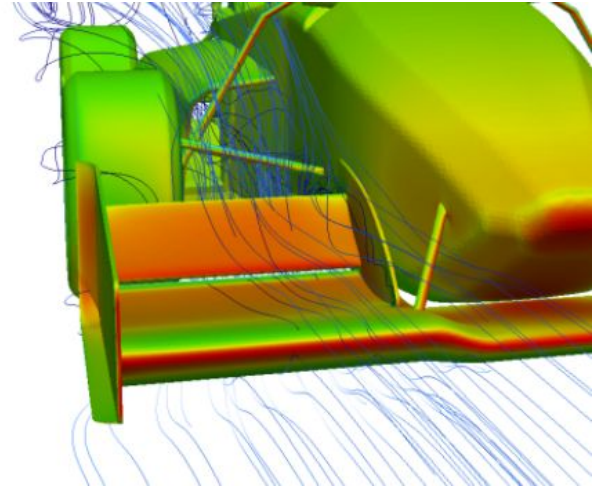


System Overview

- Active aero means the wings on car can move!
- Wings add grip in corners but drag on straights.
A fixed wing has to pick one, active aero gets both
- A servo moves the flap triggered by speed, steering, throttle, & brake
- It shifts the car's balance & adds weight, parts, & wiring, so the lap time gain has to be worth it
- If it fails, the wing defaults to high-grip position



Functional Requirements: General

Requirement	Description	Target (w/ tolerance)	Source
Edge radii	Minimum edge radii held in every flap position	Min: ≥ 5 mm horizontal, ≥ 3 mm vertical Target: ≥ 6 mm, ≥ 4 mm	FSAE T.7.1.4
HV grounding	Grounded if close to HV parts	Grounded if ≤ 100 mm from HV parts	FSAE EV.7.7
Ground clearance	Clearance held in every flap position at full dive and bump	No intentional or excessive ground contact	FSAE T.7.4, V.1.4.1, V.1.4.3
Rigidity	Rigid when static, in either flap state	No oscillation in either state	FSAE T.7.1.3, IN.6.2

Functional Requirements: Front Wing

Requirement	Description	Target (w/ tolerance)	Source
Every flap position stays inside the front wing envelope:			
Forward limit	Max distance ahead of the fronts of the front tires	Max: ≤ 700 mm Target: ≤ 675 mm	FSAE T.7.5.a
Width	Position relative to the outside of the front tires	Inboard (within front-wing width zone) Target: ≥ 10 mm	FSAE T.7.6.1
Height, outboard	Max height outboard of the inside of the front tires	Target: ≤ 250 mm	FSAE T.7.7.1.c
Height, elsewhere	Max height everywhere else	Max: ≤ 500 mm Target: ≤ 490 mm	FSAE T.7.7.1.b

Functional Requirements: Actuator & Mechanical (EE TBD)

Requirement	Description	Target (w/ tolerance)	Source
Flap travel range	Displacement between states	TBD (up to aero; depends on servo selected)	CFD and wing geometry
Positioning accuracy + DRIFT	Desired vs measured angle	Max: $\pm 5^\circ$ error Target: $\pm 3^\circ$ error	CFD and controls testing validate
Positioning repeatability	Variation in flap angle after repeated commands	Target: $\leq 0.5^\circ$ peak-to-peak	
Actuator load capacity	Output under worst-case loads	$\geq$ maximum required torque + margin	TORQUE REQUIREMENT
Position holding	Maintain position against aerodynamic forces		
Actuation durability	Target:	Min: 1,000 cycles Target: $\geq 2,000$ cycles	

Functional Requirements: Actuator & Mechanical (EE TBD)

