Brake

Future braking systems are promising even better levels of safety and performance. John Challen and Brian Tinham investigate

What good is an environmentally friendly truck, if it is out of service, having crashed under braking? This – and concerns about injuries, insurance, litigation etc – is among the driving forces behind developments, particularly with emergency braking systems, set to dramatically reduce stopping distances.

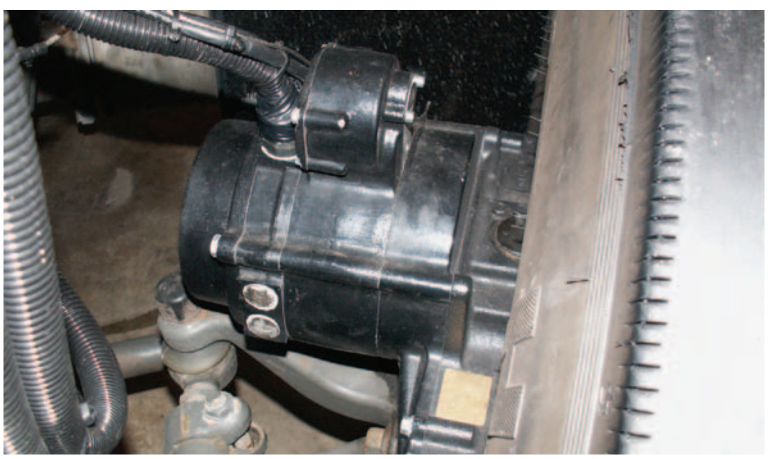
Developments come in various guises, attacking the problem from different angles. The latest innovation from systems supplier Wabco, for example, debuted at the IAA Commercial Vehicle show, builds on the company's OnGuard technology, which is a collision mitigation system for truck drivers.

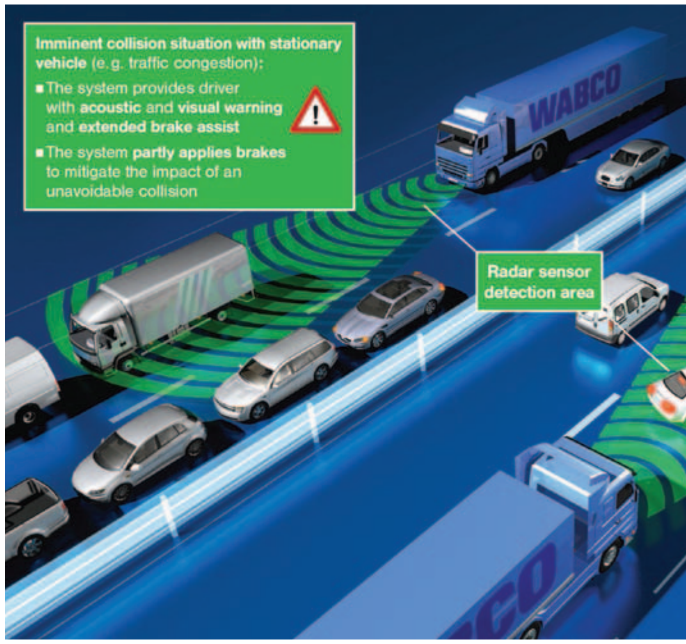
According to the company, its aptly named OnGuardPlus is the first to comply with the European Union's expected regulation to make AEBS (advanced emergency braking systems) mandatory on new HGVs from November 2013. The technology applies full brakes in imminent collision situations, reacting to decelerating vehicles and stationary vehicles in traffic congestion. Wabco chairman and chief executive Jacques Esculier explains that it initiates emergency braking, bringing the vehicle to a complete stop, if necessary. It will be available worldwide from 2012 for trucks and buses.

Meanwhile, having made great strides in the bus and coach industry, Allison Transmissions is looking to improve braking on RCVs (refuse collection vehicles), using its hydraulic output retarders. These can be fitted on vehicles above 15-tonnes and create a braking force transmitted via the transmission to the differential.

