Steering Wheel
ARG25 Spring Technical Report
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1. Introduction

The steering wheel gives the driver direct control over the car, enabling them to steer left or right through its connection to the steering system and the front wheels. Without it, the car would only be capable of moving in a straight line with no directional control. An ergonomically well-designed steering wheel helps reduce arm fatigue and discomfort, which can enhance driver performance over longer periods. The integration of new buttons and dials further improves control efficiency, allowing the driver to make critical adjustments without distraction. Additionally, by targeting a lighter design, even small reductions in mass contribute positively to overall vehicle performance—lighter cars accelerate faster.

Steering Wheel Rules 2025:

V.3.3 Steering Wheel

V.3.3.1 In any angular position, the Steering Wheel must meet **T.1.4.4**

V.3.3.2 The Steering Wheel must be attached to the column with a quick disconnect.

V.3.3.3 The driver must be able to operate the quick disconnect while in the normal driving position with gloves on.

V.3.3.4 The Steering Wheel must have a continuous perimeter that is near circular or near oval.

The outer perimeter profile may have some straight sections, but no concave sections. "H", "Figure 8", or cutout wheels are not allowed.

2. Technical Overview

The key parameters for designing the steering wheel are primarily defined by the FSAE 2025 rulebook, which ensures safety and compliance. Additionally, the steering wheel must be rigid enough to withstand the forces exerted by the driver during operation. Beyond these requirements, other important considerations include tailoring the design to driver preferences, ensuring waterproofing to protect the integrated electronics, and applying ergonomic research to reduce fatigue and improve performance.

This year marked the first time our team assigned the steering wheel as its own dedicated design task, separate from the overall steering system. This gave me more creative freedom and time to focus specifically on the steering wheel's design. One of the biggest challenges I encountered was using freeform modeling in CAD to create personalized driver grips. Since this approach was new and not widely practiced among past part designers, there was little existing knowledge or guidance. As a result, I had to teach myself the tools and techniques through hands-on trial and error. This process involved multiple design iterations and complete CAD rebuilds as I improved my skills and refined the shape.

Another significant step forward was the introduction of a testing plan to evaluate the rigidity of the steering wheel layup—something that had not been extensively tested in previous years. I was able to collect data and gain a better understanding of the structural performance, which I hope will serve as a foundation for future improvements.

3. History of Past Designs

Previously we usually purchased our steering wheel from SPA Technique but due to heavy weight (1lb) and difficulty setting up the dash, in ARG08 they manufactured the steering wheel using carbon-fiber in house to achieve lighter and more ergonomic design (can see in figure 1). We continued with the method of carbon fiber lay up with molds except the years 2011-2013 where we purchased go kart steering wheels due to time constraint and overall cheaper price. Many reports leading up to 2017 have commented on the amount of time it takes to manufacture the steering wheel – in ARG16 they stated it took over 39 hours to manufacture and hour to disassemble and reassemble. With that reasoning in ARG17 they 3D printed the steering wheel for easier manufacturing alongside being able to contain electrical components within the steering wheel (see figure 2). Moving forward we have been utilizing combined methods - carbon fiber lay up and 3D printed grips (can see figure 3). Overall in the past years they said that many judges praised the carbon fiber shell design but many questioned the rigidity of the shell carbon fiber design and big con regarding the amount of time it takes to manufacture. Last year (ARG24) didn't have any electrical components within the steering wheel thus we were able to make the steering wheel easily out of sandwich panel style lay up with 3D printed grips.

Figure 1 : ARG08 Carbon Fiber Steering Wheel

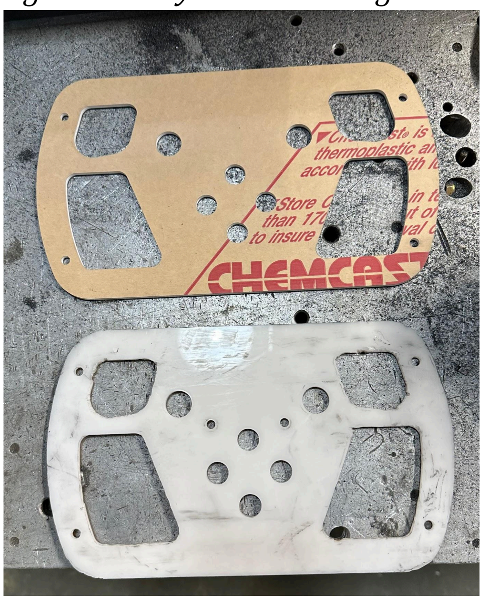
Figure 2: ARG17 3D Printed Steering Wheel

