



Might 2012 be the year that full toroidal variator technology takes its place in the commercial vehicle transmission big league? Brian Tinha reports

Turning the toroid

Even as the transport sector increasingly changes over to AMTs (automated manual transmissions) in favour of manuals – for a wide range of applications and for good, solid economic driveability and engineering reasons – the gearbox landscape is moving on.

And it's not just about a potential resurgence of good old torque converter autos beyond their heartland of construction vehicles, buses, RCVs and military vehicles. Yes, we know of Allison Transmission's current auto reengineering work, with its TC10 10-speed twin countershaft (instead of the usual planetary gears) torque converter, due for launch later this year. Allison has high hopes of pushing back AMTs in the mainstream long-haul sector with this beast.

But it also has its eyes elsewhere – on an entirely separate gearbox project with full toroidal variator (see later) specialist Torotrak. And the organisation is taking this work very seriously.

Late last year, Allison and Torotrak announced that they had entered a new phase in their multi-stage CVT (continuously variable transmission) gearbox development programme, with concept hardware performance targets having been achieved. Then the pair said that, having completed

knowledge transfer from Torotrak to Allison, the latter was ready to lead this project towards real product, with the former providing technical support.

"Our completion of a substantial proof-of-concept programme with Allison allows the programme to enter the next phase, proceeding to production-representative hardware," stated Torotrak commercial director Jeremy Deering.

It appears that CVT technology – with all its potential advantages, in terms of seamless gearing – is nearly ready to move out of theory and into hard-nosed practice. And that's way beyond the lawn tractor market, where it currently languishes. A power transmission concept first envisaged around two centuries ago is almost there for large vehicles.

In brief detail, Torotrak's variator gets away from conventional stepped gearing ratios by harnessing a combination of pairs of power input and output discs, mounted on a single shaft and in close contact with guided rollers sandwiched between them. The space dividing each disc pair forms a convex doughnut shape (toroid), so the rollers vary the output disc speed and torque according to their angle of precession – and also hence also the effective gear ratio and power.

Making this work is a mechanical control system that not only supports each roller, but also steers it

across the disc face via a single connection point, with applied force determining output disc speed. The rest is about the geometry of the variator itself, the number of rollers (normally two or three per toroidal cavity, depending on power density and cost requirements) and materials of construction – nothing more sophisticated than bearing and gear steels. The final factor is its synthetic traction fluid, which transmits power between the discs and rollers by turning highly viscous under compression.

So much for the variator itself. Putting it to work on commercial vehicles then entails adding a power split shunt, with a mechanical epicyclic gear train providing a second (direct) power transfer path, and clutches allowing multiple sweeps of the variator across the speed and torque range.

As for cost/benefits, compared with conventional transmissions, Torotrak R&D director Steve Murray suggests that vehicles will get all the efficiency of manuals and AMTs, but without the disadvantages of clutch wear and power loss between shifts.

“With Torotrak, there aren’t interruptions that allow the engine to fall off boost, which is a real benefit when a truck needs to work at full load,” he states.

“Additionally, given that engine speed stays in the maximum efficiency rpm range, operators can expect significantly improved fuel economy and



The full toroidal variator transmission: set to tackle conventional gearboxes?

reduced CO₂ emissions. And, finally, Torotrak has a very high overdrive, because the variator ratio can be used several times.”

What about pricing? Murray is coy: “Manuals and conventional automatics are well established and fully cost reduced. We won’t get to the same cost level as automated manuals initially. But automatics are more expensive and we’re extremely cost competitive on that front.” ^{TE}

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