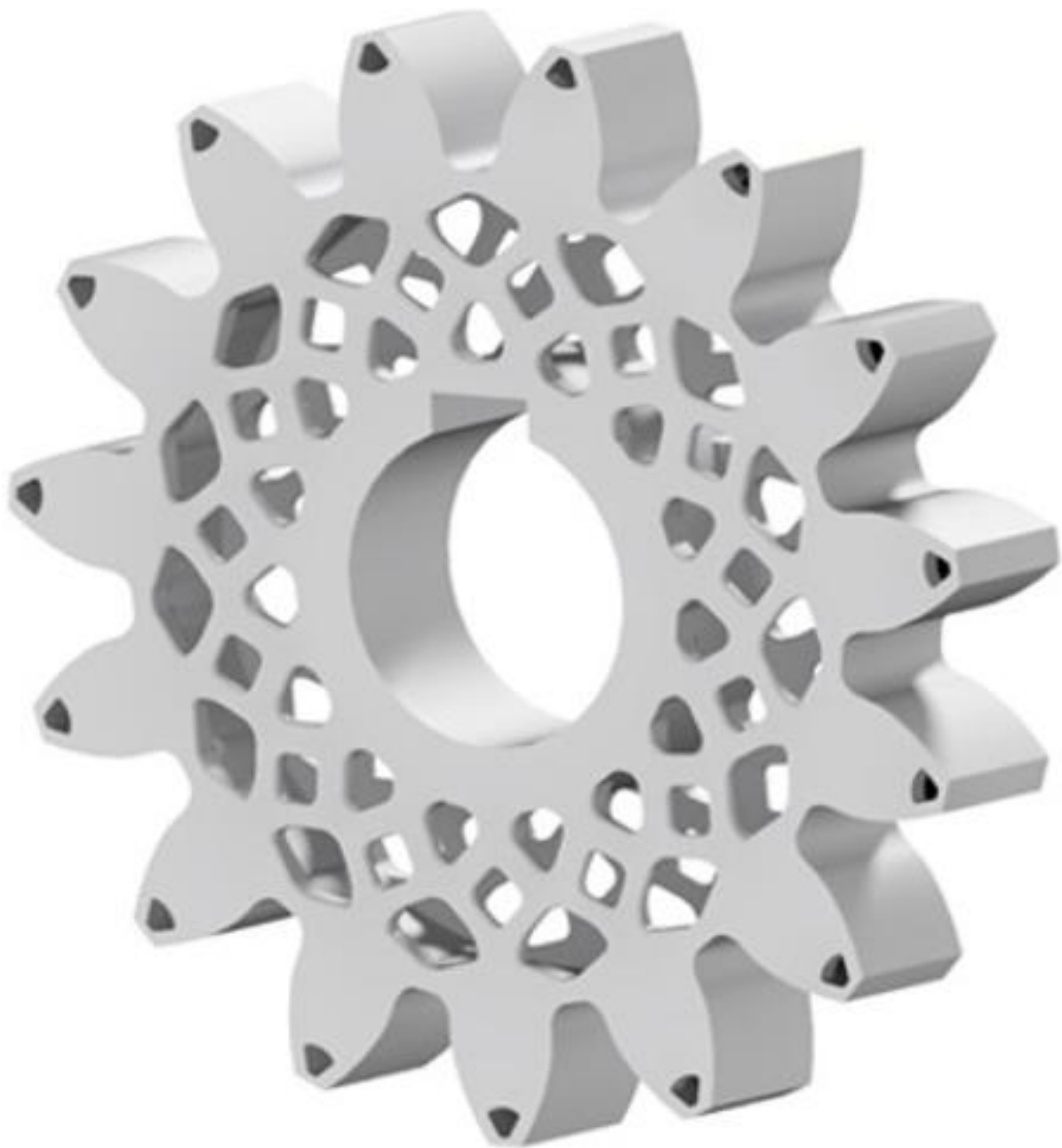


Developing lighter gearboxes for wind turbines: with bionics and innovative sensors

About this project



FlexGear

Developing lighter gearboxes for wind turbines: with bionics and innovative sensors

About this project

Developing lighter gearboxes for wind turbines: with bionics and innovative sensors

Markets:



Material:

Steel

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

[Technology Transfer Program Leichtbau](#)

Context

Wind energy plays a key role in the energy transition and is already making an important contribution to German electricity production. In order to achieve the climate targets, the expansion of powerful wind turbines is being driven forward. However, as output increases, so do the dimensions of the turbines, especially the gearboxes, which are key components that require considerable quantities of materials. This increases costs and worsens the carbon footprint of the turbines. In addition, the higher weight of the gearboxes increases the loads on the nacelle and tower, which further increases the material requirements of the entire system.

