Sim Racing Steering Wheel

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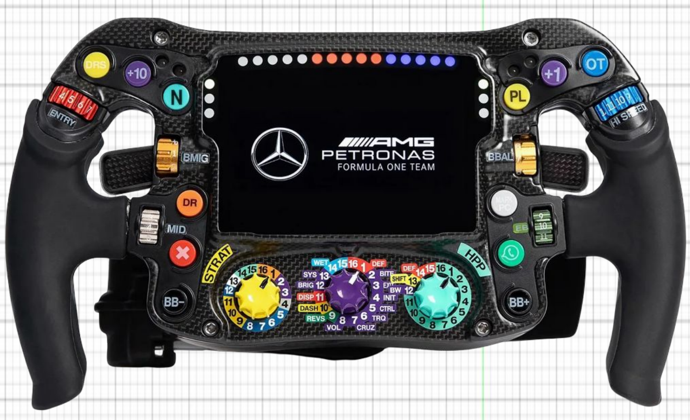
Motivation

Commercial sim racing wheels often cost upwards of $400–$3,000, which creates a barrier for students and beginners. My goal was to create a more affordable alternative that still provides a realistic steering experience, while also challenging myself to learn new technical skills.

Through this project, I set out to:

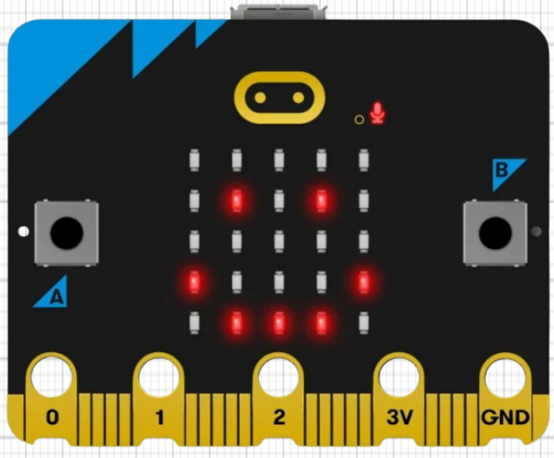
- Improve my Python programming skills.
- Learn about electronics and input mapping.
- Explore human-centered design by shaping the wheel to be comfortable and practical.

This project was driven by both my passion for racing games and my desire to gain hands-on experience with engineering design, prototyping, and iteration.



To guide my design, I studied the layout of professional racing wheels, focusing on the Mercedes F1 steering wheel used in F1 24. At $3,699, this replica reinforced my motivation to create a DIY version.

I started with a micro:bit board I had since 4th grade. Initially, I assumed it would be too simple for this project, but I discovered it had several useful features. Alongside the micro:bit, I found a set of buttons and a potentiometer from an old kit. My initial plan was to use the potentiometer to measure wheel rotation.

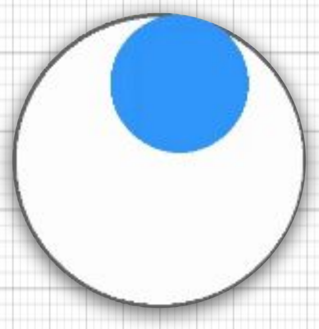


First Prototype

I connected the potentiometer to the micro:bit and began writing code in Python. The board connected to my computer via a serial port, which provided both power and data transfer. I asked ChatGPT to generate initial code, then debugged and refined it myself.

