winds of change chords," and clicked the first link. This was the result that came up. The subject says that they have used this website before.
- The user then practised the chords in the song via the chord list at the top of the page. They said this was in order to familiarise themselves with the chords.
- The user then tried playing through the song at a slower pace
    - He often struggled with chord changes, and had to adjust his hands while looking between the chord chart and the phone
    - To play the F major barre chord, the user had to click on the icon to see the chord mid song
    - The user had to stop playing for a moment to scroll to the next set of chords, and scrolled too far so they had to redo it to get to the proper place.
- They finished the song, ending the task.

Behavioural and Cognitive Task Analysis

Behavioural is in the boxes, with extra details in round boxes
Cognitive is in the thought bubbles



Takeaways

The same troubles that I experienced with playing guitar was also experienced by the novice player, although at a greater level. I would not have had to check what an F major chord was, or had to practise the chords beforehand. However, we both experienced the same pain points in the processes that involve task switching between operating the phone and playing the guitar, exemplified by the observations made. This pain point was furthered upon in the next section where I conducted an experiment to verify this problem, as well as gain further comments on the product and its usefulness.

The Process IV: Designing the interfaces

Tool used: FIGMA

While designing the app I took considerations from what the customers needed, what the device needed, and also some of the best design practices put forward by Apple's guidelines.

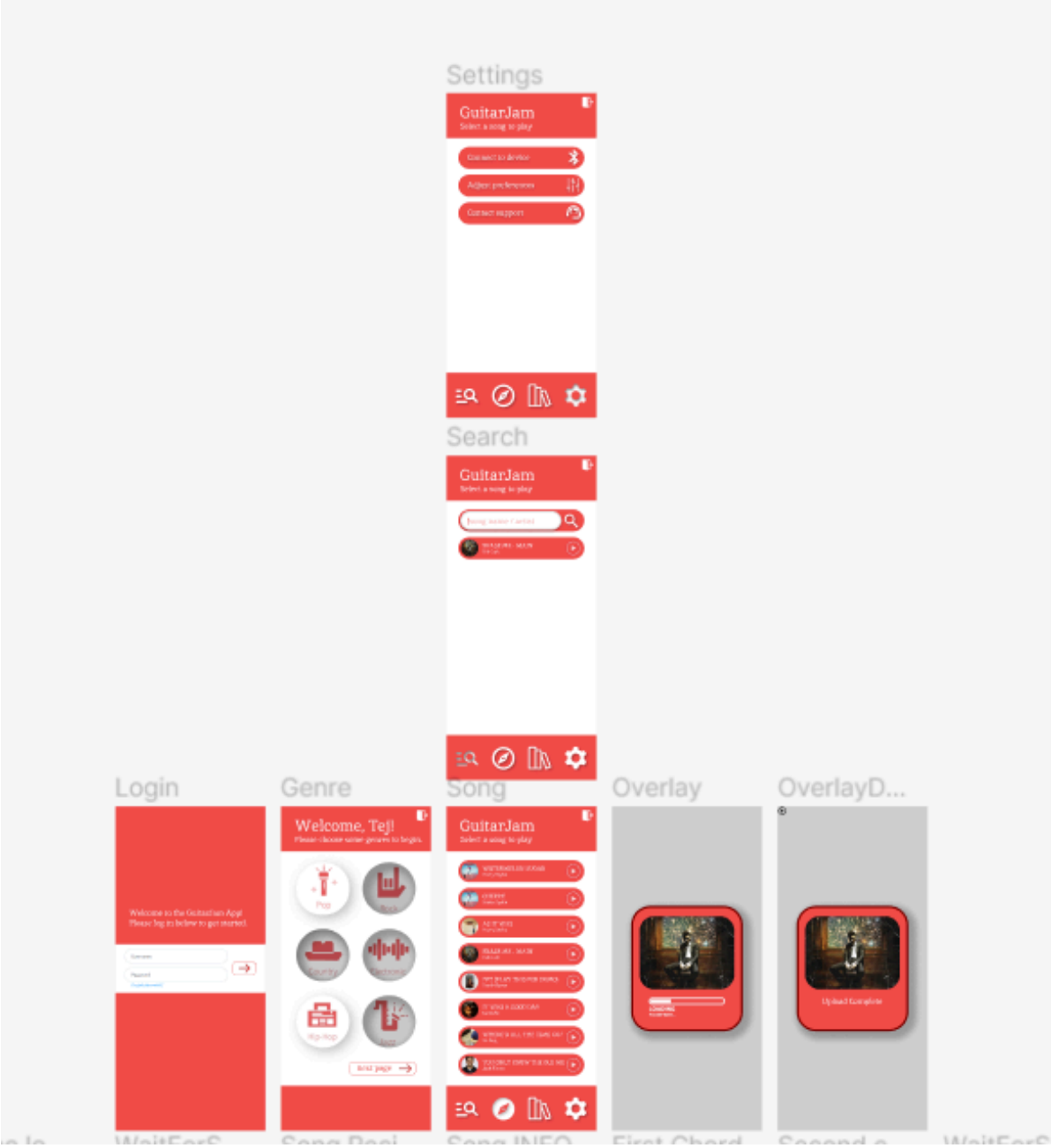
Listed below are some of the things I payed attention to when creating the wireframe

