

New steer

Could an innovative multi-axle steering system lead to renewed interest in longer, heavier vehicles (LHVs)? John Challen and Brian Tinham talk to the people behind the technology

Despite much debate, there has been little movement on the issue of longer, heavier vehicles (LHVs) in the UK. Even after hitting the headlines late last year, when his 25.1m combination attempted to move onto UK roads, Dick Denby, chairman of Denby Transport, states that he has had little feedback from the DfT – which simply served him a prohibition notice.

Seems the UK is steadfastly resisting the temptation to dip its toe into multi-trailer waters. Meanwhile, trials are already underway in European countries, including France, Italy and parts of Scandinavia. And next year Germany is set to allow LHVs on its roads, under an evaluation programme organised by the federal government. More than 200 companies have registered an interest, including MAN (Transport Engineer, November 2010, p5).

On the face of it, the DfT's reluctance to move is very strange, given the potential benefits of LHVs. Whether it be reduced congestion from fewer vehicles, lower fuel and running costs as operators shrink their vehicle fleets or reduced CO₂ emissions, the advantages of running LHVs should be obvious.

That said, data from automotive consultancy CLEAR sheds some light on why enthusiasm for

LHVs in this country might be lower than in others. Director Gary Beecroft estimates that, while eight European-style 40-tonne artics could be cut to just five LHVs, the number for UK-friendly 44-tonners drops by just one truck, to seven.

Those figures are based on a 40-tonne gvw truck offering a payload of 26 tonnes, while a UK-friendly 44-tonner provides 30 tonnes and a Scandinavian 60-tonne LHV fields a 42 tonne payload. Those figures are open to challenge, with others suggesting closer to 29 tonnes for a 44 tonner and 38 tonnes for a 60 tonner at 21.42 metres. Additionally, they take no account of the vast majority of vehicle movements where cube, not ultimate payload, is the issue. Dick Denby states that two of his Eco-Link double trailers would replace three British standard artics on low density, high cube traffic.

And then there's the political angle, which hinges on: public perception of LHVs' increased noise and size; concerns over increased road damage; and issues surrounding safety – particularly due to swing-out of extended trailer rear ends on sharp bends, at roundabouts and during high-speed lane changes.

Hope for hauliers?

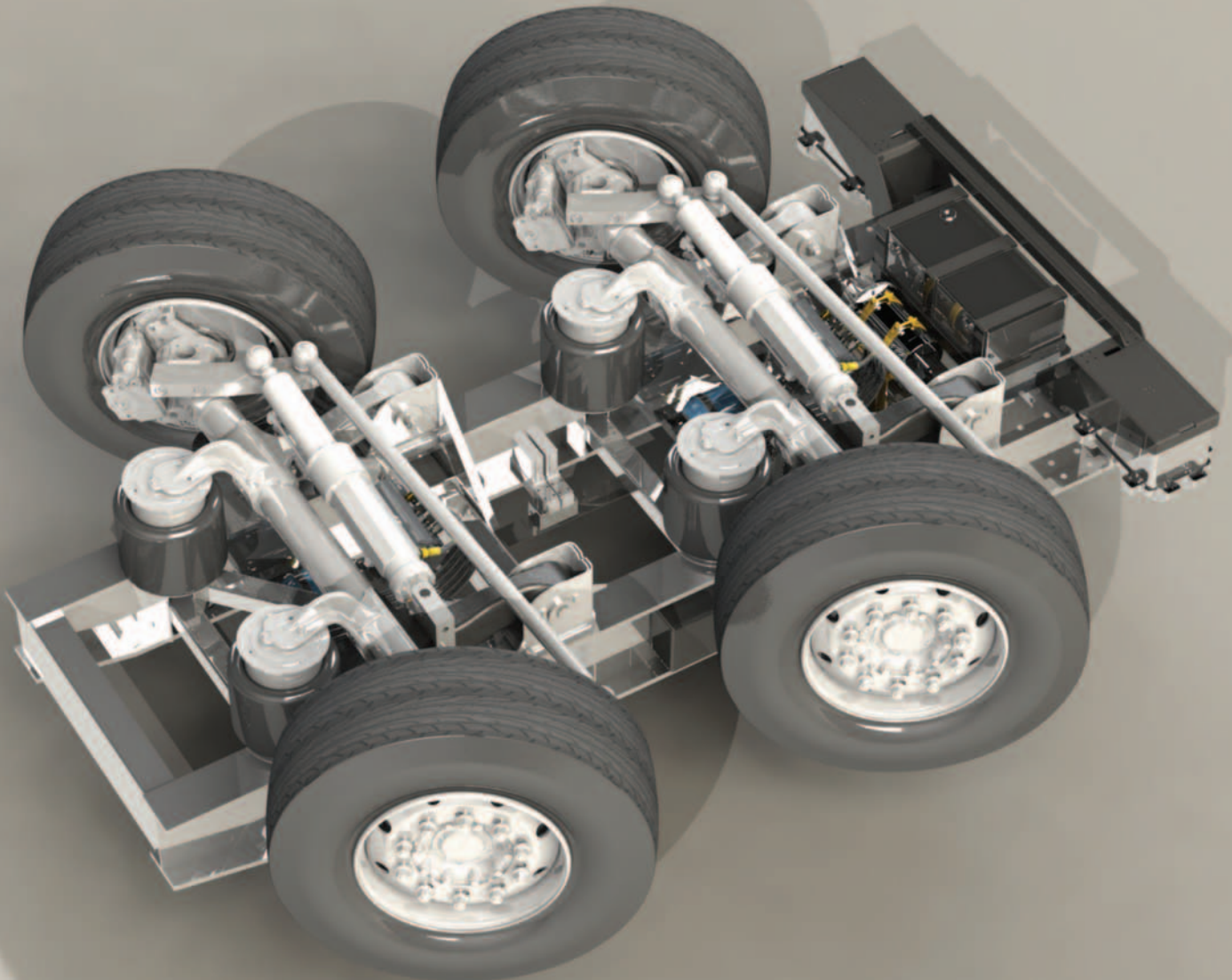
But in the last couple of months, there has been talk of developments that could yet lead to LHVs inching onto UK roads. First, DfT's professor Brian Collins promised to release the results of a report into extending the length (but not weight) of semi-trailers by 2.05m before the end of this year. Although hardly on the scale of European trials, this increase in trailer length would go some way to achieving the costs and emissions benefits promised by LHVs.

