24-25 Hyperloop Global Aeroshell FDR

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29 March 2025

1 Introduction

This year's design of the Aeroshell is building on the previous design, which was built for a chassis that was about six feet long; making the Aeroshell a similar length. This year the chassis longer, so the Aeroshell length and subsequent geometry needed updating. Furthermore, there are new mounting developments and slight alterations to the timeline to account for manufacturing and mounting subassembly construction. These alterations and updates will be the focus of this paper.

2 Aeroshell Design

The internal dimensions of the pod this year are 9 ft long, 14 in wide, and about 1 ft tall. Thus, the Aeroshell will be 2 ft wide, 1.5 ft tall, and 9.5 ft long to account for its curvature. Its nose may later have slits near the sides to allow air to enter the insides of the pod to then be directed to internal systems that require cooling by ducts. This alteration; however, may be further into the future as no plans have been made to pursue this option for the moment. See in Figure 1 the completed design for the shape of the Aeroshell. This is an image of the intended shape of the complete Aeroshell.

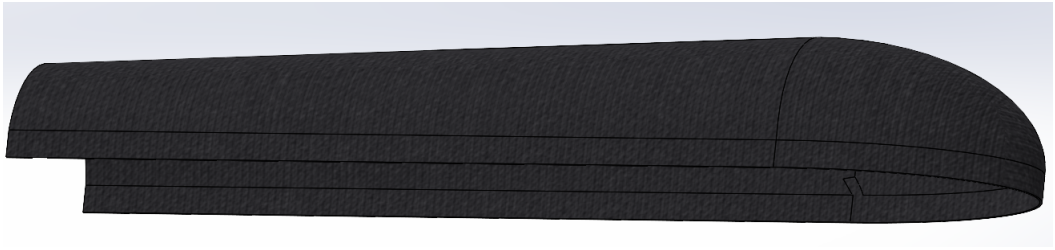

Figure 1: Aeroshell

2.1 Aeroshell Design Overview

Understanding of the Aeroshell manufacturing process for documentation purposes and later usage was a major focus. With the nine-and-a-half-foot long design, fifteen pieces of high-density foam will need to be machined, put together, and prepared into the Aeroshell's mold. See Figure 3 in Appendix A. High-density foam will be used as a base for the mold because of its resilience and ease of use with acetone and sandpaper to create a smooth mold surface. The reason there are fifteen pieces is because the CNC mill our team used to cut our foam could cut pieces of up to size 2 ft by 2 ft by 0.25 ft. Thus, we had to take our shell design, use its inside profile, and slice it into pieces that could easily be CNC milled. With the given dimensions, we found that we needed fifteen pieces and determined that we could later adhere these pieces together using 3M Foam Spray Adhesive.

Materials:
High Density Foam
Duratec Surface Primer
Acetone
Fibre Glast 2000 Laminating Resin
Fibre Glast 2120 Epoxy Cure
Mold Release Wax
Mastic Sealant Tape
Vacuum Bag
Perforated Ply
Kevlar
Carbon Fiber

2.2 Aeroshell Manufacturing

With the above materials, we will create a high-density foam mold to graft the carbon fiber on top of. The assembly and preparation of the mold will likely take two weeks. The process for this is to attach all the pieces together with the aforementioned 3M spray, sand everything down to be smooth, then use Duratec Surface Primer to make a surface that is as smooth as finished wood. The grafting in question will consist of two layers of carbon fiber with one layer of Kevlar sandwiched between them. This particular configuration leverages the unique properties of each material; creating a composite that is both strong and resistant to impact, as carbon fiber provides high stiffness while Kevlar adds significant impact resistance. This combination effectively mitigates the weaknesses of each individual material when used alone. The layers will be coated with a 3:1 ratio of epoxy resin to cure, covered and vacuum sealed until cured. After that, the shell itself is complete. The shaping and curing of the complete Aeroshell should take one to three days. The manufacturing will be completed in January when the team returns from the winter break. See miniature prototype images in Appendix A, Figures 5-7.