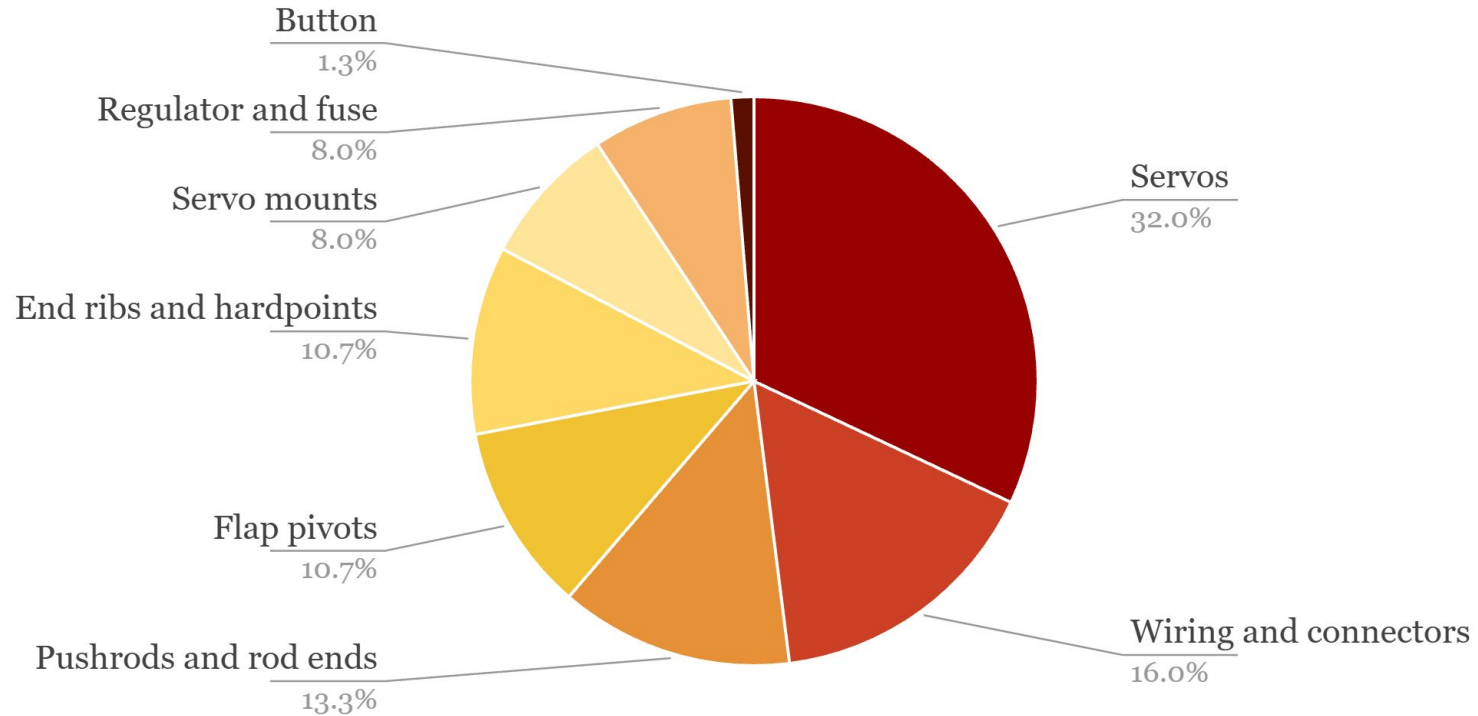
Requirement	Description	Target (w/ tolerance)	Source
Power source	Comply with team architecture	8 V LV	EE
Wing removal	Wing assembly can be disconnected without resetting linkage geometry	One connector, no re rigging	EE (detachable connector at the front)
Motion clearance	Moving flaps and linkages avoid interference		
Tire clearance	Actuation hardware does not enter tire keep-out	≥ 75 mm tire clearance at full steer and bump, if required by team design specification	Team packaging
Fail-safe travel limits	Actuation cannot move beyond approved physical limits	Hard stop travel limit for driver (value TBD)	Further analysis

Cost Breakdown

Item	Projected MY27 (lean)	Target mass	Notes
2 × 35 kg-cm waterproof servos (DS3235 class)	\$40–66	~0.12 kg	60 g each, one per side
Pushrods, rod ends, clevis pins	~\$30	~0.05 kg	Includes servo horns
Flap pivots (shoulder bolts, bushings)	~\$30	~0.04 kg	Could shed with aluminum hardware
Printed servo mounts	~\$10	~0.03 kg	About 15 g each
Lock: over-center linkage	\$0	0 kg	Built into linkage geometry
Voltage regulator and fuse	~\$20	~0.14 kg	Sits on the chassis, not the wing
Wiring and connectors	~\$30	1 kg (0.6 - 1 for harnessing)	About half is on the wing
Controller: spare PWM from existing ECU	\$0	0 kg	Existing ECU, spare PWM
Flap end ribs and hardpoints	~\$20	~0.04 kg	Added to the flap layup
Total	~\$180	~1.42kg	W/out harness = 0.4kg

