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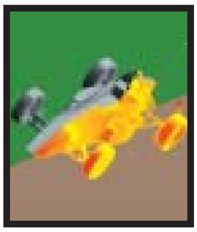

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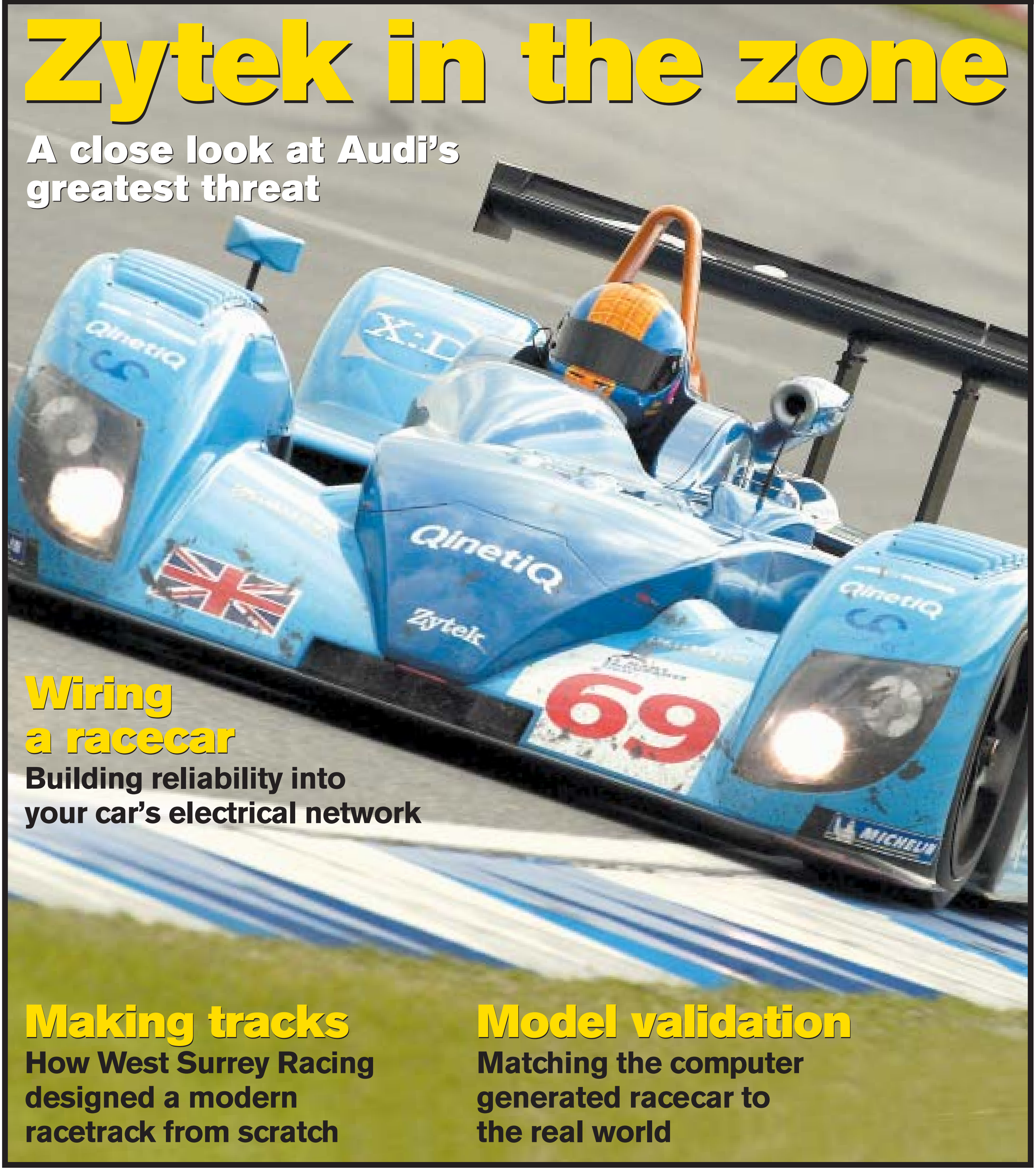

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Splitters can be so effective at generating downforce they are banned in NASCAR events

In the previous issue we looked at airdams on the front of a generic NASCAR racer and, with the aid of CFD, found out how and why deep airdams (up to a point) create useful and highly efficient front-end downforce. Though you won't see one in NASCAR, a horizontal 'splitter' added to an airdam is a common device renowned again for producing low -drag downforce. This month Advantage CFD has added splitters of various sizes to the NASCAR model used for the airdam study.

