Accelerating

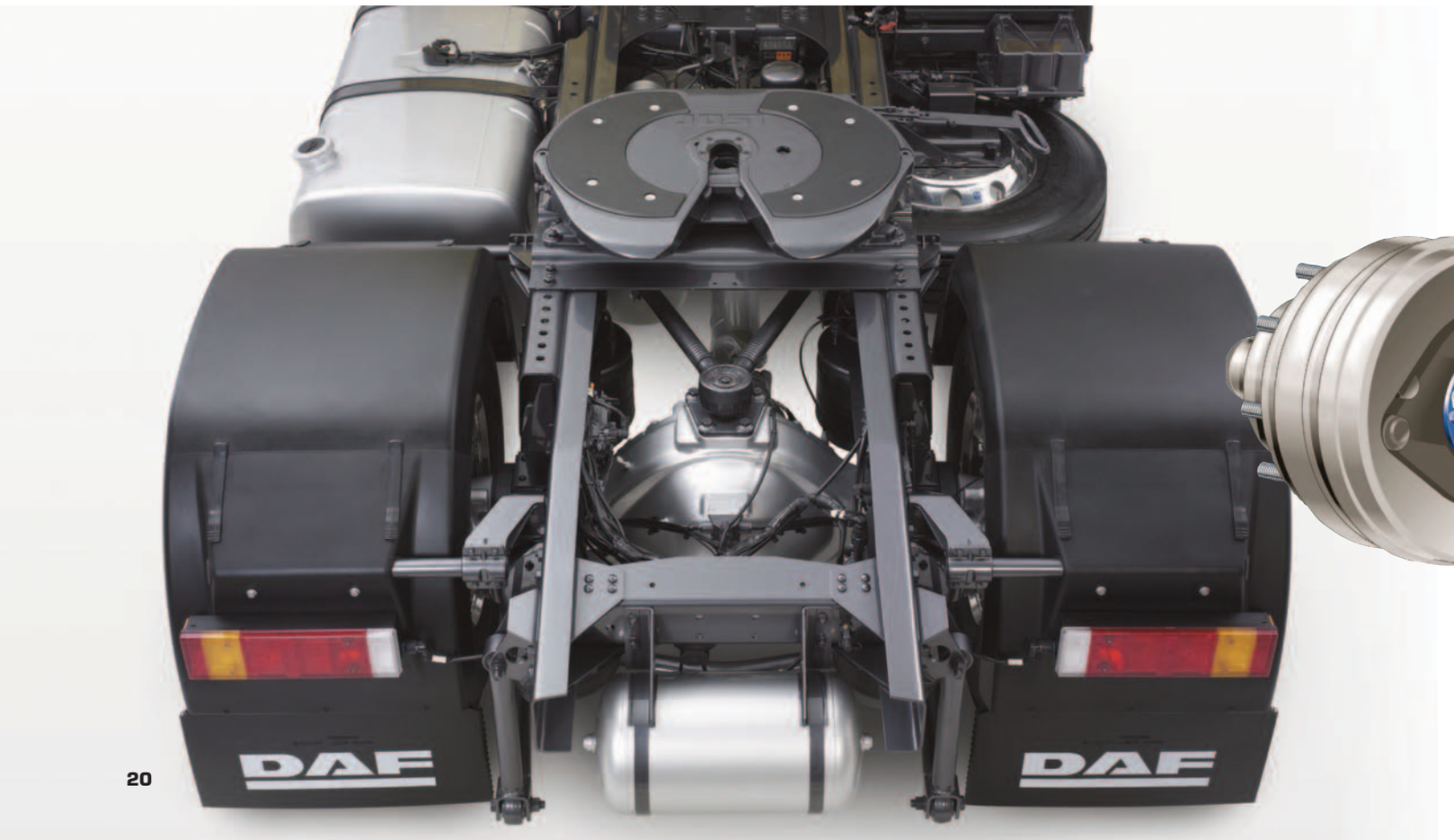
There might not be a revolution in truck axles and suspensions, but saving weight and cost remain high priorities that can, and are, being solved, says Keith Read

It's fair to say that calling the truck industry 'conservative' is more a compliment than a criticism. No surprise then that DAF UK's marketing director Tony Pain is unequivocal when questioned about developments in axles and suspensions. "Truck operators don't want new and they don't want technology," he says. "They want proven efficiency and productivity. And while they don't mind the benefit from a bit of weight saving, if we can do it, they don't in any way want manufacturers to breach reliability."

Quite simply, as he and others observe, in terms of development, the industry is a leader in reliability and a follower in technology. For example, disc brakes and the transport industry didn't see eye-to-eye for years and, although they're well accepted now, the first people in with disc brakes caught a huge cold. No truck manufacturer could ever afford to do that with new or novel axles, suspensions or anything else.