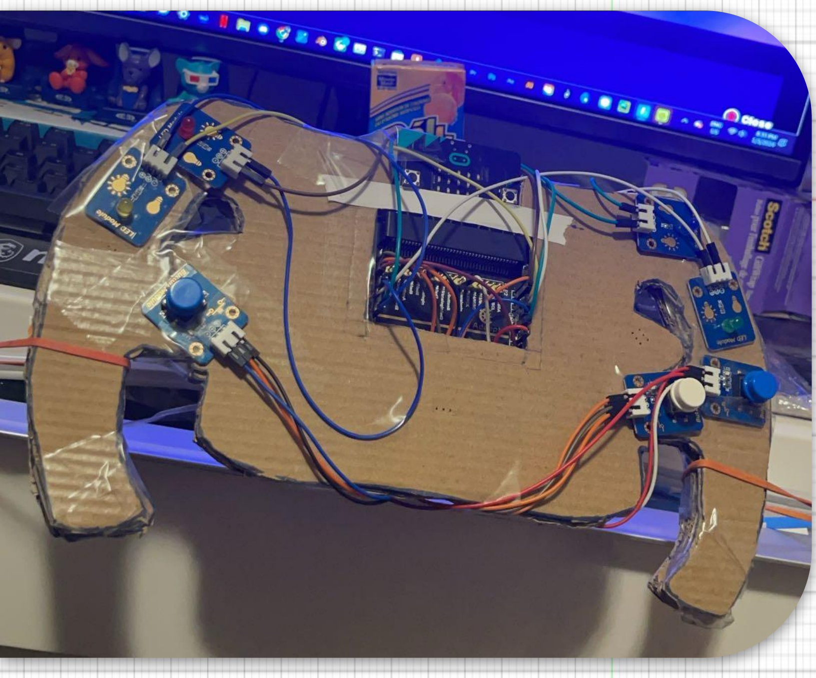
However, I discovered the potentiometer was broken. This forced me to rethink my approach. After researching alternatives, I realized the micro:bit had a **built-in accelerometer**. By writing code to process its output, I was able to successfully track rotation and feed it into my computer.

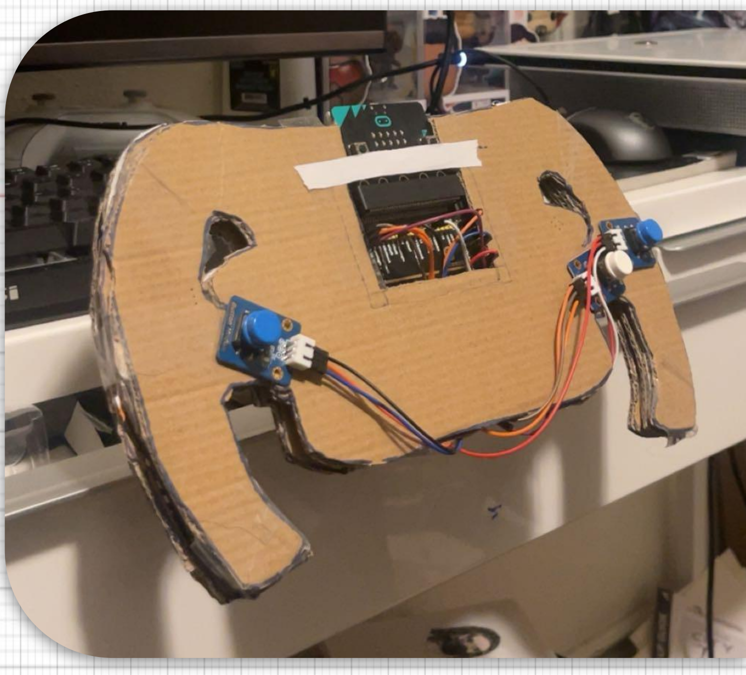
I made the code convert the microbit rotation values to map it to a turning simulation so I can see if it will work properly for precise movement in racing games. I then configured the data to emulate an Xbox 360 controller joystick, since racing games already support controller steering. This solution allowed me to test precise steering inputs in a game environment.



