A good steer

HM Government's 10-year trial of longer trailers is giving a new urgency to advanced truck and trailer steering and braking systems. John Challen reports from the IRTE Conference on pioneering work by the Cambridge Vehicle Dynamics Consortium

Transport operators striving to maximise fleet efficiency face some tough decisions when it comes to vehicle specification. While they still have the choice, should they go Euro 6 or stick with Euro 5 engines? What about investing in aerodynamic aids? And how do they overcome the problems of urban and city centre locations that are not truck and trailer combination friendly?

David Cebon, professor of mechanical engineering at Cambridge University and director of the Cambridge Vehicle Dynamics Consortium (CVDC), may not have answers to the first two questions. However, his message for delegates at this year's IRTE Conference was that his team has solutions to the third that will soon see even longer combinations delivering safely and efficiently in towns, while simultaneously improving road transport's green credentials.

Making the case for longer trailers, Cebon started by stating: "Congestion is the enemy of fuel saving. Between a motorway that is free-running and one that is heavily congested, there is a factor of two in fuel consumption." And hence his and others' assertion that night time curfews make no sense – but also that, when it comes to haulage, the bigger the vehicle, the better. Quite simply, larger vehicles mean fewer movements, so less congestion. Not only that, but fuel consumed per unit of payload also decreases.

Indeed, Cebon's analysis indicated that, if an operator moves payload from a tractor-semitrailer to two rigids, fuel consumption increases by 40%. Go the other way – onto a B-double (tractor and two semi-trailers) for example, and fuel usage falls by one-fifth. "So the bigger the vehicle, the better the fuel consumption – as long as it's full."

DfT requirements

Hence the argument for extended length combinations, and hence also the DfT's (Department for Transport's) decision to kick off a 10-year trial of longer semi-trailers in the UK, with selected operators. The only problem (apart from public perception and politics): manoeuvrability. That's why Cebon's CVDC has been developing so-called 'path following' active trailer steering systems that, he claims, revolutionise manoeuvrability, compared with conventional self- or even command-steer.

"When it comes to roundabouts, for example, we need the back doors of the trailer to follow the path of the tractor unit rear axle for all conditions," he told delegates – asserting that, with each of the trailer axles under computer control, CVDC's system does precisely that. And not only do trailer tail-swing and cut-in reduce massively, but so also do the otherwise massive scrubbing forces on trailer tyres. What's more, he said, this electromechanical steering (EMS) solution – which now uses Tridec lightweight

hydraulic steering hardware and CVDC's software, currently on an SDC trailer, with support from Wincanton – is very nearly production-ready.

Just as with any other vehicle, to be considered roadworthy longer combinations need to safely negotiate standard-size roundabouts. "Without steering aids, our B-double quickly jackknifes, if it tries to go round a roundabout," said Cebon, showing a film clip to prove the point. "So, to make the second trailer match the path of the first, the second fifth wheel has to follow the first, and the rear doors of the second trailer also have to follow the same path as those on the first."

Slick and safe

And with CVDC's path following switched on, and each axle under computer steering control, sure enough the vehicle happily negotiates the roundabout. With film evidence to back his assertion, Cebon also pointed to the safety improvements, in terms of blind spots and virtually eliminated excursions from tractor unit trajectory – and also to the system's ability to do the same backwards. With the simple addition of a camera on the rear of the vehicle, hooked up to a screen in the cab, a driver demonstrated hitherto impossible reversing precision using a joystick, instead of the steering wheel.

But making longer trailers work efficiently is not just about active steering, he said. There is the bogie configuration to consider, relative to payload. "If you

build a longer semi-trailer with the same wheelbase and axle positions as a standard 13.6m box trailer capable of carrying 26 tonnes, and you load it from the back, you get to about 70% full height before you exceed axle load limits," he stated. "If you load from the front, you get to about 80%. So you can't build a longer semi-trailer and leave the axles in the same position."

Moving the axles backwards brings capacity close to full load, whichever way you load it, he said – as long as the vehicle wheelbase is increased. That, of course, further compromises trailer manoeuvrability, making the case even more strongly for an active EMS system to counter the problem.

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The CVDC/Tridec/SDC demonstrator will be ready for further trials by the beginning of 2013, by which time, said Cebon, he hopes to have secured further interest in the technology. With CVDC looking for interested parties, now might be a good time for transport managers to make some enquiries and get in on the fast lane.

Make a brake

Aside from advanced steering systems, David Cebon, professor of mechanical engineering at Cambridge University and director of the Cambridge Vehicle Dynamics Consortium (CVDC), discussed significant inroads being made into improving truck brakes and braking systems, at the 2012 IRTE Conference.

"The problem with existing ABS [anti-lock braking systems] is that they don't work very well," he stated bluntly. "They are meant to prevent wheel lockup, using basically the same strategy as ABS on cars. But, because they operate on air brakes, rather than hydraulic lines, they are much more difficult to control and slower to respond. The result is that trucks have a longer stopping distance of around 30%."

Cebon outlined test data evidence from an instrumented truck. This demonstrated that, as ABS braking is applied, wheel speed repeatedly drops to zero every second, before rapidly returning to road speed. "This continuous locking up and unlocking process impacts on the truck slip, which is zero when the wheel is free rolling, without the brakes on, and one when the wheel is stopped and skidding."

So what's involved in CVDC's fresh approach to advanced braking? "We've built a new ABS that has much better slip control and accuracy. It offers a low-cost inertial measurement of vehicle speed [not wheel speed] that continuously estimates the optimal slip point; and a completely different form of pneumatic actuation, with much faster on-off valves," he explained.

Key to the new system is a step change in actuator technology for truck ABS systems. "The current setup leaves pneumatic propagation delays caused by the distance between the ECU actuator and the brake chambers – which means you can't control the brakes as fast as you'd like," explained Cebon.

"The first trick is to take the brake actuator away from the middle of the vehicle and, instead, have one for each axle. If you do that, you can control local pressure on each axle much more precisely." But the second, he added, is to move to a patented magnetically-controlled valve, capable of much faster switching, to control air pressure in each individual wheel's brake chamber.

CVDC's prototype system, said Cebon, can't do quite as well as car ABS, in terms of stopping distances, but can get very close. "If we want more productive vehicles, we need to be able to show safety benefits, and this is one of the ways of achieving that," he reasoned, stating that initial trials of the system will begin at the end of this year.