Now our team has begun manufacturing the full-scale Aeroshell. We have been working for 3 weeks, doing 2 hours of work for 4-6 hours a week. Thus far we have placed and adhered all sixteen of our pieces together. We are in the process of sanding and patching cracks using 3M Bondo Body Filler. The biggest challenge so far has been to stop the formation of additional cracks while we are not actively working on and adjusting the mold. To fix this problem, our team ordered two sawhorses to hold the sides of the Aeroshell mold overhanging the table it sits on. In Appendix A Figure 8 is an image of the team working to fill cracks, sand, and prepare the large mold in question. In Figure 9 an image of one of the cracks that formed over time can be seen as well.

2.3 Aeroshell Mounting

This year we will attempt to alter the way we have previously mounted the Aeroshell to accommodate easy and fast maintenance of the pod for repairs or for showcase reasons. Instead of four brackets, each with two bolts that go through the Aeroshell into the bracket, the Aeroshell will be mounted around the outside of the chassis using five L-shaped Aeroshell Brackets than can be seen in Figure 4 in Appendix A. To allow for quick access to the various subsystems inside the pod, three gas struts are placed on the right side of the pod. One such gas strut assembly is depicted in Figure 2.

These three gas struts on the right side of the Aeroshell are mounted on top of the three L-shaped brackets on the same side, and two spring latch assemblies attached to two of the L-shaped Aeroshell Brackets on the left side of the pod. The latches can be quick-released, then the Aeroshell can be rotated open 45 degrees via hinges (also in Figure 2) attached to the L-shaped brackets on the right and suspended open by the gas struts during maintenance. The struts can then be disengaged, the Aeroshell lowered, and the latches put back into place. There will also be three 3D printed pieces, designed using the inner geometry of the Aeroshell, to distribute the force of each gas strut on the

Aeroshell and allow the gas struts to comfortably mount to the top of the Aeroshell. The force distributors will be printed with two holes in them that align with the gas strut bracket. The Aeroshell, each force distributor, and each gas strut bracket will then be fastened with two nuts and two bolts. Given the varying inside height of the Aeroshell, the gas struts' mounting pin will need to be mounted at different heights at each bracket. Getting the relevant components (gas springs, 3D printed parts, hinges, spring latches) will likely take two to three weeks. The construction of the sub-assemblies will be done during the same time period as the shaping and curing of the Aeroshell.

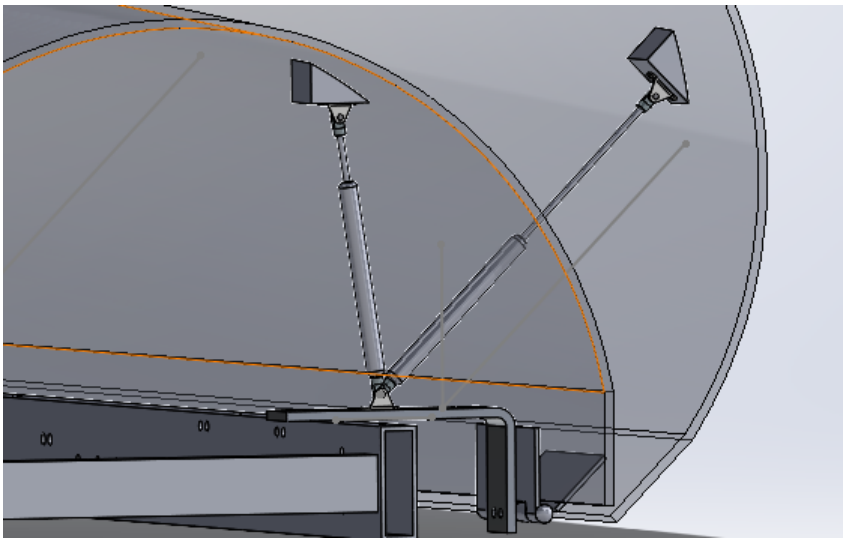

Figure 2: Gas Struts (Closed/Open Positions)

