FSAE Drag Reduction System for an F1-Style Car

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ANTEATER FORMULA RACING

Executive Summary

- The Formula SAE program at the University of California, Irvine began in 2005 as "UCI Racing" with a rebranding In 2019 to "Anteater Formula Racing" (AFR).
- Each year, students design, manufacture, verify, and compete with single-seater, open wheel, formula one style vehicles.
- In an F1 vehicle, there is a rear wing spoiler that provides downforce on the race track in corners, however is counteracted with drag force in straights reducing maximum velocities and accelerations.
- In the FSAE competition, the vehicle participates across several events including: acceleration, endurance, and design. This can potentially give the team better scores in these events.

Project Objectives

- Design and manufacture a Drag Reduction System (DRS) on the vehicle's rear wing that reduces drag during straights while maintaining the same down force in corners.
- System should decrease race time for each event compared to without DRS
- System should be activated and deactivated by the driver without change in body position

Requirements

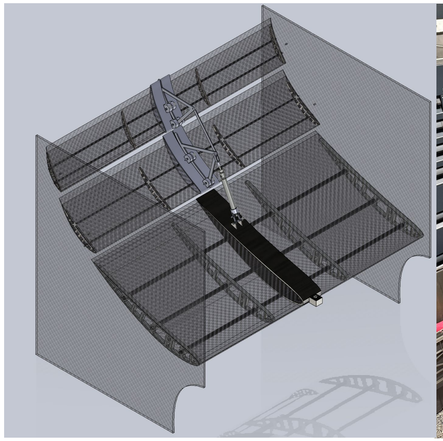
- The system shall:
  - Reduce drag coefficient of the rear wing by 55 +/- 2%
  - Actuate to angles of attack (open/close) of 0 +/- 3 degrees
  - Open completely within 1 second of activation
  - Close completely within 1 second of braking

Key Features

Design Process

- **Problem Definition**
  - Figuring out the problem at hand
  - Finding existing solutions
  - Creating systems architecture for proposed solution
- **Preliminary Design**
  - Selection of pneumatic actuation system
  - Selection of the secondary aerodynamic package when rear wing is open
- **Proof of Concept**
  - Mechanical, and Electrical Component Analysis
  - Scaled down 3D printed prototype model

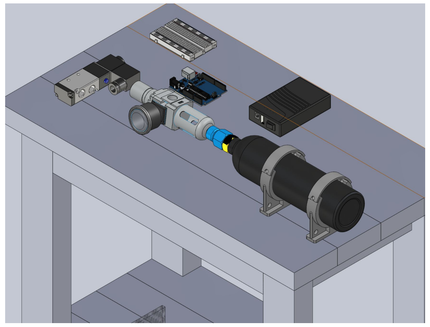
Proposed Design Solution



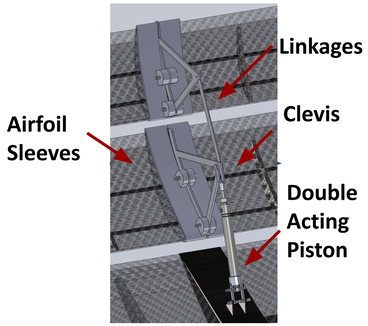
Full Rear Wing Drag Reduction System (DRS) Design

Last Year's Rear Wing (PPE)

Build & Testing



Electronics System



Linkage System

- The actuation system will use an Arduino to actuate the solenoid and provide air pressure from the air tank to the air cylinder
- The stroke extension will allow the DRS to activate while the retraction will close the system
- Integration of steering button for activation and braking system for deactivation

- The prototype will be scaled to 40% of the actual size
- Will primarily focus on the movement of the linkages at the desired specifications of 0 angle of attack when the airfoils open and at a 24 mm gap when closed
- Proper functioning of the double acting air cylinder

Jan
- Defining Problem
- Drafting Requirements

Feb
- Selecting Actuation System
- CAD Small-Scale Model

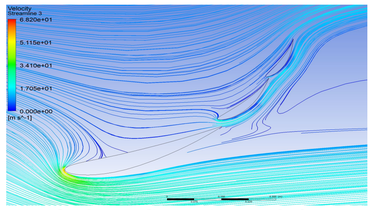
Mar
- Manufacturing Small-Scale Model

Apr
- Redefining requirements
- Finalizing Design

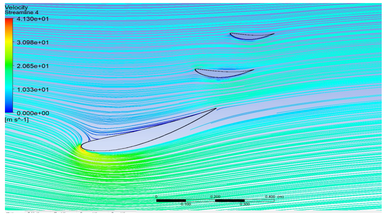
May
- Manufacturing Actuation System

Jun
- Testing and Verification

Aerodynamics Analysis



Default Configuration and Flow



Drag Reduced Variation Configuration and Flow

Computational Fluid Dynamics (CFD) is used to simulate the car's downforce and drag and flow physics through the manifolds such as the exhaust.

These analysis were critical in our selection of the active aerodynamic package.

Conclusion

- There is a lot more work to be done, but completing a small scale prototype will help us incredibly
- The Problem Definition phase of design seemed to prove most critical for overall success
- Although Integration looks to be a difficult task this system will have an overall positive impact on the teams competitive success

Future Improvements

- Improve mounting and placement of attachments
- Enhance the software responsible for connecting driver input (i.e. pressing brakes or a steering button with DRS functionality)

References

[1] Anteater Formula Racing Aerodynamics Subteam

[2] Baturone, Pablo, et al. "Project DRS San Diego State University." Accessed 27 Feb. 2024.

[3] *Formula SAE Rules 2024 Version 1.0*, www.fsaeonline.com/cdsweb/gen/DownloadDocument.aspx?DocumentID=369d01c0-589d-4ebe-b8d4-b07544f4a52b. Accessed 27 Feb. 2024.

[4] Garcia, Josue E., et al. "Drag Reduction System Spartan Racing Formula SAE." 2022, Accessed 27 Feb. 2024.