

# MAHLE Powertrain Transmissions Design and Development

Innovative Gear Development & Production

Specialist Testing of eMachines

Comprehensive Customer Support



Compact 4-Speed  
Transmission

## MAHLE Powertrain Transmissions Design & Development

Vehicle transmission systems transfer rotary energy from the motive power source to the driven wheels, irrespective of how the energy is generated. Forward and reverse motion is also enabled by the transmission using additional gear sets whilst a clutch allows a smooth transition of power during pull-aways and also complete disengagement to allow engine idle when stationary. Automatic and 'double clutch' transmissions are now in widespread use allowing vehicle developers to control the engine speed and therefore the emissions and fuel economy more closely, and also providing a more comfortable driver experience.

Electric vehicles, or hybrids with pure electric drive, do not require such a wide range of fixed ratio gears within the transmission, as their electric traction motors are capable of a much greater range of operating speeds, but reduction gears are often still required to match optimum motor speed with road speed. Electric motors provide maximum torque output from zero which then gradually decreases with speed, so the transmission gears must be designed with this in mind.

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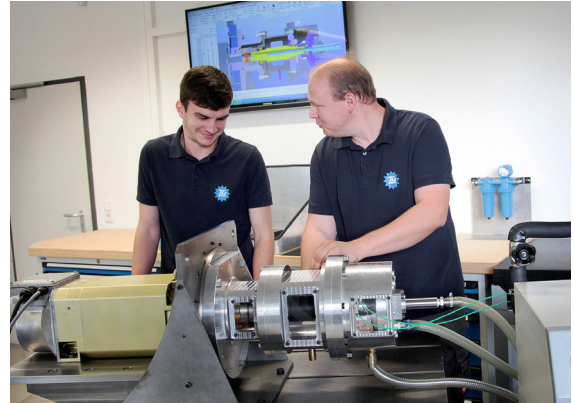
[www.mahle-powertrain.com](http://www.mahle-powertrain.com)

#### Design Process & PlanGear software solution

The initial concept design for a new transmission system involves a complex, iterative process to establish the number of ratios required, the arrangement of the gear shafts, bearings and control elements, the maximum speeds and loads to be managed and the package constraints. MAHLE ZG Transmissions has developed very powerful 'PlanGear' software in-house which generates and evaluates all possible gear configurations to fulfil the required criteria. This fully-automated gear synthesis approach is applied for automatic, dual-clutch and hybrid gears consisting of any number of shafts, spur gear stages and planetary gear sets. The 'PlanGear' programme quickly provides output in the form of a visual display showing the gear mechanics, switching matrix, load capacity matrix and corresponding ranking to allow critical design decisions to be made at an early stage in the project.

#### Transmission Design & Development Services

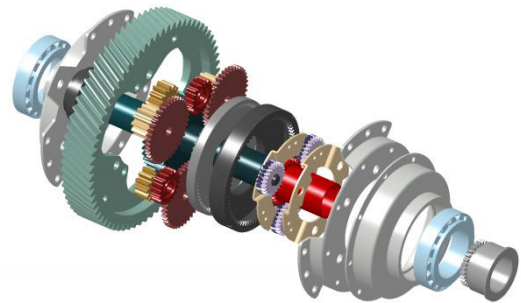
- Gear Synthesis
- Gearing Calculations
- Spur & Helical Gears
- Bevel and Hypoid Gears
- Special Gears
- Gear Construction
- Housing Construction
- Prototype Manufacture
- Component Testing
- Failure Analysis
- Consulting



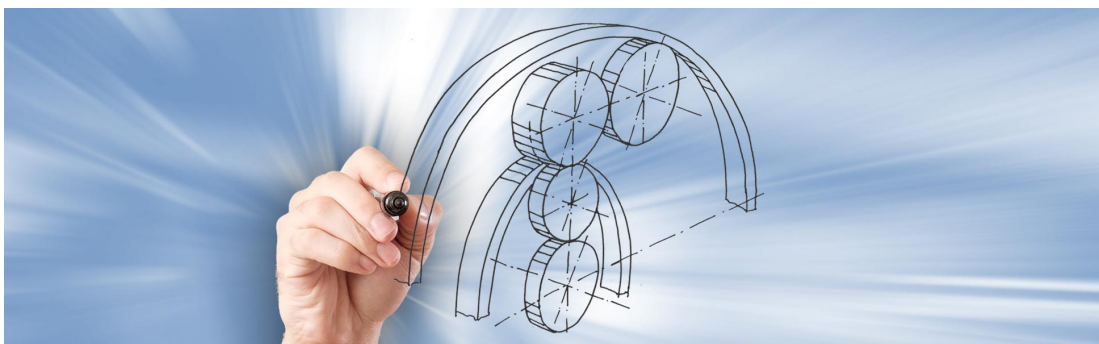
>> Modular Test Rig

#### PlanGear process

The detailed design process is based on the output from the 'PlanGear' programme which includes automatic dimensioning of the gears. A high resolution 3D CAD model is then created along with a complete set of drawings for all the gear components, shafts, bearings, switching elements and the housing. The model is then meshed into finite elements for stress, fatigue and NVH analysis.



Front Differential



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