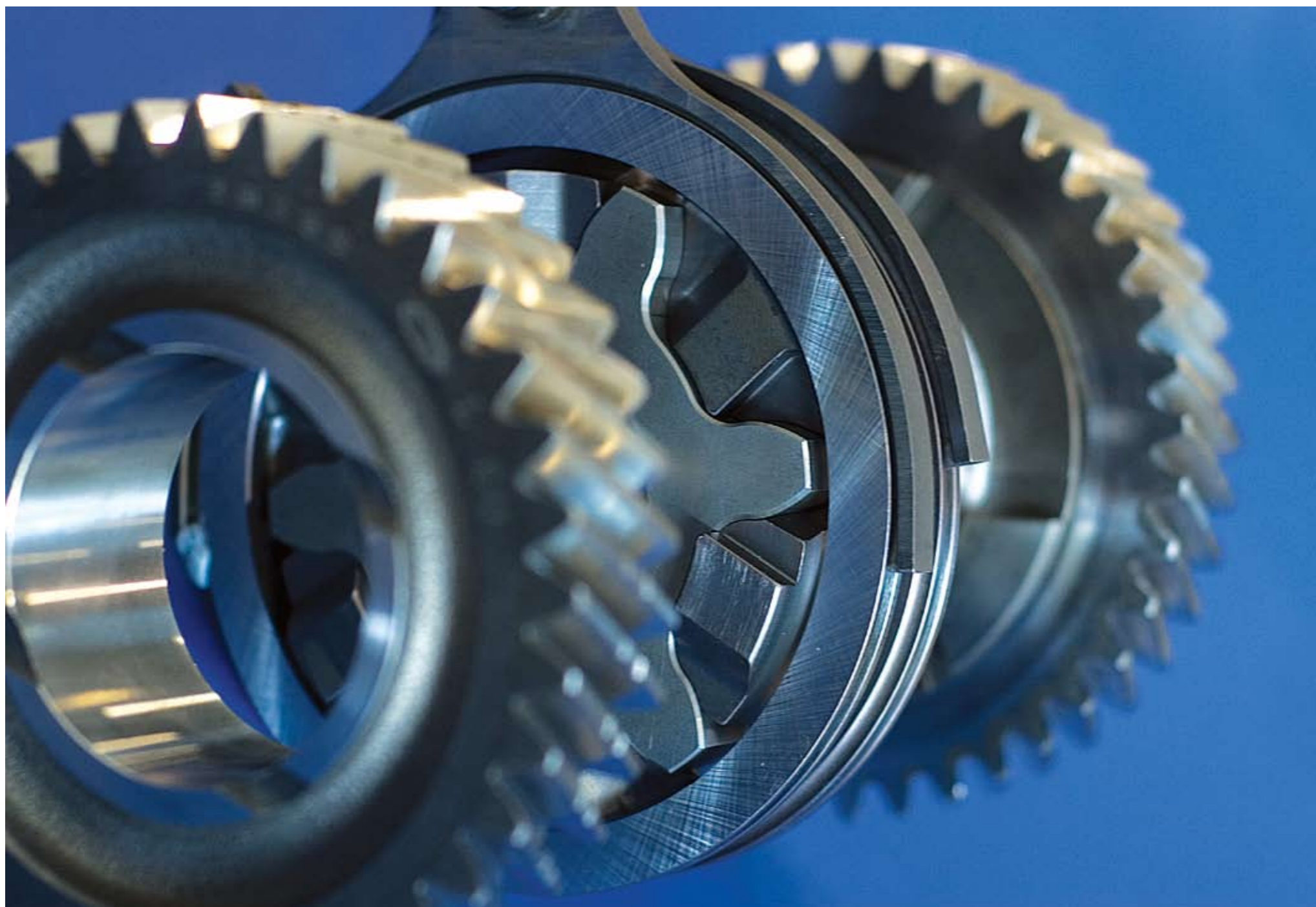


Radical shift

A new, heavy-duty version of Zeroshift's transmission will provide truck and bus operators with a competitively-priced alternative to traditional automatics.



Above: Zeroshift's heavy-duty transmission is currently being tested in a Jaguar. Test feedback will help optimise the design before a near-production version is built and fitted to a CV for demonstration to potential customers.

Above right: Zeroshift's new 12,000 square foot facility in Milton Keynes, UK.

Left: Unlike conventional AMTs, the Zeroshift system changes gear with no torque interruption, providing improved performance and refinement.

