

MY27 Aero ArchDR

9/19/2026

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because racecar.

Agenda

- Learnings from MY26 and Risk Mitigations
- System Interfaces from Everyone
- Triage list with effort + go/no-go
- Functional Requirements
- Full Aero Overview & Design Philosophy
 - Design Requirements and Constraints
 - Front-to-back flow management
- Aero Architecture Overviews
 - Chosen Architecture and Additional design choices
 - Manufacturing and Justifications
- Aero Overview
 - Mass and Budget
 - Packaging and Mounting Architecture
 - Rules and Mounting and Risks & Unknowns
 - Manufacturing timeline
- Next steps + important interfaces



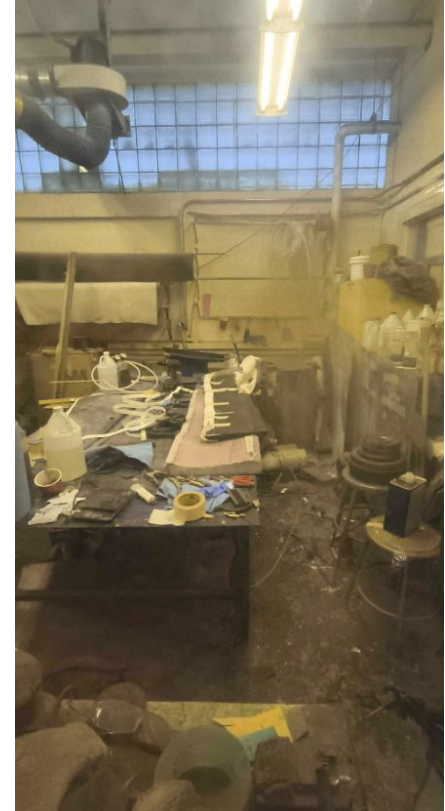
Manufacturing MY26 - learnings

- WL is time intensive and easy to do wrong (not enough epoxy/too much)
- Mounting considerations not made with loads in mind/on the spot w manufacturing floor fell off
 - Need to have protocol for mounting that allows for accurate, consistent mounting points on elements
- Surface finish poor due to the uneven coating and partly due to our current layup procedure
 - Poor CFD correlation resulted in poor performance
- Mass estimates were off due to excessive epoxy
- Need to account for time of post-processing more heavily
 - layups done $\neq$ aero package done



Manufacturing MY26 - learnings

- Mold creation protocols need to be fully defined in FabDR and communicated to all who work on molds
 - MY26 had added hours of sanding due to protocol mistakes
 - adding thickened epoxy on all molds/not just ones w mistakes
- Need to work on better CAM/consistent CAM
- had much better mold success last year after Evan started doing it



System Interfaces (everyone)

System (Name the RE)	What you need from them (due date)	What they need from you (due date)
Frame (Nichollas)	Frame layout (11/15/26)	Mounting tab locations
Aero mounting (Fatemeh)	Mounting components	CFD, wing characteristics (ie. size, weight, ribs / stiffness sensitivities), ground clearance adjustability ranges, forces Ruby - manufacturing ops
Suspension (Kate)	Sims for clearance	floor RH clearance, pitch/roll limits
VD (Evan)	Platform pitch/heave/roll limits	CLA/CDA values, floor RH clearance



System Interfaces (everyone)

System (Name the RE)	What you need from them (due date)	What they need from you (due date)
Composites (Calvin)	Prepreg send out date Tooling board? Gel coat and other possible mold finishing items	Plans for prepreg components
Cooling (Shinyoung)	Radiator positioning (mounting for Fatemeh) Radiator sizing bounds	Mass flow numbers



Functional Requirements:

Requirement	Description	Target (w/ tolerance)	Source
CLA and CDA	Coefficient of Lift * area Coefficient of Drag * are	CLA: 4.0 +/- 0.2 CDA: 1.3 +/- 0.1 lose up to 10% CLA at 5 deg yaw	ArchDR
Aero Balance	COP location- %of load on each axle	42% to the front axle 58% to rear axle	location and magnitude of CLA and CDA generators
Cost	Cost of system	\$4100	Layup materials
Total mass	Sum of masses of all aero components on the car	14.22 kg +/- .25 kg	Some parts have geometries that are easier to manufacture using wet layup method