Recapping briefly, the full scale, virtual NASCAR model incorporated such realistic details as a rough underside with exhausts, chassis rails, bumps and cavities, and also a rear spoiler (see figure 1). Several 3D CFD runs were carried out at 50m/s air speed (180km/h or 112mph) and evaluated with three different splitter lengths attached to the 100mm airdam modelled in the previous issue.

The plots in figure 3 show the results of downforce and drag (as dimensionless CDfA and CdA values, the product of frontal area and the relevant coefficient). The graph shows total downforce increasing (by just over 10 per cent compared to the baseline case) up to a splitter length of 100mm, and drag remaining virtually unchanged (it actually increased slightly but by less than one per cent). Note downforce is treated as 'positive' here in this example.

As was the case with airdams, the gains in downforce were at the front end of the car, and in fact once more the rear end actually lost some downforce. Thus, the trend of converging front and rear downforce coefficients started by the airdams was continued with the addition of the splitter, until a 50/50 front to rear aerodynamic balance was achieved with a 100mm splitter attached to the 100mm deep airdam. This may or may not translate to an aerodynamic handling balance of course, depending on the static and dynamic mechanical loadings of the car.

It would appear then that there is a maximum splitter length that ought to be run, and this tallies with the conventional wisdom found in the textbooks. Indeed figure 4 agrees nicely with the textbook explanations of how a splitter generates downforce. It is very clear in this image that the splitter 'taps' the zone of high static pressure ahead of the nose of the