As a result, there has been remarkably little change in the design of axles, especially from their outward appearance. The I-beam front axle and a banjo-type rear axle have been retained with, almost exclusively, a single-reduction rear axle. And as Pain comments: "Other than for specialist applications, hub-reduction axles are almost dead for on-road vehicles."

Nevertheless, Pain agrees that development work is going on – for example, to see if vehicle manufacturers can run their vehicles on lower lube levels in the diff, so as not to stir around all that oil and consume power warming it. However, as the DAF man explains: "We're obviously looking to oil technology here, because, although we would like lower oil levels, we still want filled-for-life."



axles

That said, many manufacturers have looked at new, weight-saving materials for axle casings, admits Pain. However, the question of increased costs versus any benefits in reduced weight or compromised strength inevitably rears its head. “When you’re going up to 30-tonne axles for heavy tractors, you are pretty well stuck with what we’ve got, unless you get into some very expensive materials. And, if you go that route, the weight saving is not really worth it, because the average operator is not looking for a 20kg saving – he’s looking for half a tonne.”

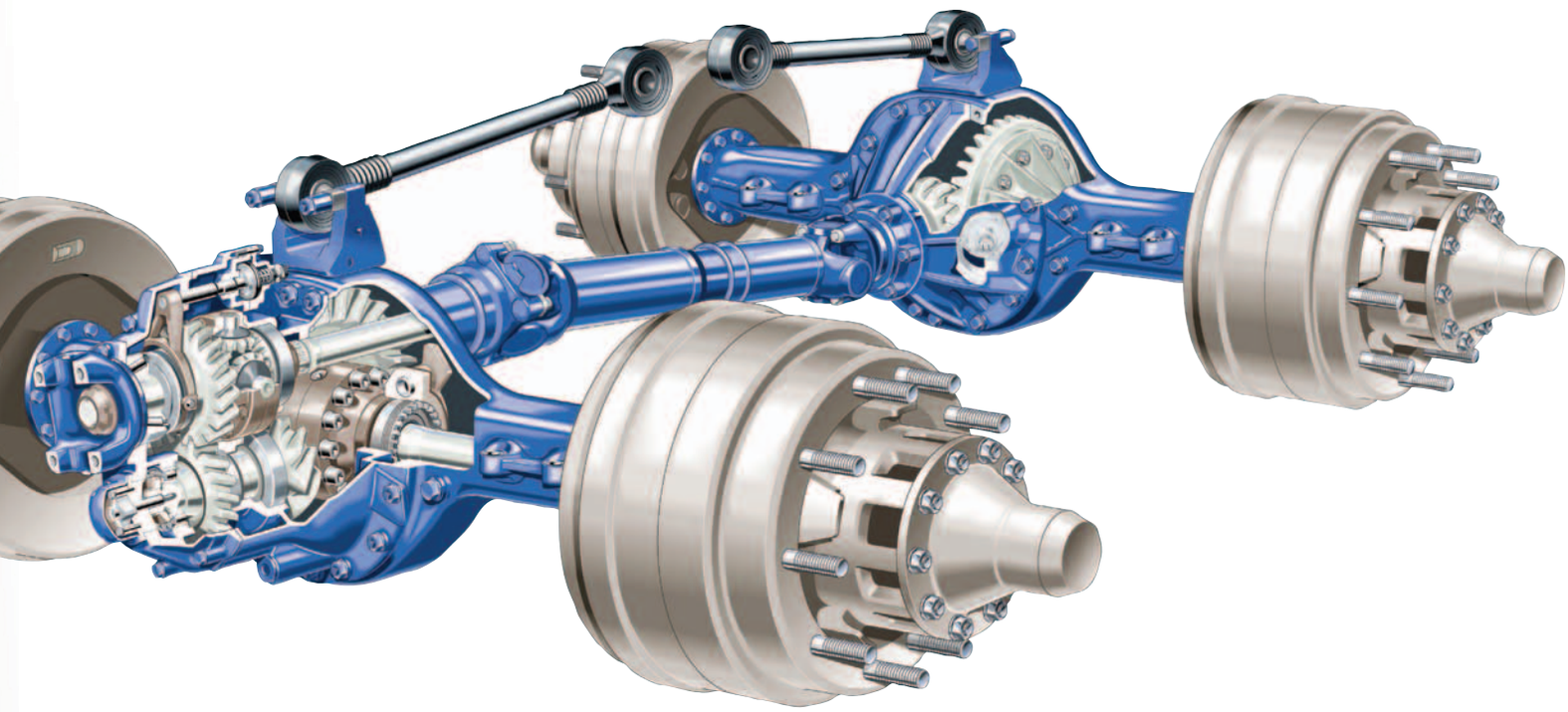
Additionally, operators expect 100% reliability. Not 99.9%, but 100%. No innovation can be allowed to risk compromising the reliability of axles. And the same applies to suspensions; Pain concedes that many manufacturers have moved from two-bag to four-bag designs at the rear, because that gives the best ride – but that’s about it. “Four-bag also evens out the stresses in the frame, because they are spread out over a larger area, and I think that will remain. We don’t want to do anything with air-suspension, because it works!”