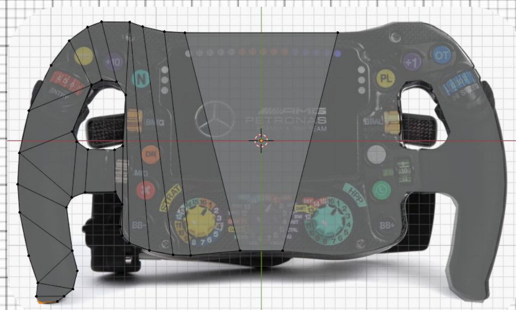
With the electronics working, I taped the micro:bit and button modules onto a cardboard cutout of the F1 wheel. The wheel was mounted to a cardboard tube inserted into a desk drawer, and elastic bands provided self-centering—mimicking a real F1 car. Two buttons were mapped to throttle and brake, replacing pedals.

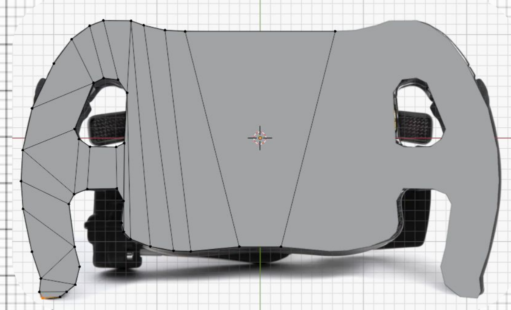
This prototype validated the functionality but was not durable or visually refined. My next step was to design a proper enclosure.

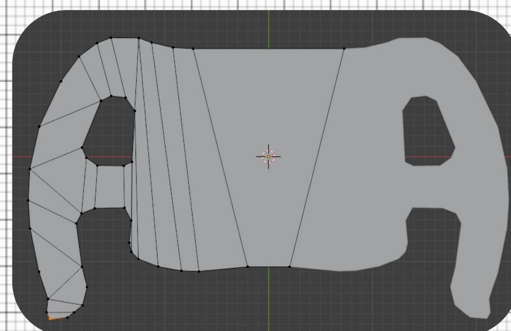




CAD Design

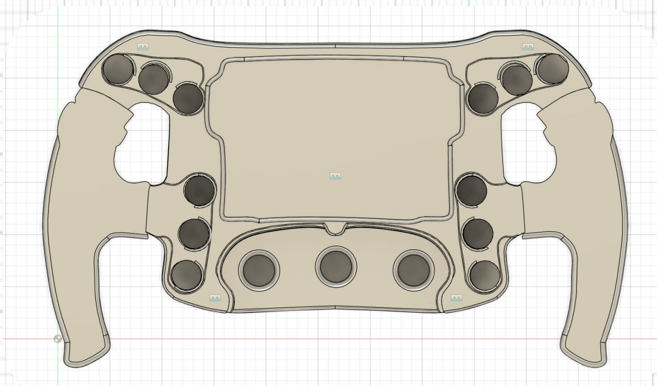




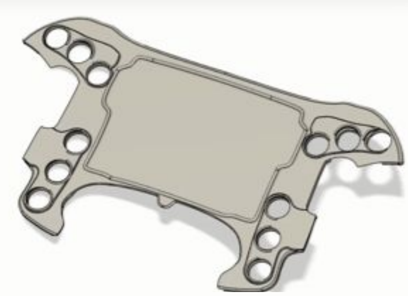


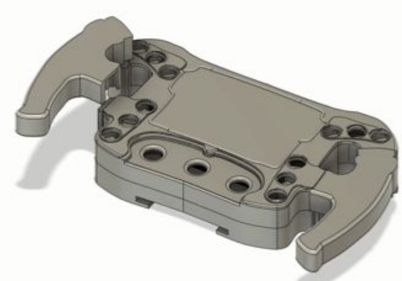
My first attempt was in Blender, where I modeled a wheel case. However, the model was hollow and unsuitable for 3D printing. I switched to Fusion 360, which allowed me to use precise measurements and incorporate mechanical features such as:

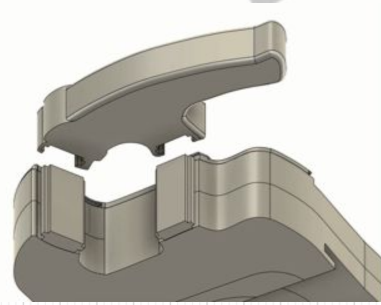
I then decided to redo the design in Fusion 360. This brought many advantages on top of the 3D printing fix such as being able to more easily input exact numbers and dimensions with units, and the various tools fusion 360 provides which will help with adding pockets for components.