The cost and performance issues traditionally associated with gearbox choice in commercial vehicles is being addressed by a new technology developed by British award-winning innovation company Zeroshift. Following the launch of its second-generation transmission for passenger cars and light vans, the company is working on a heavy-duty version of its affordable automatic transmission technology. As well as reducing capital investment for operators choosing a fully automatic transmission, the system will improve fuel economy and refinement, reduce emissions and provide smooth gear-changing with zero torque interruption.

"The CV and off-highway industries currently have to choose between compromises," explains managing director Bill Martin. "Manual boxes are compact, robust, cheap and efficient but can be tiring to use and will deliver poor fuel economy and emissions if used incorrectly. Maintenance and down-time costs can also be high. Automated Manual Transmissions (AMTs) provide automated shifting, improved productivity and useful electronic control, but manoeuvrability and refinement can be poor and maintenance and down-time costs can be high. Sophisticated planetary automatics address most of these issues and further reduce driver fatigue, but capital costs, fuel economy and packaging are compromised."

Martin believes that Zeroshift technology provides the best features of each gearbox type. "Operators will be able to specify a gearbox with the smoothness and productivity benefits of a fully automatic transmission with the attractive price and packaging benefits of an AMT," he says. "We've already presented the technology to manufacturers of trucks, buses and off-highway vehicles and the response is extremely favourable."

Proven technology

Zeroshift tech replaces the synchromesh found in a conventional gearbox with pairs of interlocking rings, each incorporating three drive elements in a single forged component. Shift forks are operated by electrical, hydraulic or pneumatic actuators to suit vehicle architecture. The electronic control system, also developed and calibrated by Zeroshift, coordinates gearshift actuation, engine management and clutch operation to provide full control of the driveline



"Initial response from heavy vehicle manufacturers to Zeroshift technology has been extremely favourable."

Bill Martin

during gear shifting.

When shifting from neutral, ring one is engaged by a shift fork to take up drive while ring two is engaged within a few degrees of revolution to take up backlash. The next shift is made with ring two taking up the drive and ring one taking up the backlash. As ring two is unloaded during the change, it requires less than one-20th the axial force required by a conventional synchro-mesh. Shift forces can be as low as 40N compared with typically 1000N for a conventional AMT. These very low forces mean that all components can be manufactured from proven lightweight materials with no additional surface treatment.

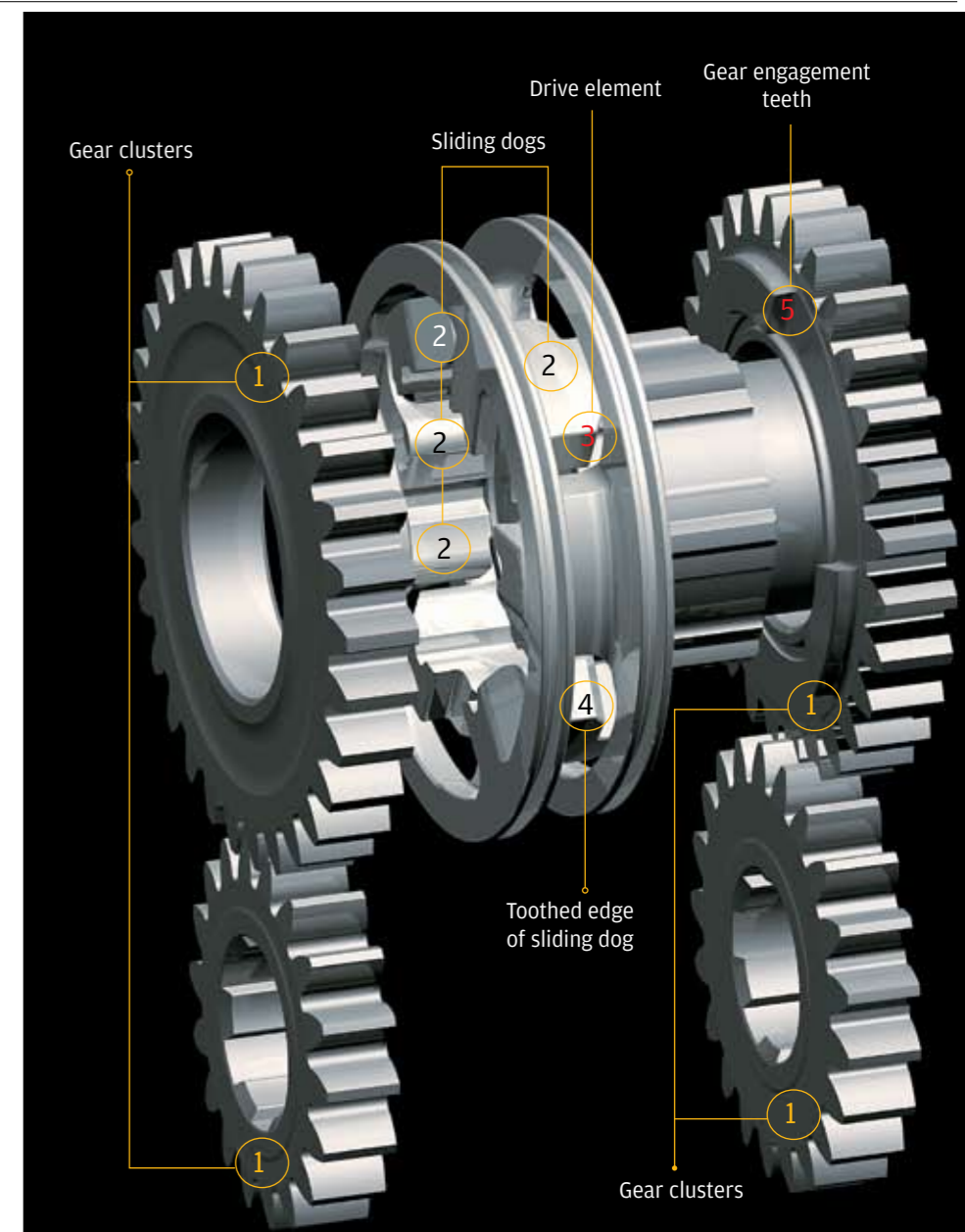
Unlike conventional AMTs, the Zeroshift system changes gear with no torque interruption, providing improved performance, refinement and comfort. The company estimates that, in a typical mixed drive cycle, the system should also generate a fuel economy saving of at least five percent compared with a typical planetary automatic. Zero torque interruption allows either improved acceleration or engine downsizing, leading to further emissions and fuel economy gains. The Zeroshift transmission is less expensive to manufacture than a sophisticated planetary automatic and the shift mechanism can be built into an existing manual gearbox so it can be assembled on the related manual transmission production lines. "The cleverness of the Zeroshift transmission is in the design innovation and the control systems," says Martin. "For an established manufacturer of manual gearboxes, it is an extremely affordable way to offer a high-quality fully automatic transmission."

