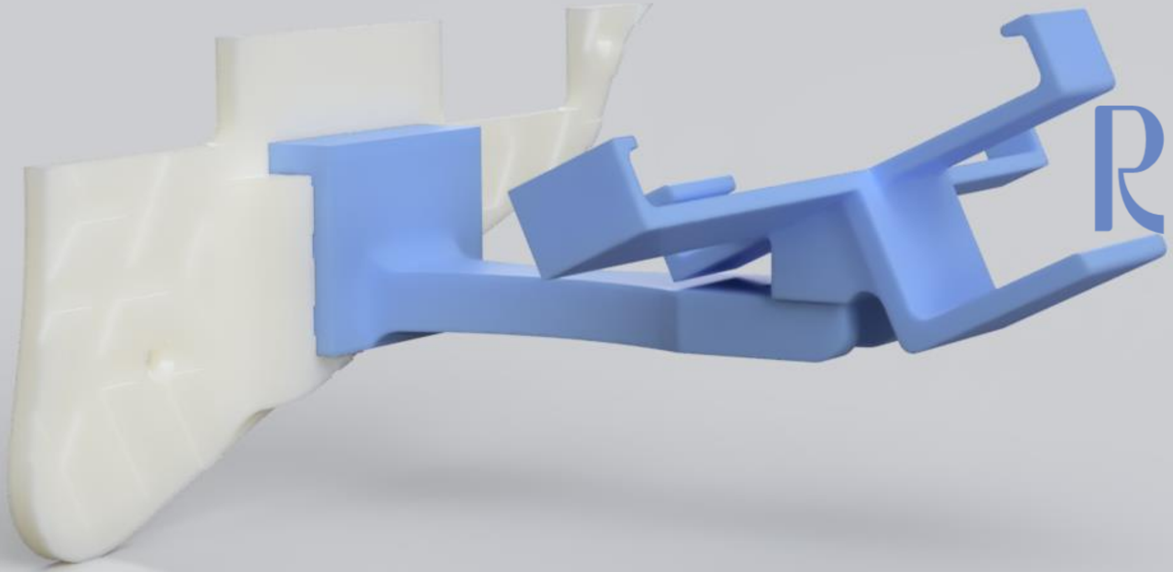


ROADIE

by Omar Ramos Escoto
ME127 Spring 2022
Project 3

PROJECT INTERPRETATION AND OBJECTIVES

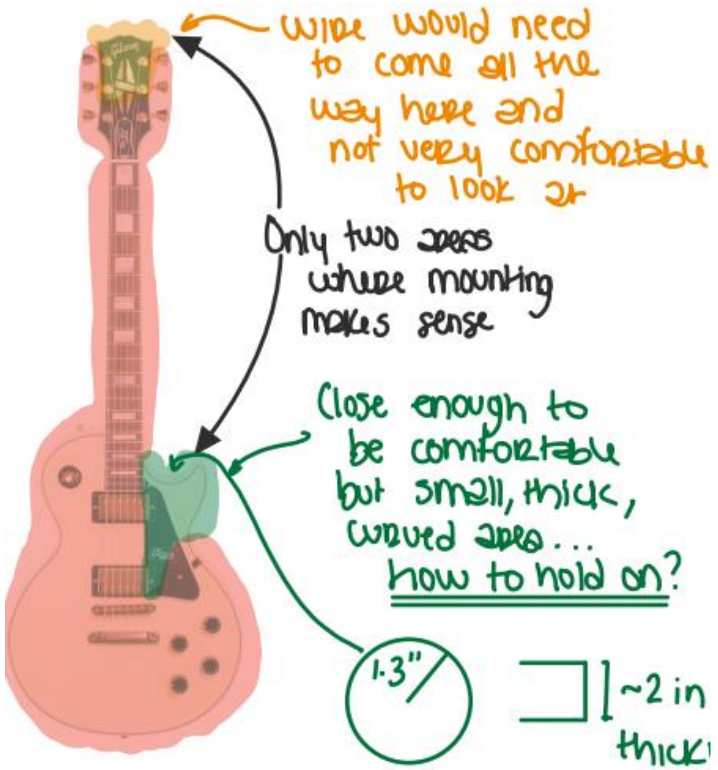
The goal of this project is to synthesize the knowledge gained from ME127 this quarter into designing fixtures/tooling or using algorithmic modeling to leverage the capabilities of AM.

My interpretation and application of the prompt was to make a fixture that would simplify something I was already doing and add some shape optimization to combine a little bit of both prompts. In addition, I wanted to make something that I would actually use, was for entertainment purposes, and had modularity as a priority.

