Blanking and wing position

Continuing our studies on the VUHL 05 sportscar

The Mexican-built VUHL 05 sports car comes under the Aerobytes spotlight again. The concept behind the VUHL 05 – in the same 'lightweight sportscar for road and track' genre as the Lotus 2-11, the Ariel Atom, the BAC Mono and the Caterham AeroSeven – belongs to the Echeverria brothers, Iker and Guillermo. The car was undergoing development work by UK-based Collins Advanced Engineering, run by brothers Jenner and Jilbruke Collins, enabling *Racecar Engineering* to host the car in one of its MIRA full-scale wind tunnel sessions.

Briefly recapping on last month's introduction, in baseline trim the VUHL 05 was found to have moderate drag commensurate of an open sportscar with quite modest, forward-biased downforce, the starting coefficients and balance figure as shown in **Table 1.**

The team wanted to ascertain the contribution to total drag of the car's cooling systems, which comprised a front mounted water radiator and an intercooler in the right-hand side duct. Inlets were at the front, in the sides and underneath at the rear, and there were through-ducts and exits in various places on the car. **Table 2** shows the changes (deltas or Δ values) from covering all the inlets and outlets.

Downforce and its distribution changed with the cooling system being blanked off, but perhaps the most important number here is the drag contribution of the system. 27 counts of cooling drag is, according to J. Katz's book Race Car Aerodynamics, better than average for a production car, with the average value quoted being 40 counts. Furthermore, the cooling system only contributed a three-count reduction in front downforce, when some production-based racecars suffer much greater front lift from poorly executed cooling systems. The 25-count benefit to rear downforce of having all ducts open was curious but useful, and may indicate that some of the drag

Table 1 – Baseline aerodynamic data on the VUHL 05

	CD	-CL	-CLfront	-CLrear	%front	-L/D
Baseline	0.533	0.135	0.102	0.032	75.6	0.253

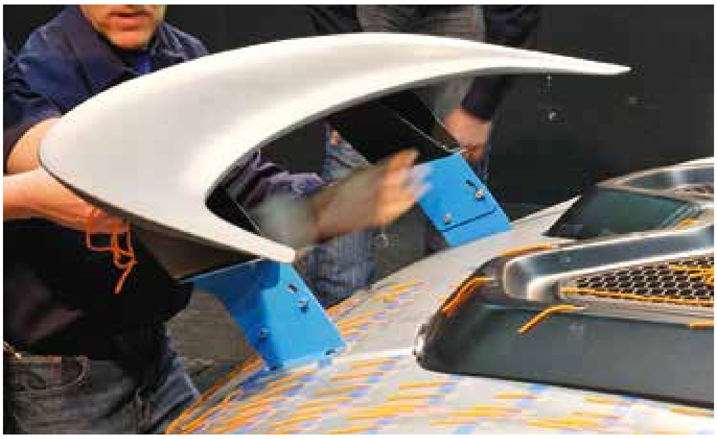
Table 2 – The effects of blanking all the cooling system inlets and outlets, changes shown in counts (1 count = a coefficient change of 0.001) relative to the baseline data in Table 1

	ΔCD	Δ-CL	Δ-CLfront	Δ-CLrear	Δ%front	Δ-L/D
All ducts blanked off	-27	-23	+3	-25	+18.2%	-31

Picture 1: Cooling flows were examined on the VUHL 05 open two-seater sportscar

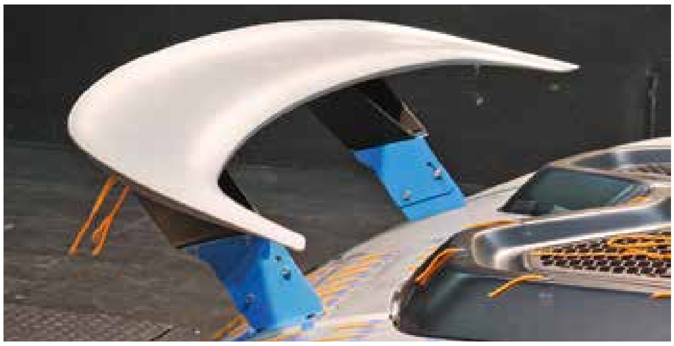
Picture 2: Inlets at the front, side, in the centre next to the driver and underneath at the rear were covered over (in blue for clarity)

Picture 3: Outlets on the rear deck and in the rear panel were also covered over



Picture 4:The rear wing was raised and moved aft with these spacers

Picture 5: The wing at the minimum angle tested (at the modified location)



Picture 6: The wing at maximum angle tested (at the modified location)