Figure 3 : ARG18 Carbon Fiber Steering Wheel with 3D Printed Grips

4. ARG25 Design

The ARG25 Steering wheel needs to be lighter, rigid, comfortable and waterproof. In ARG23 it failed the inspection test due to not being under the front roll hoop as mentioned in the rule book. The drivers feedback in the beginning of the year included wanting a larger steering wheel, thus the sizing of the steering wheel was iterated multiple times. I tested out the comfort of the sizes by simply laser cutting acrylic (Figure 4). However at the end I think it's going to be pretty similar in size as last year's steering wheel due limitations in roll hoop and where the steering wheel is placed. Thus another comment regarding this would be, next part designer should definitely speak up when they're deciding where to place the steering to maximize the steering wheel diameter.

Figure 4 : Acrylic Cut Steering Wheel

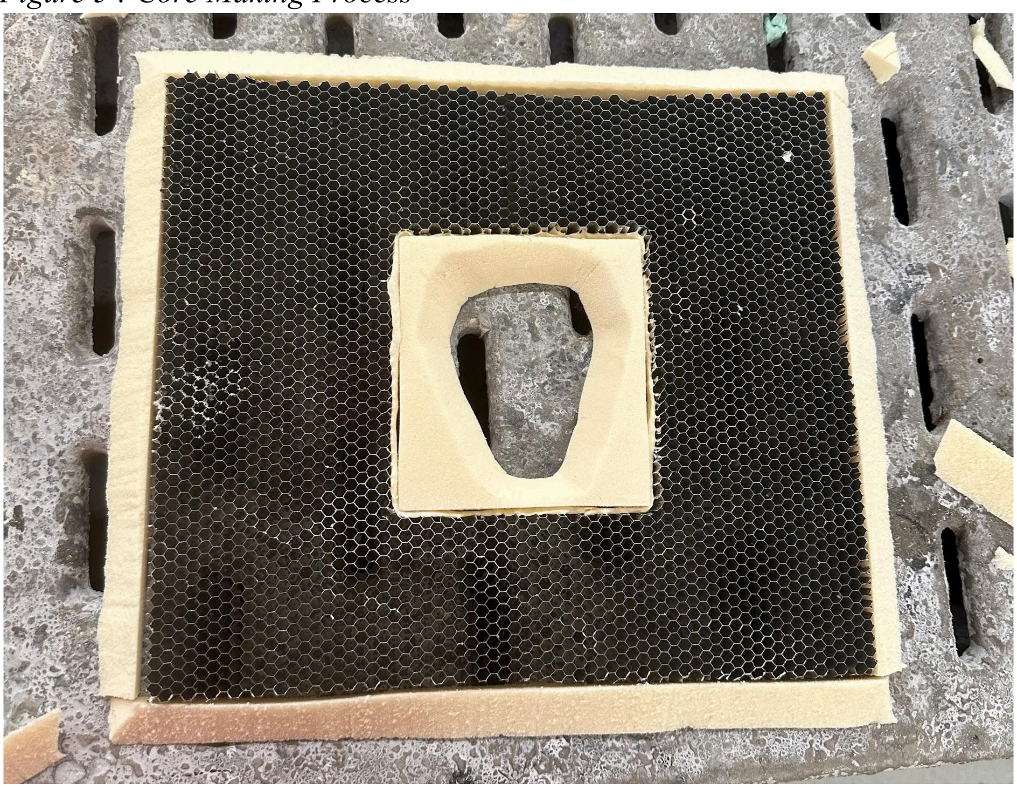


One of the biggest changes this year is the reintroduction of a dashboard interface on the steering wheel, which includes two push buttons and four rotary dial buttons. At the beginning of the year, we considered incorporating a display screen directly onto the wheel. However, after several meetings and discussions, we decided against it. Mounting a screen would have introduced significant challenges in both design and manufacturing, and there was no clear functional advantage to placing it on the steering wheel rather than elsewhere on the vehicle.

