Teardrop or

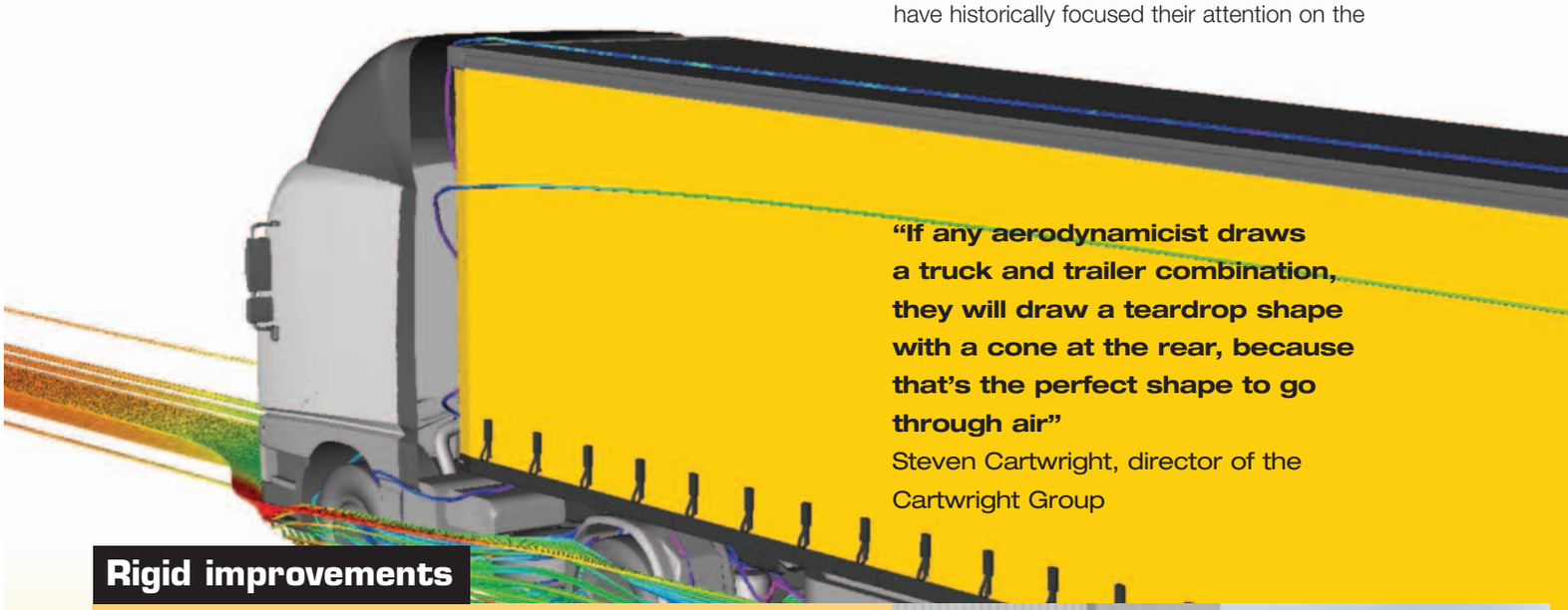
As both transport operators and manufacturers look to tick as many green boxes as they

Rising fuel prices, environmental audits and increasing pressure to reduce carbon emissions: if there is an upside for transport engineers to these three, it is that attempting to deal with one is highly likely to improve the other two as well.

Most modern car designs are a demonstration that the most aerodynamically efficient shape is that of a falling water droplet – the now classic teardrop. And if you have seen the concept trucks wheeled out at shows over the past two decades, you'll know that those same aerodynamic principals have guided most designers.

Start adding the list of restrictions governing vehicle dimensions and making teardrop designs work in practice is more difficult. Fixed combination lengths and widths, limits on height in Europe, and trailer lengths all over don't lend themselves to the ideal shape – particularly when operators want to maximise useful cubic metres. Plainly, there's not much room for aerodynamicists to weave their magic re-shaping, while preserving the load space that trailer designers have so carefully optimised.

And another thing: since European length restrictions effectively dictate the forward control, cab-over design of tractor units, aerodynamicists have historically focused their attention on the



Trailers have been subject to a great deal of CFD analysis in a bid to improve both aerodynamics and efficiency

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Steven Cartwright, director of the Cartwright Group

Rigid improvements

Can teardrop-shaped rigids deliver the same drag coefficient improvements as those recorded for trailers? The Bevan Group's Bevan21 body, developed with Cranfield University, suggests they can. The limitation here, though, is that aerodynamic improvements rarely have as much impact on multi-drop work as on long haul, simply because of the average speeds involved. Also, wisdom says stop-start situations, assisted by intelligent automated transmissions, have more impact on consumption.

Even so, with around 300 Bevan21s now on the road, operators of the body shape have recorded fuel consumption reductions of 5–18%, according to managing director Anthony Bevan. The next stage, he says, is to work on the rear end, adding a rear diffuser and, for some bodies, tapering them in from the rear axle, too.

pipe dream?

