Reducing the drag on a Formula Ford

Our quest to shave speed-sapping drag from a Swift SC92F continues

The Swift SC92F that continues under the MIRA full-scale wind tunnel spotlight this month hails from the formula's 25th year, exactly halfway through its existence. And if one thought that the designers would have whittled drag down to an absolute minimum during that first 25 years, well, our findings from this session indicated otherwise. In our December issue we used flow visualisation methods to examine where there were potential sources of further drag reduction and in January's issue we saw how four per cent was shaved off the drag by reducing the radiator inlet and outlet apertures. This month the quest for further drag reductions continues.

Table 1 shows the baseline aerodynamic data at the start of the session, and also after the runs reported last month. Coefficients multiplied by frontal area are used; these values are directly proportional to the measured aerodynamic forces (at any speed) and also eliminate any errors in the 'bare' coefficients arising from the estimation of frontal area. With a raft of additional changes made following last month's cooling duct modifications we'll tabulate all the remaining results and highlight those that yielded most benefit. **Table 2** shows the changes to the coefficients from subsequent modifications as 'Δ' or 'delta' values, expressed in counts (1 count = a coefficient change of 0.001).

The baseline data shows that the Swift, the author's hillclimb mount, had moderate drag and also generated lift, which was concentrated at the front. Following reductions in cooling duct inlet and exit areas the drag was reduced by around four per cent and, although it was not being targeted, lift was reduced by nearly 10 per cent.

Configurations 9 to 12 in **Table 2** were essentially one experiment to

Table 1: The baseline data on the Swift SC92F

	CD.A	CL.A	CLf.A	CLr.A
Baseline	0.495	0.175	0.140	0.035
After cooling duct mods	0.475	0.158	0.131	0.028

Table 2: The remaining configuration changes, results shown as Δ values in counts

Config.	Description	CD	CL	CLf	CLr
9	Tape gills on engine cover	+1	-1	-1	0
10	Tape over two thirds of engine inlet	-1	-2	-2	+1
11	Fully tape over engine inlet	+1	-1	-1	0
12	Tape fairing over engine inlet	-6	-1	-2	+1
13	Tape over NACA ducts in engine cover	+2	+1	+1	-1
14	Tape body gaps around exhaust headers	0	+3	+2	+1
15	Fit fairings behind roll hoop	-14	+2	-2	+4
16	Tape nose and other gaps	-1	-1	+1	-2
17	Fit exhaust fairing	+1	-2	-2	0
18	Fit front upper suspension mount fairings	-3	+1	+2	-1
19	Blend rear pushrod fairings to trailing edge of engine cover	+2	+2	+1	+1
20	Fit mirror vortex generators	-1	-2	-1	-1
21	Remove mirrors (illegal)	-16	+7	+6	+2
22	Raise rear ride height 5mm	+5	-3	-5	+2
23	Fit engine cover vortex generators	+2	0	+1	-1
24	Remove tyre trip strips	-3	+63	+30	+32

The writer's Swift SC92F Formula Ford 1600 undergoing its drag study in the MIRA tunnel


The object of one of our experiments was to find out if the engine inlet duct created drag


Taping directly over the Swift's inlet duct actually made no difference to the drag


A fairing placed over the engine inlet made a useful difference, but would be impractical


These roll hoop fairings were one of the most beneficial modifications of the session


A fairing positioned ahead of the exhaust actually seemed to cause a small drag increase


Shaped foam suspension mount fairings provided some help in reducing the drag

determine the engine inlet duct's drag. Partially and totally taping it over made little difference, suggesting the drag from air entering the duct was the same as the drag from bluffly taping over it. But fixing a shaped fairing over the duct effectively simulated removing the duct altogether, and produced six counts (one per cent) of drag reduction, indicative of the overall drag from the scoop (clearly then the engine must be allowed to inhale from elsewhere, hopefully with less drag accruing).

Configuration 13, taping over the NACA ducts on each side of the engine cover, caused a small but surprising drag increase, while equally surprising was the lack of drag reduction from partially taping over the large hole around the exhaust headers (config 14). However, having shown the roll hoop as disruptive to flow using the smoke plume, configuration 15's roll hoop fairings gave a satisfying 2.4 per cent drag reduction. These met the 90cm maximum height rule, and their tapered shape clearly tidied up some of the hoop's wake. Taping over panel gaps around the nose and engine cover (config 16) may have yielded a tiny drag benefit, while a fairing ahead of the exhaust (config 17) probably caused a small drag increase.

