

Shift workers

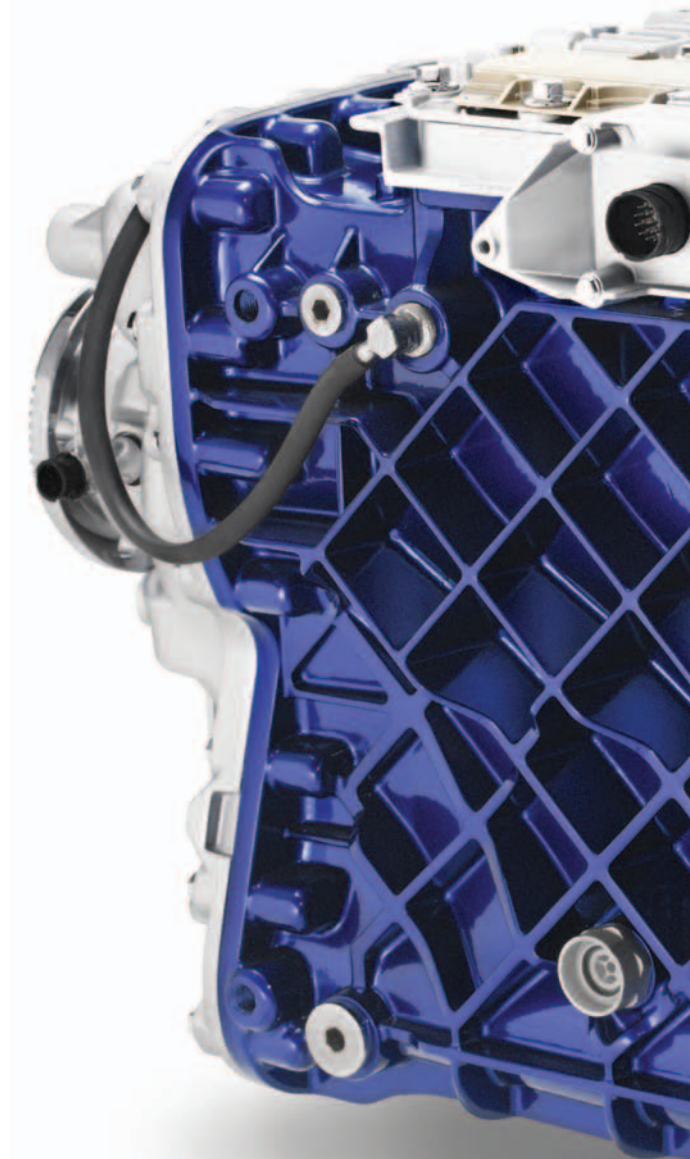
More than a decade after the first automated manual transmission appeared on a truck, the technology continues to evolve. Keith Read delves into the latest efforts

When ZF launched what is generally regarded as the first intelligent truck transmission in 1997, few could have imagined the impact it would have. If the

AS Tronic automated manual transmission (AMT) sent shivers of fear through truck workshop engineers, it sent the fear of God into Volvo, kick-starting the Swedish manufacturer to respond with its I-Shift and, subsequently, I-Sync designs.