However, for weight-saving and cost-saving, some manufacturers feel that a return to two-bag air suspension could be on the cards, provided some form of geometry control can be added to prevent longitudinal movement. A potential downside of two-baggers is that some may have to operate at higher air pressures (12- or 13-bar, as opposed to about 10-bar for four-bag systems). Then you’re into the risk of a return to the days of oil leaking from compressors and contaminating the air – and using additional energy to drive a 12-bar compressor, which then consumes more fuel.

Lightweight vehicles

The exception in all this might be vehicles that are under 10 tonnes, where Pain sees the possibility for increased use of aluminium components specifically to reduce weight. However, again he stresses that this lightweight scenario has to be carefully balanced against putting stress back into the chassis, which might then require strengthening – thereby adding weight.

Scania’s senior vice-president and head of truck, cab and bus chassis development, Sven-Åke Edström, shares many of Pain’s views – especially with regards the improvement of what is currently available, rather than worrying innovations. “Our modular system has different performance steps, and we can combine them, depending on the use of the truck. If we have good knowledge of the truck’s use, we can optimise our product in a better way than we have previously,” he explains.



DAF and Scania see evolution of truck axles as the way forward, not revolution

Weigh up the benefits

The need for operators to keep within the axle limits on their vehicles is something Keith Gresham, managing director of Runcorn-based Axle Weight Technology (Axtec) understands in minute detail. His company produces a wide range of axle weighing machines, including on-board systems, portable weighing machines, static weighbridges and dynamic weighbridges.

With a whole raft of factors – from compromised steering and handling to road surface damage – contributing to weight limits on truck axles, Gresham has seen how manufacturers have been able to optimise axle designs to avoid over-engineering, without reducing levels of durability and reliability.

In the case of a typical 7.5-tonne truck, where production volumes are sufficiently high, bespoke designs are the norm, he observes. But where production volumes are relatively small, such as for a 13-tonne truck, sharing components with a higher-capacity vehicle (a 16- or 18-tonne model, for example) is not unusual.

However, one key aspect will always be the legislation that requires drivers and operators to keep within limits – and this is where Axtec comes in. Quite simply, its products, particularly the in-cab axle weight readers, tell drivers when they are breaking the law.

A couple of manufacturers already offer Axtec equipment as options and Gresham believes that, within 10 years, the majority will follow suit on their additional equipment lists. As a result, costs are likely to fall. To fit a two-axle truck with Axtec equipment today costs a shade under £1,000. It sounds a lot. But within the overall new-vehicle cost package, viewed over a five or seven-year life, it's not very much and certainly a lot less than the penalty that the law could impose or the on-costs of losing an operator's licence. What's more, the equipment can be transferred to a replacement vehicle to extend its life and amortise the capital cost.

Keith Gresham is the managing director at Axtec

An example of how this process worked to an operator's advantage comes from a Scania project for a fuel transport company in Italy. Scania looked at the standard-specification vehicle the operator was using and analysed the usage profile. "We then optimised the truck, removing 500kg from the unladen weight," says Edström. "To me, using what we already have, but in an intelligent way, is the first step towards improving trucks."

That's not to say new designs won't happen. Scania's new R-series incorporates a new rear axle two-bag suspension arrangement, which reduced chassis weight by 100kg, compared with the previous model. That reduction was achieved by using components from the company's four-bag suspension, employing closed cross-members and optimising the main suspension brackets. "It shows it's still possible to work with more or less standard designs and improve them by reducing weight," says Edström.

Although not directly linked to reduction of axle weight, Edström believes there should be greater integration of the bodywork and chassis. "Today, bodywork, is optimised to take all forces that come from the road. But we have a chassis that is also taking on part of the stresses. If we could better integrate the bodywork and chassis, then we could distribute the stresses in a more optimised manner and, in that way, reduce the weight. We are already doing this on complete vehicles that we build. But my vision is for greater cooperation between truck manufacturers and bodywork companies."

Fuel reduction

Scania's Edström also sees that there is further potential for reduced fuel consumption – as a result of improved aerodynamics – including streamlining of the chassis, axles and other components on the under-body. "Historically, we've looked at the cab and bodywork in terms of aerodynamics," he says. "But the chassis, together with front and rear axles, can be streamlined to optimise air flow under the vehicle. Also, by lowering the height of the chassis on good roads – through the use of an intelligent suspension – we have less air passing under the truck and a smaller [vehicle] frontal area."