Previous lightweight construction approaches for gears have mostly been limited to the base body and offer weight savings of up to 45 per cent. This is where the FlexGear project comes in with a comprehensive lightweight construction concept: With bionically inspired structures that extend into the gear rims and innovative manufacturing technologies, the researchers aim to achieve weight savings of up to 65 per cent for gears.

Developing lighter gearboxes for wind turbines: with bionics and innovative sensors

About this project

Purpose

The scientists' main goal is to develop a highly optimised lightweight gearwheel with flexible structures. Their approach is based on bionic design principles that minimise the use of materials while maximising stability. The team is not only looking at the gear wheel base body, but also the gear rims, which will enable them to realise additional weight savings.

Another key element is the inside-sensing system, which is integrated directly into the gear structure. The researchers use this system to record loads and deformations in real time and transfer the data to a condition monitoring system. This enables the proactive compensation of load peaks, which not only increases operational reliability but also avoids the need to oversize the systems. FlexGear thus aims to improve the service life and efficiency of wind turbine gearboxes while reducing CO₂ emissions during both production and operation.

Procedure

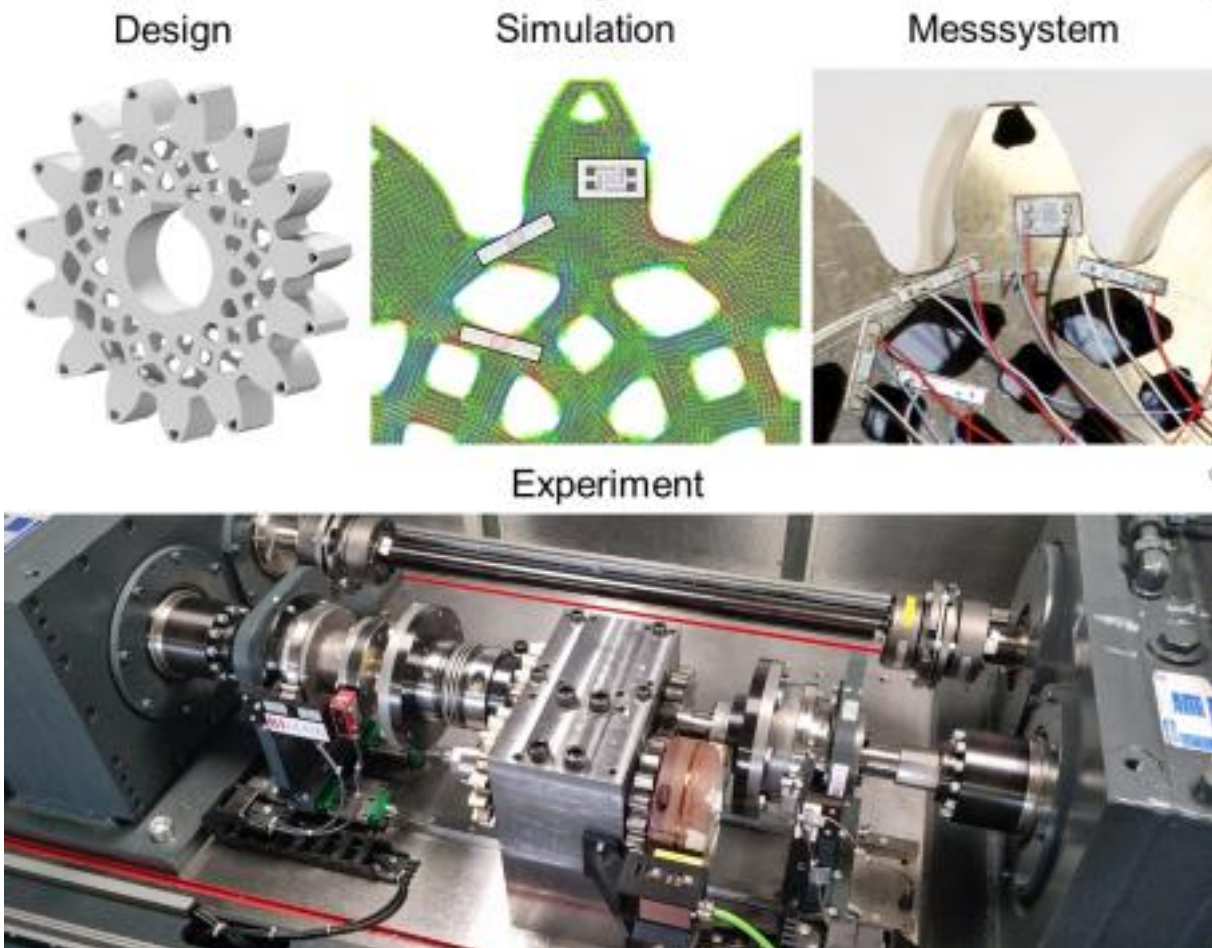
Firstly, the researchers are developing bionic designs based on natural models such as diatoms. These microorganisms are characterised by their minimal material structures with maximum stability. Using the ELiSE process (Evolutionary Light Structure Engineering), they develop optimised structures that are flexible enough to compensate for load peaks.

