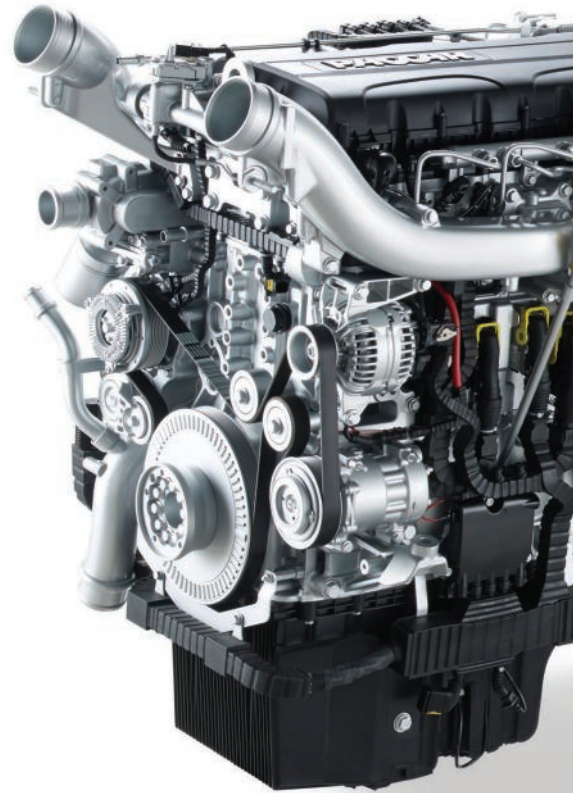


# EFFICIENCY REVOLUTION

For most of us, any consideration of transmissions is generally limited to the pros and cons of AMTs versus manuals. But there's a lot more going on with gearboxes. Brian Tingham reports



Sometimes less is more, but on other occasions more is best. So it is with transmissions, or specifically gearbox ratios that are pivotal to governing speed and torque in the drivetrain from the engine output shaft to the (primarily rear) drive shafts.

How can both be right? Because, as designers focus on maximising efficiency, diesel engines are necessarily being optimised for narrower speed bands. That generally means more gear ratios to provide a spread capable of delivering on torque. However, in this age of hybridisation, another solution is harnessing an electric motor or KERS

(kinetic energy recovery system) flywheel for a theoretical first, second and even third - leaving the diesel to handle only the higher speed range, with, you guessed it, fewer gear ratios.

Or, for that matter, designers might prefer a single IVT (infinitely variable transmission), effectively offering seamlessly delivered ratios via a single, simple (in terms of construction, if not concept) gearbox. Unsurprisingly, that's Torotrak's preference, given the firm's huge investment in its torque-controlled 'variator' and associated technologies. Certainly, together these are capable of delivering ultimate precision launch and manoeuvring control, as well as fuel economy throughout the drive cycle - including on downsized engines.

## INFINITE VARIETY

That's why, as Torotrak chief technology officer Doug Cross says, IVTs are on the up. "Everything from 80-270bhp is available, with Van Doorne now making around 3 million units per year for the Chinese car market alone," he notes.

However, Torotrak has fully and exclusively licensed its heavier-duty IVT to fully-automatic gearbox giant Allison Transmission - initially for bus and coach, but almost certainly also for mid-