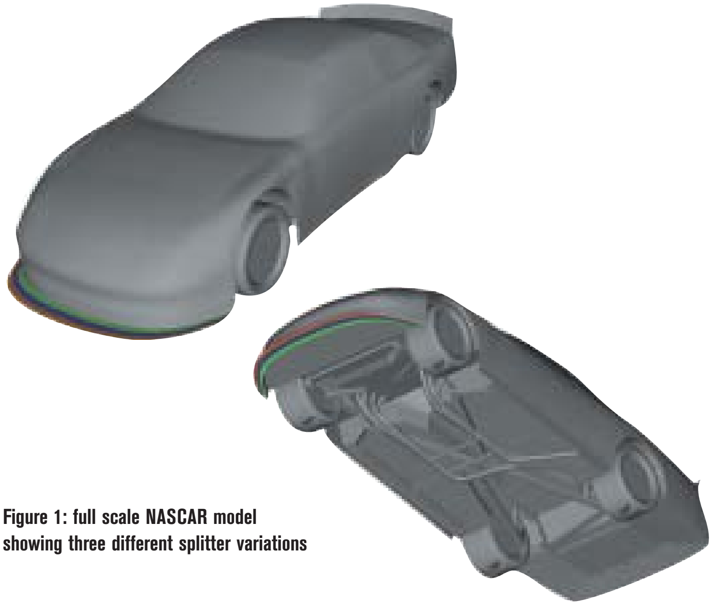

Figure 1: full scale NASCAR model showing three different splitter variations

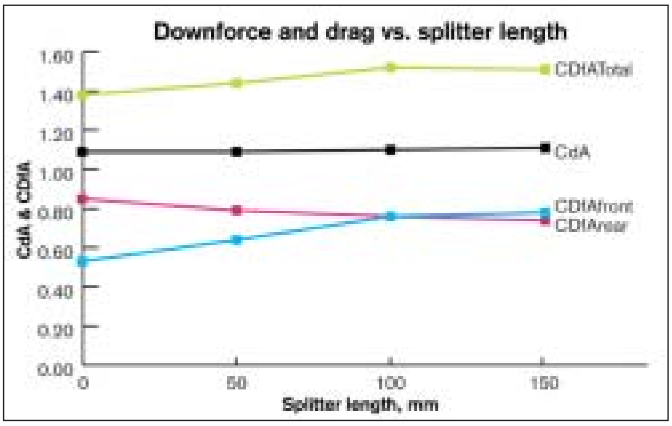

Figure 3: effect of splitter length on downforce at the front, rear and overall, and overall drag

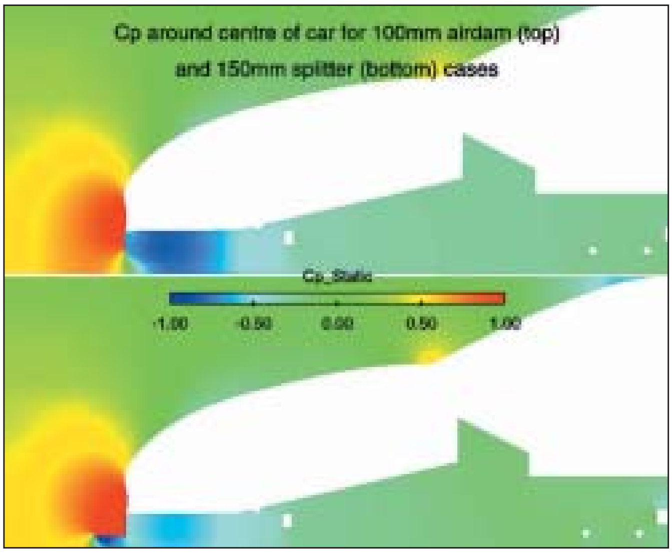

Figure 4: effect of adding a splitter on the static pressure around the front of the racecar

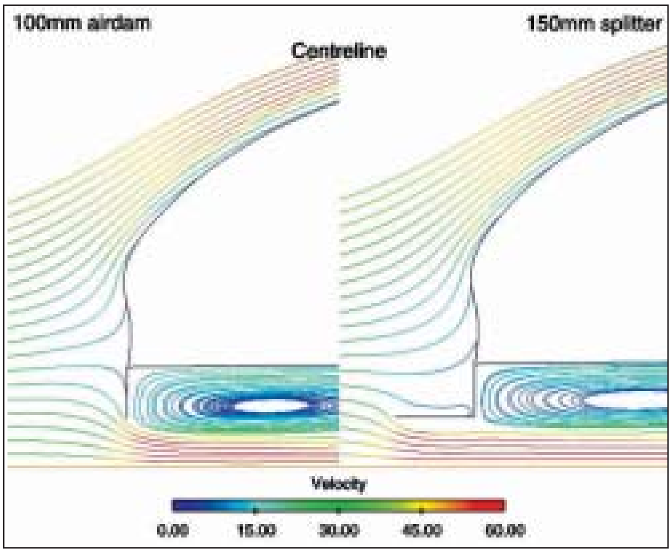

Figure 5: streamlines at the car centreline for the 100mm airdam and 150mm splitter cases

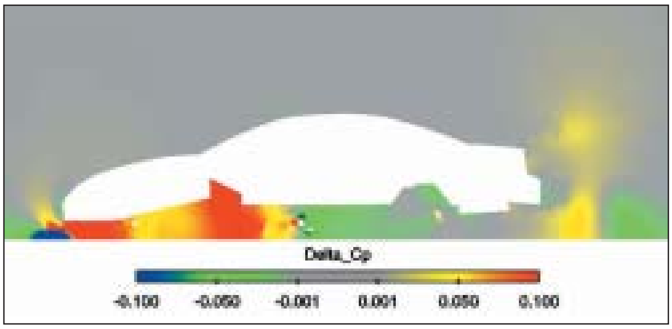

Figure 6: changes to pressure that occur by fitting a 150mm splitter to the 100mm airdam