- Linearity: In order to make the app simple to use, I made the app as linear as I could, each process directly following the previous.
- Simplicity: The app is stripped down to be what it is meant to be, a companion for the device. I wanted the app to be purely functional, and not contain frivolous details that would detract from its purpose
- Elegance: Even though the app is meant to be simple, it does not have to be badly designed. I wanted to maintain continuity in the colours and the design, so I focused on just two: Red and white.
- Feedback: Even though the colours, I used a layering system to indicate feedback to the user about selections. For example when something is selected, it appears indented into the page through an inner shadow. This makes the app seem three dimensional, a design which I have used for other websites and interfaces I have designed.

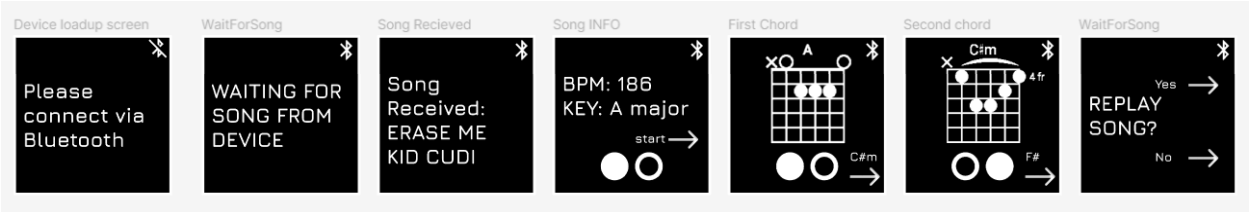
In addition to creating a figma mockup of the app, I made another one for the interface. This was more simple, as the display itself is in black and white. The design is influenced by the suggestions obtained in the observations phase, and revolves less around aesthetically pleasing content, and more around packing as much information as possible.