Secondly, however, eight years of work on active trailer steering systems at the Cambridge Vehicle Dynamics Consortium (CVDC) is coming to fruition. As Professor David Cebon, head of the consortium at the University of Cambridge, puts it: "We've been running a project on multiple axle steering of articulated tractor/semi-trailers and LHVs for some years. The technology has now been proven and we are ready for commercial development."

One of the key drivers behind CVDC's work – which also involves Volvo Trucks, ArvinMeritor, Goodyear, MIRA (the Nuneaton-based automotive engineering centre) and engineering design firm 3D

CVDC's test vehicle offers multiple trailer steering that enables perfect path following





Evolution – was a determination to deal with the fundamental problem for long trucks attempting to negotiate sharp bends. Cebon points to the problem, with un-steered longer combinations, of jack-knifing, as they attempt the 12.5m-diameter roundabout test. And he adds: “Conventional trailer steering systems just don’t work very well: the back of the trailer needs to follow the fifth wheel of the tractor unit, an approach called ‘perfect path following’. But their path-following performance is poor – with, for example, tail swing meaning that the trailer doesn’t go where the driver goes.”

CVDC’s objective, with its active trailer steering development, was to apply ‘perfect path following’ logic to B-doubles (tractor unit towing a lead trailer with a rear-mounted fifth wheel, in turn towing another semi-trailer) and European modular system (EMS) vehicles in all scenarios – including high and low speed manoeuvres, as well as forward and

reverse travel – always aiming to ensure that the entire combination steers predictably. And, following its success, LHVs can now be made much more manoeuvrable and significantly safer – and they can benefit from far lower tyre wear and 20–30% lower fuel consumption per freight task, says Cebon.

“One day, there may be a standard B-double in the UK,” he states, “but, at the moment, trucks of this length just can’t get around one of our roundabouts without jack-knifing. With our system, a dual-articulated B-double can beat a standard tractor-trailer combination easily.”

Cebon agrees that, when CVDC’s project started, there was no known way of getting the steering right for extra length vehicles. “Similar-sized combinations, such as that operated by Denby Transport [see panel], used a completely different, and more conventional, direct-acting steering system, so there was no clear approach to doing better,” he explains.

Steering a determined path

The most high-profile and often loudest voice in the demand for LHVs in the UK is Dick Denby, chairman of Denby Transport and an associate member of CVDC. Developed eight years ago, the steering system on Denby's extended trailer combination may not be in the same league as CVDC's, but he reckons it still has a place.