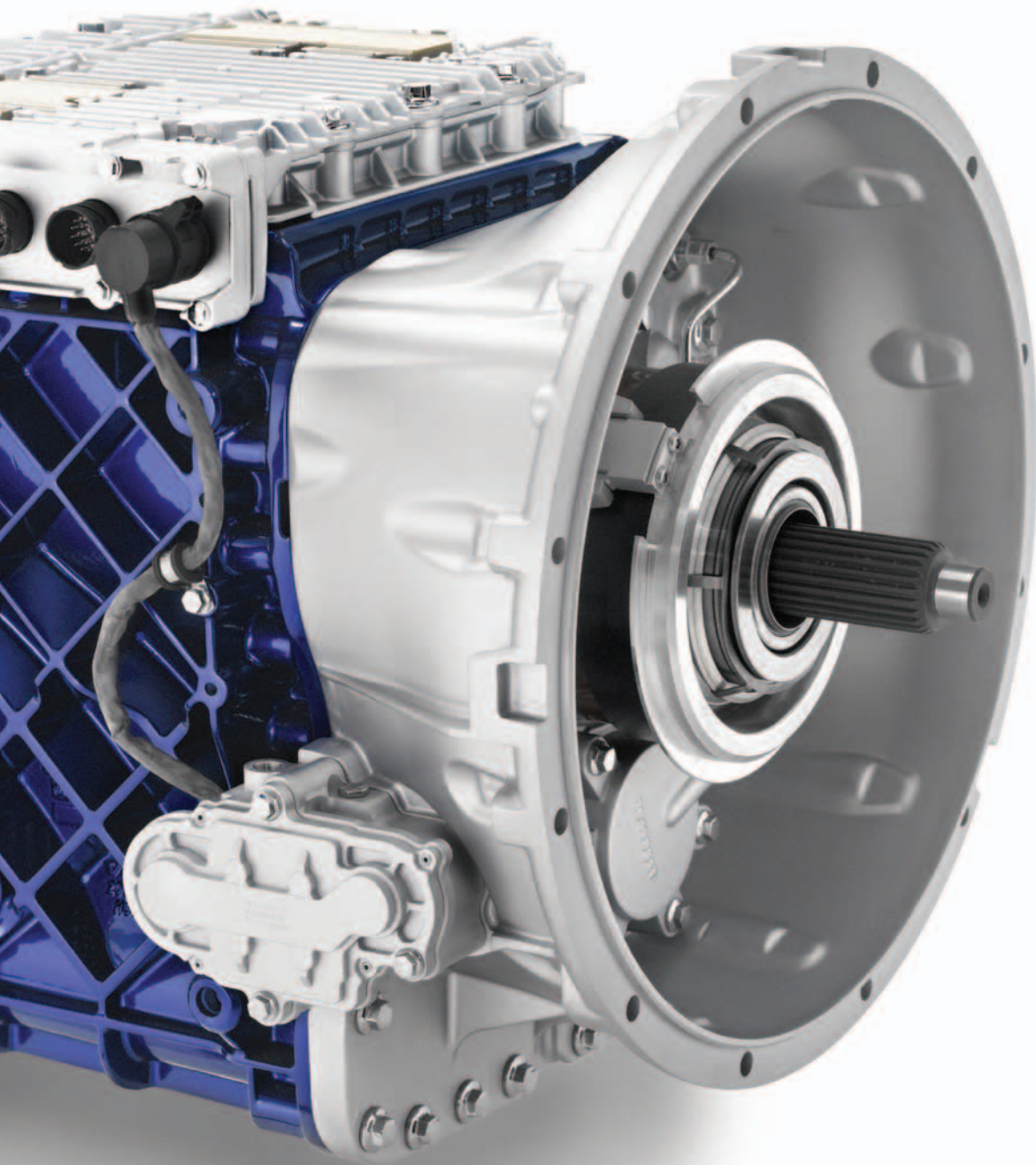
More than a decade since the AS Tronic, service and maintenance engineers largely take the additional sophistication of AMTs in their stride, while truck operators reap the benefits of fuel- and running-cost savings, and drivers enjoy more comfortable and efficient vehicle operation. And the environment also benefits from reduced emissions. Meanwhile, the development of more intelligent transmissions continues apace.

However, for Volvo, there has been an additional – possibly more important – benefit. It may be uncomfortable to admit it, but an earlier truck transmission didn't have 100% reliability. I-Shift has



almost single-handedly restored Volvo's reputation. "With the I-Shift, we now have very good reliability," says Åke Zander, technical director for driveline and hybrids at Volvo Powertrain. "Manual transmissions are more driver-dependent, which can affect the reliability. But the difference between the best and worst driver is much smaller with AMTs."

With reliability thus well established, the most important advantage of recent further development remains reduced emissions, says his colleague Sven-Erik Tibb, Volvo's manager for driveline and hybrids. And there will continue to be intense development on driving down emissions through reduced fuel consumption. "We are by no means at



Left: The mighty Volvo I-Shift AMT in of all its glory
Far left: I-Shift's simple operating controls

the end of the road, as far as I-Shift is concerned," insists Zander, although he declines to confirm or speculate about what future enhancements might bring. He does, however, agree that I-Shift's future with hybrid and alternative-fuel vehicles is assured. And the fact that Volvo will specify I-Shift for its new-generation drivelines means that unit costs are likely to fall, thanks to economies of scale.