FIGMA PREVIEW APP
FIGMA PREVIEW INTERFACE

INITIAL APP WIREFRAME



INITIAL INTERFACE WIREFRAME



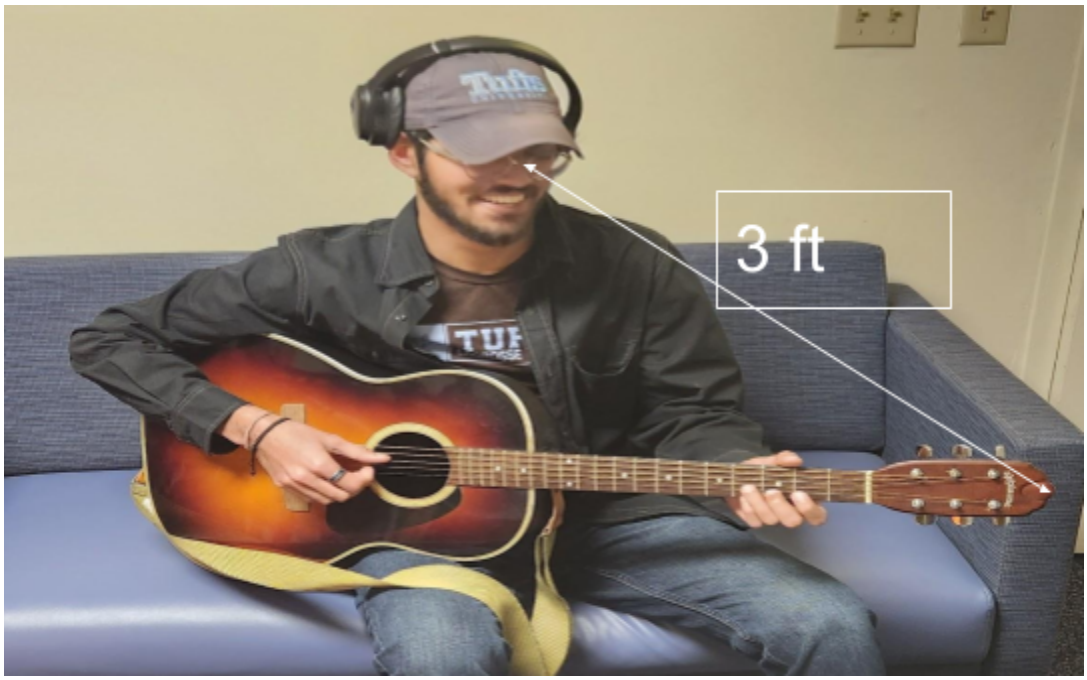
The Process V: Anthropometric concerns

This section will be broken into two parts: The visual concerns and the physical concerns. The visual concerns will tackle the design of the screen on the device, ensuring that the font size is big enough to be readable by the user. The physical concerns are mostly within making sure people of all sizes are able to physically put the device on the headstock of the guitar. The implications of these studies will determine how big to make the screen, how big to make the buttons on the controller, and how to clamp the device to the guitar. It will also influence how to keep the device as sleek as possible while allowing it to display all the necessary information.

One thing to note is that playing guitar by nature is a strenuous activity. The angle of the neck is oftentimes uncomfortable, staring at the neck for prolonged periods, the stress of a guitar strap often causes shoulder issues, and playing guitar with bad posture can lead to a bad back. Additionally, the minute movements of the fingers can lead to carpal tunnel syndrome. None of these are specific to this device, but rather playing guitar as a whole, and as such, will not be examined in this report.

Part 1: Calculating the size of the screen

One unknown about the product at this point is the size of the screen, which will be determined by cross referencing eyesight charts with the distance of the person from the screen. Below is a picture of me playing guitar, annotated with the distance of my eyes to the device on the headstock



The distance of 3ft will be used in the calculation of the size of the text and consequently the screen from here on out.

According to this chart

Recommended Minimum Text Sizes

Viewing Distance (feet)	Computer Screen (points)	Printed Maps (points)	Computer Screen (inches)	Printed Maps (inches)	Computer Screen (millimeters)	Printed Maps (millimeters)
1.5	8	6	0.11	0.08	2.8	2.1
2	11	8	0.15	0.11	3.8	2.8
3	16	12	0.22	0.17	5.6	4.3
4	21	16	0.30	0.22	7.5	5.7
5	27	20	0.37	0.28	9.4	7.1
10	53	40	0.74	0.56	18.8	14.2
20	107	80	1.48	1.12	37.6	28.4
30	160	121	2.22	1.68	56.4	42.6
50	266	201	3.70	2.79	94.0	70.9
100	533	402	7.40	5.59	188.0	141.9

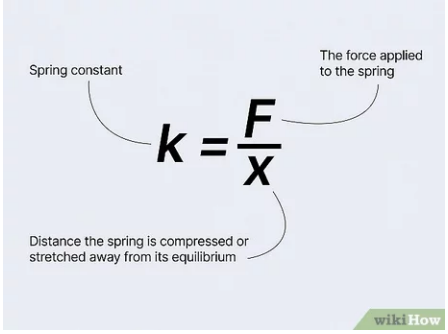
The viewing distance of 3 feet and the computer screen (millimetres), the size of the text sizes should be 5.6 mm in height for it to be completely readable. These values are probably better for the device, because it has effectively a perfect contrast of white against black, with the e-ink display ensuring fantastic contrast and crisp edges.

14	*≈ 4.939 mm*
15	*≈ 5.292 mm*
16	*≈ 5.644 mm*
18	*≈ 6.350 mm*

With the 5.6 mm minimum for the text size, I used the figma mockup for the calculation of the full screen size. I used this chart to obtain the conversion of a 5.6mm font height to a point value of 16. Using a conversion of 1.33 pixels per point, I used a character size of 22. Then with this value, I measured that the screen would be 15 characters tall. Multiplying this by the original value, I obtained a dimension of 84 mm, or 8.4 centimetres. The screen is a square, so the final dimensions are 8.4 x 8.4 millimetres, assuming that the font size is the smallest possible. Instead, the actual font sizes are at least 10 pixels larger than the minimum, so it should be legible from any distance.