Suspension mounting fairings worked on the Spectrum FF tested in 2007 and, as configuration 18 shows, shaped foam pieces based on the NACA 0024 symmetrical aerofoil profile worked here, too, yielding another 0.5 per cent drag reduction.

Wool tufts on the engine cover aft of the pushrod rocker fairings had shown flow separation, so blending these fairings to the engine cover's trailing edge was expected to yield a small drag improvement. Instead, as configuration 19's results show, a small drag increase occurred, even though the wool tufts showed the flow was tidier.

The smoke plume also revealed the mirrors' wakes in December's issue. Could the size of that wake, and hence the mirrors' drag, be

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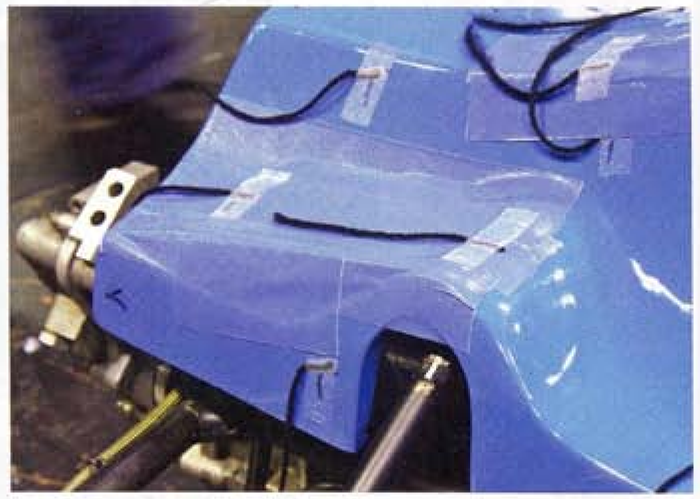
The flow was seen to be separating at the top of the pushrod rocker fairings when wool tufts were taped to the Swift to check the airflow over this crucial area of the racecar's bodywork


It was hoped that blending the pushrod rocker fairings to the engine cover's trailing edge would reduce drag but a small increase occurred, despite those tidy-looking wool tufts


Vortex generators on the engine cover and lower flanks were aimed at reducing the car's wake but actually added some drag


Small vortex generators were fitted on the car's mirrors with the object of reducing the size of their wake

reduced? Small vortex generators were applied to the upper and lower trailing edges of each mirror in an attempt to induce downwash and upwash to thin the mirror wakes.

Configuration 20's result shows there may have been a very small drag reduction here. However, configuration 21, in which the mirrors were completely removed from the racecar, provided the biggest single drag reduction of the entire session, with some 2.7 per cent. But this is one modification that the rules do not permit, even if this particular car competes in hillclimbing!

Increasing chassis rake on the Spectrum FF produced a modest but useful drag reduction, so the Swift's rear ride height was raised by 5mm (configuration 22). Curiously drag increased by 0.9 per cent, so this was another avenue that was closed to further exploration.

Note that lift was slightly reduced by the chassis rake increase, as is normally seen with this particular adjustment.

Finally, another idea – like the mirror vortex generators was borrowed from Koike, M., Nagayoshi, T., and Hamamoto, N. in *Research on aerodynamic drag reduction by vortex generators* – was to place 10mm x 20mm vortex generators (VGs) around the engine cover and lower sides of the car.

This was an attempt to induce downwash and inwash at the rear of the car to reduce the size of the wake, which is essentially what those Japanese researchers did to reduce the drag of a Mitsubishi Evo (though only very slightly, by six counts).

Clearly the results of configuration 23 show that the idea, as it is implemented here, did not work and succeeded only in adding two counts of drag. Perhaps taking a ball end mill bit and dimpling the entire body surface like a golf ball would yield more benefit? But then, what size dimples would you have to use to make this work?

The cumulative effect of all the beneficial modifications made in this session amounted to a drag reduction of 7.7 per cent, which is actually equivalent to 3.2bhp at 100mph. And who wouldn't want another 3bhp plus from their nominally 105bhp Formula Ford 1600 Kent engine?

There was one other thing we wanted to try but run out of time, and that was a reduction in the frontal area of the Swift by narrowing the sidepods. Next month we will start a new aerodynamic project.

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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