Design Constraints

- *Meets all **FSAE T.7 aero and bodywork rules** and **Fits inside the aero bounding box***
- *Keeps the **open-wheel keep-out zones** clear (V.1.1)*
- ***Leave an opening** to measure ride height **without removing any aero part** (V.1.4)*
- *T.3.4.1 The vehicle must have a Brake Light that is clearly visible from the rear in very bright sunlight.*
- *EV.5.5.1c The Manual Service Disconnect must be: Easily visible when standing behind the vehicle*
- *EV.6.2.5 Mounting location of each Ready to Move Light must: **Be visible from 1300 mm vertically from ground level, inside a 2000 mm horizontal radius from the light, with Bodywork and Aerodynamic Devices in place***
- *Mounts are rigid when static and don't move or flutter on track (T.7.1.3)*
- ***Passes the tech push test: 200 N load gives ≤ 25 mm deflection and < 5 mm permanent** (IN.6.2)*
- *Front-facing edges meet the minimum radii: **5 mm horizontal and 3 mm vertical on aero devices, 38 mm on bodywork** (T.7.1.4, T.7.2.4)*
- ***Front wing mounts can move fully aft of the AIP in a frontal impact** (F.8.6.2)*
- *Can be **assembled** with room for hands and tools and **Every mount point can be inspected***

Soft Requirements

- *Looks good and **carries the goat livery***
- ***No zip ties, aluminum tape, or etc***
- *Mistake-proof mounting: each part only fits one way, and **mount points are consistent and repeatable***
- *Quick removal: sidepods and floor come off separately in a few minutes (**down from 15+ min, timing discussed in aero-mounting drdr**)*
- *No custom tools needed to assemble; **tool-less removal where possible***
- ***Small add-ons** (whiskers, endplate sides, flaps) can be left off the package easily*

MY27 Front to Back Flow Management part 1

Front wing: makes about 39% of our downforce. It also steers air around the front tires and toward the floor, sidepods, and rear.

FW endplate sides & flaps: push the front-tire wake outward so dirty air stays off the car.

Nose cone and whiskers: guide air cleanly along the sides of the body.

Sidepods: recover pressure lost in the front-wheel wake and feed air into the radiator and cool



MY27 Front to Back Flow Management part 2

Floor edge strakes: kick tire wake and squirt out, keeping clean air going under the floor.

Floor and diffuser: a bigger, more aggressive diffuser, which means more suction and more downforce.

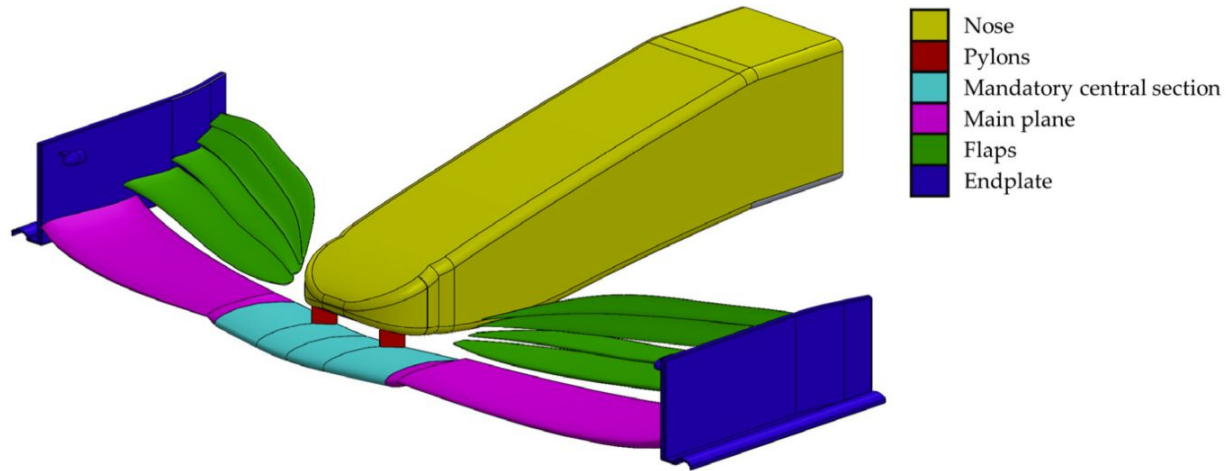
Rear wing: the main downforce element. The gooseneck mount clears the space under the wing, giving a cleaner diffuser exit and a smaller wake.



Front Wing overview

What Front wing does: Pushes the front of the car down and it's about 39% of our total downforce, also guides air around the tires and towards the floor and side pods and rear.