Part 2: Calculating the length of the grip handle

Because the clamp is a spring operated mechanism, we are going to use the physics equation on the right to calculate the force that needs to be applied in order to open the clamp so it can be placed on the guitar. This requires a



few assumptions, the first of which is the spring constant that I got from [this](#) website.

Price	Business days	Buy	Compare	Click Images for 3D Visual	OD (mm)	ID (mm)	FL (mm)	Rate (N-mm)	Max Defl (mm)	Max Load (N)	SH (mm)	WD (mm)	Material Type	Stock Part Number
~~$2.69~~ Now $2.34	SHIPS TODAY				10.312	8.230	30.226	3.440	12.195	41.953	7.544	1.041	MW - Music Wire	View QTY Discounts PC1041-10312-6250-MW-30226-C-N-MM

The website uses a spring constant of 3.440 N/mm, which we will use for the rest of our calculations. We will use the assumption that the spring must be displaced 1 cm in order to open it, giving us a required force of F=34.4 N. However, this does not consider the additional leverage we gain from applying the force at a location displaced from the place of rotation. The force at the point of rotation is given by $F_r = F_a$ x d. From the following [chart](#)

Grip Strength Ratings for Females (in kg)

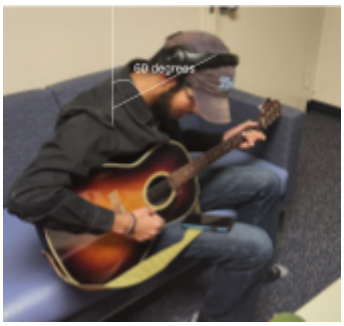
AGE	Weak	Normal	Strong
10-11	< 11.8	11.8-21.6	> 21.6
12-13	< 14.6	14.6-24.4	> 24.4
14-15	< 15.5	15.5-27.3	> 27.3
16-17	< 17.2	17.2-29.0	> 29.0
18-19	< 19.2	19.2-31.0	> 31.0

I used the value of 11.8 kgs, which is equivalent to 115.64 N of force that can be applied. Obviously, this value is the full force of the grip strength, so to make it easy to operate, I used 20% of this number, which is 23 newtons. Going back to our torque equation we have d = F_r/F_a=34.4N/23N, or around 1.5 centimetres.

This means that the grips must be placed at least **1.5 centimetres from the point of rotation.**

With these two measurements, I can begin work on the CAD model. First, I wanted to discuss one final anthropometric concern that this device would help repair.