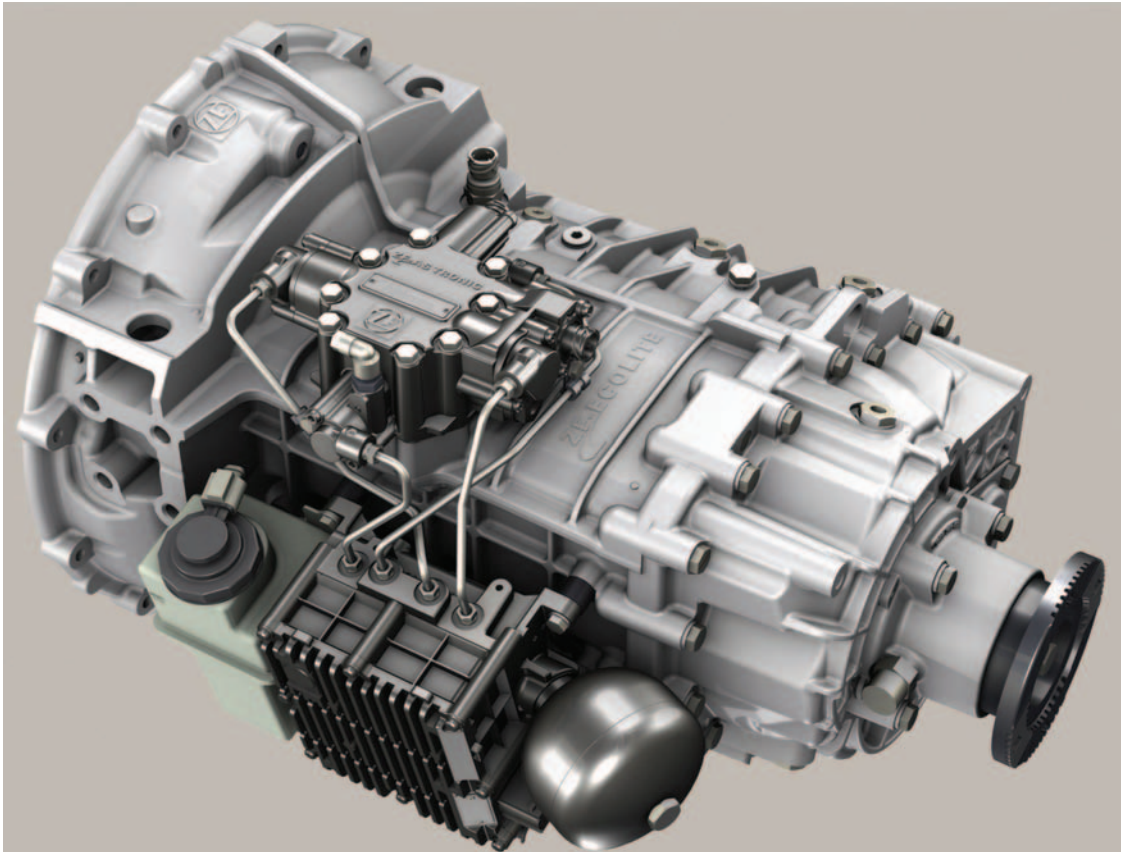
Happy operators

Unsurprisingly, both engineers believe Volvo's AMT development has gone well. "Of course, there are always things that we could have done better," says Tibb. "But we are very pleased with our I-Shift

development. Our customers – internal and external – have given us feedback that makes us very happy about the decisions that were made at the end of the 1990s. We have to thank the people in the company who had the long view of the future and made the decision [to develop I-Shift]."

Meanwhile, at ZF, Bernd Stockmann, head of the truck driveline technology business unit, says the focus of its next generation of AMTs will also be further improvement of fuel economy and emissions. "It's getting more difficult, but there's always room for improvements," he says.