PROJECT MOTIVATIONS

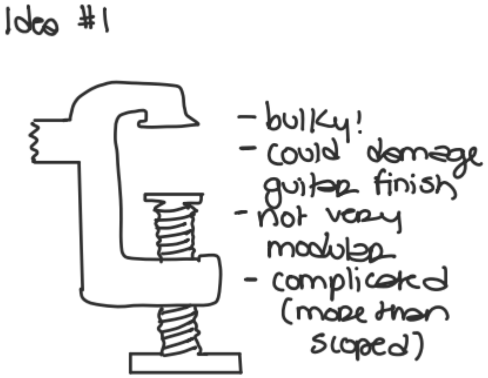
This has been my practice equipment since I was a sophomore in high school. However, for the last few years, I find myself barely picking up my electric guitar because of how tedious it can be to set up all the cables and sound. Even just using my practice equipment, trying to change sounds on my phone while holding my guitar and making sure no cables get tangled or get in front of me makes it very difficult to enjoy my time playing. My goal was thus to find a way to make this painless, immersive, and much more likely to get me to play my electric guitar again by **creating an easy-to-assemble mount that would attach to my guitar and hold on to my phone and audio interface in a comfortable way at an easy-to-reach position**.

DESIGN EXPLORATIONS

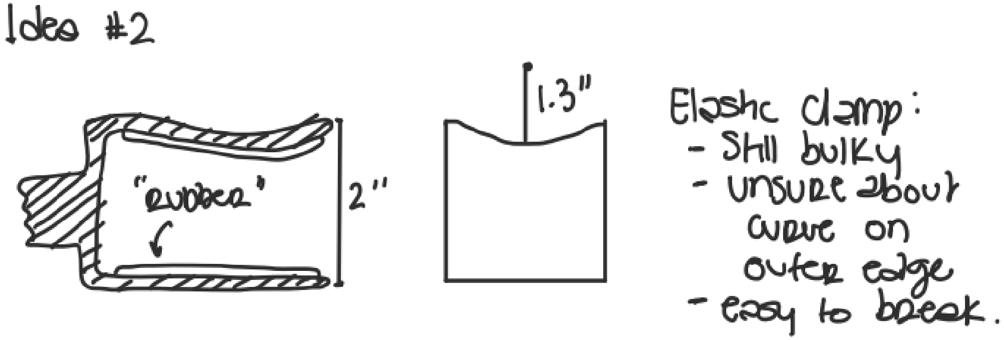


Because of the way this guitar is shaped, finding a place to mount something onto was the main challenge. I could either mount it on the top part, which made it easy to design but hard to use, or mount it close to the user in the green area, which was great to use but very difficult to design because of the curves.

Existing market solutions either use a clip to attach it to the top of the guitar or a suction cup, but neither of these worked for me.

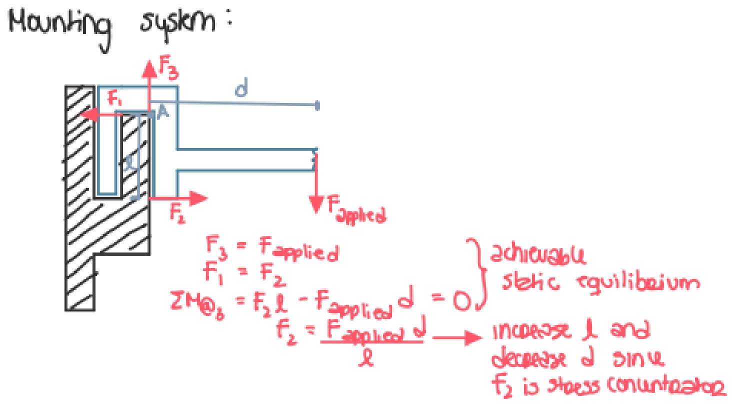


Traditional clamps, either elastic or with screws, were good solutions to hold on to the irregular surface. However, both were bulky and more complicated than what I had time to design. The traditional clamp could damage the guitar's paint easily and the second mechanism relied on deflection, so after many uses, it could deform and not provide enough clamping force.



