F1 AUTOAERO

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BACKGROUND & MOTIVATION

- The drag reduction system (DRS) of a Formula 1 car actuates the rear wing flap, reducing drag to enable drivers to increase their speed for overtakes
- As wind tunnel testing is essential for aerodynamic development and this time is highly regulated, Williams Racing's current manual process for testing their DRS is inefficient

A solution is needed to eliminate manual adjustments of a wind tunnel model rear wing to its DRS open and closed positions without affecting aerodynamic surfaces

CRITERIA & CONSTRAINTS

- Able to withstand forces from a minimum wind speed of 5 m/s
- Solution cannot impact aerodynamic surfaces or other devices on the model

The actuation system must fit within a housing that is **smaller than an iPhone**

DESIGN ALTERNATIVES

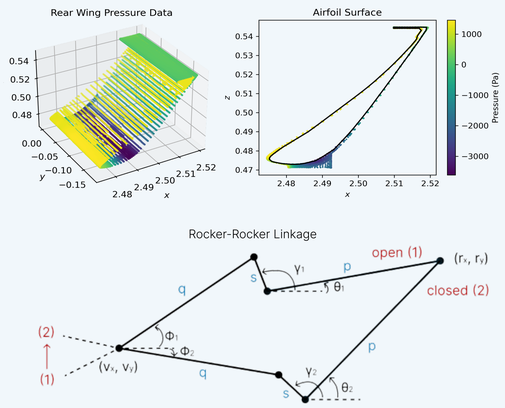
Spring & Electromagnet	Motor & Gear System
👍 Size Constraint	👍 Feedback Control
👎 Robustness	👍 Accurate
👎 Bi-Directional	👎 Size Constraint

ADVANTAGES OF FINAL DESIGN

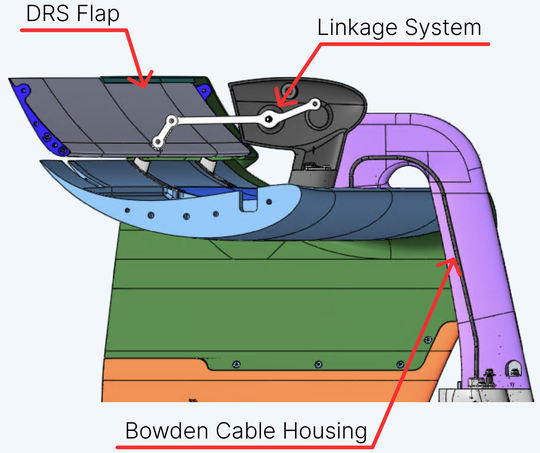
A Bowden cable and motor solution was selected as it allows for flexible placement and is adaptable for future seasons

OUR SOLUTION

THEORY



- Data from the Williams' wind tunnel was analyzed to determine the required conditions
- Strict geometric constraints informed the design of an optimal non-locking four-bar linkage system for the desired motion
- Machine analysis guided material and part selection



PRINCIPLE OF OPERATION

- Within the core of the model, a motor and custom spool attachment allows for precise movement under high loads
- The flexible Bowden cable transmits the force enabling actuation, keeping the system within the aero surfaces

TESTING & VERIFICATION

Due to limited access to wind tunnels, our testing plan was adapted to estimate wind loads using a physical prototype under static loading and analytical verification

$$m_{load} = \frac{M_{wing} * r_{centroid}}{g} + \Delta m_{wing}$$

Weight Equivalents:
5 m/s wind = 1.1 kg 50 m/s wind = 7.4 kg

RESULTS

700 hours
saved annually

- Only responds to user input
- Actuates DRS wing automatically, eliminating manual adjustments
- Is fully enclosed within aerodynamic surfaces

WILLIAMS RACING

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