

# Slipstreaming

**Radical designs of trailers are racking up big gains in fuel consumption on the road in research and development tests. They suggest that we are entering a new era in aerodynamic design for large goods vehicles, reports Steve Banner**

**A**djusting the height of a semi-trailer's roof so that it tilts downwards towards the rear doors could do wonders for its aerodynamics. Fit side-skirts and boat-tails and curve the front bulkhead to smooth out the air flow and you could potentially be looking at a 9.2% cut in fuel consumption and CO<sub>2</sub> emissions.

Constructed by Schmitz Cargobull, just such a trailer took part in the recently completed Transformers project. A four-year-long €7.9 million initiative supported by the European Commission and coordinated by Volvo, Transformers involved 13 companies and research institutes. They included DAF and Bosch.

Four different trailer positions are possible, offering varying potential fuel benefits. Hydraulic cylinders powered by a hydropneumatic pump are used to raise and lower the Schmitz curtainsider trailer's single-section roof (shown above) and can drop it from a standard running height of 4m by up to 500mm at the front and 800mm at the rear.

"Wabco supplied the 500mm OptiFlow boat-tails," says Birger Queckenstedt, senior research and development engineer at Schmitz Cargobull. The movable roof means they had to be shortened.

Wabco also supplied the OptiFlow side-skirts.

The difficulty with aerodynamics is that it makes its maximum contribution at the sort of steady speeds hauliers aim

to achieve on long-haul runs. It delivers far fewer benefits if a truck is plodding slowly up a steep single-track B-road, heavily laden.

That is why the Schmitz trailer was also fitted with a hybrid-drive system with an electric motor and a 22kWh lithium-ion battery.

Relying on energy recuperation from electric braking on the trailer's rearmost axle blended with the service brakes, it can drive one of the trailer's axles whenever the truck needs a bit more power. It can deliver a healthy 200Nm of torque.

Signals from the largely standard tractor unit request power and torque. "Minor modifications have been made to the unit's switch functionality and an extra cable has been fitted so that



additional signals can be sent," says Volvo's Paul Adams, who coordinated the Transformers project.

Providing emission-free energy, it means the trailer's CO<sub>2</sub> output is down by a further 6.6%, says Queckenstedt, with a concomitant cut in fuel usage. Savings can vary significantly depending on the terrain, however, according to the Transformers final report, with busy urban areas with lots of steep hills delivering up to 18%, and flat intercity runs with the odd modest incline offering up to 4%.

"There are plans to use the energy stored to power Schmitz Cargobull's refrigeration unit as a next step," says UK technical director Derek Skinner.

The concept is not a new one. SDC has built a semi-trailer fitted with a





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Derek Skinner



kinetic energy recovery system and a bank of ultra-capacitors that also uses energy that would otherwise go to waste to drive an axle electrically. It can shrink fuel usage by up to 25%, says the trailer builder.

Queckenstedt admits that going the hybrid route can have drawbacks. In Schmitz Cargobull’s case it includes the extra 1.14-tonne burden imposed by the weight of the system. Then there is the front-end cost, he says, which is likely to be substantial; and the battery will eventually have to be replaced.

Dutch trailer maker Van Eck contributed the second semi-trailer which took part in the Transformers programme (not shown). Box-bodied, it is fitted with a flex-floor system which allows a second deck to be created in a series of sections that can be set at different heights if required. The idea is to achieve maximum utilisation of the available load space while remaining within the European overall 4m height limit. It too has boat-tails, side-skirts and an electrically-operated movable roof. The roof is in four segments and can be configured in a variety of different shapes.

What happens if you combine the features of both trailers? “A reduction in energy use per tonne/km of goods transported of more than 25% can be achieved for almost all mission profiles at an average 15 tonnes payload,” says the Transformers report.

What is in effect a successor to the

Transformers programme has now been announced. Called Aeroflex and led by MAN, it involves many of the same participants as Transformers.

An alternative approach could be to supplement the effect of aerodynamics and a hybrid drive by lightening the trailer through the use of composite materials, aluminium and high-tensile rather than mild steel; but what will this achieve, and by how much should you lighten it?

That is one of the questions being addressed by an Innovate UK-funded trial involving SDC, Lawrence David, Tesco and the Centre for Sustainable Road Freight (CSRF). The centre is the result of a collaboration between Cambridge and Heriot-Watt Universities.

The trailer builders will construct six standard-length semi-trailers, all maximum height (4.9m) double-deck ambient box vans with fixed upper decks, explains Lawrence David’s technical director Andy Richardson. “Two of them will be aerodynamic, two of them will be lightweight and the remaining two will be both aerodynamic and lightweight,” he says. They will be compared with two conventionally designed trailers.

“The new trailers will be tapered as much as possible towards the rear and the underside will be kept as clear as possible,” says SDC director Paul Bratton. “We’re going to put everything we can behind the cross-members.”

High-tensile steel will be used in the chassis to help keep the weight down, by about one tonne.

The design work has been completed and the six new trailers are currently being built, according to Cambridge University professor David Cebon, who leads CSRF’s executive team.

It is by no means the first trailer aerodynamics project that CSRF has been engaged in.

Some 18 months ago it collaborated with Gray & Adams and John Lewis Partnership in the design of a new refrigerated semi-trailer which is now in service with Waitrose (pictured). Features which help cut aerodynamic drag by around 14% include a tapered boat-tail on the upper rear of the trailer, sidewalls which taper slightly towards the rear and a smooth, unobstructed underside with an open rear section to help the air flow out.

Thirty-six of the trailers have gone into service with Waitrose. It reports that they are delivering a 7% fuel saving.

Finally, trailer builder Cartwright is looking at ways in which the Coanda effect can be harnessed to improve trailer aerodynamics, says technical director Lionel Curtis. Named after Romanian-born aeronautical pioneer Henri Coanda who discovered it over 100 years ago, it describes the way in which a flow of air can attach itself to a nearby surface and remain attached even when the surface curves away from the flow’s initial direction.

“In conjunction with Strathclyde University and with the support of Innovate we’ve been doing research in ways in which the effect can be incorporated into trailer side-skirts to improve airflow,” says Curtis. [IE](#)