DESIGN EXPLORATIONS CONTINUED

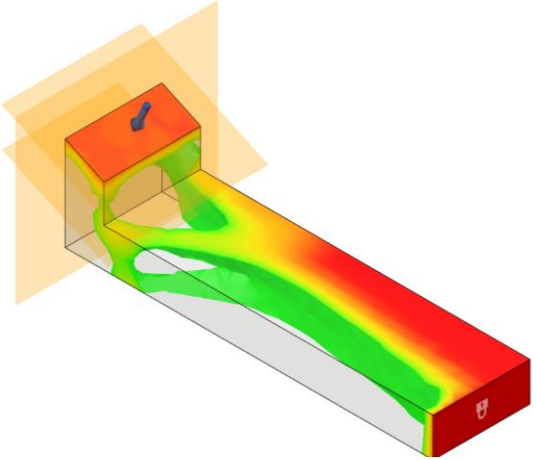
After struggling to find a solution to the mounting problem, I realized that one area of the guitar I had not thought about was the pickguard! It was flat, attached to the guitar with screws in a great position, was very original, and had great potential to become modular.

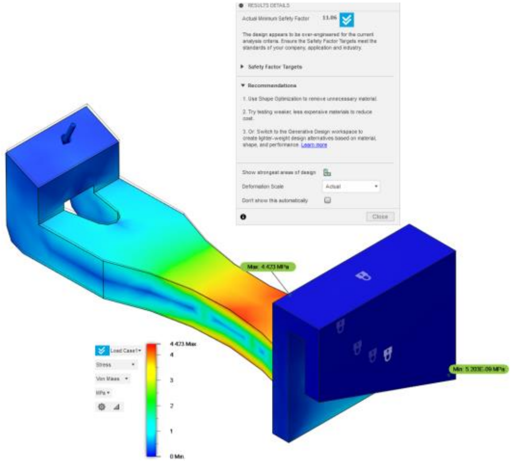


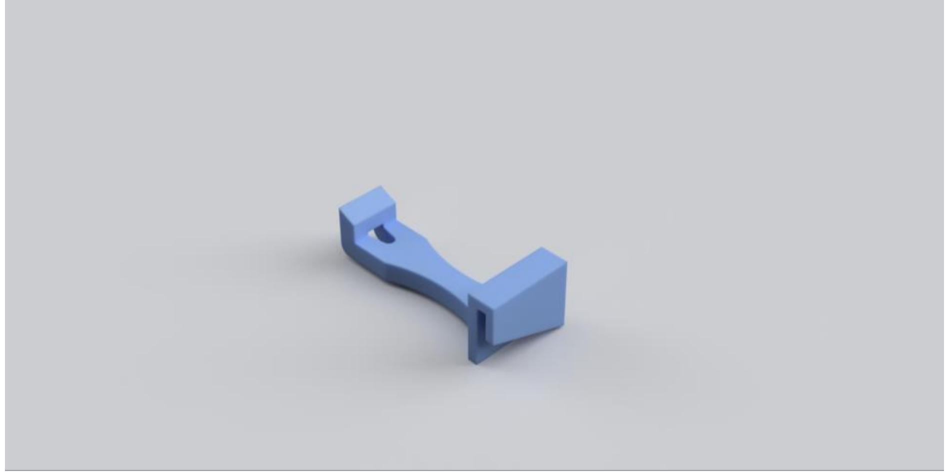
A **slot mechanism** would allow for extremely easy assembly and disassembly. FBD's showed that it could be in equilibrium, and I could take advantage of lever arms to reduce force magnitudes were convenient.

Mesh and Prototypes: Learned how to use Fusion 360's mesh tools to make a pickguard mesh I had into a body with faces that I then iterated on first to align holes/cutouts and then thickness before moving on to the final slot design seen on the right.

This component is essentially a cantilever beam, simplified and studied as such in the **shape optimization** study shown. A 15N force was applied at the tip (right under where the phone will sit) and the curved pattern with the internal cutout was returned, suggesting changes to the original rectangular design. These changes were verified in an updated FEA that confirmed a high safety factor, which was acceptable since I was planning on printing at only 20% infill.

