Lifting the lid on aero balance

A new project begins; a lightweight sportscar from Mexico

Launched in the UK in 2013, the VUHL 05 apparently impressed Mexican former F1 driver Esteban Gutiérrez when he drove it at the Goodwood Festival of Speed that year. This sportscar fits the genre of road-cum-track car already populated by such as the Lotus 2-11, the Ariel Atom, and the BAC Mono and perhaps the Caterham AeroSeven concept. However, the prime movers behind the car, the Echeverria Brothers, Iker and Guillermo, have said they think of it like a Lotus Elise; a car anyone can drive quickly. With the prototype in the UK undergoing development by Collins Advanced Engineering (another fraternal partnership run by antipodean engineers Jenner and Jilbruke Collins) it was a timely coincidence that brought the VUHL 05 into the MIRA full-scale wind tunnel with *Racecar Engineering* to share some of the findings on a car that will surely find its way onto the racetrack of the world very soon.

The VUHL (Vehicles of Ultra Lightweight and High performance) featured the expected aerodynamic aids aimed at creating modest downforce, namely; a small front splitter; side splitters or running boards; a flat underside; a short, curving rear diffuser; and a small, low-mounted rear wing. The car's cooling package comprised a front mounted water radiator plus an intercooler mounted at the rear of the right hand side duct. All of these aspects would come under the spotlight during the session. Collins Advanced Engineering also fitted a 46-port pressure tapping loom on the car prior to our session, with ports along the centreline of the car and at other points of interest in the hope of being able to correlate measured pressures with CFD data derived from the digital model of the car. We'll visit that aspect in a future issue. Meantime, let's take a look at the baseline coefficient data on the car as delivered to the wind tunnel. **Table 1** shows the coefficients and aerodynamic balance of the car at 16.2m/s (58km/h or 36mph), 26.2m/s (94km/h or 59mph) and the wind tunnel's maximum of 35.3m/s (127km/h or 79mph).

Table 1 – baseline coefficients on the VUHL 05 as delivered to the wind tunnel

Speed	CD	-CL	-CLfront	-CLrear	%front	-L/D
16.2m/s	0.539	0.108	0.071	0.036	65.7	0.200
26.2m/s	0.535	0.119	0.083	0.036	69.7	0.222
35.3m/s	0.533	0.135	0.102	0.032	75.6	0.253

Picture 1: The VUHL 05 open two-seater sportscar from Mexico

Picture 2: Compact and lightweight, but was it efficient?

Picture 3: Front splitter and cutaway airdam in front of the front wheels

Picture 4: Low-mounted rear wing

Picture 5: Twin short rear diffusers at the termination of the flat floor

Picture 6: This motorsport-modified Lotus Exige produced comparable CD but greater CL from a more aggressive aerodynamic package

Table 2 – the effects of yaw angle on the aerodynamic coefficients and balance

Yaw angle	ΔCD	Δ-CL	Δ-CL front	Δ-CL rear	Δ%front	Δ-L/D
+5.0deg	-	-34	-6	-27	+19.5%	-64
+2.5deg	-5	-12	+1	-12	+8.1%	-20
-2.5deg	+3	-23	-1	-21	+14.6%	-44
-5.0deg	+3	-45	-12	-31	+23.3%	-83

So let's examine the key facts from this initial data set. First, the car generated modest drag and downforce. The CD value was very similar to the motorsport-modified Lotus Exige that we tested back in 2007, but the –CL or 'downforce coefficient' value, was somewhat lower. However, given that the VUHL's primary downforce inducing devices, the front splitter and the rear wing, were more modest then this should be expected.

Second, the aerodynamic balance in the baseline configuration was front biased. The car's static weight distribution was around 37-39 per cent on the front, so in that sense the baseline aerodynamic configuration was too forward-biased. With sufficient downforce at the rear to get the aerodynamic balance closer to the static weight balance, the car would have significantly higher total downforce. We shall examine various changes that bear out this assertion in the next issue.

Third, the changes in the data with test speed were interesting. With increasing speed:

- CD decreased very slightly
- CL increased
- CL front increased
- CL rear barely altered
- Balance shifted forwards

As to the cause of these changes, it is most likely that a front-located downforce producer started working better as speed increased. This could really only be attributed to the front splitter. However, the extent of the change in –CL front seemed to be relatively large. We have seen slight increases in –CL front as speed has increased on cars with splitters previously but, relatively speaking, these are not as big as those witnessed on the VUHL. However, the VUHL was not producing very much rear downforce in this configuration, and there was very little change in CL rear as speed increased, so any front end speed sensitivity would probably be more evident as a result.

In terms of the actual mechanisms that produced lower -CL front values at lower speeds, the splitter was seen to be roughly 10mm closer to the floor at 35m/s than at rest, which would certainly contribute to the data trend. It might also be that the airflow was separating at the splitter's leading edge, but as speed increased this separation was suppressed by the increased mass flow under the splitter. If this was the case then a thicker splitter with a more generous leading edge radius to the lower face might perhaps be less speed sensitive.

To round off this opening instalment on the VUHL we'll look at how the data changed with yaw angle. The car was rotated on the tunnel's balance turntable, first 'nose to the right' (positive yaw), then to the left (negative yaw) to 2.5deg and 5.0deg. For clarity the data are shown in **Table 2** as changes (deltas or Δ values) in counts (1 count = a coefficient change of 0.001) from the highest baseline speed values in **Table 1**, all subsequent tests having been run at approximately 35m/s.

Clearly the most significant change to the data was the reduction in downforce, the majority of which was at the rear, where downforce was already quite small in the baseline configuration. The other most striking aspect was the asymmetry in the data, negative yaw (nose to the left) producing greater effects than positive yaw. It doesn't take a leap of imagination to think that the off-centre location of the dummy driver had much to do with the asymmetry in the changes, although this was not the only non-symmetric characteristic of the car; as previously mentioned the intercooler was located on the right side while the duct on the car's left side was empty. Nevertheless, at 5deg yaw either way the small amount of rear downforce had all but disappeared in this configuration, while front downforce reduced by just 12 per cent of the straight ahead value at -5deg yaw.

Next month: We'll look at the effects of blanking off the various cooling ducts to get an idea of total cooling drag, and further explore the characteristics of the VUHL.

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

Getting the aerodynamic balance closer to the static weight balance gives greater downforce

CONTACT

Simon McBeath offers aerodynamic advisory services under his own brand of SM Aerotechniques – www.sm-aerotechniques.co.uk.

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

Produced in association with MIRA Ltd

Tel: +44 (0) 24-7635 5000
Email: enquiries@mira.co.uk
Website: www.mira.co.uk