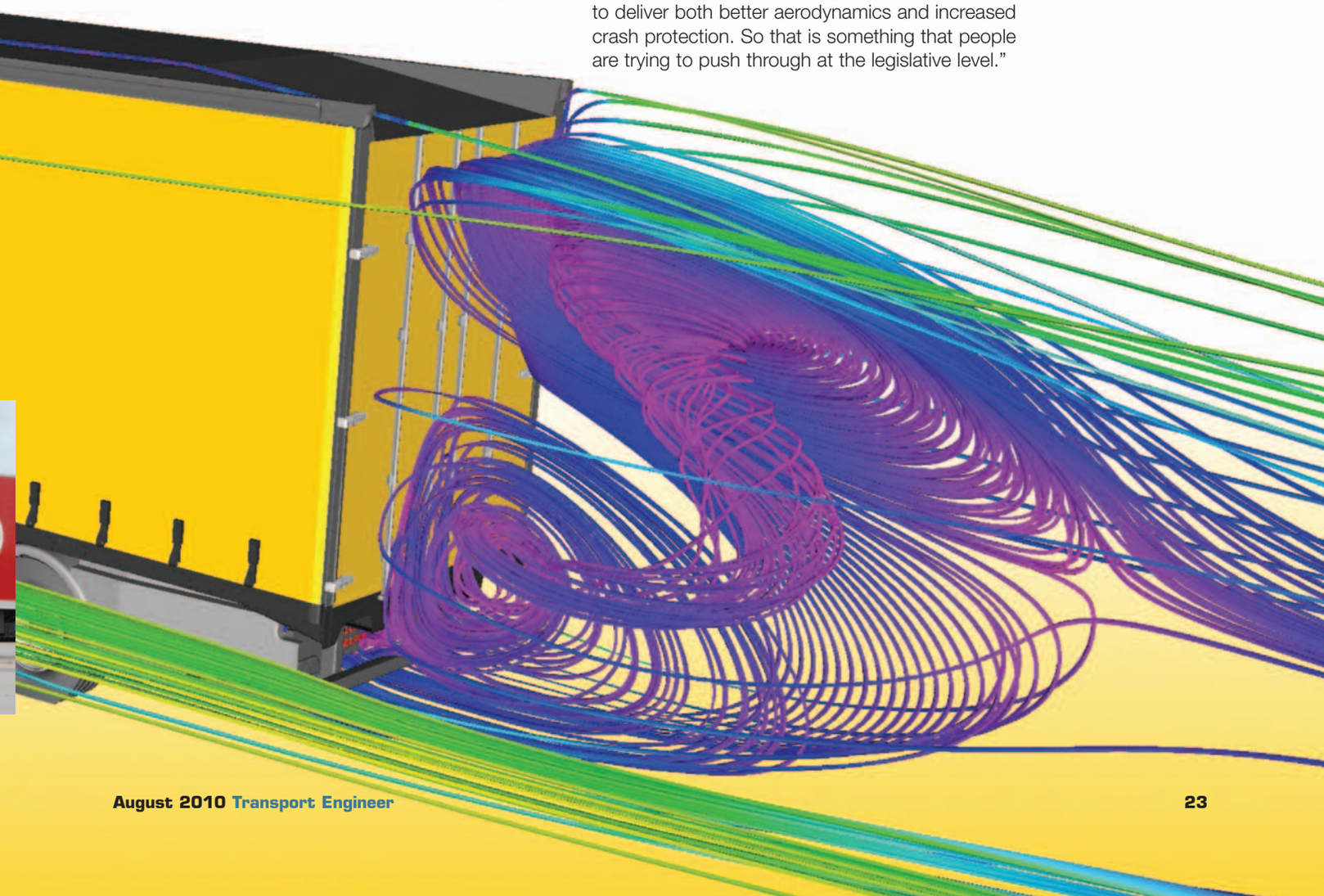
possibly can, John Kendall reports on the changing face of trailers and rigids

front end of something with the natural aerodynamics of a house brick. It's an aside, but almost everyone accepts that, in an ideal world, the tractor frontal area would be reduced and its length increased to reduce drag coefficient – as with modern express trains. But, since there is little evidence of any change of heart among the lawmakers, OEMs must keep tractors as short and blunt as possible.

Is the teardrop the only game in town? Is it as much about gimmick as it is about aerodynamics, as some insist? And, for that matter, what else is likely to shape trucks in the future?

"If any aerodynamicist draws a truck and trailer combination, they will draw a teardrop shape with a cone at the rear, because that's the perfect shape to go through air," comments Steven Cartwright, director of the Cartwright Group. "But we're stuck with this combination length. The tractor unit guys work to their dimensions and then you're left with the length behind the cab. I know that increasing the overall length is still only a long distant possibility, but, from both a safety and a fuel efficiency point of view, a teardrop design would yield massive savings for operators."