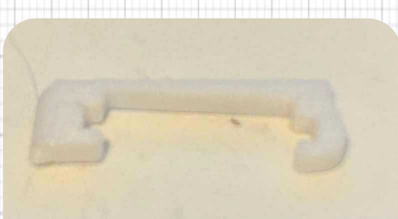
Above is the basic design I made in fusion 360. I wanted to print it in parts so when I upgrade parts I can replace them individually instead of having to reprint the entire thing. I modeled a custom rail system to slide the handles down into the controller as seen in the images to the right. I also made the top part snap on with holes in the base and studs on the lid.

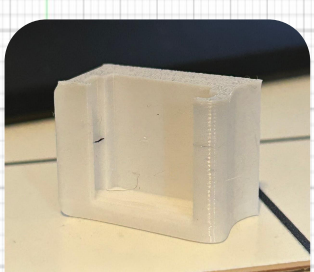






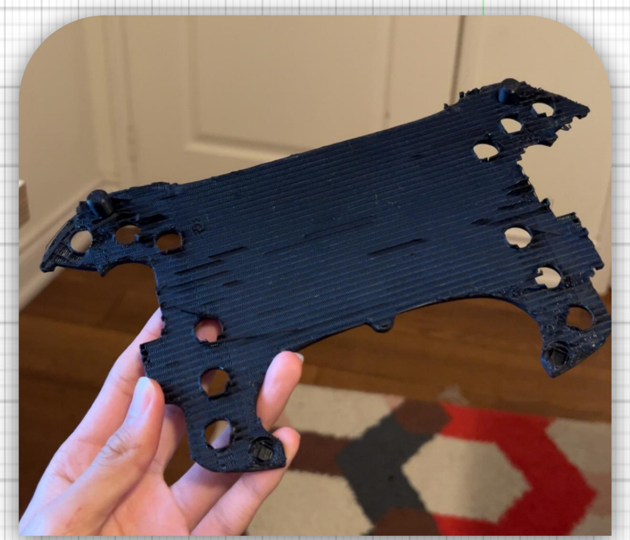
On my first attempt to print the handles the tolerance was too tight, to minimize wasted filament, I printed smaller sections to refine tolerances





First Prints

1. Base printed with micro:bit placed in it



3. I realized if I print the lid with supports, they would be too hard to remove. I decided to print the studs, used to clip onto the base, separately so that the lid will have a flat bottom surface which will print well without supports