Stockmann talks of the two areas ZF is currently looking at. One is the ratios and mechanical side,



The AS-Tronic Lite, ZF's AMT for light trucks, which allows drivers to concentrate on manoeuvring while the system maintains fuel efficiency, even in stop-go operations

where the spread of the transmission can be increased, in order to allow the driver to reduce truck engine speeds. "The other is the further development and improvement of software functionality and driving strategy, where we can combine data available from GPS to take into account the road conditions and topography where the truck is operating," explains Stockmann.

Will the future generation of intelligent transmissions – and automatic gearboxes in general – demand higher levels of knowledge among workshop and maintenance teams? Stockmann believes not. "I would not suggest that there will be a difference between the current products and the next generation of systems. We have reached a good level of knowledge in the servicing of such transmissions and the concept of maintenance is not changing a lot."

That said, our ZF man agrees that, while there are few examples of such transmissions failing, making the most of diagnostic tools is vital for workshop technicians. "The main thing for the service teams is that they know how to adapt their diagnostic systems to the vehicle, and its engine and transmission, and to read the information provided."

Failure rates are, he says, very low and on target to further improve, bringing benefits of reduced servicing costs. Running costs are also on course to fall. "In our next generation [of AMTs], we have

already seen clear ways to further reduce fuel consumption overall. We have defined our target improvement and, in test runs, we have proved that development target."

Intelligent or automatic?

While many define intelligent truck transmissions as automated manual boxes, Allison Transmissions has no doubt that its range falls firmly into the category of 'intelligent'. Engineer Manlio Alvaro is European marketing manager at the company: "Our transmissions are becoming more and more intelligent. There are advances that can be made to hardware, but the main focus of development and enhancement is in the electronic controls," he says.

"Our automatic transmission is already extremely efficient, thanks to the power-shifting, which means as much energy as possible is always transmitted to the wheels," adds Alvaro. "The electronic controls we have introduced also help to optimise the operation and fuel consumption, and ensure that the performance is always suitable for all road conditions and gradients, fully loaded or unloaded."

This feature, dubbed LBSS (load base shifting scheduling), plays a key role soon after the truck moves and the torque converter locks. "At this point, you have to make the right decisions to optimise the engine rpm, the vehicle speed and the vehicle operation," observes Alvaro. "This is where

Innovative Vehicle Transmission

What will the next decade bring, in terms of intelligent truck transmissions? Torotrak believes that its infinitely variable transmission (IVT, below) could not only seriously challenge established designs, but replace automatic transmissions altogether. Steve Murray, director of R&D, says: "We are actively working on two truck projects, both of which are heading towards a production sign-off. I can't say what the time frames are, but it's fair to say that we're not far off prototype hardware for evaluation."

"It's no secret that we're working with Allison. It is a very high profile customer and, as a transmission supplier, it has a very good reputation across the globe. Ultimately, I hope that IVT replaces automatic transmissions in its applications."

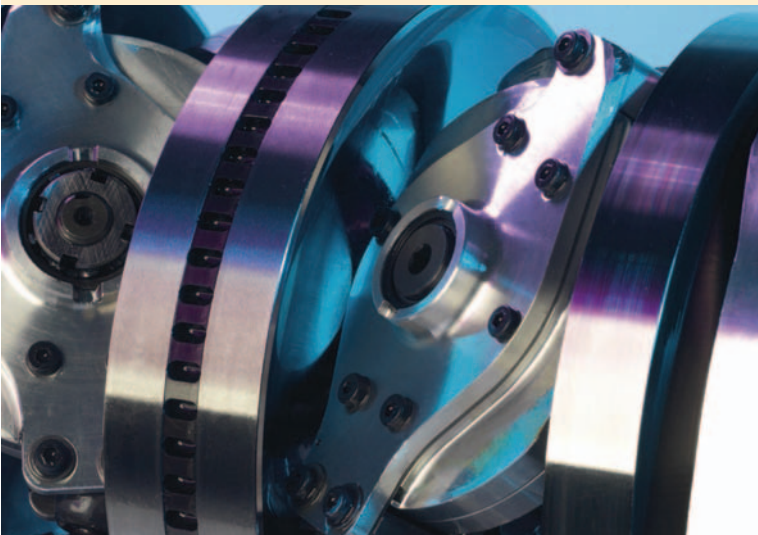
Murray also says Torotrak has independent evaluation data suggesting that its transmission will cost much less than today's AMTs. "Both manufacturers we're working with believe that there are cost advantages [for IVT]," he comments.

