Reducing drag on a Swift Formula Ford

We use flow visualisation to find the draggy bits on an FF1600

Woody Allen is reputed to have said he lived in New York because he didn't trust air he couldn't see. Maybe that city has improved its pollution levels since then, but with his throwaway line Allen (presumably) unwittingly hit upon a problem for anyone wanting to visualise how the air moves around a racecar: we need to make it visible so we can see where it flows. And if we can do that we can then develop a better understanding of how we might be able to influence things to improve aerodynamic performance.

Our new mini-series then goes back to basics in more than one respect, for the subject of our latest session at the MIRA full-scale wind tunnel is a Swift SC92F Kent-engined Formula Ford. This particular example has been used by your writer for his hillclimbing forays in the past couple of seasons, but apart from the timing strut on the nose it is representative of pre-1994 Kent engine FFs worldwide. While except for the wider sidepods that house lateral intrusion structures on later FFs, it's not too far away in overall aerodynamic concept from *any* Formula Ford. Which is to say, with no downforce generation permitted in the rules, the only thing you can do aerodynamically speaking is to make sure drag is kept to a minimum.

Formula Ford designers had been chipping away at frontal area and looking for sleekness – for which read 'drag coefficient' – for 25 years by the time this 1992 Swift was built. The question is then, did they leave anything on the table that's still to be found?

For once, our quest will not be about chasing downforce and aerodynamic balance, but instead in identifying where there are sources of drag that we might be able to do something about. So we started our wind tunnel session by taking a close look at the flows around the car and over its external surfaces with the MIRA smoke plume and trusty wool tufts (any section of track or private road where you can run your car at a reasonable speed alongside a chase car with photographer installed will of course also enable effective wool tufting trials to be carried out).

The first task after installing the car was to affix trip strips to the tyres. These are to better simulate the flow separation that occurs on a rotating wheel, given that the MIRA wind tunnel's floor is stationary and the test car's wheels are, thus, non-rotating. Historical research found that positioning half-inch

For once our quest will not be about chasing downforce and balance

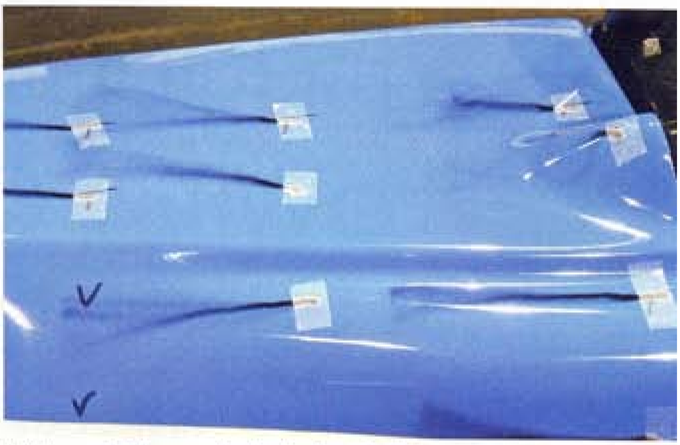
There is no downforce on the writer's Swift SC92F so the focus was on identifying drag sources. Note trip strips on tyres which simulate the flow separation on a rotating wheel

The smoke plume revealed that, usefully, the front wheel wakes partially impinged on the rear wheels, which would help reduce drag caused by the rear wheels and tyres

Wake from the mirrors was quite pronounced and these will certainly be causing drag

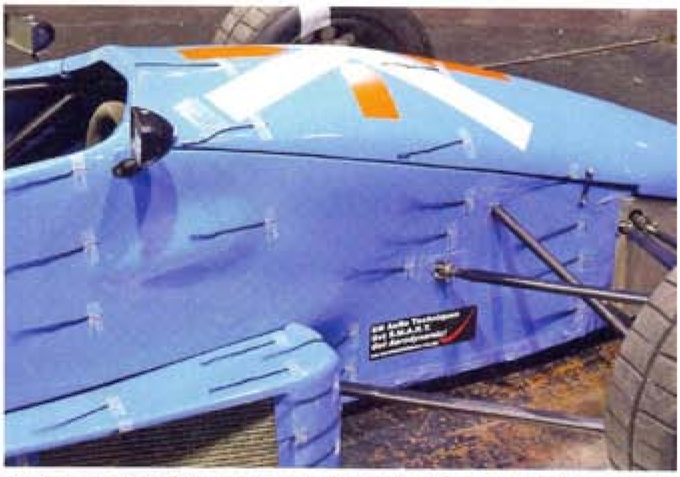
Flow down the rear of the engine cover was not fully attached; this could also add drag

The roll hoop clearly has an effect on the airflow but as a safety device it cannot really be altered. But could changes to the bodywork around the hoop help with reducing the drag?



Note the unsteadiness revealed by the almost invisible wool tuft immediately aft of the near leg of the roll hoop (centre right of the picture). Bodywork mods could help here

The exhaust headers and the regulation-spec silencer will also be adding unwanted drag



Upper centre wool tufts show the front suspension mounting brackets were disruptive

(12.5mm) tapered Gurneys just aft of the tops of the tyres on open wheel cars produced flows (and results) more akin to what is found when the wheels are rotating. In our May 2008 (RCE V18 N5) edition we examined the effect of trip strips on a then current Spectrum Formula Ford and found that they actually reduced the drag of the car by about one per cent. It was felt this extra step towards realism was important enough to include in our current study as we were probably going to be looking at quite small percentage changes.

The MIRA team positioned the trip strips so that their top edges were aligned horizontally with the top of the tyres. Of course there's nothing that can be done about the drag of the wheels and tyres, which are both controlled items. Suffice to say that, usefully, the wakes of the front wheels seemed to impinge on the rear wheels, which would at least reduce the drag the rear wheels might otherwise cause.

Rear view mirrors are not normally mandatory wear in hillclimbing, but the category's Pre-'94 FF class requires adherence to the original formula regulations in this and other respects. The picture on p57 shows the extent of the mirror's wake. So what, if anything, could be done to reduce their drag, given that their minimum area is specified?

The smoke plume passing over the driver's head shows a reasonably clear passage for the airflow over the centre of the engine cover. However, where the engine cover turns from roughly horizontal down towards the rear there appears to be too sharp an angle change because the plume was not remaining fully attached. Does this mean the engine cover needs re-shaping, or could some other means of improving flow attachment be applied? See, for example, *Research on Aerodynamic Drag Reduction by Vortex Generators*, by Masaru Koike, Tsunehisa Nagayoshi and Naoki Hamamot (which is published by Mitsubishi Motors and is available online).

The roll hoop is not something that can be altered but it clearly has an effect on the airflow. Bodywork maximum height is 900mm from the ground and the roll hoop top is 930mm. The wool tufts in centre right of the photograph at the top right of this page suggest fairings around the sections below 900mm could well bring some benefit.

The exposed exhaust system is also obviously disrupting the airflow along the left side of the car. Would a deflector or fairing ahead of the exhaust have a net benefit?

The suspension links may only be manufactured in round or oval tubing, but would fairings to ease flow around the mounts adjacent to the body help? The wool tufts in the centre of the bottom-right image suggest this (along with a better panel fit) might be an improvement. These, and other questions, will be answered in the next two issues.

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CONTACT

Simon McBeath offers aerodynamic advisory services under his own brand of SM Aerotechniques – www.sm-aerotechniques.co.uk.
In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

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