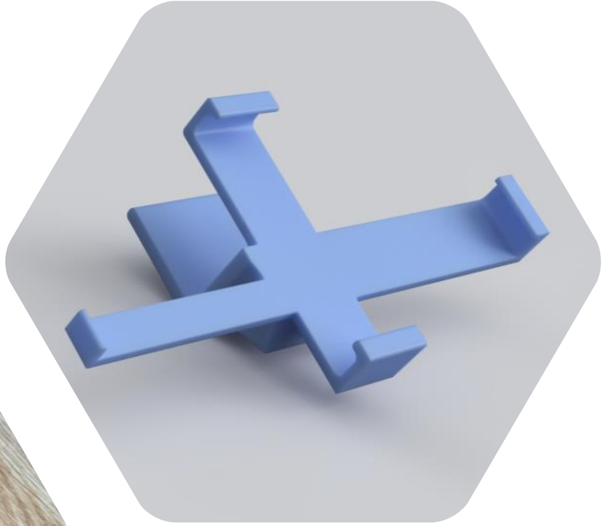


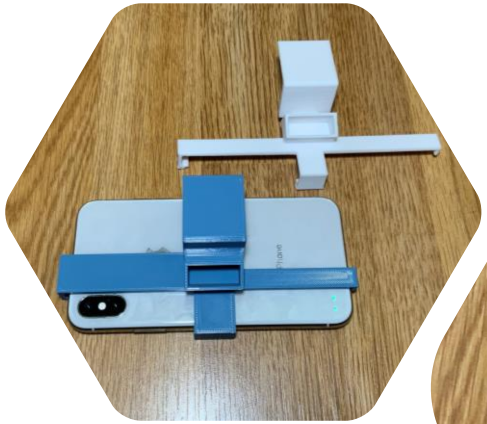




ASSEMMBLY COMPONENT NO.1 : CANTILEVER ARM

This member was originally designed to be made from Nylon due to Nylon's impact resistance and compliance. I wanted to have something that I could throw around in my bag without breaking from being too brittle. Nylon was a durable choice that would remain dimensionally consistent to guarantee a good fit after many uses. Unfortunately, the printer I used kept having layer shift issues that I could not solve so I went back to using PLA. PLA is a strong material that is not brittle (especially at low infill), it's readily available and I also have PLA of colors I like, so using PLA in this case where I was looking for a lightweight, dimensionally stable material that was just strong enough worked out perfectly. Additionally, since the cross sections were relatively thick, this member is ideal for the loading since it's moment of inertia helps reduce deflection



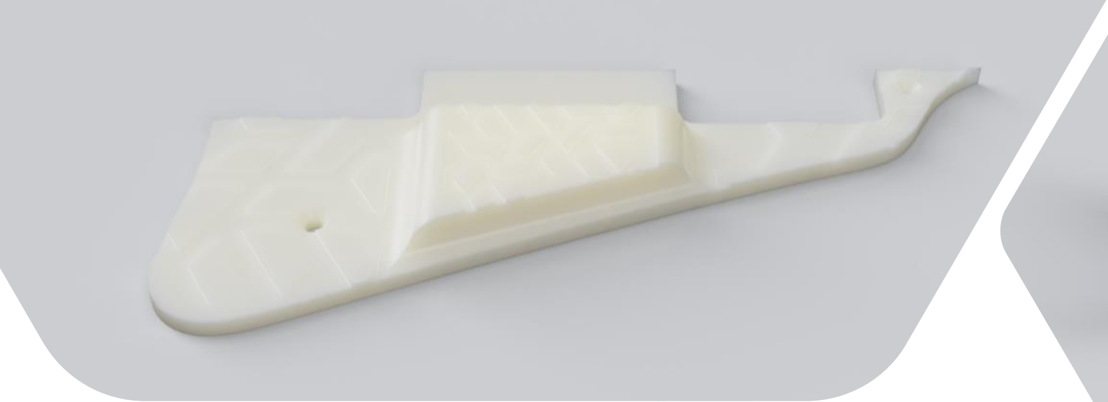


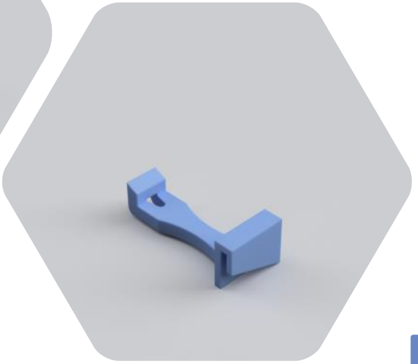
ASSEMBLY COMPONENT NO. 2:

PHONE MOUNT

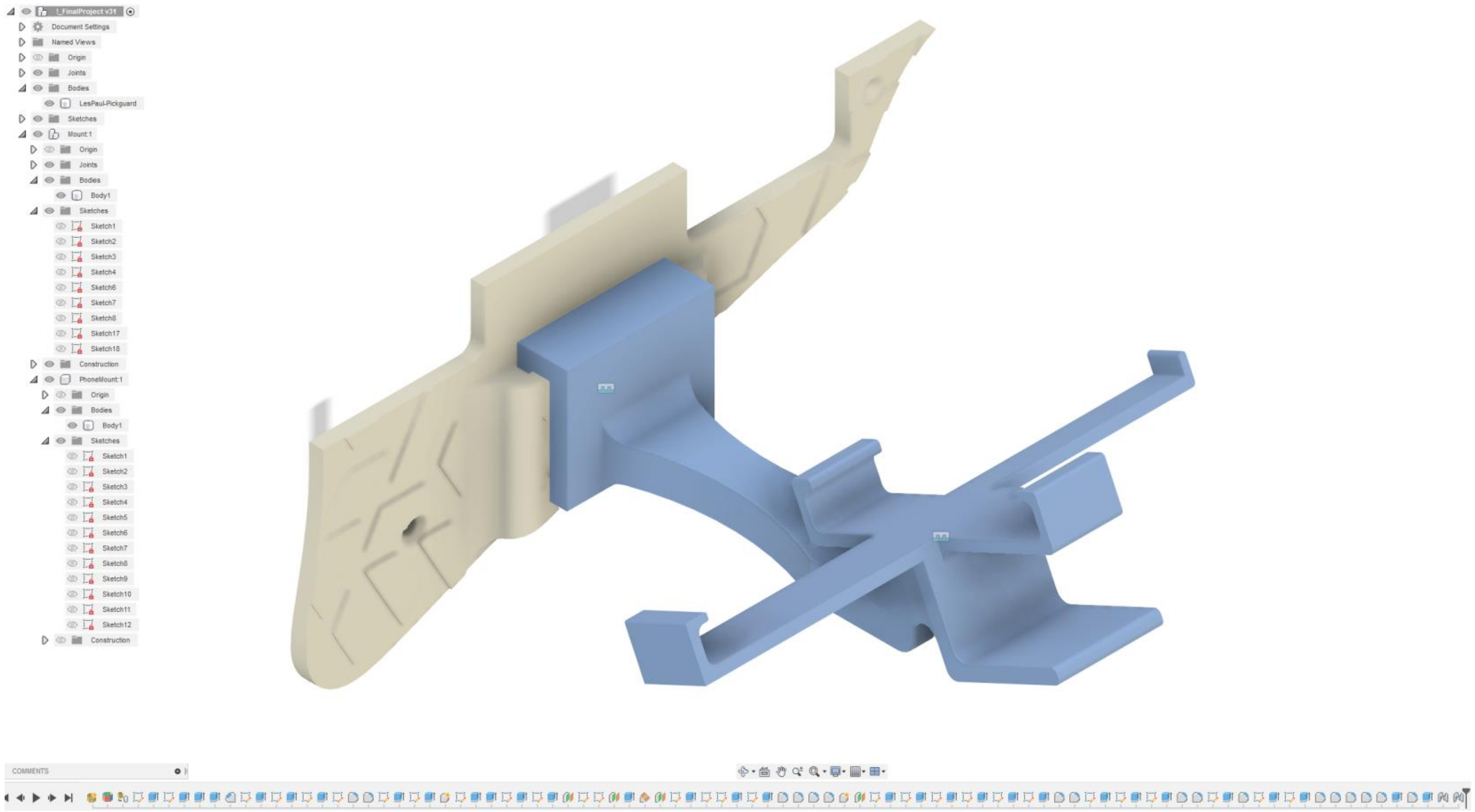
Similarly to the cantilever arm, this component was supposed to be made from Nylon, but this time the prints kept warping on top of the layer shifting issue. Therefore, I again used PLA for the same reasons: aesthetically better in terms of matching color, not brittle and able to withstand the wear and load.

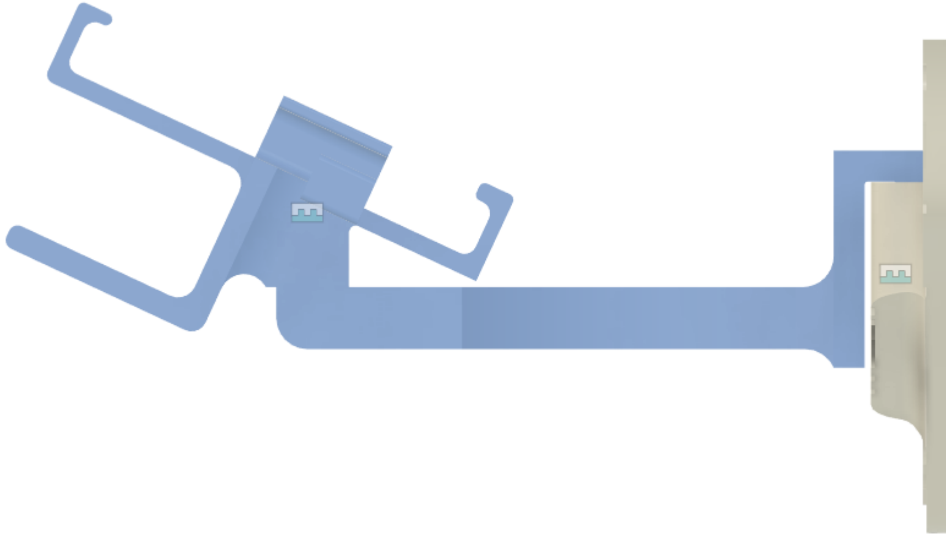
The component is designed to hold an iPhone X and can be used on its own (on top of a table, for example). The phone can slide into the enclosure from the left side since that lip is shorter, but it can also snap into place from the top. The two iterations shown vary in the width of their arms, with the blue one being wider and leading to more stability.





