Anteater Formula Racing Drag Reduction System

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Executive Summary

- Anteater Formula Racing is the University of California, Irvine's Formula SAE team, where students design, build, and compete with high performance, open-wheel cars in national competitions.
- This project enhances AFR's vehicle aerodynamics by developing a Drag Reduction System (DRS) for the rear wing.
- The DRS uses actuation mechanisms to enable adjustable wing configurations that optimizes speed and handling, improving AFR's race performance.

Project Objective

- The system must reduce aerodynamic drag on straights while ensuring stability and downforce in corners.
- The system must actuate seamlessly though driver-control or activated through speed sensors.

Design Solution

- The DRS utilizes a pneumatic piston and linkage connection for adjustable rear wing mechanism.
- The actuation system is designed for fast and reliable deployment while being rigid and compliant with FSAE rules.

Overall Success

- Implementation is expected to result in improved acceleration, higher top speeds, and reduced lap times.
- The system prioritizes safety, reliability, and ease of use.

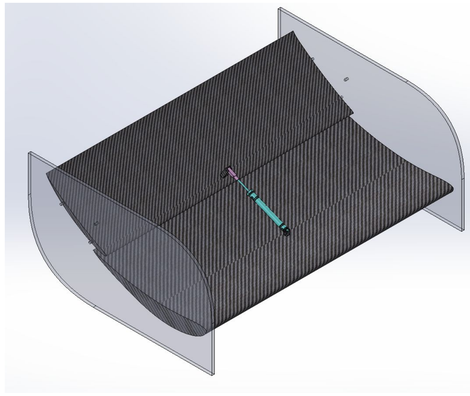
Key Features in Design Process

- **Problem Definition Stage**
  - Sponsor Needs & Requirements
  - Existing Solutions
  - Functional Hierarchy
- **Preliminary Design Review**
  - Key Component/Actuation Method Selection
  - CAD Model Complete
- **Proof of Concept**
  - Component Analysis
  - Prototype Complete (⅓ Scale Model)
  - Simulations Complete

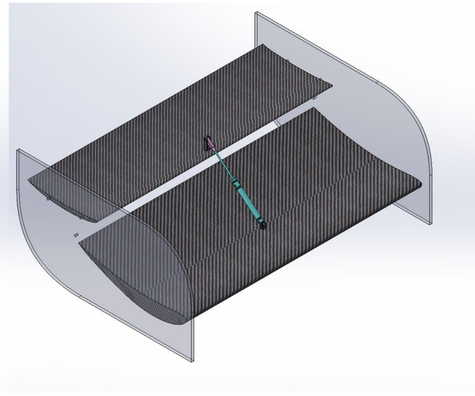
Acknowledgements

Special thanks to Professor Tryphon Georgiou, Nicholas Choi, and the AFR team.

Design

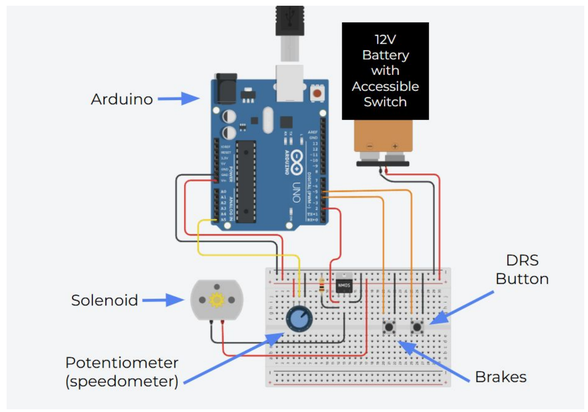


Carbon Fiber FSAE Rear Wing DRS Not Activated



Carbon Fiber FSAE Rear Wing DRS Activated

Prototype Build and Testing



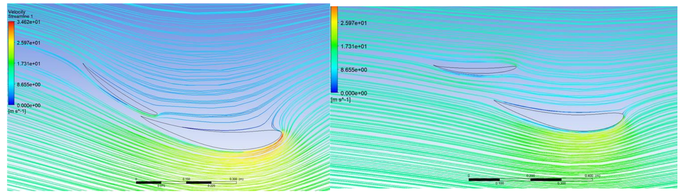
Wiring Diagram

- The actuation components will be connected and coded in Arduino IDE
- The solenoid will be connected to a piston and air tank controlled by an air pressure regulator (not shown in diagram)

3D Printed Test Airfoils

- The prototype will be a 33% 3D printed scaled down version of Anteater Formula Racing's 2024-25 Rear Wing
- DRS activation/deactivation will be represented by two buttons and a potentiometer
- Activation: DRS button, and speedometer represented by a potentiometer
- Deactivation: Driver braking the vehicle, represented by the second button

Simulation



High Downforce / High Grip Configuration

Low Drag / High Speed Configuration

- Computational Fluid Dynamics (CFD) simulations conducted in ANSYS (Fluent)
- Utilized CFD results to iterate and optimize downforce to drag ratio while ensuring DRS design does not negatively impact the aerodynamic performance of the vehicle
- Proposed design reduces drag from 47.61N to 7.3N on straights, due to the zero angle attack configuration of the top airfoil

Conclusion

- Prior to the course, the base rear wing structure was developed by the AFR team.
- The DRS was successfully modeled using CAD, optimized through CFD simulations, and validated through the physical prototype.
- The system provides a 15.33% drag reduction while still giving rapid and reliable actuation.
- The developed prototype will undergo testing for aerodynamic efficiency, durability, and actuation reliability. (Wind tunnel)
- Future improvements could include a multi-position piston for more wing adjustments at different speeds and real-world testing on car to validate CFD results.
- The system impacts safety through its automatic deployment.

Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
• Start of Design Process • Engineer onboarding	• All Sub-system design • Competition Registration	• Chassis Designed • ETC Notice of Intent	• Jig Manufacture • Design Review	• Chassis Manufacture • SES Submission	• **Problem Definition** • **Drafting ideas**	• **Design DRS** • **Create BOM** • **Manufacture**	• **Test DRS Design** • **Proof of Concept**	• **Rear Wing Complete** • **Implement DRS** • **Track Test**	• Finalizing Track Setups • Competition