Adding FW Endplate
sides, 3D print + epoxy
attached to endplate, light
weight

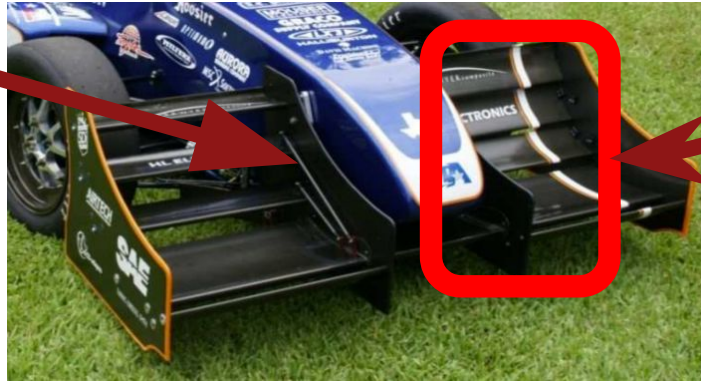


not ours but same words

Front Wing overview

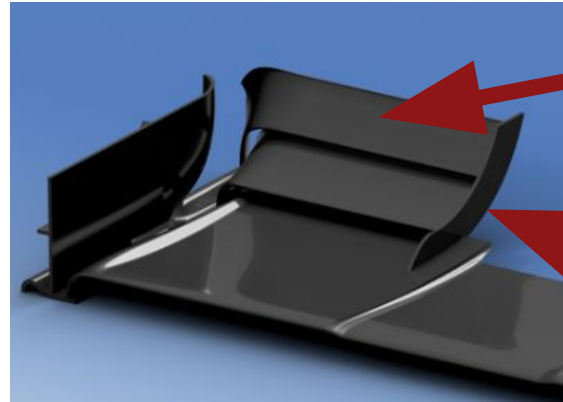
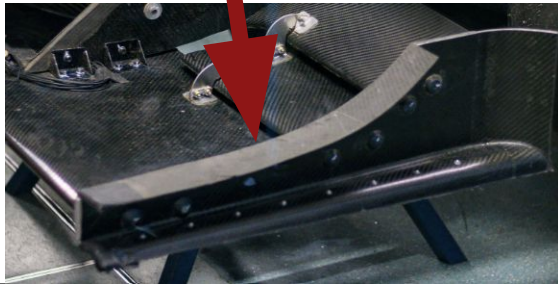
Adding tertiary front wing flaps to improve airflow over tires + downforce, 3D print + epoxy, light weight

Goosenecks FW connected to the main plane and to only have 1 on each side respectively to simplify overall - **aluminum 6061 for material**



Front Wing Justification

- **Front wing flaps:** Improve airflow over the tires and add downforce
- **Goosenecks:** Single gooseneck connecting to the main plane, replacing the previous multi-point mount. Simplifies the mount, reduces part count, and cleans up the local wake.
- **FW End Plate sides:** Reduces tire wake and diverts air away from the tires



Front wing flaps but we'll have 3 flaps

Goosenecks

Body Panels/Nose Cone Overview

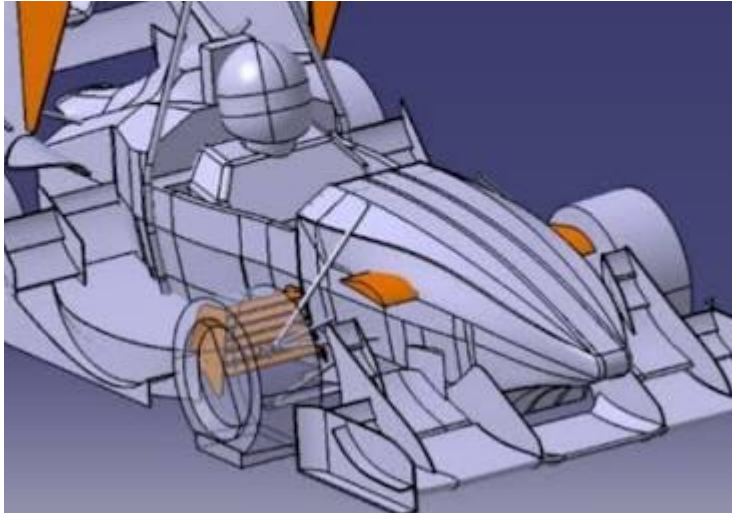
Top Access Panel over the Nose Cone - dzus quarter turn quick release

We'll have a **full nose cone** (Prepreg) and then the **access panel will be on the top panel in the main body behind it**, unlike the two halves nose cone



Body Panels/Nose Cone Overview

Side Nose Cone Whiskers: Light weight, 3D print, bolted on, helps direct air easy to manufacture



Sidepods Overview



Rods replace safety wires for the side pods and rear wing (with no gooseneck mount). All brackets are aluminum.

