With the rising price of diesel focusing fleet engineers' minds on how to get more for less, Brian Weatherley looks at how truck and trailer manufacturers are casting their...

fates to the *wind*

MAN claims aerodynamics improvements helped to achieve a 25% saving in both fuel and CO_2 for its Concept S vehicle

Overlay the price of diesel for the past five years against the growth of aerodynamic devices on trucks and trailers during the same period and it's not hard to spot a close correlation. But then, as SDC Trailers' chief design engineer Tony Sturgess says succinctly: "You've got to save fuel, because it's the cost of fuel that everyone is looking at now." With 40% of all fuel used simply to overcome air-resistance at 85km/h, reducing the drag on your truck or artic will undeniably help preserve your liquid assets.

That's doubtless why Mercedes-Benz spent 2,600 hours fine-tuning the aerodynamics of its New Actros tractor unit in its full-size wind tunnel – equivalent to more than 100 days. Creating a cab demonstrably more wind-cheating than its predecessor was, says the German truck maker, "one of the top priorities". And, in fact, since 1973 the aerodynamic performance of Mercedes' trucks has improved by more than 30%, culminating in the arrival of the New Actros last year.

But why spend all that time and effort? Because, with most, if not all, of the low-hanging fuel-saving fruit (eco-driver training, lower speed-limiter settings etc) already picked, and with the best heavy-truck diesel engines still barely achieving more than 45% brake-thermal efficiency (Fiat Powertrain, Iveco's diesel engine provider, recently disclosed it intends to raise that to 55%, but not until 2020), better aerodynamics is the obvious next step to reduce diesel consumption.

Yet for Europe's truck makers, when it comes to creating a super-slippery high-roof sleeper cab, life's all about compromises. Giving a windscreen a pronounced rearward rake will certainly smooth the air flowing over it, reducing drag and saving fuel. But it also eats into the cab's living room, restricting movement and storage – a criticism levelled at the 'old' Volvo FH cab, since replaced by the recently-unveiled New FH, with its far less radically-sloped screen (7–8°), with one cubic metre more space inside.

However, having lost the old FH's trademark heavily-raked 21° front profile, the Swedes insist: "Despite its bigger cab, the new Volvo FH still has the same excellent aerodynamic properties of its predecessor, not least thanks to the increased radius of the cab corners." Following its extensive wind-tunnel tests, Mercedes' designers settled for

a 15° rake (noticeably more than in the previous Actros), but one that it says has "met both sets of requirements" – of aerodynamics and space.

Renault Trucks' latest CX-03 design study provides an interesting clue to future aero developments here. The centre section in its carbon fibre and aluminium cab has a retractable sliding panel that descends as the artic's speed increases. An air dam at the bottom of the truck then performs a similar function, reducing ground clearance, while three aerodynamic blades push the airflow out along the rig's sides. The objective, says Renault, is "…to improve air penetration, and thereby enhance [fuel] reduction." Interestingly, the CX-03's windscreen/A-post rake is a modest 12°, described by Renault as "the optimum aerodynamic compromise".

When designing the perfect aerodynamic cab, it helps to start with a blank sheet of paper. It's always harder working with an existing structure. Having taken its old Stralis cabin and given it a new, more aerodynamic central grille, redesigned air deflectors and a new bumper dam, Iveco has reduced the drag coefficient of its new Stralis Hi-Way by some 3% – thereby "delivering a significant fuel advantage on long haul missions".

Naturally, current vehicle length legislation means there's a limit to what manufacturers can do with a forward-control cab. And when it comes to creating the optimum airflow over a complete vehicle, the cab is just one piece of the jigsaw. At the last IAA show, Mercedes revealed what it called aerodynamically-optimised Actros rigid and artic models, the latter with a Schmitz-built trailer. Recent trials of its artic have shown an 18% improvement in aerodynamic efficiency, translating to a 4–5% fuel reduction, it says. Improvements for the already more efficient rigid are slightly lower, at 12% aerodynamics, meaning 3% fuel.

Extending the current 16.5m artic limit would undoubtedly help both at the front (with an 'aero nose') and the back (with a 'boat-tail'). MAN's Concept S tractor, unveiled in Hannover in 2010, returned to IAA this year with a curvaceous Krone Aeroliner semi-trailer. According to MAN, with a drag coefficient (cD value) of around 0.3, the concept road train has the kind of aerodynamic performance previously found only on modern passenger cars.

Condemned concept?

While MAN's 25% fuel and CO_2 reduction claims for Concept S are impressive, for it to be practical, Brussels would have to significantly budge on overall length limits – and certainly by more than the 50cm at the rear when amendments to the 97/27/EC directive come into force.

A sizeable increase in allowed EU artic-lengths would also spur further interest in the kind of extendible, metre-plus, boat-tail devices found in the US. Modest (30cm) boat-tails have already been tested by Scania, which says: "Trials are still going on at the Scania Transport Laboratory and show a 1.5% fuel saving."

Boat-tails up to two metres long have also been examined by the University of Delft, which says it achieved fuel savings of 7.5%. More recently, TNT Express in Holland trialled a 120cm boat-tail, developed by Ephicas and US manufacturer AT Dynamics, gaining a fuel saving of some 6%.