FINALIZED CAD



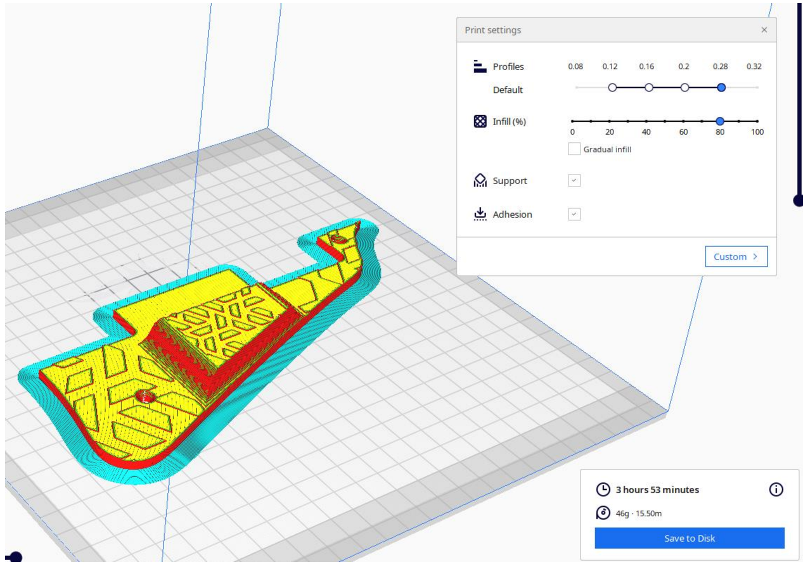


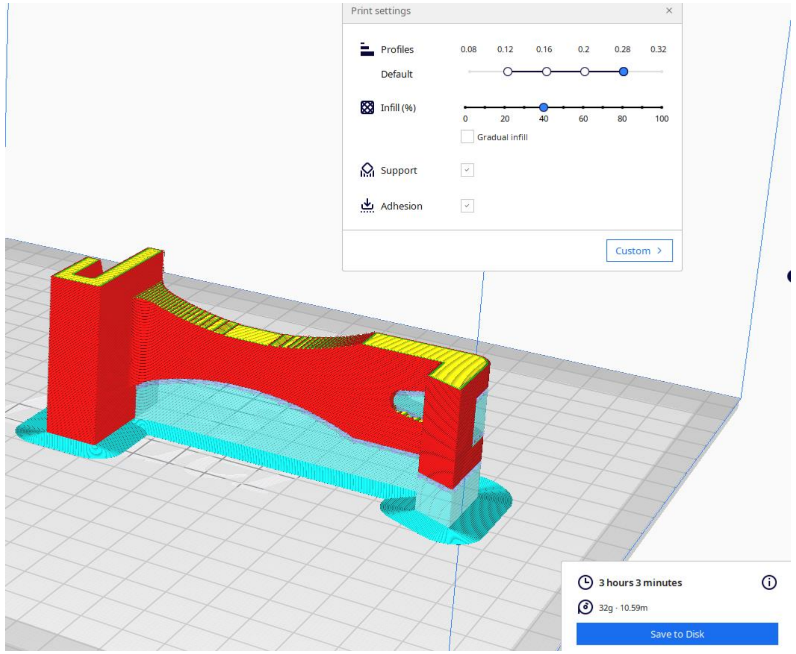
SLICED PARTS

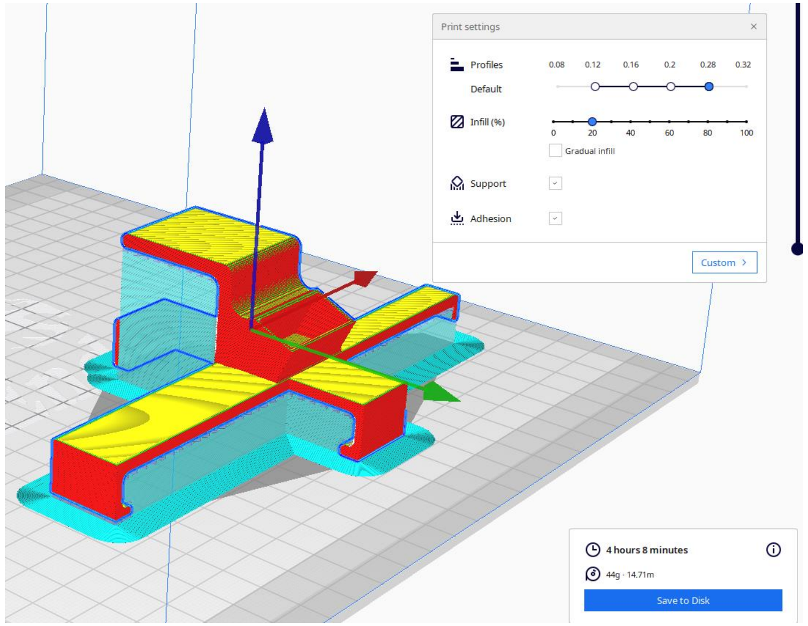
The orientation for this part is determined by its very planar geometry and the extruded designs on the top. Although not the best orientation for the slot connection when loaded (would result in shear between layers), the loading is not nearly high enough to consider it an issue. Therefore, first layer adhesion and the top design were prioritized.

The orientation for this part is determined by its loading. Due to the cantilever load, printing it