"The Australians and New Zealanders have been saying for years that, if you have multiple fulcrums, stability and safety dictated you need them as far away from each other as possible," says Denby. "On rigid trucks with dollies, some can be as little as 4.5m from pin-to-pin, but they are trying to lengthen the drawbar arm to stretch that."

Denby says his B-double has a pin-to-pin length of 8.75m. As for the detail, his steering system comes from Breeman International Supplies, based in Rotterdam, which also supplies technology for long low-loaders. "Instead of the trailer kingpin mounted traditionally, it is placed on a large turntable, with a steel wedge, which mounts on the fifth-wheel plate of the tractor unit," explains Denby. "The pin turns with the tractor unit, not the semi-trailer," he adds, observing that a potentiometer sensor on top of the fifth-wheel/wedge combo then measures the yaw angle.

"An onboard computer is alerted when the yaw angle reaches 3°," continues Denby. "It gets a speed signal from another axle [and] if that is in excess of 40km/h nothing happens, because it is in failsafe mode. But between 15 and 40km/h, maximum steer is available."

From a mechanical aspect, Denby explains that it is "similar to the steering on a twin-steer truck", with the hydraulic ram on the rear axle of the link trailer connected to the front axle, using serial arms. "We've licensed the technology to a Dutch company called Jumbo and it is currently being used by a Dutch supermarket," he adds, remaining hopeful that further applications will be achieved in the near future.

As it happens, CVDC's experience with active roll control on tankers provided a background. "This was complex engineering and helped to create the only tilting trailer in the world, with the biggest anti-roll bar in the history of HGVs," he laughs. "There were four active anti-roll bars – on the tractor drive axle and all three semi-trailer axles – and 10 semi-active dampers. And all were connected via the vehicle's CANbus, using three networked computers."

That system reduced lateral transfer by 25%, but was deemed too expensive and heavy to be practical. It did, however, prove that stability could be improved through active controls. The next step was to turn that to steering, developing software to control the vehicle and a mechanical actuation system to effect independent steering on each axle.

Today, CVDC's steering is modular and detachable, with the hardware built onto the trailers. Controlled via the CANbus, the system allows all axles, except the tractor drive axle, to be steered. Electrical power comes from a 24V source, while hydraulic pumps drive the individual trailer steering axles. In terms of the hardware, similar systems are used on earthmovers and construction equipment, reveals Cebon, but CVDC's requires considerably greater computing power and feedback sensors.

How good is it? So good that, using a rear-facing camera and joystick mounted in the cab, a driver can even reverse a full length B-double safely down small side streets, round bends and up to a loading bay, without touching the truck steering wheel – and with the entire combination faithfully following the rear wheels. "The driver now has a vehicle that drives a bit like a car," comments Cebon. "He points the lead vehicle where he wants it to go and he knows that all of the other vehicle units will follow."

What about high speeds, where the engineering problems are more about safety and stability? "Conventional semi-trailer steering systems have to be locked at high speeds or they make the trailers unstable. Further, on existing multi-trailer vehicles, if you perform a sudden lane change, you get rearward amplification and the first trailer deviates slightly from its path, while the second deviates even farther, and is could be in danger of rolling over," explains the Cambridge man. "But, by steering each axle along the vehicle quickly and using the correct control strategy, you can ensure that each vehicle unit faithfully follows the correct path – which also dramatically improves stability."

High-speed headaches

Cebon says that trials to date show that, whereas a conventional trailer rear end on an EMS vehicle swings out 1m on a 2.5m width lane change at 80km/h, his trailers, equipped with individual steering and path following software, achieve zero oscillation. Simulation suggests that, even on motorways, where lane widths are 3.65m, the oscillation would be less than 20cm (half a tyre width), compared with a standard unsteered tractor trailer combination, which swings out 1.3 metres. Also, lateral accelerations and yaw are reduced by 18% and 46% respectively. "So this turns out to be a better way or achieving anti-roll than our earlier mechanical tipping trailer approach," adds Cebon.

While maintenance is a little farther down the line, Cebon assures technicians and fleet managers that standard technology and components will predominantly be used for production vehicles. "We've been working on a hardware setup where the whole system sits on a subframe. That allows you to bring in the bogie and bolt it straight on to an existing trailer or tractor unit. If you have a maintenance issue, you can unbolt the bogie, put another one on and be away," he explains.

But there are other approaches when it comes to volume production of these vehicles. For now, with the technology proven and already demonstrated working effectively with a Volvo tractor unit, the next hurdle is a business one. "Turning this into a commercially viable proposition for manufacturers is the next step. It could be tough, but we think it might be helped along by changing legislation," observes Cebon. 