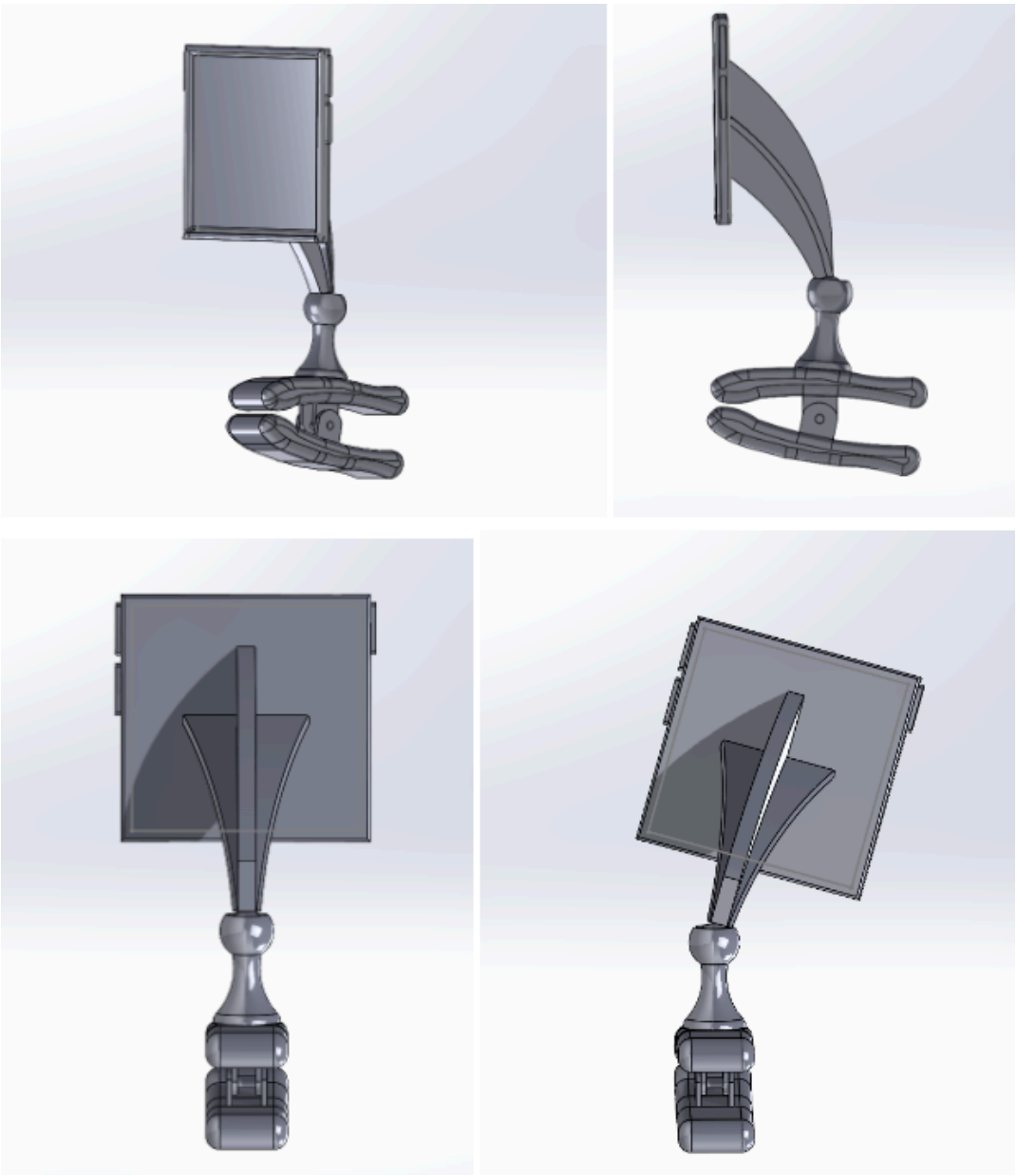
Part 3: Neck injuries



The picture on the left depicts what I look like when I am trying to learn a song. After consulting with two other guitarists that I know, they also assume a very similar position when they are learning a song off of their phone. After doing some research, I found a disease called cervicalgia, which is a pain that starts in the

neck and can spread lower to the arms. The disease is caused in part by spending a lot of time with your neck at an awkward and uncomfortable angle. Without the device, the neck is in this position for a long time, at around a 60 degree deviation from upright. With the device, the neck angle returns to a significantly more reasonable 15 degree angle deviations, which happens anyway from having to look at your hand for chord placements. The device not only is a great tool for learning how to play songs, but helps reduce the possibility of neck injuries.

