FIRST PRINCIPLES

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Streamlining surprises

Fitting a fastback infill panel to a production-based GT racecar produced some unexpected extra benefits

All photos: Simon McBeath

The smoke plume shows the airflow separating sharply at the rear of the roof, but the rear deck sees a wake-like region of turbulent, recirculating airflow

Continuing our observations at the MIRA full-scale wind tunnel, this month we turn our attentions toward a GT racing variant of the UK-built Noble M400. The silver car featured here, although road registered, competes in the UK-based Britcar series. Its owner, Paul Cundy, and friends also brought along the near standard blue M12-3R to enable some baseline measurements and comparative flow visualisations to be made, keen to establish where the cars were, aerodynamically speaking, and to attempt some modifications to better optimise the racecar.

Our friends at Reverie Ltd had provided a number of devices to test, one of which was a fastback infill panel that fitted over the flat rear deck and behind the standard vertical rear window. The results of running with and without this infill panel on the blue 'standard' car are shown below in table 1. The main observations to emerge from these results are as follows:

- There was a negligible change in drag.
- There was a small gain in total downforce, amounting to 0.9 per cent.
- A loss of front downforce (22 per cent of a small amount) and a gain of rear downforce (2.8 per cent) saw a balance shift to the rear (this on a car already struggling for front downforce).

However, the team was expecting a more significant reduction in drag from this modification, so let's pause and think about some of the mechanisms that were probably at work here.

DRAG AND LOST ENERGY

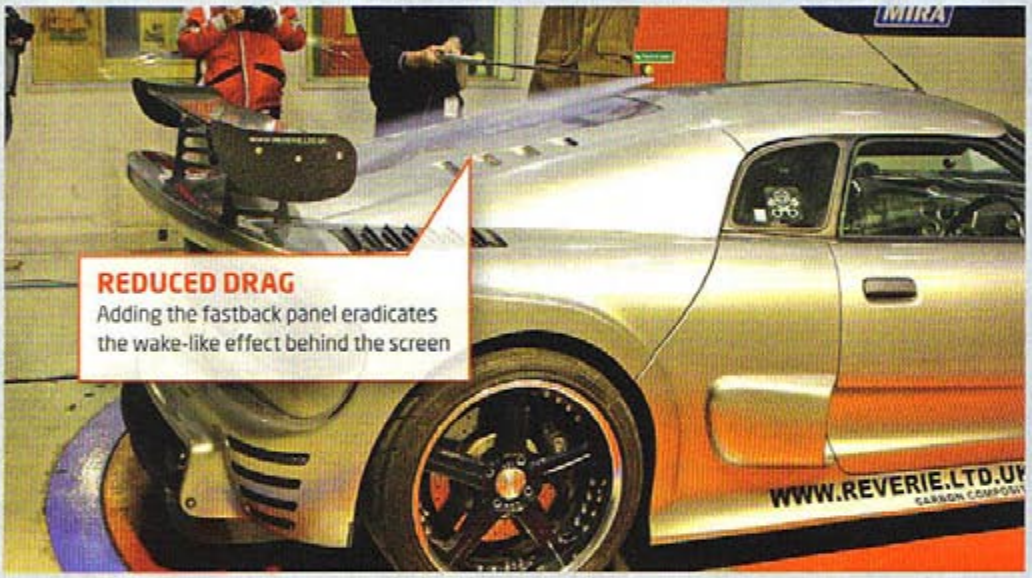
Without the fastback panel, the airflow can be seen to separate at the rear edge of the roofline, while behind the rear window and over the flat rear deck there is a region of slow moving, turbulent, recirculating air that is in a similar state to the car's wake. By virtue of considerable lost energy this region of the flow field is at reduced dynamic and reduced static pressure, just like the wake. This reduced static pressure acts on the horizontal deck to produce a lift contribution and on the rear

TABLE 1

The effect of a fastback infill panel on the aerodynamic coefficients of a Noble M400 (coefficients based on estimated frontal area of 1.87m²)

	CD	-CL	-CLfront	-CLrear	-L/D
Without	0.470	0.348	0.032	0.317	0.740
With	0.469	0.351	0.025	0.326	0.748
Change	-1 count	+3 counts	-7 counts	+9 counts	+8 counts

INCREASED DRAG
Slow moving, recirculating air is trapped in the original rear screen aperture



REDUCED DRAG
Adding the fastback panel eradicates the wake-like effect behind the screen

screen to produce a drag contribution. The slow moving recirculation was very evident when the smoke wand was placed in this region, as in the photo right, the smoke being 'trapped' within this recirculating bubble.

Fitting the fastback panel obviously tidied up the airflow over the rear of the car, eradicating the wake-like region behind the rear screen. Anticipating this effect is what led to the expectation of a reduction in drag. However, it will be evident that the air over the fastback panel now has greater energy and is maintaining higher velocity. Static pressure would again be low over the fastback, and since the fastback panel is sloping, that reduced static pressure would again create both a lifting and a drag component. So does this explain why drag barely changed after fitting the fastback? Perhaps only partly, because there were other aerodynamic changes recorded.

DOWNFORCE CHANGE

The natural assumption as to the cause of the rear downforce increase is that the fastback panel permitted a feed of 'cleaner', higher-energy air to the rear wing. It does indeed seem highly probable that without the fastback panel the air flowing down the centre of the car's rear would be robbed of more energy than when the panel was in place. That being the case, the centre of the wing would generate more downforce with the panel fitted. This in turn has a span-wise effect that helps the outer portions of the wing produce more downforce, too. And in its turn, this increases the strength of the wing tip vortices, the net result of which is an increase in the wing's vortex drag, as governed by the well known 'law of no free lunches'.

So if the wing's drag contribution increased, and it must have if its downforce contribution increased, yet the car's overall drag barely changed, we must conclude that the car body's drag contribution did in fact *decrease*. So it is probable that the fastback did have the expected effect but, because the rear wing soaked up the energy saving benefit, what we saw was no overall drag change.

> **"the difference between the two configurations would likely be more marked if the car were at a yaw angle"**

On this subject, MIRA's chief aerodynamicist, Angus Lock, made an interesting observation, noting that the difference between the two configurations would likely be more marked if the car were at a yaw angle. With no fastback panel in the straight-ahead position the flow separates pretty cleanly at the rear of the roof. However, at yaw the flow would also separate over the raised sides that partly enclose the rear deck, and this would likely disrupt the airflow in this region more than when running straight. However, with the fastback panel in place this additional disruption would be eradicated, so the difference between the 'with' and 'without' states would be greater in yaw. This would probably affect both drag and downforce changes, too.

DOWNFORCE REDUCTION

The apparent loss of front downforce with the fastback panel fitted could be put down to mechanical leverage from the increase in rear wing downforce. However, it is possible that the small improvement to the flow over the rear has had an upstream effect, leading to slightly raised velocity over the whole upper body. This would increase the contribution to positive lift from the reduced static pressure regions that exist over the front upper surface and the roof.

CONCLUSION

So, was it worth fitting this fastback panel? Yes, but not for the expected reasons. This car was suffering from a lack of front-end downforce and, in the context of finding aerodynamic balance, fitting the panel was counter productive. More on this car's balance issues next month.

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