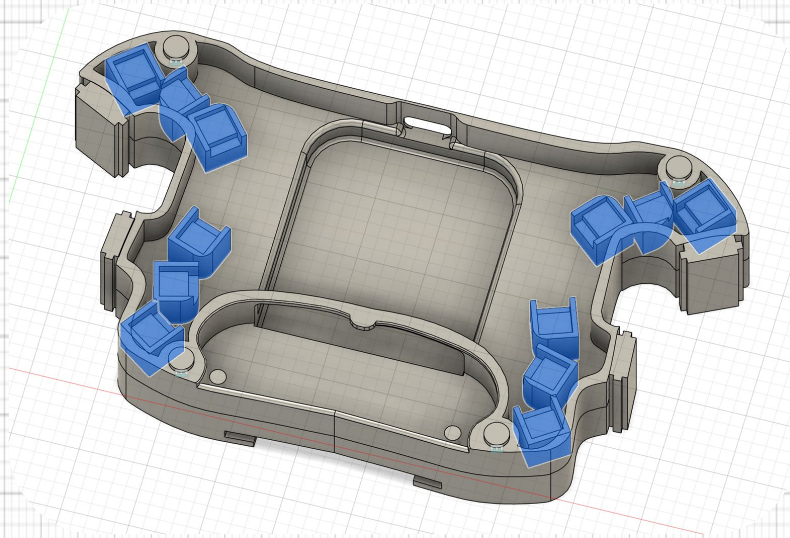
2. Lid printed

4. Lid attached

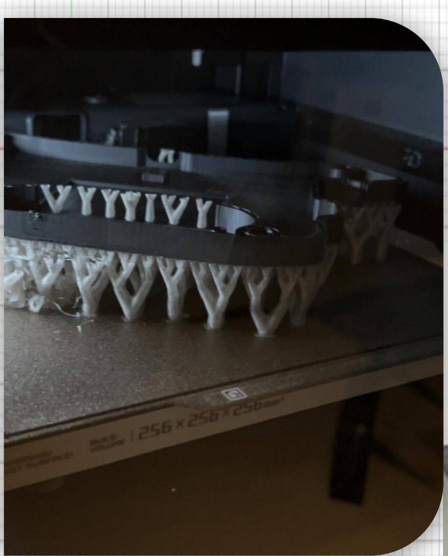
5. Buttons, rotary encoders, and wires added

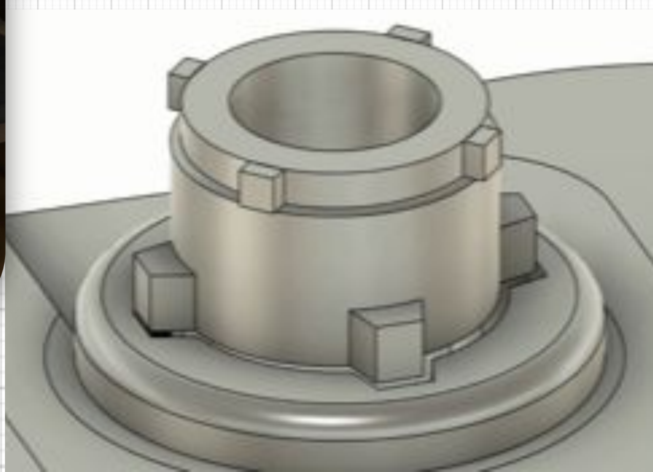
Design Changes

I put all the components into this new 3D printed steering wheel, but the buttons didn't have anywhere to go, I tried taping them to the lid from underneath but whenever I pressed a button it would go deeper into the case. I solved this problem by modeling specially measured rectangular holes for which the button modules will fit in, they are highlighted in blue on the image to the right

