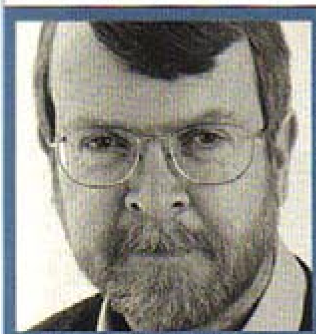
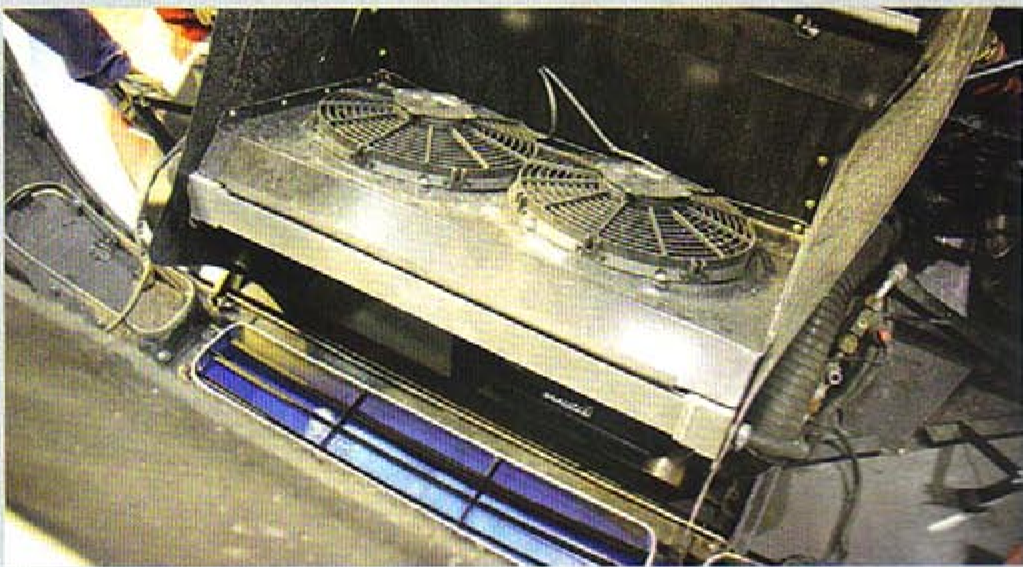


FIRST PRINCIPLES

Simon McBeath is an aerodynamic consultant and manufacturer of wings under his own brand of The Wing Shop - www.wingshop.co.uk. In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

Duct tape to the rescue!

Preventing the air going where you don't want it to go



All photos: Simon McBeath

The initial radiator and ducting on the Britcar Noble. Improvements made to this installation included raising the angle of the radiator nearer to vertical so the pressure drop across it created less lift force and less obstructive supports for the fans that blanked off less radiator area. Both sought to reduce drag and increase front downforce

Carefully guiding the air through the cooling system can yield some useful benefits, not just to efficient cooling, but also to a racecar's balance and grip. And in the wind tunnel, the strategic application of duct tape often provides a quick, easy means of finding out what happens when gaps that shouldn't be there are sealed.

The Britcar Noble M400 we have been studying recently began its session in the MIRA wind tunnel short of front-end downforce. Detail improvements to the front splitter and the use of front-mounted dive planes addressed the balance issue, so this month we focus on the under-bonnet aerodynamics.

As delivered to the wind tunnel this Noble featured an inclined radiator supplemented by a pair of electric fans that were panelled in against the downstream side of the radiator. However, the inlet duct was not sealed to the radiator, nor was there anything to prevent the heated air from bypassing the exit duct and heading under and into the wheelarches. So time was spent with cardboard, foam block, rubber edging strip and duct tape, making sure the inlet *did* seal against the front of the radiator and that the sides of the radiator surrounding panels also sealed against the underside of the clamshell.

TIGHT SEAL
Foam and card was used to seal the radiator to the inlet duct and rubber strip to seal the duct sides to the underside of the clamshell when it was closed

Results of these modifications are shown in table 1. This achieved a slight decrease in drag but also a small loss of overall downforce and efficiency (-L/D). It also produced a helpful forward shift in downforce balance percentage.