However, according to Angus Lock, aerodynamicist at MIRA (Motor Industry Research Association), moving the tractor engine forward to provide both an impact-absorbing zone and scope to reduce frontal area drag may not be such a distant possibility."We've been involved in a DfT project here, as well as speaking to a European action group on these specific items," he reveals. "We've looked at lengthening the nose of the cab to deliver both better aerodynamics and increased crash protection. So that is something that people are trying to push through at the legislative level."



Alternative efficiency

Aerodynamic improvement is one way that fuel consumption for vehicles can be reduced. The Motor Industry Research Association (MIRA) is working on several other projects that could have a positive impact.

A hybrid drive system, recovering energy during braking and downhill running that can be stored and then used under acceleration, opens up a number of possibilities with a tractor/trailer combination. Power, for instance, could be applied to the trailer.

"Hybridisation is usually beneficial when you can reduce the size of the engine and supplant it with some other form of motive power, whether that be electric or hydraulic," comments Derek Charters of MIRA.

"The only time to augment vehicle power is during acceleration and, again, the only real reason to fit [a hybrid drive] is to enable regenerative braking, so you can recover the energy from slowing down.

"So you end up not with the hybrid that you might design for a car, which might have a significant quantity of energy, but with a hybrid system that has a large quantity of power and just enough energy to deal with variations in speed and load – maybe a few hill climbs.

"Hence the interest in: hydraulics, which exhibit high torque; supercapacitors that have high power; or some of the more expensive battery packs, such as lithium ion phosphate."

But, while that is encouraging, formulating European legislation and cascading it down to national level will take time. So what developments can we expect in the meantime? Lock sees two more immediate possibilities, as far as trailers are concerned. First is the path pursued by TNT, together with Cartwright, using MIRA's wind tunnel. That project, which dates back to 1990, was about optimising a full aerodynamic package on a standard tractor unit and trailer. "It's still a fairly competitive design," insists Lock – and Cartwright adds that his company has instigated several tweaks since then – notably to the sideguard design and the underside of the trailer chassis.

The other path is that pursued initially by Don-Bur and now others, all of which are developing

variations on a theme of curved roof designs. "What we've done more recently is try to meet somewhere in the middle," advises Lock, who reckons that there has been a lot of dialogue between MIRA and trailer-maker Lawrence David.

Looking at the Don-Bur project, the requirement was to maximise volume for pallet loading, so MIRA determined that the shape had to be kept as box-like as possible. As Don-Bur marketing manager Richard Owens explains, when the company developed its original teardrop for Marks and Spencer, those trailers were used for carrying rack-loaded garments, so it was possible to use the space under the curved roof to accommodate an additional row. That resulted in an additional 10% usable cubic volume over and above a standard box trailer. However, it's clearly not space that can be exploited with, for example, palletised loads.

"What we achieved now is a 4.5m-tall trailer that looked very normal, but actually had the same drag performance as a 4.0m high trailer – only marginally more than the Don-Bur teardrop," claims Lock. "So it gives an approximately 17% reduction in drag over the baseline 4.5m trailer, which already had aerodynamic treatment on the cab end, at least."

However, our MIRA man explains that this project was based on an holistic approach and that one problem identified is that OEMs optimise for a 4m trailer or a 3.8m trailer, and that's it. He explains that MIRA, together now with Lawrence David, has not only designed an aerodynamic trailer, as Don-Bur did, but also reworked the cab roof spoiler.

It seems that MIRA's clients have been pleased with their results. "Both Lawrence David and two of its major customers have conducted real-world trials that have shown a reduction in consumption of between nine and 13%. This is huge for what was a very small project, compared to what the big OEMs spend on aerodynamics," says Lock.

"I'm now very keen to see more pressure from the fleet operators and for more trailer manufacturers to implement this kind of trailer," comments Lock. "A 10% reduction in carbon dioxide output of the truck fleet in the UK would mean huge emissions savings and it's very easily achieved. If I was given a bit more free reign, in terms of the design of the trailer, and a bit more collaboration with the cab manufacturers, we could be looking at something more like a 15–20% reduction in carbon dioxide emissions from trailer aerodynamics technologies alone."

The MIRA man reckons the key to achieving reductions of this magnitude is the interaction between the cab and the trailer. "I would do a lot more work on optimising the shape of the front of the trailer," he states. "We've then done obvious things such as the side skirts on the Lawrence David. I'd have to take that a stage further and look at covering the wheels."

Beyond that, though, MIRA carried out a research project into a composite trailer a few years ago, with the major structure produced in carbon fibre – sadly, far too expensive for production reality. Others have also been built using GRP and at least one such trailer is currently undergoing trials. "The problem is that you don't get any benefit from [the flat trailer underside] unless your cab has a completely flat floor and the bumper is designed for a flat floor. This is where there needs to be more collaboration between the cab manufacturer and the trailer manufacturer," insists Lock.

That could also lead to researching advantages of lengthening the tractor unit and/or the trailer combination – bearing in mind that much of the drag comes from disturbed air to the rear. A teardrop design could make a difference – and, at the same time, cut spray in wet weather. TE

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