Shaving drag from a Formula Ford

Our quest for a super-slippery Swift SC92F continues

When the Swift SC92F that is the subject of our current investigations was originally constructed, Formula Ford had already been in existence for 25 years, so the designers of this, and other marques, had had plenty of opportunity to minimise frontal area and drag coefficient. But did they leave any stones unturned in the quest for optimum sleekness? We put the writer's hillclimb variant to the test in the MIRA full-scale wind tunnel to find out.

Other than the timing strut on the nose this car is representative of pre-1994 Kent engine Swifts and indeed Formula Fords worldwide. And apart from the wider sidepods that house lateral intrusion structures on later Formula Fords, it's not too different in overall aerodynamic concept from any Formula Ford racecar. Thus, with no downforce generation permitted in the rules, aerodynamic improvement is solely down to minimising drag. Given the reasonably sleek shaping, any improvements were thought likely to be small, so the overall gains found throughout our session were actually a pleasant surprise.

Last month we used the MIRA smoke plume and wool tufts to visualise and identify areas that might yield drag reductions, and there were several areas where improvements looked achievable. In this issue we'll examine the initial batch of improvements made, but first let's look at the baseline data and compare it to the Spectrum Formula Ford we examined in 2007, a car that featured the aforementioned wider sidepods and lateral intrusion structures.

In order to directly compare the data we will be using CD.A and CL.A figures, that is, coefficients multiplied by frontal area, as these are directly proportional to the measured aerodynamic forces at any speed and also eliminate any discrepancies in the measurement of frontal area.

So if there was any doubt that the earlier car had room for drag improvements then **Table 1** must surely eliminate this, for despite the somewhat wider sidepods the Spectrum's drag was more than 15 per cent lower than the Swift's, suggesting the intervening 15 years of development had yielded aerodynamic fruit.

Interestingly, the Spectrum also developed greater rear lift than the Swift; lower drag and higher rear lift may not be unrelated if both arose from sleeker shaping at the rear. However, the focus here was squarely on examining drag reductions as being the only legitimate and worthwhile way of improving aerodynamic performance, so let's not dwell

Would the writer's 25-year-old Swift SC92F respond to our drag reduction measures?

Table 1 – Baseline data on the 1992 Swift SC92F and the 2007 Spectrum FF

	CD.A	CL.A	CLf.A	CLr.A
Swift	0.495	0.175	0.140	0.035
Spectrum	0.428	0.261	0.140	0.120

Table 2 – The effects of taping over the radiator inlet

	CD.A	CL.A	CLf.A	CLr.A
Baseline	0.495	0.175	0.140	0.035
1 strip	0.493	0.173	0.138	0.035
2 strips	0.485	0.165	0.132	0.033
3 strips	0.483	0.163	0.133	0.030
Δ, counts	-12	-12	-7	-5
Δ, %	-2.4%	-6.9%	-5.0%	-14.3%

The Spectrum we tested back in 2007 had lower overall drag than the earlier Swift despite the presence of those wider sidepods, which house lateral intrusion structures

Strips of race tape were applied incrementally to the radiator inlet ducts of the Swift

Blanking plates were fixed to radiator exit apertures to mask a quarter, then a half, of area

Would these shaped inlet reducers prove more efficient than the simple race tape?

Table 3 – The effects of blanking the radiator exit apertures (inlets still taped)

	CD.A	CL.A	CLf.A	CLr.A
No blanks	0.483	0.163	0.133	0.030
¼ blanked	0.478	0.162	0.134	0.029
½ blanked	0.475	0.158	0.131	0.028
Δ, counts	-8	-5	-2	-2
Δ, %	-1.7%	-3.1%	-1.5%	-6.6%

Table 4 – The effects of the radiator exit blanks alone, compared to the baseline

	CD.A	CL.A	CLf.A	CLr.A
Baseline	0.495	0.175	0.140	0.035
½ exits blanked, no inlet blanks	0.478	0.162	0.133	0.029
Δ, counts	-17	-13	-7	-6
Δ, %	-3.4%	-7.4%	-5.0%	-17.1%

Table 5 – The effects of shaped inlet reducers, when compared to the race tape inlet blanks

	CD.A	CL.A	CLf.A	CLr.A
Using tape	0.475	0.158	0.131	0.028
Using reducers	0.476	0.162	0.133	0.029

on the fact that both these racecars actually created modest lift forces.

The race tape is generally only brought to bear at the end of a session, but as the Swift had been run with more than half of the radiator inlet ducts taped over for the past two seasons (to prevent over-cooling and hopefully to reduce drag), this was the first configuration change in this session. Three strips of tape were applied incrementally, the third diagonally at the outer, lower corner of the duct inlet, and **Table 2** shows the results along with the overall changes, expressed as 'Δ' (Greek letter delta) values in 'counts' (1 count = 0.001 in a coefficient) and percentages. The '%front' and 'L/D' values usually reported in these tables have been omitted because we are not looking at either the balance or the efficiency of downforce, as we normally do.

Blank tape

Once more race tape proved its worth then, with a useful drag reduction and, as a bonus, a significant lift reduction, too. In addition to tape over the inlet ducts, roughly half of the cooling exit apertures had also been taped over for the past two seasons. How much drag was this worth? Panels were taped in place to incrementally mask a quarter, then a half, of the exit apertures, and the results are in **Table 3**.

Further benefits were achieved with the exit blanks then, and in combination with the inlets being taped over, a worthwhile 20 CD.A counts or four per cent drag reduction was achieved by partly blanking the cooling exits. And again there was the bonus of lift reductions that amounted to almost 10 per cent in total. It was also noteworthy that the wool tufts on the vertical face of the sidepod downstream of the radiator duct exit showed that the flow was faster and better attached with the blanking plates fitted, suggesting better acceleration (and extraction?) of exhausted cooling air.

But what would the radiator duct exit blanking panels achieve on their own? The tape was removed from the radiator inlet apertures and the car was run again; results in **Table 4**.

We can see that most of the benefit of blanking both the inlets and outlets was achieved by just blanking the outlets. This points to somewhat different mechanisms that were clearly not additive. Individually, comparing Table 4 with Table 2, blanking the exits achieved a better drag reduction than blanking the inlets, while the changes to lift were very similar. However, the drag (and lift) reductions were greater when using both inlet and exit blanking.

Radiator inlets on most racecars have generally been well designed with nice, radiused lips to encourage clean flow into the ducts, and your writer has always frowned upon the use of tape to blank them off (despite using the technique himself) because flow separation is likely to occur at the sharp edge.

Shaped reducers

Surely properly shaped inlet aperture reducers would function better and yield further improvements? With this in mind reducers comparable in coverage to the three pieces of tape were hand-shaped from polyurethane foam block, with radiused lips and tapered internal faces, and taped in place, with the exit blanks still affixed. **Table 5** shows the results.

Rather frustratingly, the results with the shaped inlet reducers were certainly no better than using the tape, and may even have been a little bit worse! Perhaps the workmanship was not quite up to standard here?

Next month we'll look at more ways in which drag was reduced on the Swift; some were surprisingly successful, some less so.

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CONTACT
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