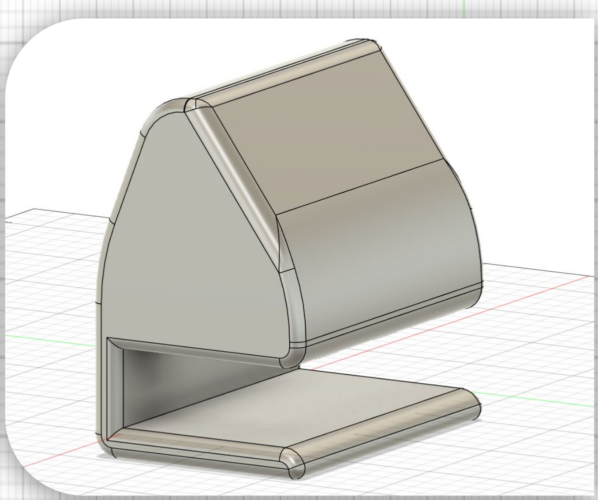


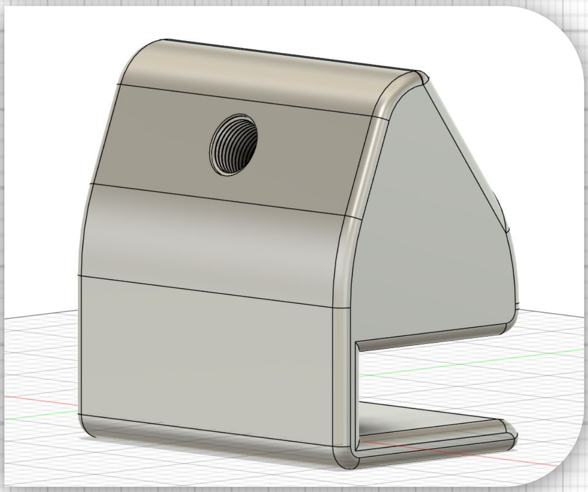
I tried printing the base multiple times with supports but it came out deformed on some corners and I couldn't remove the supports. My next thought was to print the supports in a special bambu labs support pla which is made to be easily removed. The supports remained difficult to remove, so I experimented with print settings such as changing the z axis gap between the support branched and the model to improve separation. This didn't work either so I contemplated making the base thicker so it solid all the way to the bottom, I saw photos of the side view of the real f1 wheel and its supposed to be thicker anyways so I chose that. The reason there is a cylindrical piece at the back is so that the future desk mount will go inside and turn to lock in place