The concept of IVT is, for many, coloured by the memory of early DAF cars, driven by rubber bands. More-recent CVTs with steel bands – used by Ford, among others – disappeared without a trace. But Torotrak's concept – already used on ride-on lawn tractors – should not be confused with yesterday's designs. "There are three main components to our IVT," says Murray. "We have a full-torodial variator, which comprises two input discs and two output discs, with six rollers in truck applications. We have epicyclic gear sets [and in truck applications it tends to be more than one]; and we have clutches to select different regimes of operation."

Murray says these components allow Torotrak to produce a multi-regime transmission that offers interesting features. "One of the main factors is that the epicyclics are used in conjunction with the variable-ratio device to power-split – which allows us to put power through a fixed mechanical path and through a variable-ratio path, and recombine them at high levels of efficiency."

A geared neutral facility also prevents roll-back on gradients and its operating efficiency, says Murray, is in the mid-90s. "This compares favourably with two of the best automated manual transmissions, and is better than automatics. In addition, the transmission can be optimised to allow the engine to operate at best efficiency. This contributes to the IVT's better fuel economy than automatics and AMTs."

Why so good? The big disadvantage of AMTs is the fall-off of boost during gear changes. "This compromises acceleration, especially on uphill gradients. The continuous nature of the IVT means that, once the driver presses the [accelerator] pedal and boost is achieved, it is maintained throughout the process. The engine is maintained at peak power, rather than having to shift around. So, overall, the performance is comparable with, or better than, a conventional automatic, and with fuel consumption benefits over a manual."



LBSS comes into play. With the torque converter locked, our transmission is always shifting under power, because planetary gears always keep power flowing to the wheels."

Alvaro says the electronics take care of this energy by optimising either for performance or for covering a greater distance on the same quantity of fuel. "Our intelligence can be tuned to take best advantage of the efficiency of the automatic transmission, according to the desired duty cycle," he explains. "Although ours is a mature technology, we are always looking to new features and to adopt different technology. But we do believe that power-shifting is still the way to go. Bringing 100% of the engine power to wheel rotation, without interruption, means you don't have that moment [when the clutch is operated] when the truck is decelerating."

Guaranteed payback

Incidentally, Allison points out that it has also worked with Castrol to develop synthetic oils that have a longer life than mineral oils. As a result, in combination with a high-capacity filter, oil changes can now be as far apart as 250,000 miles – so helping to reduce servicing.

However, Alvaro reckons electronic can again make an even greater contribution. He makes the point that Allison's Prognostic system brings the status of both oil and oil filter directly to technicians' attention. "This allows operators to plan their maintenance to avoid any unnecessary fluid or filter changes, while also monitoring the condition of the transmission to avoid unexpected malfunction," insists Alvaro.

All well and good, but which way should you go? ZF's Stockmann is unequivocal: while operators have to accept a higher initial cost with AMTs, they can also expect good payback. "ZF's target is that there will be financial benefits to operators over the lifetime of their trucks. The higher initial costs could be seen as a disadvantage, but over its lifetime, and even earlier – perhaps in just two to three years – it is possible to amortise the higher initial cost," he says.

In Western Europe, acceptance of that assertion is growing, and the proof is the 34–35% of trucks of 6 tonnes gvw and above in the region that now have AMTs. Those figures will only continue to climb as operators increasingly feel that AMTs are, after all, in their comfort zones. As Stockmann puts it: "They see the advantages and they calculate that they will show savings."

However, in developing markets, initial cost appears to be a much more important factor. For this reason – and the fact that, in such markets, higher levels of technician training are still proving more of a challenge – AMTs are not yet the automatic choice. However, for the rest of us, the future is very clear. 