Sidepod mounts on **floor undertray**. Last year's shared mounting took 15+ min to remove for access. Now it comes off with **bracket-and-bolt mounts**.



Sidepods Overview

Maximize airflow through the radiator.

Two designs could be:

2–3 stepped elements feeding the radiator

Airfoil-section elements

Material: WL, or prepreg carbon if the sponsorship comes through.



Sidepods Justification

Radiator:

Heat load is 1120 W per motor. The total is **4.68 kW (one loop)** or **2.34 kW per loop** (two loops), from last year's data and inverter testing (provisional). Mass flow coming soon.

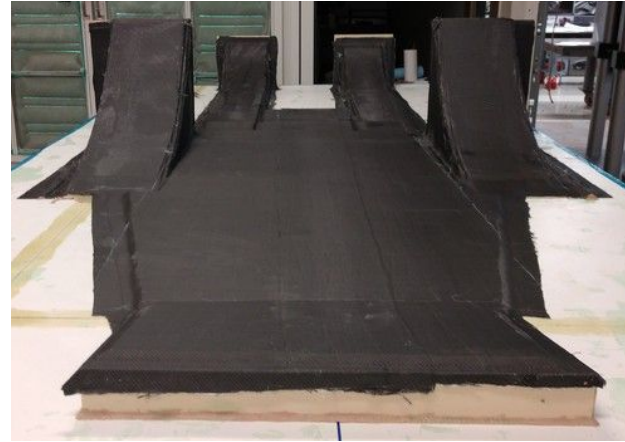
Sidepod also **shapes flow to the floor and diffuser** and also cools the components. Spinning front wheels **generate turbulent air** and **sidepod outer surface routes air** around the rear wheels. The elements and airfoils are there to recover pressure lost in the front-wheel wake and we'll test with **CFD, CD and CL**

Floor/Diffuser Overview

Floor: Controls airflow through the bottom of the car.
Ensures diffuser gets as much clean air as possible.

Diffuser: Area at the back of the floor that opens up.
Lowers pressure of air through the floor, generating more downforce and suction.

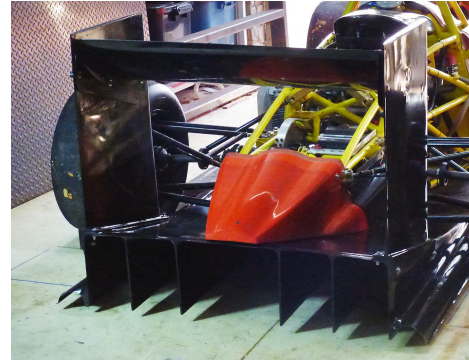
Will make the **diffuser a part of the floor**. **Sidepods will be mounted on the floor** → broader undertray.
More stability for sidepod mounting.



Floor/Diffuser Overview

Compared to last year, diffuser area could be **increased and more aggressive**. **Diffuser strakes** added as an entire part, carbon fiber bonded to diffuser.

Floor edge strakes will either be bonded or part of the mold. All features designed to be **lightweight**, use wet layup and epoxy.



Floor/Diffuser Justification

Aggressive Diffuser: Including diffuser within the floor helps with mounting, increased diffuser area, **larger diffuser -> more suction -> more overall downforce**

Diffuser Strakes: Will use **CFD** to justify, helps **manage aero underneath diffuser**, having all strakes together increases **stability** and integrity

Floor Edge Strakes: **Directs clean air towards diffuser**, kicks out tire wake

If we have room for a larger diffuser this year, adding a floor will be needed to maximize its effectiveness -> **justify increased CG height with downforce from sims**



Rear Wing Overview

Rear Wing: Main downforce element, manages and makes use of flow at back of car

Design Changes and Justifications:

Gurney Flaps on tertiary airfoils: better downforce generation

Gooseneck mount: better diffuser and wake reduction

Rear Wing Endplate with **slots** and **flaps**: better air control and RW performance



Rear Wing Manufacturing

General:

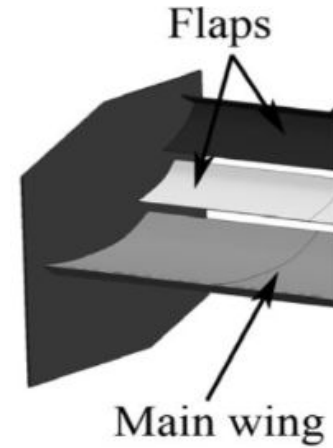
Hollow Airfoils: good interfacing w mounting, have experience with

Specific:

Gurney Flaps: will add flap to $\frac{1}{2}$ of selected airfoils layups

Gooseneck Mount: Aluminum, threaded rods

Endplate Slots: Pre-preg if flaps, if js slots wet layup and cut in post-processing



Rules that Drive the Design get it?

- T.7.1.3
 - **Mounts must be rigid when static**, and devices must not oscillate or move excessively on track (checked under IN.6.2)
- T.7.1.4
 - Forward-facing edges that could hit a pedestrian (wings, endplates, undertray) need at least a **5 mm radius on horizontal edges and 3 mm on vertical edges**. Permanently attached edge pieces count
- Length (T.7.5): **At most 700mm ahead of the front tires and at most 250mm behind the rear tires, in plan view**
- Height, in Rear Aero Zone (T.7.7.1a) : **1200 mm**
- Height, everywhere else (T.7.7.1b) : **500 mm**
- Height, ahead of front axle and outboard of planes touching the inside of the front tires (T.7.7.1c) : **250 mm**



Rules that Drive the Design get it?

- **F.5.11 External items on the Main Hoop:**

- This applies if the rear wing pylon or any wing mount attaches to the Main Hoop or its braces. A mount must either use tabs at the hoop-to-brace node that are free to rotate, or sit above added bracing with calculations showing it fails below the permitted load. Mounts must also be offset longitudinally to avoid point loading, and should not point at the driver.

- **IN.6.2 Tech inspection:**

- Inspectors can push on any aero device at any point. If deflection looks significant, they apply roughly 200 N, which should give no more than 25 mm loaded deflection and less than 5 mm permanent. Officials can black-flag a car for large uncontrolled wing movement on track.

Rules that Drive the Design get it?

- **V.1.4.2–3 Ground clearance:**

- The lowest point of the Lower Side Impact Structure must be 90 mm or less from the ground, and should be 75 mm or less. There must be an opening to measure ride height without removing aero devices. Sliding skirts and intentional ground contact are banned, and violations forfeit a run or an event.

- **F.8.6.2 Front wing:**

- The wing and its mounts must be able to move completely aft of the Anti Intrusion Plate without touching the front bulkhead in a frontal impact. Mount points should be aft of the plate, and tabs may not extend more than 25 mm forward of it.



Active Aero Justification Overview

Cornering sim and lapsim for **front wing** active aero, **different angles of attack**

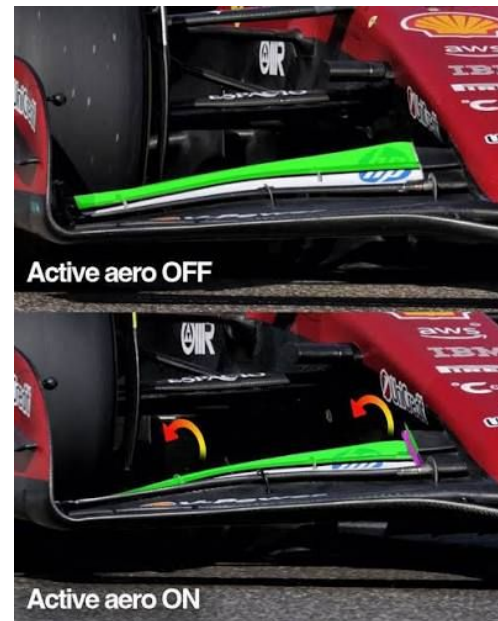
Use CFD to find best location for actuation mechanisms (**servos**)

Determine whether to house internally or not

Will create locking mechanism to **limit power usage**

For inexperienced drivers, being able to shift COP is good

Go no go Oct. 24



Active Aero Go/No-Go Criteria

Make sure everything is legal and corresponding with the rules

Lapsim with VD shows downforce gain offsets CG change, added mass, and power change