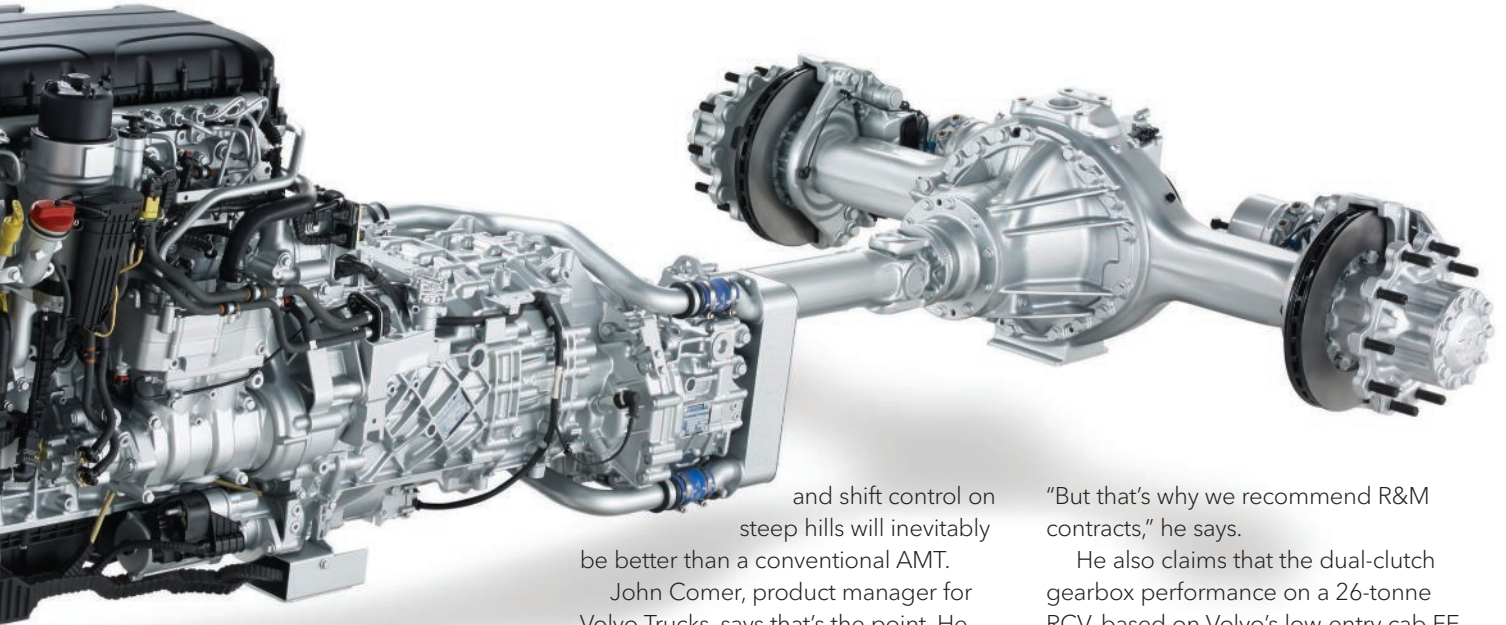
range and urban, stop-start heavy truck applications, such as RCVs (refuse collection vehicles). So, since that company is tight lipped on the subject, we're going to have to wait and see what emerges.

But there are other developments already in the here-and-now that go way beyond currently dominant AMTs (automated manual transmissions) and even advanced torque converters, which are seeing success in RCV and bus applications. Mike Savage (left), chief engineer at transmission and axle development specialist Drive System Design, points to dual-clutch systems.

"Eaton's new Precision DCT [dual-clutch transmission], for example, is aimed at winning market share from Allison, which dominates the US Class 8 vocational circa 1,000Nm torque truck sector," observes Savage. "The system was launched at last year's IAA show [in Germany] and a lot of development work was done with support from European and UK business units. So there's no reason why it shouldn't come over here and also compete with the likes of ZF's AS-Tronic AMT," he adds.

However, Eaton's focus is initially on North America and volume production is only just starting. So, while it might be





attractive for medium-duty trucks, we're not there yet. Savage describes dual-clutch systems as good for stop-start driveability and low-shock shifting, at least in city and urban environments on vehicles up to, say, 26 tonnes. But he wonders about their value elsewhere, raising his eyebrows at Volvo's iShift Dual Clutch on the big FM. "On a 400–500bhp truck, which spends most of its time on long-distance haulage, the fuel advantages must be marginal," he argues. "And there are efficiency trade-offs with the idling clutch – although much less than on a torque converter." That said, he concedes that driveability

and shift control on steep hills will inevitably be better than a conventional AMT.

John Comer, product manager for Volvo Trucks, says that's the point. He accepts that the industry is somewhat wary, and not only over the £3,000 on-cost, but says: "The benefits in hilly terrain – smooth changes and no break in torque – are phenomenal. Early adopters in Ireland, for instance, are seeing 3% fuel improvements and better productivity because of their trucks' ability to climb hills faster."

#### DUAL CLUTCH

Clearly, operators trunking through the Alps and Pyrenees would benefit even more. Nevertheless, Comer agrees that, although the dual-clutch system requires no more attention than a conventional set-up, maintenance does demand special tools and specialist knowledge.

"But that's why we recommend R&M contracts," he says.

He also claims that the dual-clutch gearbox performance on a 26-tonne RCV, based on Volvo's low-entry cab FE, rivals that of Allison's industry-preferred torque converter. "We would recommend a 2412 iShift DC [12-speed, 2,400Nm] as a direct top solution. But there's also an overdrive version to match hub reduction applications typically on FM and FH trucks in heavy haulage, which gives the right balance of torque to the rear axle plus fuel economy."