The device uses a vaned flywheel in the

Haldex's electro-mechanical braking system is currently under evaluation





transmission housing. The transmission directs oil into the retarder housing to counter the vehicle's momentum via the drive shaft. Energy is converted to heat and dissipated through the vehicle's cooling system. Resistance from the flywheel, augmented by stators on the inside of the housing, delivers braking force to the drive wheels. More oil in the housing translates into more aggressive braking and. since there is no mechanical friction or wear to shock the drivetrain, maintenance costs can be reduced, too.

Hot braking

Tests at Ohio's Transportation Research Centre in the US prove the retarder's effectiveness during stop-start duty cycles. Without the retarder, front brake temperatures reached 266°F, while the rear linings topped out at 390.2°F. However, with the retarder engaged, brake lining temperatures on the front axle reached only 120.2°F, while the rear brake pads were measured at 172.4°F.

Retarders may have been around for a while, but Allison Transmission area manager Riccardo Sardelli suggests that transport engineers shouldn't imagine that development has stopped. "We see the future in more control and greater integration," he hints. "The only way forward is to change the metrics. We are changing designs to give higher retardation levels for

expectations

heavier load applications, such as articulated dump trucks. It's about changing the internal geometry."

This is important, because, when retarders are used on RCVs, brake wear can be improved by as much as 30%. That's why, in the future, Sardelli believes they could become standard on up to 60% of RCVs. "Vehicle sizes, weights and horsepower are all increasing, so you need a more effective method of stopping the vehicle," he asserts.

As for the future, one interesting project that looks set to come to fruition for the next generation of trucks is emerging out of the Cambridge Vehicle Dynamics Consortium (CVDC) – a network of transport industry companies and the University of Cambridge Engineering Department, focused on truck safety, productivity and environmental improvements.

New technologies

Cambridge postgraduate Jonathan Miller is part of a team that includes high performance valves firm Camcon and Haldex, working to update two of the mainstays of truck braking systems – the hardware and the software. He points out that hardware on trailer brakes, for example, hasn't been modified to any great extent since the 1990s, while ABS algorithms also "haven't changed much". Miller contends that it is shortcomings in both the hardware and the software that cause the familiar 1–2Hz pulsations of ABS-assisted braking on trucks during emergency stops, which, on analysis, results in the braking wheels spending too much time either locked or free-rolling – leading to suboptimal deceleration.

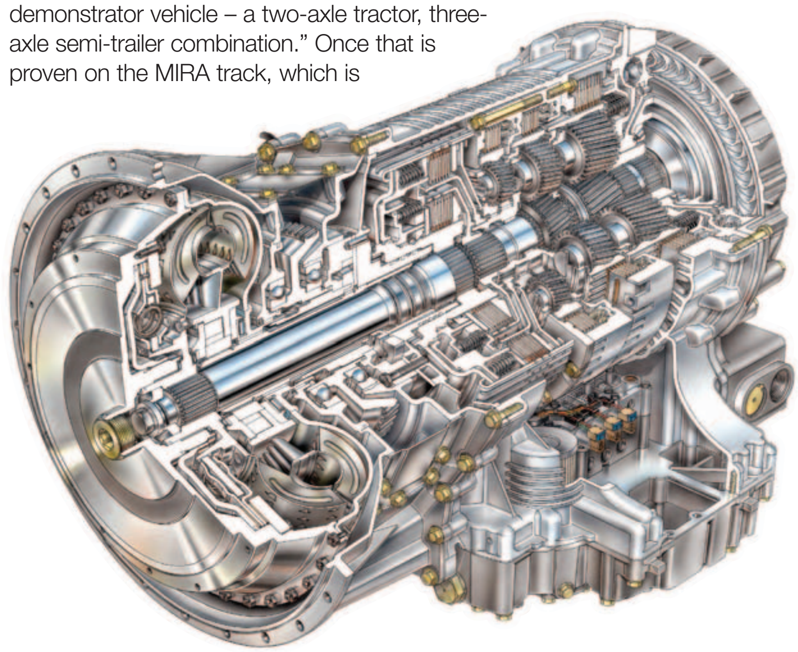
"So we have modified ABS algorithms to implement slip control that massively reduces trucks' stopping distances. Effectively, our software continuously optimises the braking forces, so that the wheels ride the perfect point on the curve between locked-up and free-rolling, for maximum braking," he explains. And that includes dealing with varying road surfaces, having different friction coefficients.