Mass: the whole system (servos, linkages, lock, wiring) adds no more than 0.3kg

Power draw, wiring, and control logic agreed with the controls team

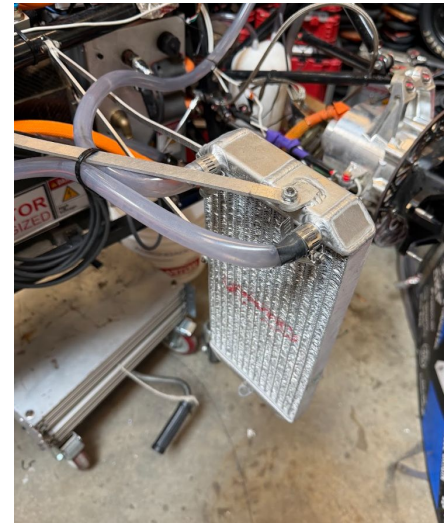
if power or a servo fails, the wing locks in a known, safe position

CFD: servo placement doesn't hurt front wing performance



Mounting Summary Architecture

- Side pods mounted with floor = undertray
 - To remove battery requires floor removal
 - More structural for the sidepods rather than designing plates for positioning
- Dzus quarter quick release
- FW gooseneck
- Aluminum 6061 for brackets / adjustable endplates
- Active aero CoDR exploration
- Rear wing 6061 gooseneck design
- Radiator mounting
 - Attached to frame



MY26 Radiator Mounting



Mass + Budget

	Hollow	Foam Core	Delta	Hallucination	Delta	
Front Wing	2.99	3.03	0.04	2.27	-0.72	For Mass Sheet
Floor/Sidepods	4.09	4.09	0.00	1.91	-2.18	3.18
Body Panels	1.31	1.31	0.00	0.55	-0.76	4.30
Nosecone	1.74	1.74	0.00	1.21	-0.53	1.38
Rear Wing	3.01	3.22	0.22	2.68	-0.33	1.83
Other Elements	0.12	0.13	0.02	0.09	-0.03	3.39
Total (pre mfg.)	13.25	13.53	0.28	8.72	-4.53	0.14
Total (post mfg.)	13.92	14.21	0.29	9.16	-4.76	

MechE: Structures				
Aero: Composites	\$1,000.00	\$0.00	0.00%	
Aero: Molds	\$2,000.00	\$0.00	0.00%	
Aero: Other	\$1,100.00	\$0.00	0.00%	
Aero: Testing	\$1,000.00	\$0.00	0.00%	



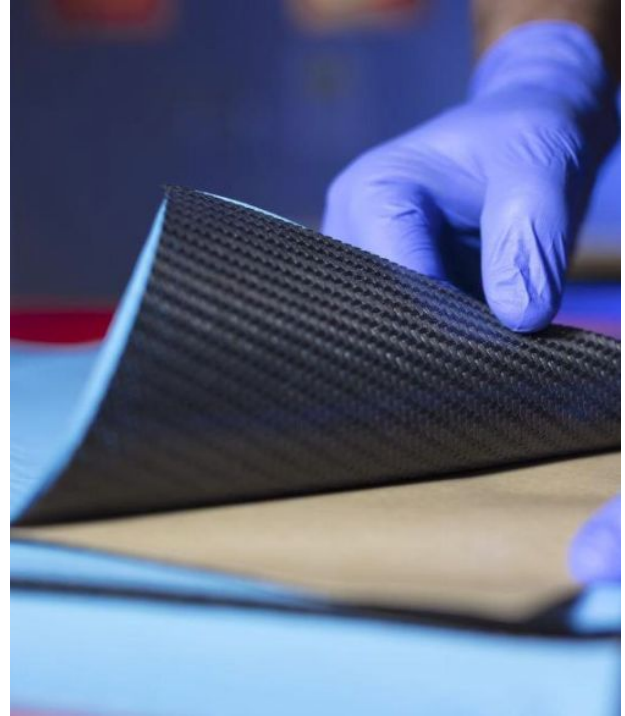
Risks and unknowns for Aero Architecture

- Manufacturing timeline
- Aero mounting delay
- Interference with other systems
- Wet layups done wrong (not enough epoxy)
- Post-processing takes longer than planned
- Mold mistakes cost hours of sanding (MY26)
- Tooling board sponsorship



Manufacturing MY27 Risk Mitigation

- Planned for PrePreg (best case): sidepods, nosecone, RW endplates
- if prepreg plans/molds fall through, endplate simplified (no flaps), sidepods get dropped, nosecone first priority on manufacturing
- Wet layups - all done w at least one upperclassman and up to 2 freshmen
- will 3d print or do molds w 3d printing



Triage list with effort + go/no-go part 1

Whiskers, vortex generators, FW tertiary flaps, FW endplate sides

- Effort: low (3D printed, bolted on)
- Go/no-go: none needed. They go on last, and the package is complete without them.