SDC Trailers has been appointed UK supporter-cum-partner for AT Dynamics' TrailerTail and is looking to supply two of its products: the Eco 50, a short 50cm valance that extends around the top and sides of the rear frame (permissible under the proposed 97/27/EC changes); and the more efficient Eco 120, which projects 120cm rearwards around all sides of the rear frame and has been used by US operators for many years.

Both devices fold flat origami-style, allowing the trailer's rear doors to swing back 275° for normal loading. In the event of a rear-end collision or a

Don-Bur, like many other trailer manufacturers, has been promoting the benefits of teardrop-shaped trailers

driver backing into an obstacle, they're designed to fold inwards, reducing the risk of damage. AT Dynamics says its Eco 120 has shown fuel savings of between 5 and 7% in independent tests at highway speeds. SDC will offer the ATD TrailerTails either as an on-line option or retrofitted through its FP&S parts operation.

However, SDC adds that the TrailerTail project is in its infancy, not least as it is seeking permission from the DfT to allow the fitment of the longer Eco-120, possibly within the current Longer-Semi-Trailer (LST) project. SDC's Sturgess says: "There is growing interest in boat-tails. We think that it could be a very cost-effective solution when added to a standard trailer." The Eco 50 and 120 could also complement SDC's existing Aeroliner aerodynamic package, available on its trailers.

Aerodynamics for LCVs

Even the most humble of trucks – lowly 7.5-tonners – have been given the aero-treatment. DAF's factory-fitted Aero body, for LF chassis between 7.5 and 12-tonnes, features a moulded sloping-front roof fairing and cab collars, aerodynamically integrated with the LF cab, together with a curved front part of the body and tailgate air diffuser over the rear frame. DAF says it can reduce fuel consumption at cruising speeds by up to 8%, compared to a similar-capacity conventional box body with a simple roof fairing. The figure has been ratified using back-to-back trials at MIRA at 56mph.

And while conventional wisdom suggests that aerodynamic aids are less effective on vehicles running at lower speeds, the results from a two-year trial by Argos are worth noting. In 2008, it took delivery of its first streamlined Bevan21 body as part of an order for 77 boxes fixed to 7.5-tonne chassis. Despite the nature of its multi-drop operation, the Bevan21-bodied rigid produced an average fuel cost saving of around 4.5%, compared to Argos's standard box bodies, described by the retailer as "…certainly beyond our expectations".

Also, the UK's leading cab deflector specialist Hatcher Components has taken its Active Freddie cab air management kit (jointly developed with Mercedes and Cranfield University) one step further. As well as automatically sensing and adjusting itself to the height of the trailer behind, offering fuel savings of up to 5% over normal factory deflector kits, Active Freddie now includes an 'active yaw angle optimisation' function, which detects and adjusts itself to side winds.

What about rigid reefers? It's previously been a challenge to make these more aerodynamic – especially around the top-mounted fridge. The Slipstream aero package, from temperature-controlled bodybuilder Solomon Commercials, offers fuel savings via a combination of an integrated cab deflector, tapered front bulkhead and curved cant rails, as well as a recessed vortex deflector in the rear of the roof. Earlier this year, Tesco Distribution conducted its own trials at Millbrook when a Slipstream-equipped Mercedes Axor rigid, travelling at 50mph, proved 10.67% more fuel-efficient than an unmodified Axor running around the track at the same time.

Sticking with reefers, controlled trials at MIRA have confirmed that Gray & Adams' Eco-Aer trailer can reduce fuel consumption by as much as 10%, compared to a standard model, after having tested both at 56mph in identical operating conditions. Eco-Aer modifications include wide-radiused top-cappings that smooth air flow over the top of the trailer, a rear vortex generator in the roof, which delays air-flow separation behind the

trailer, and tapered side skirts. G&A says that, based on its MIRA results, a reefer fitted with its full Eco-Aer package could save almost £4,700 per year in fuel, recouping the cost of any additional outlay "…comfortably within less than a year."

With its trail-blazing Teardrop design epitomising developments in UK trailer aerodynamics, Don-Bur's group marketing manager Richard Owens confirms that the rising cost of diesel has spurred a growing interest in its iconic design. However, he adds: "It was only really when the recession started biting and fuel prices increased astronomically that people started saying, 'we've really got to find other ways of saving some significant amounts of cash'. If we'd launched Teardrop even two years earlier, it would not have had the same effect."

With the first prototype delivered in 2007 to M&S, to date Don-Bur has supplied 3,012 Teardrops (including trailers and rigid-body versions) to no fewer than 157 operators. Earlier this year, it revealed its Mk II, which refined the Teardrop design even further. "We're now working on the third iteration," reports Owens. "We've not only focused on the success from the Mk II, in terms of its cD and aerodynamics, but also, from a build point of view, bringing the cost down. So the payback period is extremely fast."

Don-Bur bases its fuel-saving predictions on data supplied by customers. Aggregated data is then presented on Don-Bur's website, which predicts an 11.26% improvement over box vans and 11.18% for curtainsiders.

Clearly, there are limits to how much further trailer makers can go. Based on recent CFD (computational fluid dynamics) analysis, Owens reports that the combination of a standard tractor with Don-Bur's Mk III Teardrop design now registers a cD of 0.402. "As a proportion, that totals 1,686 Newtons at 56mph – 1,609 Newtons of which are attributable to the tractor alone. So we now have a trailer representing an extremely small proportion of the drag. At the end of the day, we can't really do that much more."