The Process VI: Designing the CAD model

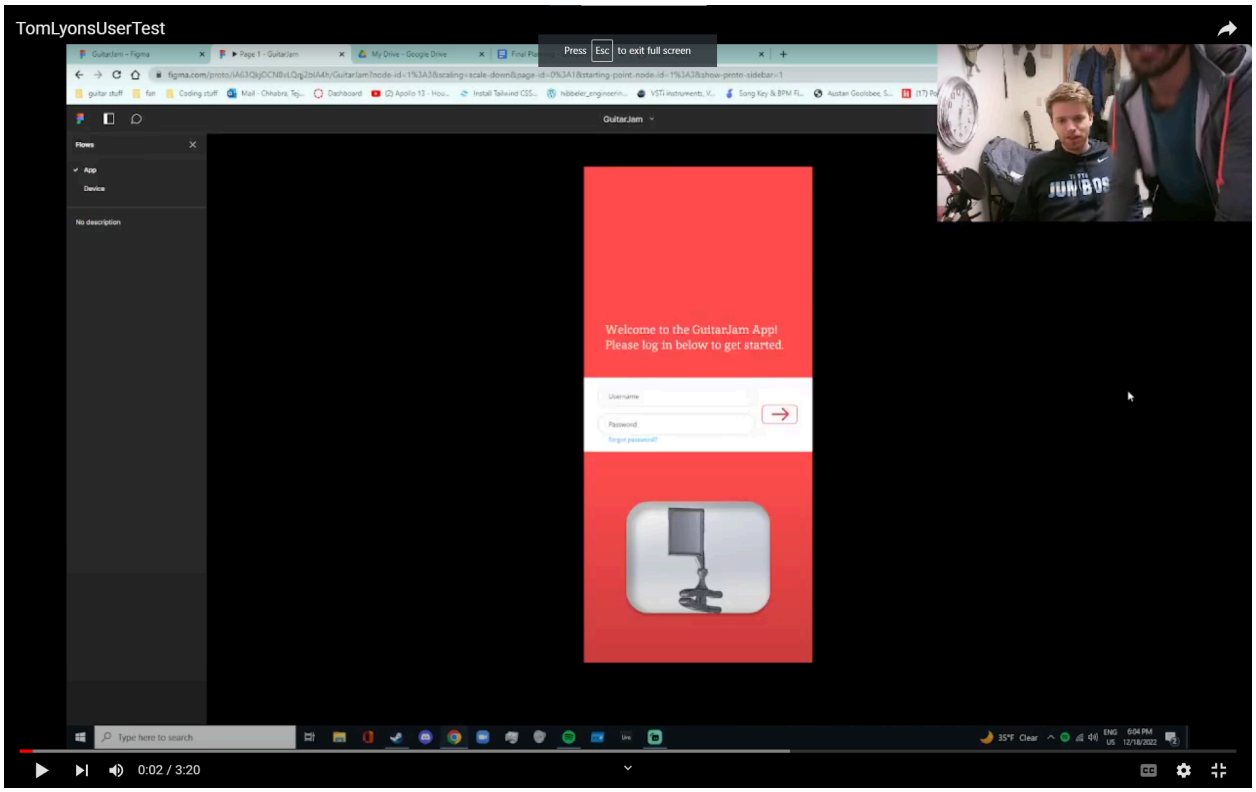


Using the values obtained from the anthropometric section and the design sketches, I created the prototype model in SolidWorks CAD software. The CAD file is attached, and contains four different parts that have been assembled into the final part. The first part is the screen, which ends in the ball joint. The ball joint then is mated to the top of the clamp which has the socket. The to pof the clamp is connected to the bottom of the clamp via the final part, a pin. The entire assembly has been put together so that the product is able to move like it is supposed to in real life.

The Process VII: User Testing and Reactions

In order to start the user testing process, I came up with a task for them to do with the app and the device. This task was for them to log in, pair the device, navigate to the search bar, and upload a song to the device. Then, they had to use the other interface to play the song. Along the way I let them ask me any questions they needed to assess any confusion in the process.

Here is the link for the user testing: https://youtu.be/pTNI9_PUnlg



The results from all of the user testing I did was largely positive, I think in part due to the thorough observational and interview work done beforehand. The only concerns with the device was when operating the device interface, where all of the problems were with figuring out how to advance with the arrows, a problem which would not exist if the testing was done on an actual device with physical buttons.

Concluding the app design and the CAD designing, I feel like the major concerns brought up during interviews and testing were addressed, and I am satisfied with my product.

Conclusion and Reflection

I thoroughly enjoyed completing this project. It allowed me to take something I love and solve a problem that I had with it. In addition, I learned that many other people who also play guitar have had a similar problem as me, which helped me to keep going. Since most of the developments for this project were purely digital, I had trouble recreating user testing for the actual device, since it was not possible to develop it for this project. It was interesting to come up with solutions for this, and how to still test the product without having the actual product. I also enjoyed synthesising information from across the internet in the biometrics section in order to develop a product that was usable for all ranges of people, not just my target audience.

One of the most important takeaways from this project for me is my love for vertical thinking, or thinking not just about one of the parts of the device, but for all of it. Part of this process is balancing feasibility with imagination, and knowing when to stop adding features to create an actually viable product, and not just a dream. In my designs, I not only used what the users said they wanted, but the unspoken wants. The user wanted an affordable device that is durable and useful. This led me to think about the kind of materials this product would use to make sure it feels good but keeps manufacturing costs low. Additionally, I designed it so it has little moving parts that could cause degradation in the product, and kept the mechanisms simple so that a part could be replaced without breaking the whole product. Lastly, I considered the screen types and what would offer good contrast and battery life to the consumer.

I have been on both sides of the business, designing and implementing ideas, and I have a passion for both. This product allowed me to expand my knowledge of Figma and SolidWorks, something which will indubitably aid me in future endeavours. This product also lets me take something that I am passionate about and love doing, and combine it with the topics we have covered in this class, something that will resonate with me as I approach my future career in school and beyond.

Deliverables

USER TEST
FIGMA APP
FIGMA INTERFACE
CAD FILE (GOOGLE DRIVE LINK)
CAD FILES (BOX LINK)