Optimised for heavy-duty applications

For heavy-duty applications, extensive CAE analysis has been used to validate new ring architectures that use proven, volume production materials to deliver reliability beyond one million kilometres. Additional control channels provide the ability to integrate features such as safety cut-outs and Power Take-Offs, which can be engaged smoothly while the vehicle is moving.

The transmission allows power-on gearshifting including forward to reverse, providing a 'shuttle' capability and making it ideal for applications such as quarrying and construction where vehicle productivity can have a substantial impact on overall site efficiency. Zero torque interruption ratio changes make acceleration very smooth, eliminating the 'nodding head' effect associated with manual and traditional AMT transmissions, making it ideal for bus applications. Sophisticated electronic control allows the integration of application-specific features and provides creep and hill-hold facilities.

Martin also believes that the Zeroshift transmission will make automatics attractive in the highly price-competitive LCV sector, from light vans up to around 7.5 tonnes. "Automatics can bring significant benefits to this sector, particularly when used in pick-and-drop applications, but so far the cost of planetary gearboxes has been too high and the controllability of AMTs has been too poor to achieve significant uptake. Zeroshift technology could change this." ■



TUTORIAL SEAMLESS-SHIFT AT WORK

The first generation Zeroshift transmission was pneumatically operated and used six drive elements – specially contoured metal 'bullets' – to engage and disengage the drive gears in a similar manner to dog clutches, replacing the synchro-mesh found in a conventional gearbox.

In the second generation system, these have been replaced by a pair of interlocking rings, each incorporating the three drive elements in a single forged component and operated by shift forks.

When shifting from neutral, ring

one is engaged to take up drive while ring two is engaged within a few degrees of revolution to take up backlash. The next shift is made with ring two taking up the drive and ring one taking up the backlash. As ring two is unloaded during the change, it requires less than one-twentieth the axial force required by a conventional synchro-mesh. The control system, also developed and calibrated by Zeroshift, coordinates gearshift actuation, engine management and clutch operation to provide full control over the driveline during gear shifting.

Refinement and durability have been further improved through careful design of the working surfaces. One side of the drive element has a retention angle to take up the drive, while the opposite side has a ramp face to smoothly disengage drive.

At this point, we're in two gears at once and the 'box ought to be destroying itself. Instead, the higher gear spins faster and its 'clamping force' on the previous gear's bullets dissipates, leaving it free to move away under the spring's power.