What about those Allison fully automatics? Marketing manager Manlio Alvaro is keen to stress that the latest iterations are more than mere torque converters. He points to the xFE six-speed transmission, launched earlier this year, which has already demonstrated a 7% fuel economy improvement on

### Conventional considerations

If you're ordering a truck for something different, mention it to the dealer. That's the advice from DAF marketing manager Phil Moon. "Over the years, we've moved to taller gearing to improve fuel economy, with boosting to hold high gears on hills while also delivering low-end torque," he says. But that doesn't mean the common 2.64:1 ratio for a direct top gearbox is the automatic choice.

"Dealers normally look for a combination that puts the engine at cruising speed in the heart of the green band at 90kph. But they can optimise your truck against vehicle type, engine rating, tyres, payload, the terrain, etc." And he adds that DAF dealers use its Topex software to fine tune everything.

Moon also advises that the advent of Euro 6 coincided with improved clutch control on AS-Tronic AMTs, as well as fine manoeuvring control and fast shifts in the top two ratios to maintain momentum. And he points to DAF's and other OEMs' software variants, mainly for vocational trucks such as tipper, heavy haulage and bulk liquid transport. "For tankers, the software selects a taller gear for launch to reduce liquid movement, but also engages the brakes for longer

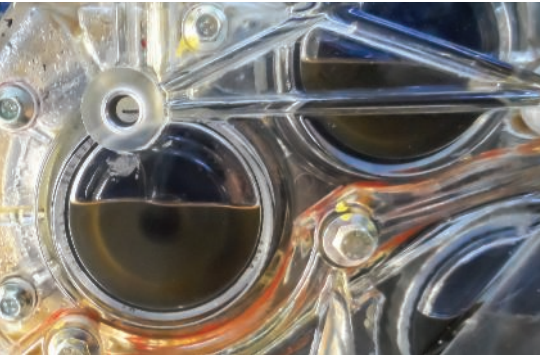
when the vehicle comes to a halt, to prevent surges from pushing it forward."

Iveco product director Martin Flach echoes these thoughts, and reminds transport engineers that they, or the dealer, also need to specify the gearbox torque. "We offer several ZF Eurotronic AMTs, starting at the 12AS1402 [12-speed, 1,420Nm nominal torque limit] direct-drive box, and going all the way up to the 2330 direct-drive and 2530 [2,530Nm] overdrive. Then the 16-speed boxes start at 16S1620 direct-drive for the Cursor 9 engine, moving on to the 1420 to 2320 for Cursor 11 and 2320 to 2530 overdrive for Cursor 13."

Much the same applies to the rear axle: there's a choice of 16 rear axle ratios on the Stralis alone. "Too many people don't think about the impact of their operations on the rear axle. A few years ago we built some vehicles for a customer in Yorkshire. The gearbox and engine were fine, but he specified a long rear axle ratio. The geared speed in first was too fast for slow-speed manoeuvres and the Yorkshire hills. A six-speed AMT might have been okay with a slower rear axle, or a combination with the nine-speed box." Be warned.

***"It's a bit of a black art ... but we are developing solutions that could cost pence, yet save thousands of pounds"***

Mike Savage



severe-duty city buses compared to the previous generation. And that's over and above Allison's FuelSense intelligent shifting software.


"It's because we have extended the new transmission's lock-up clutch operation to include more of the second

gear range and a period in first," he explains. The result is more torque, but, most importantly, reduced efficiency losses in city buses' critical launch gears. And he adds that the unit also triggers higher ranges at lower engine speeds.

Three versions will be available for Europe, with capacity up to 1,450Nm and 360bhp. "The current xFE is approved for city bus applications but over time we will evaluate its behaviour for other applications, such as urban trucks, which show similar profile requirements," says Alvaro. And, given that production is due to start in Hungary in Q1 2016, that might be sooner, rather than later.

As for the future, Savage suggests

focusing on Volvo and ZF. "Volvo has a parallel hybrid transmission for its buses that could be dropped into city and urban trucks at a moment's notice. And ZF showed similar components, with a flywheel mounted to an electrical machine, at last year's IAA."

Meanwhile, Drive System Design presented a paper at the 2014 CTI Symposium, in Berlin, on designing conventional gearboxes for improved efficiency by rethinking lubrication flows. "It's all about using the gears as pumps to lift and distribute oil in a controlled manner while reducing energy losses. It's a bit of a black art ... but we are developing solutions that could cost pence, yet save thousands." 



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