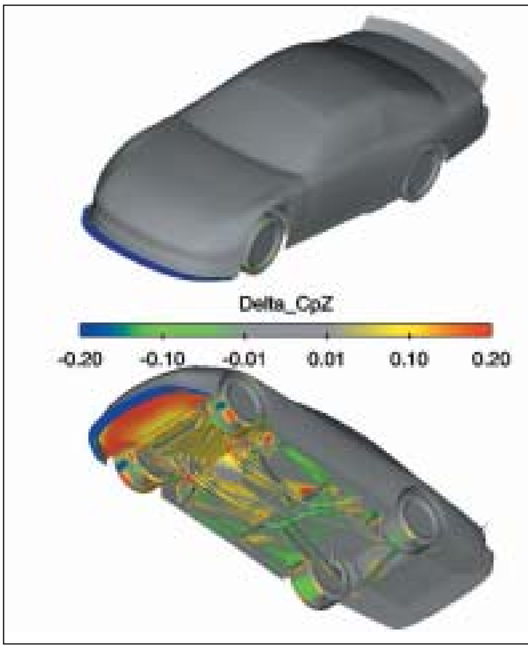

Figure 7: effect of adding a 150mm splitter on downforce

car, and furthermore that there is a very marked low pressure zone immediately under the splitter. These pressure changes add up to downforce. It is also apparent that there would be little point extending the splitter further forward than the extent of the high pressure 'bubble', and this may be at least part of the reason why maximum downforce peaks at the 100mm splitter length in this case.

Figure 5 shows that the splitter has the effect of channelling more air up and over the car, but also that the reduced volume of air going under the splitter is locally accelerated to generate the low pressure there. But going back to figure 4 again, it is also apparent that the pressure is not as low behind the airdam when the splitter is fitted, as evidenced by the paler blue colour, compared to the airdam-only case. Figure 6 shows a ρCp plot, which indicates the difference in static pressures, between the airdam only and airdam plus 50mm splitter cases. The pressure reduction (blue) under the splitter is clear, but so too is a rise in pressure (red and yellow) behind the airdam and under most of the front of the car's underside.

Thus, although there is a very useful net benefit in front end downforce achieved by fitting the splitter, there is a trade off in that the front underbody pressure is raised, which counteracts some of the splitter-generated downforce. This might also have implications for the venting of cooling air in some front-engined applications where this raised pressure works against air exiting the cooling system towards the underside.

That the splitter is a powerful device for the generation of downforce is clear in figure 7, which is a ρCpρZ plot, indicating pressure changes in the vertical or Z-direction only. From above and below the downward-acting pressure changes (seen in blue) on the splitter are abundantly clear, but so too is the rise in pressure behind the airdam. Why does this happen?

We have already mentioned that the splitter directs more air over (and around) the car, and that what went under the splitter was accelerated. This is where the downforce accrues. But this reduced volume of air passing under the splitter then slows aft of the splitter to a lower velocity than was the case without the splitter, and this is associated with the enlarged recirculation zone apparent in figure 5. So now the dynamic pressure in this region is lower than the airdam-only case, and the static pressure is higher. It's swings and roundabouts, but the swings win.

The very small increases in drag are the result of some pluses and minuses, too. There are modest reductions in drag felt by the car's body, wheels and the airdam, but these are offset by slightly less modest increases in drag felt by the underfloor and its tubes and protrusions, which result from the rearward component of the aforementioned increase in pressure in that region acting on these components.

In practical terms the splitter is an uncomplicated device that can be a very useful, efficient generator and balancer (by adjustment, where permitted) of downforce. Its ability to function will be affected by the shape of car it is attached to – clearly a blunt front end like on our NASCAR model here will have a more pronounced high pressure zone to 'tap' ahead of it than a sleek, low-line front end. And another issue to keep in mind is that, being close to the ground, there is the possibility of ride height or pitch sensitivity cropping up with a splitter.

Next month we'll add a diffuser to the airdam/splitter assembly.

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