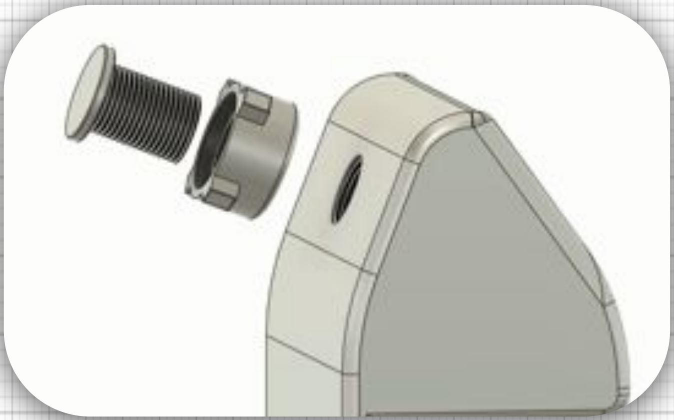


Desk Mount CAD Design

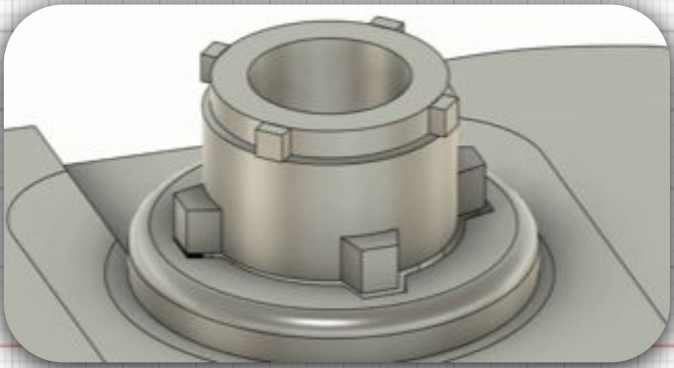


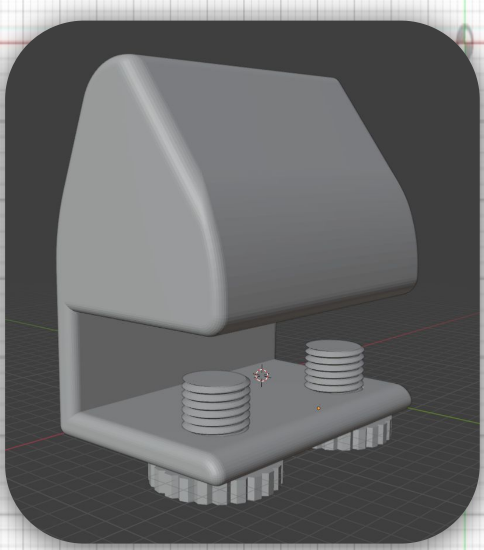


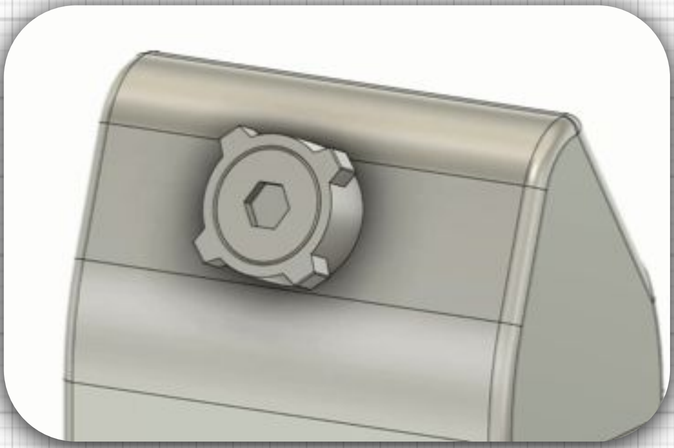
Next, I designed and printed a desk mount. I designed it so that the base of the mount will slide onto my specific desk which I measured with a digital caliper. There is then a special component I modeled which locks into the steering wheel and is connected to the base with a screw. There is inverse threading in the base but none in the middle piece so it can still rotate with the wheel freely.



I later decided to reprint this piece with 2 screws at the bottom so it can be adjusted to fit on other desks as well by turning the screws to the desired desk width.



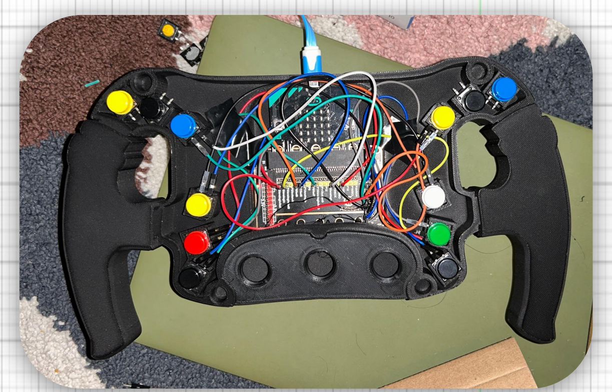




Once I was happy with the overall design and refined the design as needed. I decided to reprint everything but instead of using a PLA filament which is a basic plastic, I would instead use a PLA-CF material which is similar to PLA but has shreds of carbon fiber embedded in the filament. This gives advantages such as making the print stronger and stiffer so it won't break easily, as well as giving it a very smooth and premium feeling finish.

Parts List (and software)

- Microbit
- Button modules x 12
- Rotary encoders x 3
- Microbit extension board
- Wires
- Black Bambu Labs PLA
- White Bambu Labs PLA
- Black Bambu Labs PLA-CF
- Tape
- Cardboard
- Micro USB Cable
- Blender
- Fusion 360
- Bambu Studio
- PyCharm
- Vgamepad



On the right is a look inside at how the buttons and microbit are placed and wired inside the base of the steering wheel

Reflection

Through this project, I refined my skills in Python debugging, CAD design, electronics integration, and prototyping. I grew as an engineer by learning to embrace failure as part of the process and by continuously iterating on my designs until they worked effectively. If I were to continue this project, my next steps would include adding pedals with hall-effect sensors, implementing force feedback for greater immersion, and redesigning the handles to improve ergonomics and comfort. Beyond the technical outcomes, this project confirmed my passion for hands-on engineering and design. It strengthened my persistence, creativity, and problem-solving abilities, and gave me confidence in my ability to take an idea from concept to functional prototype. Most importantly, it deepened my motivation to pursue engineering at the university level, where I look forward to applying these skills to more advanced projects and continuing to grow as both a learner and a builder.