STATIC PRESSURE

The gain in front downforce can probably be most easily explained by the small increase in static pressure ahead of the radiator that would occur now

THE WRONG WAY
Smoke can be seen escaping from the windscreen scuttle area, as well as the exit duct in the clamshell

THE RIGHT WAY
The air should have been emerging only from the exit duct here

that the air was restricted to passing only through the radiator. However, the loss of rear downforce would seem to be more than would have occurred just through the mechanical leverage arising from the increase in front downforce. Given that less air may now be passing through the radiator, and that this air was constrained to pass through the two fan apertures only, maybe the flow now emerging from the radiator was simply slower and less energetic. And of course, this air passes over the central roof and ultimately encounters the rear wing, which would now generate less downforce.

This might also explain the decrease in overall drag. The static pressure increase ahead of the radiator would be expected to add drag, but the reduced energy feed to the rear wing would also see it generate less drag. The result was a small reduction in drag.

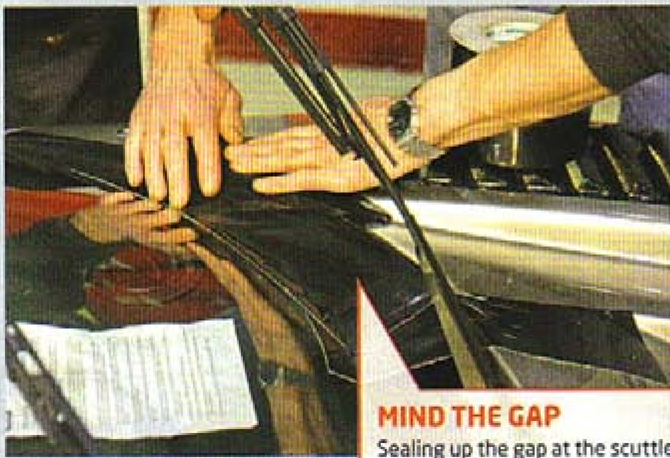
As shown in the accompanying images, air leaving the radiator was also appearing through the gap ahead of the windscreen scuttle. The preferred fix here would have been to extend the clamshell exit duct so it sealed against the rear face of the radiator, but an expanded metal grille bonded to the clamshell duct prevented this. The next best thing was to tape over the gap between the rear of the clamshell and the windscreen scuttle.

With the sides of the radiator surround panelling already sealed to the underside of the clamshell the air could now only exit through the clamshell duct. Results are shown in table 2.

DOWNFORCE GAIN

In this instance drag barely changed, and a modest gain in total downforce was found (all of which was at the front), while a small loss of downforce again occurred at the rear.

The mechanisms here are far from clear, but the gain in front downforce may again have accrued from increased static pressure ahead of the radiator inlet pushing down harder on the splitter. Or as MIRA's chief aerodynamicist, Angus Lock, explains, it might also be that by eradicating the radiator exit flow through the scuttle region, this area at the bottom of the windscreen, which is generally at raised static pressure, saw an increase in that pressure. Being ahead of the car's c of g this would manifest itself as an increase in front downforce.



MIND THE GAP
Sealing up the gap at the scuttle increased downforce and improved balance in this instance

The loss of rear downforce was small compared with the gain in front downforce, and may just have been the result of mechanical leverage arising from the gain at the front. But according to Lock, 'The flow around the A-pillars of any car is especially complex, and anything like this, that potentially alters that flow, can create some quite unexpected results.' In this instance, it may be that the flow around the A-pillars was modified in such as way as, for example, to adversely affect the outer sections of the rear wing.

Whatever the mechanisms, this modification to the cooling flow benefited the car's overall aerodynamic efficiency (-L/D) and once more improved the downforce balance of the car, transferring a further proportion to the front.

Thanks to Simon Farren at Reverie, Paul Cundy, Richard Gould, Phil Brett and Adrian Winch.

TABLE 1

The effects of sealing the radiator ducting on the Britcar Noble

	CD	-CL	-CL front	-CL rear	% front	-L/D
Before sealing	0.502	0.504	0.109	0.394	21.63	1.004
After sealing	0.500	0.498	0.118	0.380	23.69	0.996
Change, counts	-2	-6	+9	-14	+2.06	-8

TABLE 2

The effects of taping up the gap in the front scuttle

	CD	-CL	-CL front	-CL rear	% front	-L/D
Before sealing	0.503	0.523	0.137	0.386	26.20%	1.040
After sealing	0.504	0.530	0.151	0.379	28.49%	1.052
Change, counts	+1	+7	+14	-7	+2.29%	+12