upright would result in shear between the layers throughout the whole piece. Therefore, the orientation is set such that the layers are placed on the axis of the beam, resulting in only the expected bending of a cantilever beam.

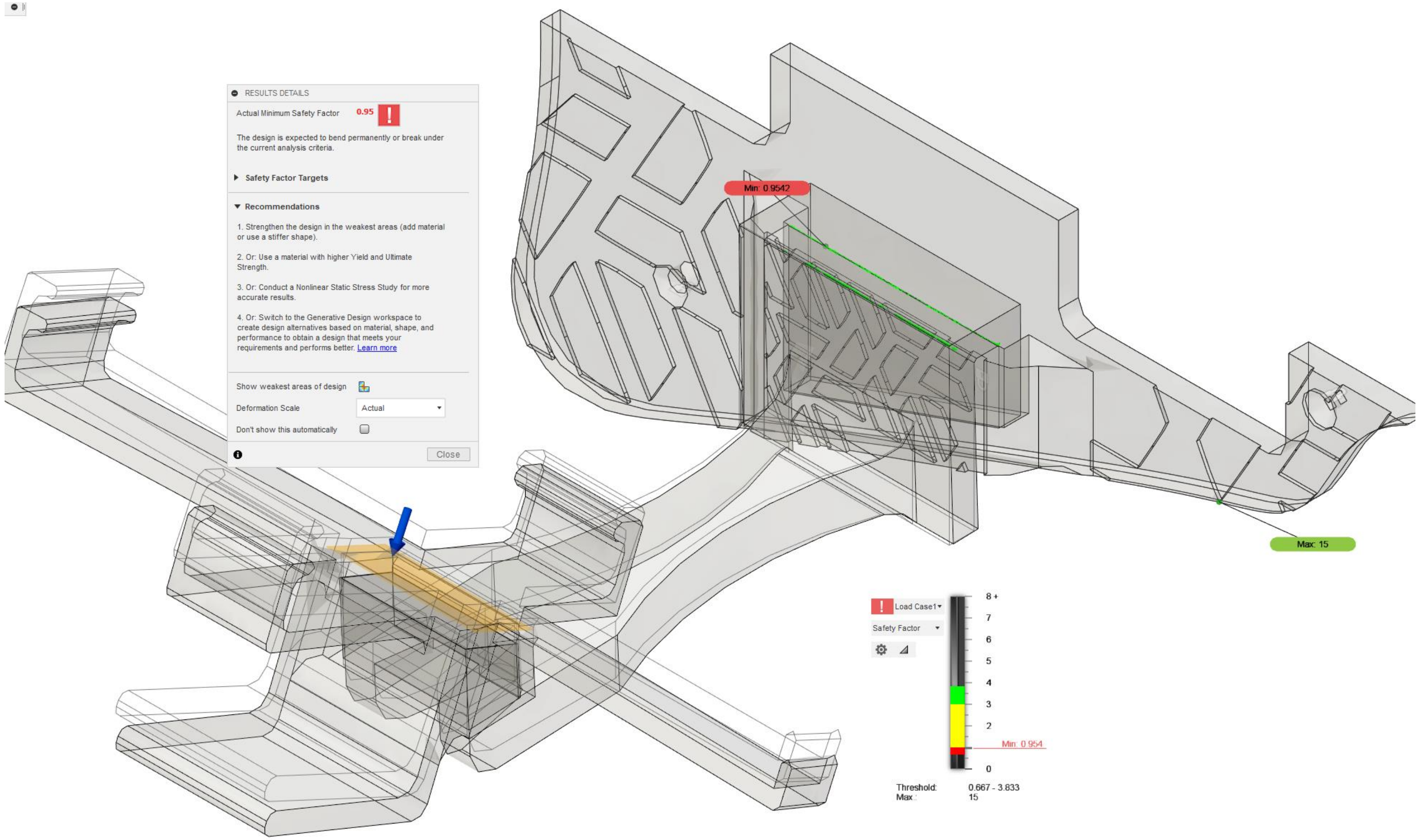
The orientation for this part is determined by supports and minimizing z-axis movement. There is no concentrated load on this member, but there are multiple offset planes upon which it is built so it was oriented such that the resulting supports were in areas that were easy to reach. This was also the fastest printing orientation.