Mass Breakdown

MY27 Active Aero Mass Breakdown (Target)



Rules Breakdown

SIZE ENVELOPE

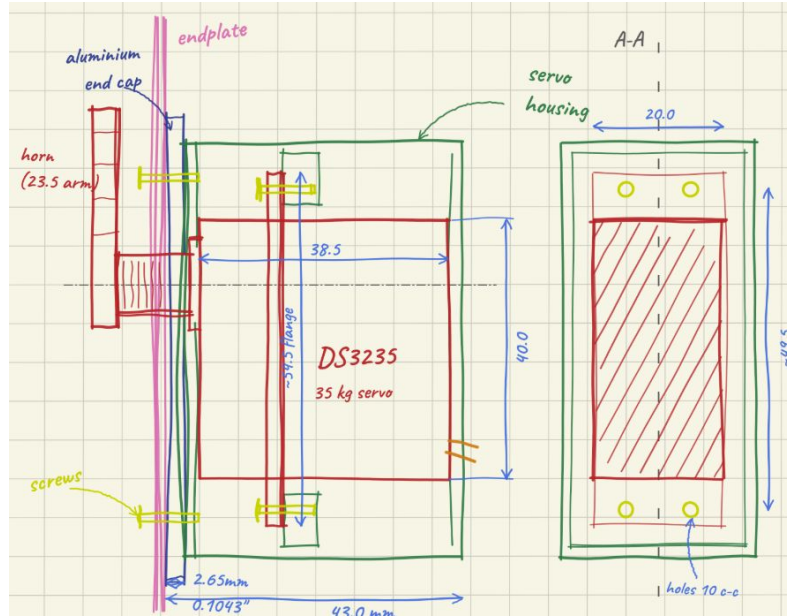
- T.7.5.a: max 700 mm forward of the fronts of the front tires.
- T.7.6.1: inboard of the outside of the front tires
- T.7.7.1.b: max 500 mm above ground
- T.7.7.1.c: max 250 mm above ground where outboard of the inner surface of the front tires
- V.1.1.c: nothing within 75 mm ahead of or behind the tire
- T.7.1.4: forward-facing edges min radius 5 mm horizontal, 3 mm vertical
- GR.6.4.1: rules apply at all times, so every flap position must stay inside this envelope

Rules Breakdown

MOVING ELEMENT

- T.7.1.3.b: devices must not "oscillate or move excessively" while the car is moving
- IN.6.2.2: push test of about 200 N anywhere on the wing; max 25mm deflection, under 5 mm permanent
- IN.6.2.3: "large, uncontrolled movements" on track = black flag
- V.1.4.3: no ground contact, including "as a consequence of moving"

Hand Calcs & Mounting for torque/Why the previous servo?



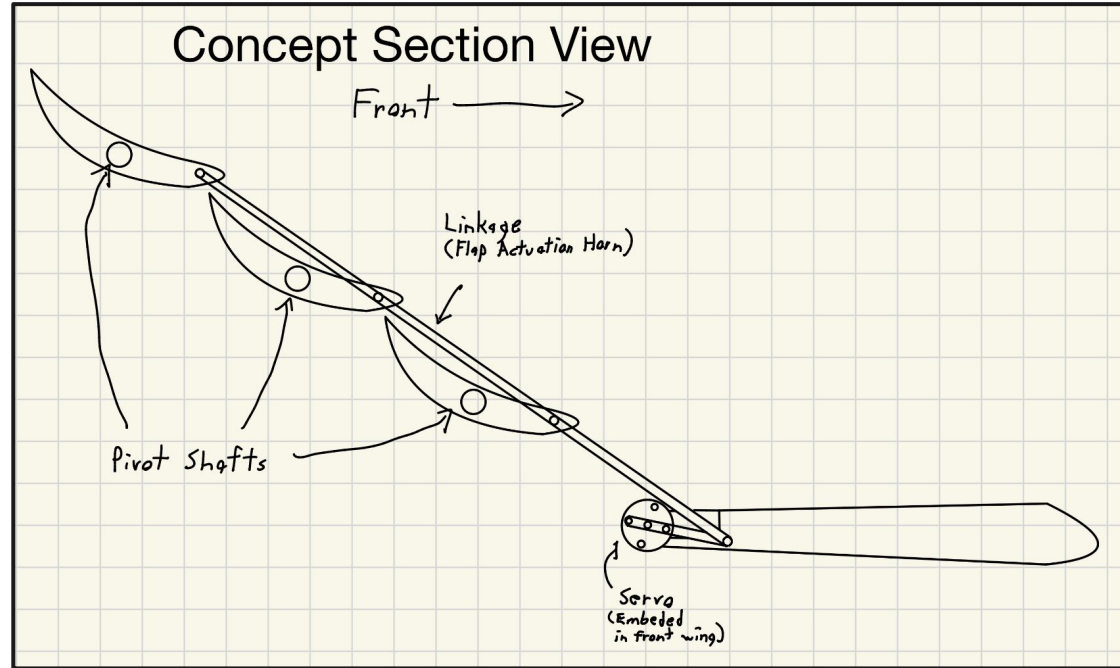
- This servo fits all our requirements for torque, battery, etc

