

# MAHLE Powertrain Transmissions Design & Development

- > Innovative Gear Development & Production
- Specialist Testing of eMachines
- Comprehensive Customer Support



## 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.



>> Compact 4-speed transmission

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# MAHLE Powertrain

## Transmission Design & Development

### Design Process

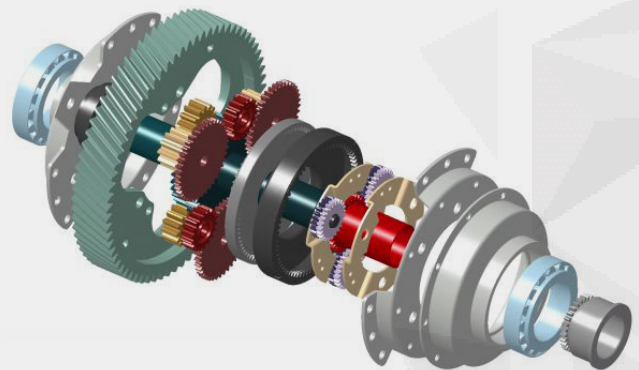
- In-house development of powerful 'PlanGear' software solution
- Fully-automated gear synthesis approach
  - › Generates & evaluates all gear configurations to meet required criteria
  - › Applied for automatic, dual-clutch & hybrid gears
  - › Consists of any number of shafts, spur gear stages & planetary gear sets
- 'PlanGear' provides visual display output showing:
  - › Gear mechanics
  - › Switching matrix
  - › Load capacity matrix
  - › Corresponding ranking
- Allows critical decisions to be made at an early stage in the project



>> Modular test rig

### PlanGear Program

- Process is based on output of the 'PlanGear' programme
  - › Automatic dimensioning of gears
  - › Creation of high resolution 3D CAD model
- Complete set of drawings for all gear components
  - › Shafts
  - › Bearings
  - › Switching elements
  - › Housing
- Model meshed for finite element analysis
  - › Stress
  - › Fatigue
  - › NVH



>> Front differential



### 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

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MAHLE product information 05/2022

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