
The car had been track tested with various configurations of wings during the 2018 season

A Caterham with Wings? Part 1

Caterhams have often been referred to as having "the aerodynamics of a brick" but with the handling of a well set up Seven already so good, most owners just accept the car for what it is. Over the years, some efforts have been made to explore improving the airflow around the contours of Chapman's classic design, but racer **David Long** had the unique opportunity to study the subject using MIRA's wind tunnel, alongside author and aero expert **Simon McBeath**. This article, to be published over two editions of Lowflying, tells the story of a very successful investigation.

Anyone who buys a Caterham probably doesn't think too much about aerodynamics. I certainly hadn't given the subject any serious thought until I found myself competing in a 600 bhp-per-tonne car where even on supersoft sticky tyres, traction was a problem. Competition in my case refers to the Super Lap Scotland championship, an intense time-trial challenge where drivers compete to post the fastest lap time around Knockhill. The class structure is based on the bhp per tonne of the car and the driver. My Caterham S3 R400 (2.5L Duratec, Sadev sequential gearbox, Penske shocks, Titan LSD) puts me in class A where I get to compete against a variety of highly tuned and developed cars including Misubishi Evos and Toyota Supras. The format of the competition is that after qualifying, drivers get just one "Superlap" – a solitary flying lap which ultimately separates the winners from the losers. It really is, for want of a better phrase, a "One lap dash for the cash"!

I was class A champion in 2014, and it's an achievement I very much wanted to repeat. I knew that one way forward would be to add some downforce, but my experience in this area was minimal. It was Simon McBeath's book 'Competition Car Aerodynamics' that saved the day… After swapping a few emails with him, I went ahead and purchased a SM183 profile rear wing, made by DJ Racecars, to mount on the Caterham. That was to mark the beginning of a fairly interesting period in my Caterham's evolution.

Mine was not the first Caterham to use this wing however; it had successfully been used by a Caterham racer in South Africa. However, this was the first time it had been used in the UK, so Simon was interested to see the results. In the hope of adding some aerodynamic balance to the car, I managed to pick up a second hand Lavante front wing, but when I tried it, I found that it was not adding the level of front downforce that I had been hoping for. I therefore replaced it with a hybrid double-element version. In this guise, the car went on to win its class championship, but I was never really happy with the aero balance, and some aspects of the 'aero' just made no sense to me at all.

So, when an invitation from Simon McBeath to put the car in the MIRA wind tunnel came

along, there could only be one possible answer! It also provided the opportunity to test the new SM153 front wing that I wanted for the 2019 season. With less than two weeks to build the wing before the test date, DJ Racecars took on the challenge and we were able to pick it up on our way to MIRA.

Despite having read up on the subject and taken any advice available, my aero experiments to that point had been pretty much trial and error. Air naturally wants to flow from high to low pressure but in the dynamic environment in which a car operates, a whole range of localised pressure variations get generated, meaning that air will flow in ways that do not necessarily follow the shape of the car. You can sometimes get glimpses of this when it's wet from the way the spray flows, and dust and dirt sometimes mark out flow lines, but essentially it's guesswork as to how the air travels over and around the car.

Access to a wind tunnel changes all that, and the facility at MIRA is hugely impressive. The aircraft-sized hanger that houses the tunnel has its own substation to power four beautifully-crafted WWII bomber propellers. It can whip up an 80 mph breeze in seconds, measure the forces on your wheels to within a few grams, and pop out fully calculated data in seconds – a far cry from the guesstimates of track testing.

If you turn the speed down a little, you can also join the car in the wind tunnel and visualise the flow with the aid of a smoke

The full size MIRA wind tunnel dwarfed the Caterham. The 'V' shaped boundary fence generates a vortex that re-energises the flow close to the floor in front of the car.

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The flow over the Caterham was cleaner than I was expecting.

wand; suddenly there is so much information heading your way that you need to take photographs and videos to capture it all.

So what is involved?

It takes a little time set up the wind tunnel session, and the load cells need adjusting for your wheelbase. Coefficient calculations need to know the car's frontal area, and knowing the car's corner weights is useful too as theory states that the aerodynamic balance should mirror the normal balance of car as closely as possible. However, when it comes to Caterhams, I have come to the conclusion that any downforce is actually beneficial as the front-rear balance is typically managed with the throttle!

The key to getting the most out of the wind tunnel is to have a plan. It's an expensive facility, so you want to utilise every possible minute to take measurements. Time out to change things is best kept to a minimum, and objectives should be as simple and as straightforward as possible.

In the two hours I spent in the tunnel, we fitted in seventeen runs and generated a huge volume of data – the first 10 minutes probably equalled a whole season of track testing. I could have spent all day there, but this was at the invitation of Racecar Engineering magazine for Simon McBeath's Aerobytes article. Our goal was to look at a Caterham with wings, not to satisfy my own Caterham curiosities.

So, what did we find?

We started with some baseline runs with the car in its standard trim – a S3 Seven with a race aeroscreen rather than a windscreen.

The drag coefficient was surprisingly low at 0.645. This is comparable to most track cars, and despite what is often claimed, is actually a long way from the 1.1 of a brick!

The aerodynamic balance however will probably come as no surprise to anyone who has driven a Caterham flat out. The centre of aerodynamic force is somewhere behind the rear wheels; with the balance so far behind the car's centre of gravity, the inevitable outcome is understeer which increases with speed. It approximate terms, we measured 46kg of lift at 100 mph, and probably nearer 100kg at top speed, all on the front.

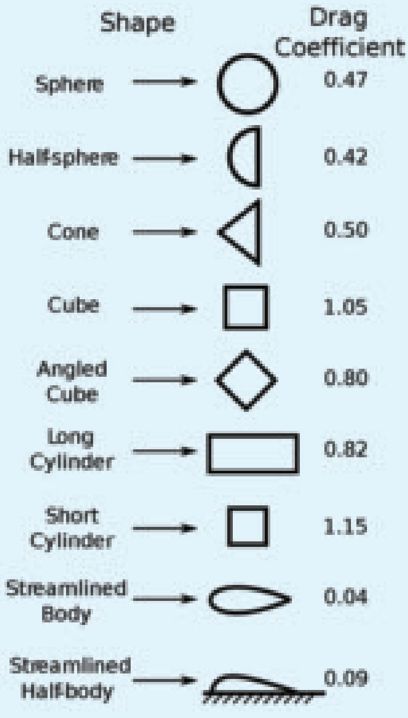
Next month, David reports on the effects of adding front and rear wings to a Seven in terms of both downforce and drag, and reaches some unexpected conclusions…

Our thanks to David Long @duratec.in.detail
Photographs copyright Simon McBeath, John Stewart, Flatout photography, & David Long

The standard S3 race car generated a large amount of lift but had a reasonable drag coefficient at 0.645. The dummy driver was used to make it as close to real life conditions as possible.

What is Drag Coefficient?

In fluid dynamics, the drag coefficient is used to quantify the drag or resistance of an object in a fluid environment, such as air or water. A lower drag coefficient indicates that the object will have less aerodynamic or hydrodynamic drag. The drag coefficient is always associated with a particular surface area.



The frontal area was calculated by placing a scaled grid over a photograph, and then counting the squares (with and without wings).