No.	Operating Voltage	5V	6V	7.4V
3-1	Idle current (at stopped)	5mA	5mA	5mA
3-2	Operating speed (at no load)	0.13 sec/60°	0.12 sec/60°	0.11sec/60°
3-3	Stall torque (at locked)	29 kg-cm	32 kg-cm	35 kg-cm
3-4	Stall current (at locked)	1.9A	2.1 A	2.3A

Linkage System Overview (Rods)

What concepts will we go into detail about?
(high-level list)

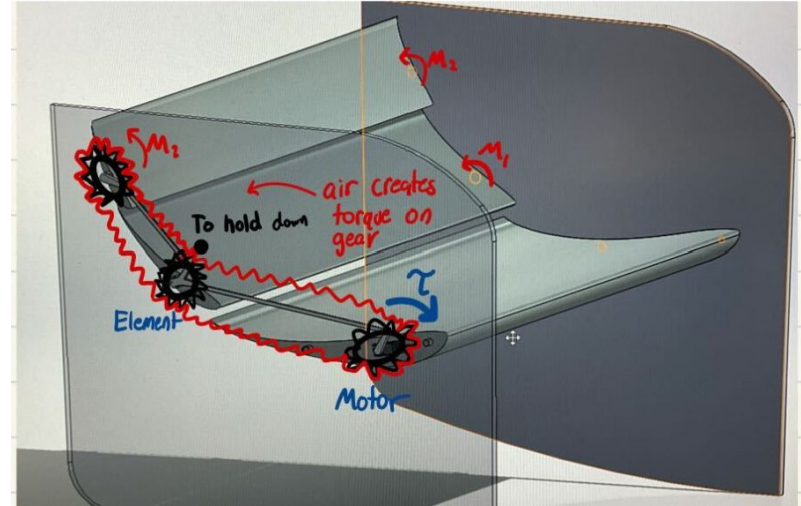
- Manufacturing for each active aero concept
- Specific placements to optimize torque



Linkage System Overview (Pulleys / Belt & Sprockets)

What concepts will we go into detail about? (high-level list)