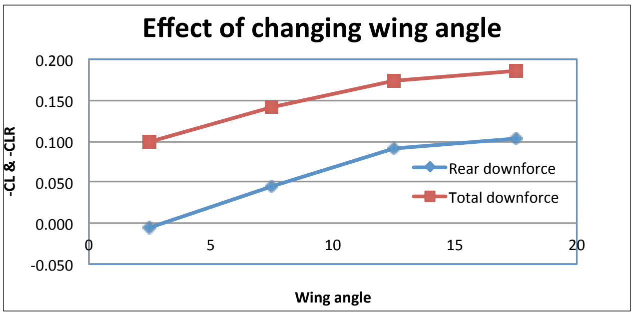


Figure 1: Rear and total downforce versus wing angle at the modified location

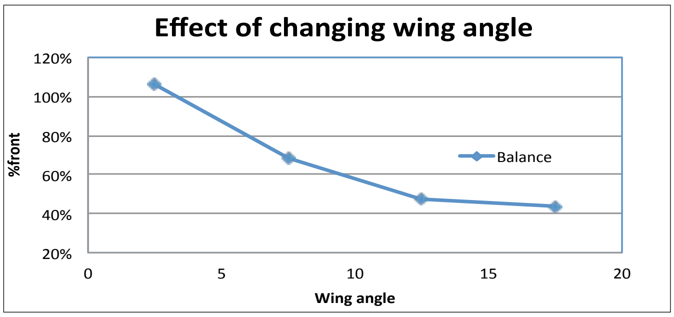


Figure 2: Percentage front versus wing angle at the modified location

Table 3 – The effects of raising the wing by 115mm and moving it 100mm further aft, changes in counts relative to the baseline

	ΔCD	Δ-CL	Δ-CLfront	Δ-CLrear	Δ%front	Δ-L/D
Move wing	+9	+39	-19	+60	-27.9	+68

Table 4 – The effects of altering rear wing angle and fitting a 30mm Gurney; the datum angle was 12.5deg, measured in the centre

Wing angle	CD	-CL	-CLfront	-CLrear	%front	-L/D
2.5deg	0.512	0.099	0.105	+0.006	106.1	0.193
7.5deg	0.524	0.141	0.096	0.045	68.1	0.269
12.5deg	0.542	0.174	0.081	0.092	46.6	0.321
17.5deg	0.553	0.185	0.081	0.104	43.8	0.335
17.5deg + Gurney	0.590	0.233	0.064	0.169	27.5	0.395

attributed here to the cooling system in fact came with this rear downforce increase, with additional induced drag accruing from the wing.

Rear wing

Prior to the session VUHL shipped over some rear wing mounting extensions to evaluate a higher, further aft location. The extensions also allowed some wing angle changes to be made. **Table 3** shows the results of moving the wing up by 115mm and aft by 100mm.

Moving the wing up and back thus produced an efficient rear downforce gain (60 counts of rear downforce for just nine counts of drag, a gain in the ratio of 6.66:1), but also a significant shift in overall balance, this now being 47.7 per cent front. The 19 count drop in front downforce would be the result of the wing's mechanical leverage from its position aft of the rear axle. The flows on the wing's important lower surface exhibited less separation at this raised, further aft location, as evidenced by wool tufts. It was also apparent that the wool tufts in the rear diffuser showed surprisingly well-attached flow with the wing working better in this location.

The wing was then swept through a set of angle changes, and finally a large (30mm) Gurney was installed (along with some 'spill plates' adjacent to the mounts, although it was ascertained in a subsequent run that these had almost negligible effect so the data is shown as the product of the Gurney alone). **Table 4** shows the full data set, and **Figures 1** and **2** plot the effects of the wing angle sweep on rear downforce and balance.

The changes fitted the expected patterns, with drag rising more or less linearly across the wing angle range, while rear (and total) downforce gains started to tail off as the wing got towards its stall angle at this new location, as the plot in **Figure 1** demonstrates.

Figure 2 shows how the balance altered with wing angle at this location, and indicates that in order to achieve a value of around 35 per cent front (to better match the static weight split of 37-39 per cent front) it would be necessary to either trade off some front downforce or increase rear downforce still further. One such method would be to add a Gurney to the wing to enable the stall point to be delayed, and the last line in **Table 4** shows the effect of a large 30mm Gurney. This produced a further 65 count gain in rear downforce, albeit with a not very efficient 37 count increase in drag.

Forces for courses

To put this interpolated 'balanced data' into a more practical context we should examine what the tyre contact forces would be relative to static weight. In rough terms these coefficients would see an additional 4.4 per cent vertical force on the front tyres and 5.3 per cent on the rear tyres at 100mph (44.7m/s). This may sound modest, but from a run in which all the aero devices were removed, the VUHL would generate as much positive lift without its downforce-inducing appendages as it produced in actual downforce with them. In other words, the VUHL would have 9-10 per cent more grip at 100mph with its aero kit.

Next month: We conclude our study on the VUHL 05 by examining the car's front end.

Racecar Engineering's thanks to Iker Echeverria at VUHL, and Jenner and Jilbruke Collins at Collins Advanced Engineering.

CONTACT
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In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

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