But that's far from the end of it. "We have also developed and built a new brake valve that switches 10 times faster than conventional units," reveals Miller. And it's not just the valve: unlike existing trailer brakes that rely on a central solenoid valve, in CVDC's design its new fast valves sit on each wheel's brake chamber, acting directly. That both cuts out air pressure lag and enables independent braking force per wheel. Miller reckons that, based on simulations on Cambridge University's laboratory rigs, the new valve design will reduce stopping distances by up to 30% (within a whisker of passenger cars' capabilities).

Incidentally, it will also cut compressed air usage by up to 50%, leading to an additional potential payload and energy usage advantage for hauliers. "The valves use less air, which is typically an energy source and needs to be stored in reservoirs on the vehicle," states Miller. "If we can build the brake systems to operate using less air, there will be smaller reservoirs and more space to haul cargo." And who knows: insurance premiums might be reduced, too, given the shorter stopping distances.

Unfortunately, engineers and fleet managers will have to wait a little longer before they see the technology. "At the moment, we are still prototyping, but we are about to put our system on the CVDC demonstrator vehicle – a two-axle tractor, three-axle semi-trailer combination." Once that is proven on the MIRA track, which is

Allison's output retarder has attracted interest from many RCV operators in the UK



likely to be sometime in the next 12 months, the university man expects more news. And he maintains that it will be retrofittable for any truck. "Because the system is fitted to the individual brakes of each wheel, it shouldn't matter if it is a rigid truck or a dual trailer combination," he asserts.

Such an elegant solution will probably be more attractive – at least initially – than another approach, which uses electro-mechanical braking (EMB) systems that are not so easily retrofittable. However, Bob Prescott, chief engineer for truck projects at Haldex, believes these may well have a future, not least because they compensate for disc friction.

Electric dreams?

Haldex's system uses a brushless dc electric motor to apply the brakes, rather than air – which sounds simple enough, until you consider the forces and computing to make it work. "Normally, the electrical energy required, if you were simply replacing the air actuator with an electric motor, would be huge," concedes Prescott. "However, rather like a drum brake, our system uses the vehicle's own momentum to pull the pad onto the disc." The motor just moves the pad up a ramp at an angle, such that friction from the disc pulls it on, meaning that only tiny currents are needed to control and then release the pad.

"If the pad friction is low, then the system has to apply more power to maintain braking – but that's better than losing braking efficiency."

As for the hardware, the system uses two microcomputers sited at each wheel – one controlling the foundation brakes and the other the parking brake, which is held open against a spring by an electromagnet. Electrical power comes form two batteries, sited in an enclosure on the chassis – one for each braking function.

Sounds great, but Prescott warns there are still hurdles to overcome – one being cost. "On a 4x2 tractive unit, you get 4S4M ABS controls – meaning individual wheel speed sensors and modulators per wheel. But on a 6x2 or 6x4, the rear axles share the modulator. So, to get the individual wheel control we need, we have to add modulators and that means cost." That sounds worse than it is: most of the money is in electronics and prices will only fall.

Meanwhile, there remains the dual electrical system required to ensure fail-safety. "In the test vehicle, we have two dc to dc converters connected to the vehicle single circuit and they charge our batteries, while providing isolation. That also adds cost, but, in the future, designers might share the batteries with, for example, electrically powered steering – so we could amortise the cost."