- Manufacturing for each active aero concept



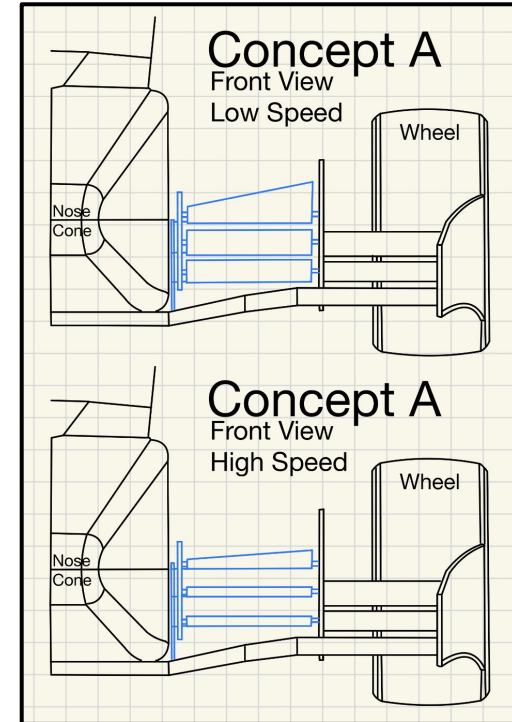
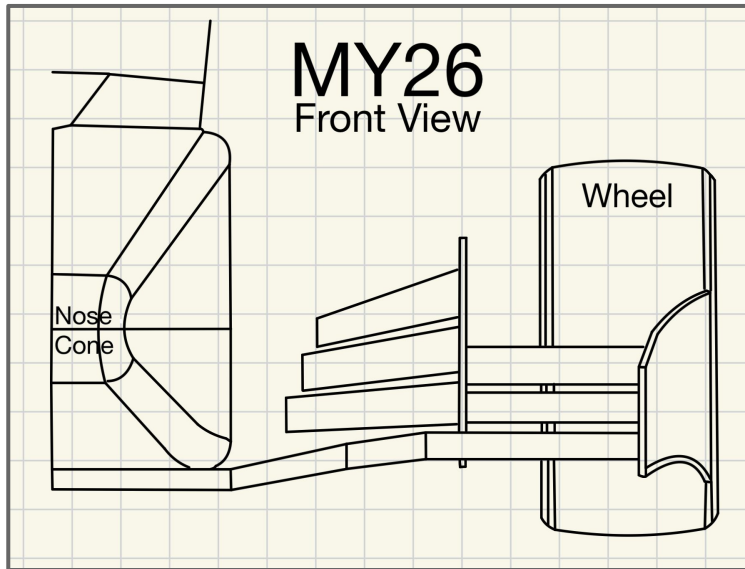
Concept Overview

Why front wing? Why not rear wing? Why not both?

- Traditionally RW done with other teams
- RW intended for drag adjustment
 - & increasing downforce
- FW for COP shifting
 - Great for new drivers

Concept Overview

How do our architectures differ? (clear visual of each)



Criterion (linked FR)	Close to Nose Cone	Inside the FW Endplate
Wing removal	Unhook linkage	One connector
Mass	Lighter	Heavier (full shaft)
Flap accuracy	More slop	Less slop
Motion clearance	Nose cone conflict	Tight space
Tire clearance	Clear	Needs check
Accessibility	Hard	Moderate
EE wiring	Harder	Easier
Endplate impact	None	May flex

Feasibility of Active Aero: Timeline

PDR

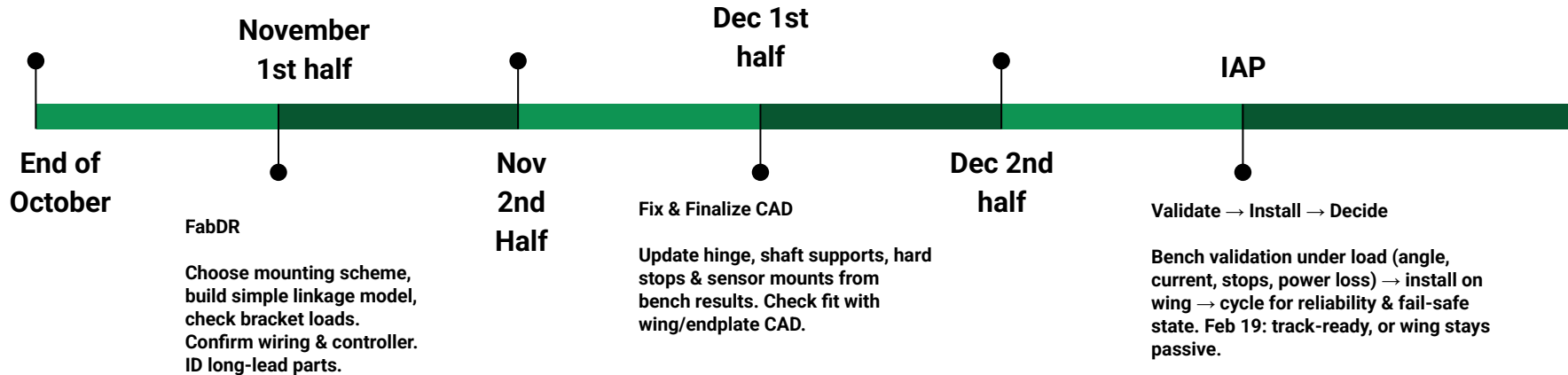
Have PDR and we already have some rough aero load & torque estimates.

First Bench Test

Actuator + linkage on a fixture. Test both positions, binding, range, and rough actuation time.

Make Parts

Machine/print brackets, get hardware in, build wiring harness. Flag anything that will slip over break.



Critical Path