The inclusion of electronic components within the steering wheel required a complete redesign of the manufacturing process. In the past we did have electronic components, the method used was to CNC mold and lay up inside using carbon fiber. Inside the hollow parts the electronic wires and other parts can be placed. However in past reports many highlighted that this method was very difficult to carry out and the rigidness was in question. As mentioned in ARG24 Fredric Leal's report, deciding to manufacture the steering wheel through sandwich panel carbon fiber layup allowed us to cut a lot of weight compared to ARG23 and was easy to manufacture. Continuing with this idea and carbon fiber shell, we came up with the idea of still creating a sandwich panel for the steering wheel but with a hard point. This is something we have done with monocoque, where clevis need to be mounted. Compared to the carbon fiber shell, hard point style is more rigid as it still contains a core in between the carbon fiber as well as space for electrical components.

I’ve talked about exploring the option of using foam core for the steering wheel in my last technical report with reasoning that it’s much simpler to work with and at the end product we don’t have to worry about covering the exposed aluminum honeycomb core. Thus I used the same exact Lay up plan - which you can find in my Fall Technical Report - but with foam core (2 Lb. Polyisocyanurate Foam Sheets ¾”). The outcome was very flimsy on the thinner cutout areas and when I squished the steering wheel I could hear the foam sinking – overall definitely not strong enough. One good thing that came out from this trial was the hardpoint style space in the middle came out much nicer. I was able to route the shape to my desire compared to routing the honeycomb core with a router which had its difficulties and was more time consuming. At the end I came up with the idea to combine the 2 cores together. I routed the hardpoint out of a square shaped foam core and added a honeycomb core as the outer part (see figure 1). With this idea I was still able to save time by using foam core for hardpoint but also by adding the honeycomb it made sure it’s strong enough to handle the driver's maximum applied force. Few additional tips for making it : I used a router template as a guide to cut the foam core and a steak knife worked wonders on foam. In addition to preventing core crush we used to have a welded dam for each panel, however using a foam core as a dam was easier and felt that it’s cheaper and you don’t have to worry about welding one (see figure 5).

Figure 5 : Core Making Process



Another major change in this year’s design was the 3D-printed top cover. Throughout the process, the cover top underwent numerous small and large revisions, and the final version looks quite different from what I initially envisioned last semester. One of the first challenges I encountered was related to the buttons: in my first iteration, I realized that the backs of the push and dial buttons, along with the connecting wires, were too bulky for the limited internal space. To address this, I created a protruding platform for the buttons, which provided additional clearance behind them.

Based on ergonomic analysis, I also angled the push buttons approximately 20 degrees outward. This adjustment significantly improved usability by making it easier for drivers to press the buttons during operation (see Figure 6). As we began the harnessing process for the steering wheel, it became clear that the wiring was much more complex and space-consuming than expected. Once again, space became a critical issue. To solve this, I redesigned the cover by lifting the entire middle section outward to create more internal volume—this solution worked effectively and is shown in Figure 6.

Figure 6 : Updated 3D Printed Top

I also redesigned the steering grips by personalizing them to fit each driver's hands, this allows for better comfort for the driver in the longer run . Together, these new design and manufacturing choices—including 3D-printed custom grips and updated structural testing—have allowed us to achieve a steering wheel that is more rigid, ergonomically effective, and lightweight. More information regarding how exactly the grips are done are detailed in my Fall Technical report, and of course if you need help just reach out to me!

One important aspect I didn't cover in the fall technical report and here was the steering wheel harnessing process. I worked closely with Aneesh Naresh to complete this, and more detailed information can be found in his spring technical report. Overall, the steering wheel uses 8 wires connected to the 8-pin quick disconnect. These consist of one power wire, one ground wire, two signal wires from the push buttons, and four signal wires from the dial buttons. To simplify the wiring, we spliced all the power lines together into a single power wire, and all the grounds into a single ground wire.

Additionally, we added spade connectors to each of the three wires per push button. This design choice allows the top cover to be removed easily, which is especially helpful for troubleshooting or replacing components without having to rework the entire harness.

5. Manufacturing and Assembly

As mentioned earlier, the manufacturing process begins with laying up the main body of the steering wheel. The specific carbon fiber layup order is detailed in my fall technical report, but in general, the process starts by routing the core, followed by the carbon layup and baking. After curing, we move into post-processing, which involves routing the outer shape, drilling all necessary screw holes, and preparing mounting features.