To manufacture the gears, the team uses additive manufacturing processes that enable the realisation of highly complex geometries. This technology also makes it possible to integrate sensors directly into the gearwheel. To this end, the researchers are developing an inside sensing system based on thin-film technology. It measures loads and deformations directly inside the gearwheel and transmits the data in real time to a condition monitoring system that recognises and compensates for critical load peaks.

Finally, the team tests the gears on a specially designed test bench under realistic loads in order to check both their structural properties and the functionality of the sensor system. In order to assess the actual mass savings and mechanical load capacity, the researchers compare the demonstrator with conventional gearwheels. At the same time, the bionic design process is being automated so that the knowledge gained can be transferred to other applications in the future.

Developing lighter gearboxes for wind turbines: with bionics and innovative sensors

About this project



Funding duration:

Funding sign:

03LB1000

Funding amount:

EUR 919 thousand

Final report

Further websites

foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB1000A - FlexGear in the federal funding catalogue

Developing lighter gearboxes for wind turbines: with bionics and innovative sensors

Project coordination

Contact:

Mr Prof. Dr.-Ing. habil Andreas Fischer

+49 0421 218-64600

andreas.fischer@bimaq.de

Organisation:

University of Bremen

Linzer Str. 13
28359 Bremen
Bremen
Germany

☐ www.bimaq.de/



English (EN){ { Projektpartner } }



ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG



Lightweighting classification

Realisation

Offer

Products

Parts and components, Software & databases



Services & consulting

Engineering, Prototyping, Validation, Simulation



Developing lighter gearboxes for wind turbines: with bionics and innovative sensors

Lightweighting classification	
	Realisation
Field of technology	
Design & layout Lightweight design	✓
Functional integration Sensor technology	✓
Measuring and testing technology Component and part analysis, Non-destructive analysis	✓
Modelling and simulation Loads & stress, Optimisation	✓
<i>Plant construction & automation</i>	
<i>Recycling technologies</i>	
Manufacturing process	
Additive manufacturing Selective laser melting (SLM, LPBF, ...)	✓
<i>Coating (surface engineering)</i>	
<i>Fibre composite technology</i>	
<i>Forming</i>	
<i>Joining</i>	
<i>Material property alteration</i>	
<i>Primary forming</i>	
<i>Processing and separating</i>	
<i>Textile technology</i>	

Developing lighter gearboxes for wind turbines: with bionics and innovative sensors

Lightweighting classification	
	Realisation
Material	
<i>Biogenic materials</i>	
<i>Cellular materials (foam materials)</i>	
<i>Composites</i>	
<i>Fibres</i>	
<i>Functional materials</i>	
Metals	✓
Steel	
<i>Plastics</i>	
<i>Structural ceramics</i>	
<i>(Technical) textiles</i>	