Gurney flaps on the RW tertiary airfoils

- Effort: low (built into the layups of half the selected airfoils)
- Go/no-go: decide which airfoils get them before FabDR (11/22).

RW endplate slots and flaps

- Effort: medium (flaps need prepreg; slots alone can be wet layup, cut in post-processing)
- Go/no-go: if prepreg isn't confirmed by FabDR (11/22), go slots only, no flaps

if behind on post-processing cutting slots will be dropped

Triage list with effort + go/no-go part 2

Sidepods

- Effort: high (new parts, new mounts, radiator interface)
- Go/no-go: prepreg or plastic plan confirmed by FabDR (11/22), and a backup radiator mount ready. If not, drop them.

Floor with the bigger diffuser

- Effort: high (big mold, wet layup, bonded strakes, CG impact)
- Go/no-go: lapsim shows the downforce is worth the CG rise by the OML freeze (11/15), and the mold is done by **(end of IAP)** in manufacturing.

Active aero

- Effort: very high (servos, locking mechanism, controls, rules check)
- Go/no-go: **10/24**

MY27 Aero Architecture Summary

Summary

- Chosen architecture: front wing, rear wing, floor/diffuser, and sidepods, working together (see the front-to-back flow slides)
- Sidepods mount onto the floor as one broader undertray unit rather than as separate pieces
- Meets the functional requirements: Cl_A 4.0 ± 0.2 , Cd_A 1.3 ± 0.1 , 42/58 aero balance, 14.22 ± 0.25 kg total mass, \$4,100 budget

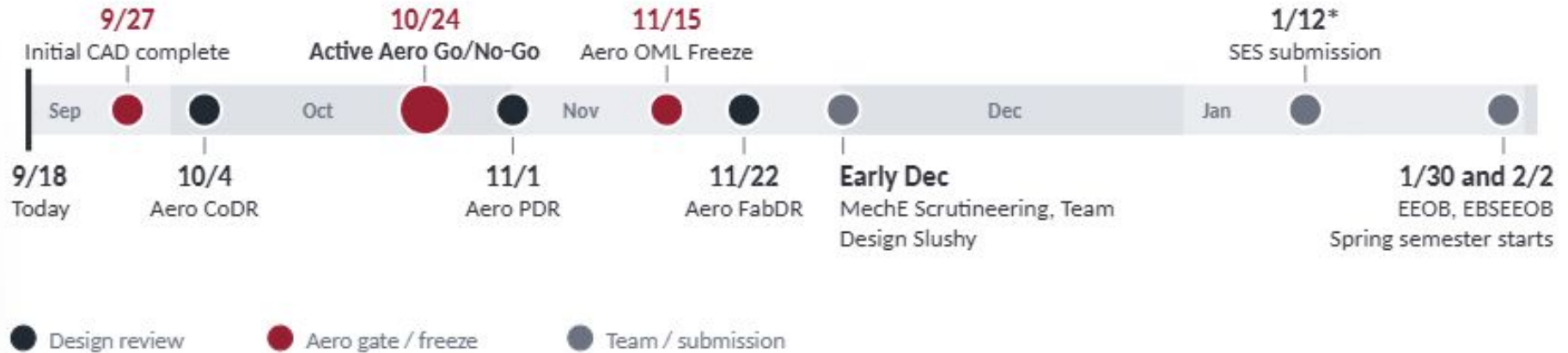
Why

- More downforce than a front-wing-only package, without oversizing the wings
- Fits mass and cost targets with room to spare
- Active aero stays a separate go/no-go, so the core package doesn't depend on it



Timeline and Go/No-Gos

Some of these are bound to be delayed, etc



Manufacturing Major Dates

End of Semester Goals:

All Molds Designed

Prepreg Molds Manufactured

End of IAP Goals:

Body Panels Mounted

All Molds Finished

Prepreg Layups Sent to Autoclave

Goals Pre-Roman:

Front Wing Mounted

Pre-Hybrid Goals (w time for testing):

Rear Wing Mounted

Nose cone Mounted (dependent on autoclave)

Floor Mounted

Sidepods Mounted

Next steps + important interfaces

- Is 10/4 CoDR still on the table or are we not doing it?
- Finish initial CAD for all elements by 9/27
- Run CFD deltas (ClA, CdA) for each new element, plus Nevin's full-car flow sims
 - Setup - though no geometry put into them either
- Run the lapsim with VD: floor vs. CG, and active aero
- Active aero go/no-go on 10/24
- Prep for PDR on 11/1
- Aero outer-surface (OML) freeze on 11/15
- Start manufacturing after MechE Scrutineering in early December





Q, C, C, WW?



