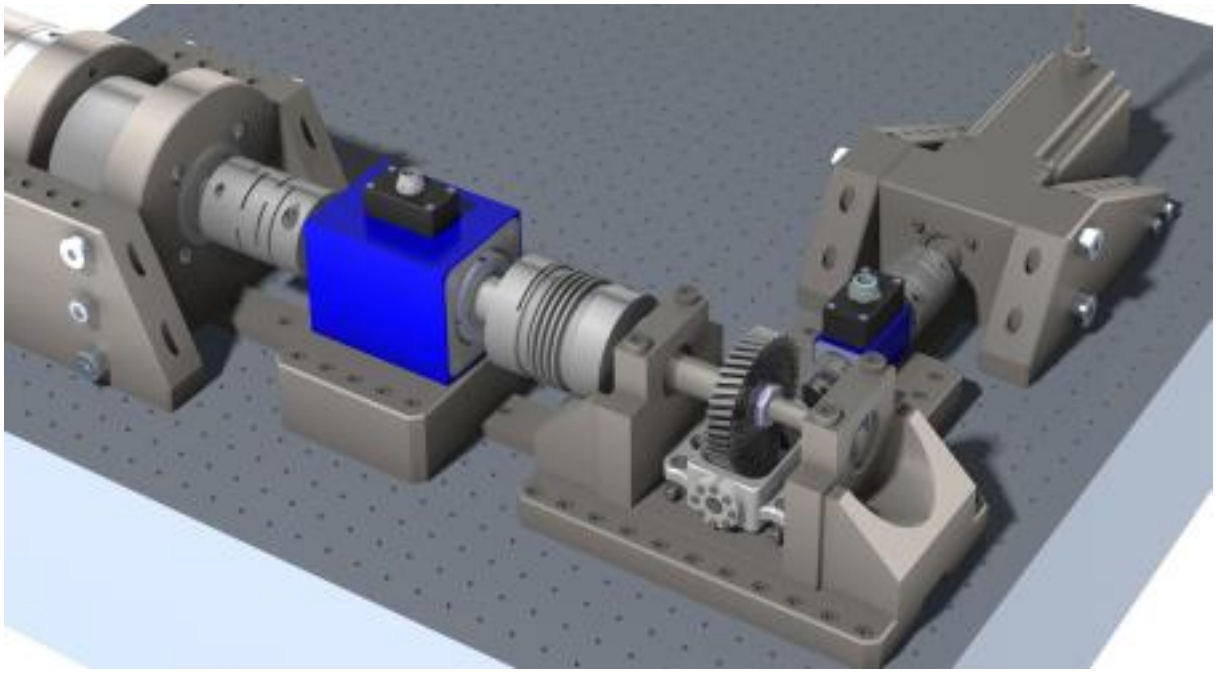
Manufacturing lightweight worm gearboxes efficiently: with profile rollers and 3D printing

About this project



WormGear4_0

Manufacturing lightweight worm gearboxes efficiently: with profile rollers and 3D printing

Markets:

Material: Glass fibres, Carbon fibres, Thermoplastics, Steel, Glass-fiber reinforced plastics (GFRP), Carbon-fiber reinforced plastics (CFRP)

This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Energy.

Technology Transfer Program Leichtbau

Manufacturing lightweight worm gearboxes efficiently: with profile rollers and 3D printing

About this project

Context

Worm drives transmit rotary movements via a helical shaft - the worm - to a gear wheel. They enable large transmission ratios in a small installation space and transmit forces reliably, even if they are subjected to permanent loads. This is why vehicle manufacturers often use worm gears in auxiliary drives and adjustment mechanisms, for example in steering, seat or flap systems.

With increasing requirements for CO# reduction, material efficiency and cost-effectiveness, the production and operation of these components are becoming more and more important. Today, many worms and gears are still produced using machining processes - with high material loss, energy-intensive machining and additional costs for chip treatment and cooling lubricants.

Forming processes and additive manufacturing can replace machining process chains where they are particularly resource-intensive. In this way, lightweight construction potential can be realised not only on the component, but also in production. At the same time, companies need new concepts for quality assurance because modern processes require different process windows, measurement parameters and inspection scopes.

Purpose

The team in the WormGear4_0 research project is developing a resource- and energy-efficient production process for high-performance lightweight worm gears. Two gear components are at the centre of the project. The team produces a steel worm in a cold state by profile rolling into the full material, using two externally toothed round roller tools. In addition, a lightweight counter gear made of fibre-reinforced plastic is produced additively.

The participants are testing the components for applications with high requirements in terms of load capacity, efficiency, noise behaviour and service life. At the same time, they want to deliver measurable ecological effects: less material usage, lower process-related emissions, less waste and stable process control with minimised rejects. The project team is also transferring the results to other fields of application, such as mechanical engineering.

Manufacturing lightweight worm gearboxes efficiently: with profile rollers and 3D printing

About this project

Procedure

Firstly, the researchers define a reference gear stage and derive requirements for geometry, surface, load-bearing capacity, efficiency and acoustics. Based on this, they develop the rolling process for the worm contour, including tool design, process parameters and strategies for error avoidance. At the same time, the team is optimising the additive manufacturing of the fibre-reinforced counter wheel, using internal structures that are suitable for the load and designing the structure specifically for lightweight construction and load-bearing capacity.

The participants then produce prototypes of both components, test them under defined load conditions and test their operational capability in the system. Data-based process monitoring is a central component: sensors record relevant signals, AI methods recognise deviations and link process data with component quality. On this basis, the participants also adapt the end-of-line testing, reduce testing effort and rejects and create quality assurance close to series production.





Funding duration:

Funding sign:	03LB3072	**Funding amount:**	EUR 1.4 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3072A - WormGear4_0 in the federal funding catalogue

Manufacturing lightweight worm gearboxes efficiently: with profile rollers and 3D printing

Project coordination

Contact:

Mr Matthias Kirner

+49 0771 8507-402

matthias.kirner@imsgear.com

Organisation:

IMS Gear SE & Co. KGaA

Heinrich-Hertz-Straße 16
78166 Donaueschingen
Baden-Württemberg
Germany

www.imsgear.com

English (EN){{ Projektpartner }}

Lightweighting classification

	Realisation
Offer	
Products Parts and components	✓
Services & consulting Engineering, Prototyping, Simulation	✓

Manufacturing lightweight worm gearboxes efficiently: with profile rollers and 3D printing

Lightweighting classification

	Realisation
Field of technology	
Design & layout Lightweight manufacturing, Hybrid structures	✓
Functional integration	
Measuring and testing technology Others (Process analysis of plastic injection moulding)	✓
Modelling and simulation Loads & stress, Optimisation, Processes, Structural mechanics	✓
Plant construction & automation Others (Test bench setup for worm gearboxes)	✓
Recycling technologies	
Manufacturing process	
Additive manufacturing 3D printing	✓
Coating (surface engineering)	
Fibre composite technology	
Forming Rolling	✓
Joining Adhesive bonding, Screwing	✓
Material property alteration Heat treatment	✓
Primary forming	
Processing and separating Grinding	✓
Textile technology	

Manufacturing lightweight worm gearboxes efficiently: with profile rollers and 3D printing

Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Glass-fiber reinforced plastics (GFRP), Carbon-fiber reinforced plastics (CFRP)	✓
Fibres Glass fibres, Carbon fibres	✓
Functional materials	
Metals Steel	✓
Plastics Thermoplastics	✓
Structural ceramics	
(Technical) textiles	