And while air suspension would be a key element of a flexible chassis height system, Edström reminds us that the compressors involved increase fuel consumption. "Perhaps we should question whether it is wise to have air suspension," he says. "It's something that we could always think about, if we are really looking at CO_2 emissions."

For the future, however, Edström fancies high-tensile steels that allow thinner – and therefore lighter – sections to be used. But he cautions against lost stiffness, which would affect vehicle stability. He sees potential for composite leaf springs, already used by some competitors, but Scania won't use them until the company resolves the problem of maintaining vehicle steering and stability, if a composite leaf spring should break.

Meanwhile, optimisation is seen by most in the truck industry as the best route to reduce weight, improve fuel economy and reduce emissions. As Martin Palming, product manager at Volvo Truck, puts it: "We have to optimise vehicles even more. We've seen over the past few years that customers are coming to us with even more specific demands. It could be from a weight perspective or from a [cargo deck] height or length perspective.

Operators want their vehicle optimised, so they can carry more on one journey, rather than having to make extra journeys."

Repackaging the configuration of components has enabled Volvo to meet some of these requirements, without having to compromise the suspension. One example involved removing heavy battery boxes from the frame side rails to the overhang. Another entailed relocating climatic equipment (heaters and refrigerators) within the chassis frame.

But it's not only about higher payloads. Vehicle safety remains the critical factor. As with all truck manufacturers, extensive use of CAD and virtual testing gives Volvo the ability to tailor models to different markets and industries, without having to compromise safety. "We could never physically build and test every solution – there wouldn't be time," Palming points out.

Electronic controls

The view from French vehicle manufacturers mirrors much of their northern European and Scandinavian counterparts. Armando Carneiro, axle programme manager for Renault Trucks, says: "In the coming five to 10 years, the main focus will be on fuel efficiency improvement. This [change in focus] will result in an improvement in gears and carrier lubrication, as well as a move from hub reduction [a French preference] to single reduction axles. In this respect, we could see the introduction of electronic control systems – sensors, etc – in rear axles to control losses and oil deterioration. Rear axles will also be fine-tuned to better fit hybrids and electrical drivelines, and a development with electrical motors will probably appear."

Luc Winocq, chassis and vehicle dynamics advanced engineering manager for Renault, confirms that optimisation will be the name of the game in the immediate future. "Suspension systems will contribute to trucks' adaptation to evolving transport systems, aiming to optimise urban distribution and long-haul, as well as combining with other transport solutions, such as rail and shipping. I see energy management, motion control for safety and agility, traffic density and nuisance limitation as the main drivers," he says.

And Winocq continues: "Compact and modular designs will enable trucks to adapt to specific usage. By integrating several functions or systems – for example, steering and suspension – there will be opportunities to reduce weight and make chassis installation easier, even with conventional materials. Wheel units, incorporating brakes, suspension and steering, could also contribute to a very high level of compactness, modularity and flexibility. And weight reduction will also be achieved by closer integration within the chassis structure – thus also reducing the number of parts."

Take it to the limit

Paring down the weight of a truck axle is one thing. Proving that it will still stand the rigours of a lifetime's hard work is another. Which is why Volvo Truck has installed the world's largest truck axle test rig at its Gottenburg factory in Sweden.

The 220-tonne monster rig – 14m x 8m x 4.5m high – sits on a 1,000-tonne concrete 'seismic base' which, in turn, rests on air cushions to absorb vibrations from the rig that might otherwise damage the test rig building.

Capable of handling full-scale tests of axle assemblies up to 32-tonne bogies, the rig can simulate in a few weeks all the stresses and strains that a truck is subjected to throughout its entire life. "The tests that we can now perform in six to 10 weeks used to take six to eight months and involved running the vehicles out on the track," explains Göran Johansson, manager of test operations at Volvo Truck.

"The rig also gives us better quality test results. Optimisation is all about ensuring that customers can depend on the truck's various systems always functioning correctly, while simultaneously ensuring that the systems do not weigh or cost too much, due to over-dimensioning," he adds.

During tests, input data can be gathered from more than 100 measurement points. To achieve the required degree of simulation precision, the parameters in the test rig's control electronics can be updated more than 1,000 times a second. There are several basic programs for the various test cycles – long-haul, distribution operations and construction duties. In addition, test cycles can be individually tailored to driving conditions within each transport segment.

So axles could be the subject of more innovation than some people might think – with reduced fuel consumption still among the key drivers. Consider energy-recovery systems attached to components such as shock absorbers and springs, for example. Active and semi-active suspensions could be the next step forward. TE

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