Appendix



Main Rules for Bodywork and Aero Devices

- T.7.1.1
 - An aero device is any part that guides airflow to make downforce or change drag (wings, undertray, splitter, endplates, vanes)
- T.7.1.2
 - No powered device may move or remove air from under the car. Powered ground effect and power-driven aero devices are prohibited
- T.7.1.3
 - Mounts must be rigid when static, and devices must not oscillate or move excessively on track (checked under IN.6.2)
- T.7.1.4
 - Forward-facing edges that could hit a pedestrian (wings, endplates, undertray) need at least a 5 mm radius on horizontal edges and 3 mm on vertical edges. Permanently attached edge pieces count
- T.7.1.5
 - Any other edge a person could touch must not be sharp
- T.7.2.1-2
 - Conventional bodywork or a nose cone is not an aero device, but any part designed to (or that may) produce aero force is
- T.7.2.3
 - No openings into the cockpit from the nose back to the Main Hoop or Firewall, apart from the cockpit opening and minimal gaps around the front suspension
- T.7.2.4
 - Forward-facing bodywork edges, including the nose, need at least a 38 mm radius, carried at least 45° around the top, sides and bottom



Rear Aero Zone Rules

- Location (T.7.4): Must satisfy V.1.1 (open wheel) and V.1.4.1 (ground clearance)
- Length (T.7.5): At most 700mm ahead of the front tires and at most 250mm behind the rear tires, in plan view
- Width, ahead of front axle (T.7.6.1): Inboard of planes touching the outside of the front tires at hub height
- Width, between axles (T.7.6.2): Inboard of a line joining the outer surfaces of the front and rear tires at wheel-center height
- Width, behind rear axle (T.7.6.3) :Inside the Rear Aero Zone
- Height, in Rear Aero Zone (T.7.7.1a) : 1200 mm
- Height, everywhere else (T.7.7.1b) : 500 mm
- Height, ahead of front axle and outboard of planes touching the inside of the front tires (T.7.7.1c) : 250 mm
- Bodywork height (T.7.7.2) : Unrestricted between the axle-centerline planes and within 400 mm of the centerline on each side



Rules outside of T.7 that also affect Aero

- **V.1.1 Open wheel:** The top 180° of each wheel must be clear from above and the wheel clear from the side. Nothing may enter a keep-out zone 75 mm ahead of and behind each tire outer diameter in side view.
- **V.1.4.2–3 Ground clearance:** The lowest point of the Lower Side Impact Structure must be 90 mm or less from the ground, and should be 75 mm or less. There must be an opening to measure ride height without removing aero devices. Sliding skirts and intentional ground contact are banned, and violations forfeit a run or an event.
- **F.8.6.2 Front wing:** The wing and its mounts must be able to move completely aft of the Anti Intrusion Plate without touching the front bulkhead in a frontal impact. Mount points should be aft of the plate, and tabs may not extend more than 25 mm forward of it.
- **F.5.11 External items on the Main Hoop:** This applies if the rear wing pylon or any wing mount attaches to the Main Hoop or its braces. A mount must either use tabs at the hoop-to-brace node that are free to rotate, or sit above added bracing with calculations showing it fails below the permitted load. Mounts must also be offset longitudinally to avoid point loading, and should not point at the driver.
- **IN.6.2 Tech inspection:** Inspectors can push on any aero device at any point. If deflection looks significant, they apply roughly 200 N, which should give no more than 25 mm loaded deflection and less than 5 mm permanent. Officials can black-flag a car for large uncontrolled wing movement on track.
- **IN.16.2.3 After tech approval:** Wing or element **angle** can be adjusted, but wing **location** cannot change.



Links

[Subteam Timeline \[Aero MY27\]](#)

[Subteam RAIL \[Aero MY27\]](#)

[Subteam Budget \[Aero MY27\]](#)

[Mass Estimate \[Aero MY27\]](#)

[MY 2027 Rockers Mass Budget ArchDR](#)