3 Conclusion

In this paper, the Aeroshell manufacturing process is outlined and relevant design tools are presented. The manufacturing and assembly plans were stated, as well as the timeline of the project. The work for the immediate future will focus on manufacturing the Aeroshell and its mounting subassembly in April 2025 and complete assembly between April and May 2025. Through manufacturing we are learning that we should make the mold more like a tub in which the carbon fiber is laid, that we should lay down vacuum bagging before working on the mold to avoid adhesion to the table, and that we should do everything in our power to create perfectly level surfaces to avoid the creation and propagation of cracks. Further than that, we will try to create some sort of system by which Aeroshell's of different lengths can be manufactured without having to create an entire new mold for each. The reason this is important is because the high density foam necessary for a mold of this size is two to three thousand dollars. To save the team from this troublesome expense in the future, a method for molds of different sizes appears necessary. Another future task is to ensure clear documentation for design and procedure when it comes to Aeroshell manufacture. Future members of the team should not have to completely learn the process on their own without the help of those who came before them. Whether that be in person teaching or clear documentation that does not leave them confused. This concludes the plans for the Aeroshell now and in the future to come.

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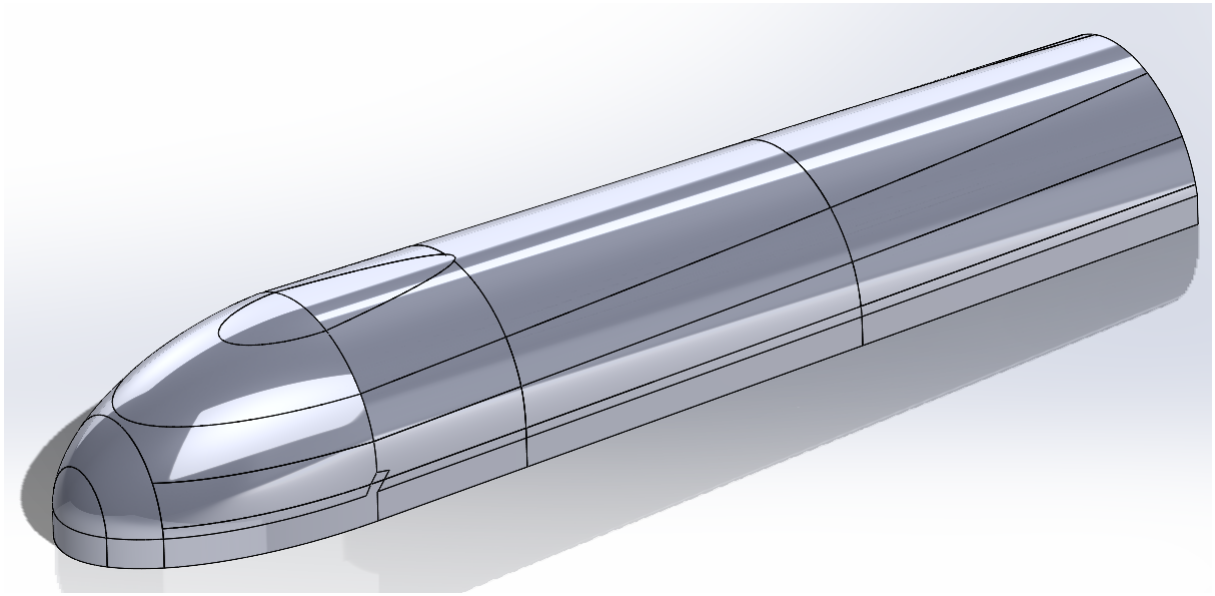

Figure 3: Assembled Aeroshell Mold

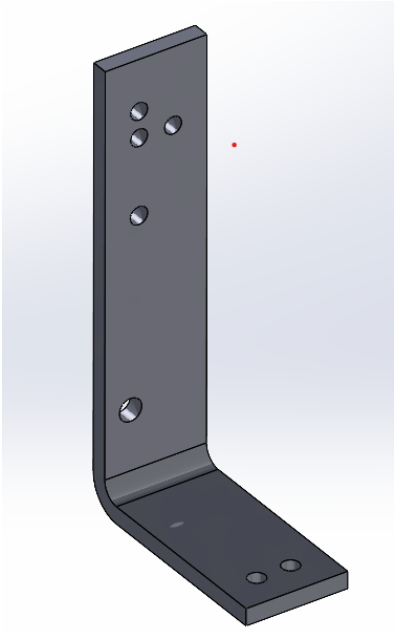

Figure 4: Aeroshell Support Brackets



Figures 5-7: Aeroshell Manufacturing Process

Figure 8: Large Aeroshell Sanding

Figure 9: Mold Crack