AEROBYTES

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FIGURE 4
The wind tunnel allowed a balanced but higher downforce set up to be obtained on the modified Lotus Exige tested here compared to the standard version

Race vs road

Comparing aerodynamic modifications destined for the track against a road set up reveals some useful information

The Lotus Exige might come out of the factory as a road car, but it is also an increasingly popular platform for a racecar at all levels of motorsport, up to and including international GT series. So, in order to understand the aerodynamic differences, *Racecar Engineering* set up a comparison test in the MIRA full-scale wind tunnel between a more or less externally unmodified Exige S2, and one that carried a number of aerodynamic components developed for the racetrack (primarily for GT3 and Britcars) by UK-based Reverie Ltd.

The modified car sported a complex front splitter arrangement that essentially led into a smooth, flat underside with front dive planes. The standard rear diffuser arrangement was still fitted at test time, but 40mm wider wheelarches were installed front and rear. Lastly, a new, more aggressive rear wing profile was used, with a full car-width span and incorporating planform curvature. This wing shape permits the boot to be opened for engine access, while keeping the wing within the maximum extent of the bodywork in plan view to remain within FIA GT rules.

SIGNIFICANT OTHERS

The externally unmodified car did have one alteration that was to prove especially significant. Whereas ordinarily the exhaust system's twin tailpipes (on the un-supercharged model) emerge into the central channel of the rear diffuser, on this car the exhaust emerged in the rear panel above the diffuser. In comparison, the modified car was fitted with a standard exhaust protruding into the diffuser. Otherwise, the road car featured the standard front splitter (which did not have a smooth, flat underside), a reasonably flat bottom, the same standard three-channel diffuser as the racecar (with cut-outs in the outer channels that allow for rear suspension droop) and the modestly profiled, curved, part-width span wing.

After ensuring that both cars' ride heights were the same, the road car was run first to establish a set of baseline aerodynamic data, and to provide the opportunity to do some flow visualisation with the inevitable wool tufts and smoke. Following this, there followed a session in which various configurations on the racecar were evaluated, and the next few Aerobytes columns will focus on some of the findings in more detail. This month though, we'll review the data comparisons between the road and race versions as tested, and discuss some of the preliminary conclusions reached.

Fortunately, in the generous

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Produced in association with MIRA Ltd

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Thanks to Simon Farren at Reverie Ltd and friends for exposing their cars to open scrutiny spirit of data sharing, we are able to publish actual coefficients and forces from this session rather than relying on percentage changes relative to some unquantified baseline configuration. So tables 1 and 2 show the data on the road car and the first data set derived from the racecar as it was delivered into the wind tunnel. Needless to say, the racecar's aerodynamic numbers changed significantly throughout the test, but the first run with any car in the wind tunnel is one that allows a quick assessment of which directions to head in, and subsequent columns will discuss those directions more fully.

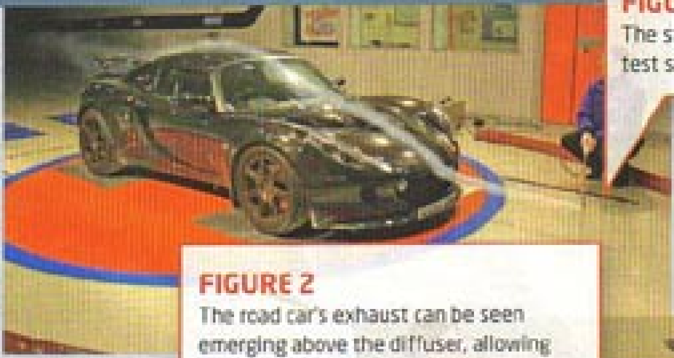

FIGURE 1
The standard road Exige used in this test session to establish baseline data

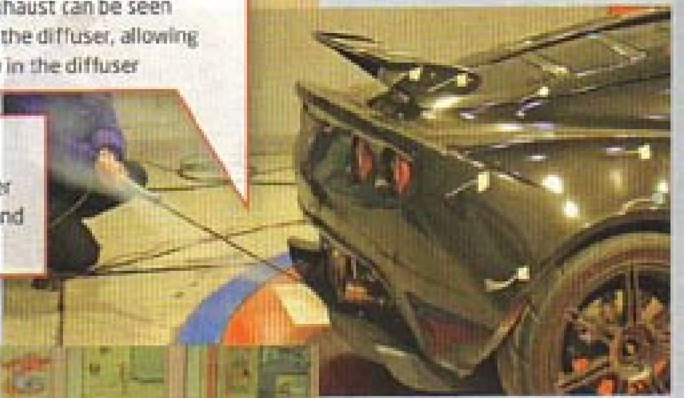

FIGURE 2
The road car's exhaust can be seen emerging above the diffuser, allowing improved airflow in the diffuser

FIGURE 3
The modified car featured a bigger splitter, dive planes at the front and a more aggressive rear wing

DOWNFORCE DATA

The frontal area values used for the coefficient calculations were 1.7m² for the road car and 1.74m² for the racecar, due to the wider wheelarches. Looking briefly at the road car's data first, the CD value measured here is pretty close to those values to be found in the public domain for the Exige, typically around 0.43 or so. Interestingly, the road car actually generated a modicum of downforce, amounting to a total of about 95lb at 100mph. The downforce split was slightly forward biased in relation to its static weight split, which saw 39.2 per cent of the car's weight on the front axle when at rest.

Moving on to the data from the racecar's initial run and we see first that the drag is higher, but also that the downforce is much higher, the two parameters of course being inextricably linked. However, whereas the drag increased by 25.8 per cent (comparing CD values), downforce increased by a massive 200.5 per cent (again comparing coefficients) to over 300lb at 100mph. This level of downforce represents nearly 15 per cent of the car's own weight at 100mph, which would make a significant difference to the level of available grip at this speed.

Having said that, the aerodynamic balance was not in line with the racecar's static weight distribution in this first configuration. Statically, the racecar had 40.7 per cent of its weight on the front axle, but the split of aerodynamic forces put just 31.8 per cent on the front, which would almost certainly see understeer develop and worsen as speed increased (if nothing was changed), given the significant levels of downforce being generated on this car. Fortunately, a number of options were available to address the balance issue. For example, as mentioned earlier, in order to directly compare the racecar with the road car, the two cars were set at the same 'road useable' ride heights, nominally 120mm front and rear. This meant there was zero underbody rake angle in both cases. Clearly, in full race configuration, a lower ride height would be used, and also a positive (nose down) rake angle. As we have seen previously in Aerobytes this would have had the effect of increasing the racecar's downforce and also of shifting the aerodynamic balance further forwards.

But the purpose here in this test was simply to illustrate the basic differences between the road car and racecar in a comparable way. And this initial overview also gives an idea of how the first couple of runs in the wind tunnel serve to answer some very basic questions, but simultaneously raise very many more! More on this interesting test session next month.

TABLE 1

Road and racecar wind tunnel coefficients and related data during initial runs

	CD	CL	CLf	CLr	%front	L/D
Standard car	0.442	-0.204	-0.086	-0.119	42.2	-0.462
Racecar	0.556	-0.613	-0.195	-0.436	31.8	-1.10

TABLE 2

Road and racecar wind tunnel forces at 100mph in initial runs

	Drag, N	Downforce, N	Front Df, N	Rear Df, N
Standard car	928.7	424.9	177.9	247.0
Racecar	1195.2	1346.3	416.2	930.0