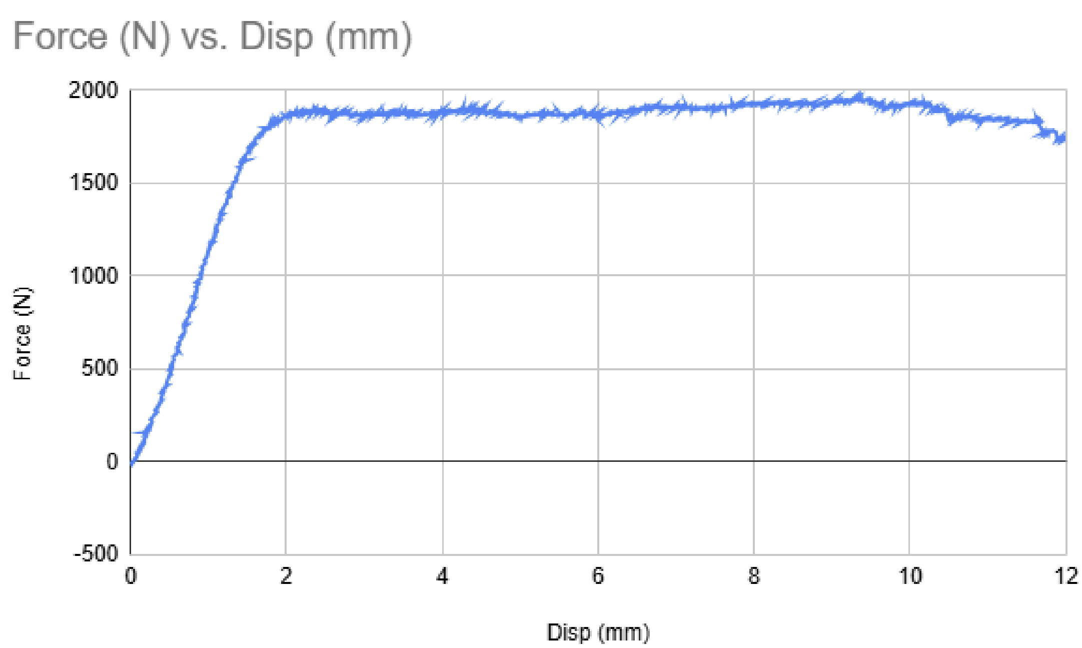
To assist with this, I created two routing templates. The first was a rectangular template the size of the steering wheel, which included all major screw hole locations as well as four additional holes to secure it in place during routing. The second template matched the final steering wheel shape and included cutouts for the grips and the quick disconnect. This system worked fairly well, but one safety concern arose: the acrylic laser-cut templates posed a hazard during close routing work, as fragments would occasionally break off and fly. For future iterations, I strongly recommend using either wood laser-cut templates or 3D-printed versions for improved safety and durability.

After routing, I used a drill to create the screw slots and larger drill bits to prepare oversized holes for easier routing. Once all the features were complete, I sanded down any rough edges using 220-grit sandpaper to finalize the part.

The next phase was harnessing the steering wheel. As covered earlier, the integration of electronics—including two push buttons and four dials—presented space constraints, which led to a redesign of the top cover. I re-CADed and 3D printed the new top cover to better accommodate the wiring. One challenge we faced was that the actual hole locations and depths differed slightly from the CAD model, due to human error during routing and difficulty estimating how much thickness the carbon fiber layup would add. To address this, I re-measured all dimensions manually and added more slack in the top cover and grip designs to ensure proper fit. Once harnessing was complete, final assembly was straightforward— attach quick disconnect, assemble main body to top plate and add on the grips.

6. Test Results

Figure 7 : Data Collection from the 3 Point Bend Test on the Steering Wheel



The decision to lay up the steering wheel early on and test the rigidity was one of the best decisions. The manufacturing process of sandwich panels with hard points was something I was pretty unfamiliar with, however completing it early on helped me so much understanding the ‘how to’ in addition to the difficulty of the manufacturing process which I found was pretty easy even though it was my first time doing so. Regarding the testing process I tested till the steering wheel reached the plastic deformation stage. And based on the data collected (see figure 6) the steering wheel can take up to approximately 1700N force before reaching plastic deformation. This validates the rigidity of our steering wheel as that’s way more than what we expect our drivers to exert on the steering wheel.

In addition, after drive days, it’s helpful to gather direct feedback from drivers through targeted questions to inform improvements for the next iteration of the steering wheel grips.