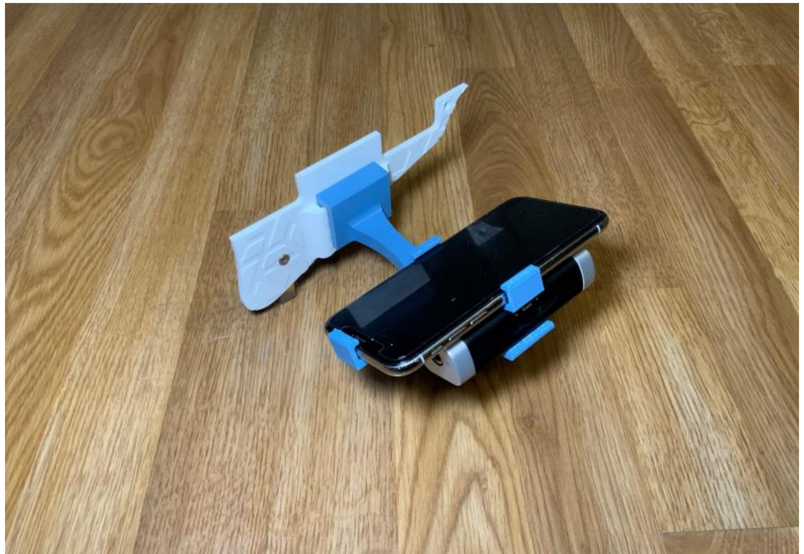




FINALZED ASSEMBLY FEA



According to the most complete FEA, the design is very safe. The material used for the bodies is acrylic, since it is the closest in relevant properties to PLA in Fusion's library. The only areas of concern are the corners where the cantilever arm and the pickguard meet, but this is completely expected and is a reinforced area since the printer puts solid material on edges of faces. The rest of the body has a factor of safety of above 5, meaning this fixture can be printed at very low infill without concerns.



Time: ~15 hours
Cost: $5

FINALIZED ASSEMBLY & REFLECTIONS

I feel like I rarely end up making something that I actually use, but I played more electric guitar while just testing prototypes than I have over the last year!

I think the design ended up performing very well. I expected things to move around a little more or feel more unstable due to manufacturing error, but it felt very sturdy, and I found myself turning my guitar in every direction knowing that my phone was not going to fall off. If I had more time, however, I would smooth out corners and make it more user friendly. I only hit the assembly once, but it hurt so I would need to be more thoughtful about how to completely avoid being in the user's way.

My main takeaways are that 3D printing can be extremely practical. Fixtures and tooling being available so easily, with choices in material and even different ways optimizing for different parameters (algorithmic modeling), makes me feel very fortunate about being surrounded by this technology and excited about how many more uses it will have in the near future. I will now think twice about if a standard tool is truly the best option!

Testing Video:
https://drive.google.com/file/d/1m9sUUfd04P1ykNUuLmltRiCflhbHbWui/view?usp=sharing